EPIDEMIOLOGY OF INJURIES IN ELITE MALE AND FEMALE FUTSAL: A SYSTEMATIC REVIEW AND META-ANALYSIS

Data sharing statement

The codebook can be obtained from the corresponding author on request.

ABSTRACT

The main purpose of this study was to conduct a systematic review and meta-analysis quantifying the incidence of injuries in futsal players. A systematic search was conducted using MEDLINE, PubMed, Web of Science and Scopus databases and subsequently six studies (14 cohorts) were selected. Two reviewers independently extracted data and assessed trial quality and risk of bias using the Strengthening the Reporting of Observational Studies in Epidemiology statement and Newcastle Ottawa Scale, respectively. Quality of evidence was also determined using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach. Separate meta-analyses for male and female players were conducted using a Poisson random-effect regression model approach. The overall and match incidence rates in elite male futsal players were 6.8 (95% CI = 0.0 – 15.2) and 44.9 (95% CI = 17.2 – 72.6) injuries/1000 hours of exposure. Pooled training injury rate in male players was not calculated due to the lack of studies reporting training injuries in this cohort. For females, an overall, training and match incidence rates of 5.3 (95% CI = 3.5 - 7), 5.1 (95% CI = 2.7 - 7.6) and 10.3 (95% CI = 0.6 - 20.1) injuries/1000 hours of exposure were reported. In males, match incidence rate in International tournaments was 8.5 times higher than in national leagues (77.2 [95% CI = 60.0 - 94.5] vs 9.1 [95% CI = 0.0 – 19.3] for international tournaments and national leagues, respectively). Elite male and female futsal players are exposed to a substantial risk of sustaining injuries, especially during matches.

KEYWORDS: injury incidence, sports Injury, injury prevention, five-a-side football, risk of injury

INTRODUCTION

Futsal is the official name for the 5-a-side indoor version of associated football (i.e. 1 goalkeeper and 4 outfield players) that is sanctioned by soccer's international governing body Federation Internationale de Football Association (FIFA). Futsal is played worldwide with more than 12 million players all over the world (Beato, Coratella, & Schena, 2016; Tessitore et al., 2008). During the game of futsal, players are exposed to regular collisions and repeated high-intensity physical demands such as sudden accelerations and decelerations, rapid changes of direction, tackling and kicking (Castagna, D'Ottavio, Vera, & Álvarez, 2009; Dogramaci & Watsford, 2006). Similar to that which has been observed in other intermittent team sports (e.g. football [López-Valenciano et al., 2019], rugby [Williams, Trewartha, Kemp, & Stokes, 2013] and basketball [Taylor, Ford, Nguyen, Terry, & Hegedus, 2015]), at top levels, the combination of these heavy physical demands, the frequent exposure to collisions and contacts along with the current congested calendars and the high levels of performance-related psychological stress may place futsal players at substantial risk of injury. In fact, it has been suggested that futsal is among the top ten injury-prone sports (Junge & Dvorak, 2010).

However, before implementing any injury prevention measure it is essential to know the injury profile of futsal, in terms of incidence, severity and location of the most common injuries (Finch, 2006; van Mechelen, Hlobil, & Kemper, 1992; Van Tiggelen, Wickes, Stevens, Roosen, & Witvrouw, 2008). Currently, the available prospective epidemiological studies in futsal that report time-loss injury incidence data have shown incidence rates that range from 0.9 to 195.6 and from 6.7 to 86.6 injuries per 1000 hours of male (Álvarez Medina, Murillo Lorente, Giménez Salillas, & Manonelles Marqueta, 2016; Angoorani, Haratian, Mazaherinezhad, & Younespour, 2014; Junge & Dvorak, 2010; Ribeiro, Oliveira, & Costa, 2006) and female (Angoorani et al., 2014; Hamid, Jaafar, & Ali, 2014; Ruiz-Pérez et al., 2019) players exposure, respectively. This large variation in injury incidence exhibited by futsal epidemiological studies may be attributed to differences in the number of players included in these studies and the competition analyzed (e.g.: national leagues and international tournaments) alongside disparity in injury definitions and data collection procedures. These inter-study differences may have clouded our understanding of the incidence, severity and location of futsal-related injuries. Therefore, a study that reviews and employs a meta-analytical approach to the currently available epidemiological data to identify the incidence and severity of futsal injuries, separately by sex, as well as when (matches or training sessions) and where (anatomical location) they occur is warranted. This knowledge could lead coaches and sport science specialists to priorities the application of sex-specific measures to prevent or reduce the risk of sustaining such injuries.

Therefore, the main purpose of this study was to conduct a systematic review and meta-analysis quantifying the incidence of injuries in male and female futsal players.

METHOD

To conduct this study (PROSPERO ID: CRD42020153544), guidelines for reporting meta-analysis of observational studies in epidemiology (Preferred Reporting Items for Systematic Reviews and Meta-Analyses [PRISMA] guidelines) were followed (Hutton, Catalá-López, & Moher, 2016). The PRISMA checklist is presented in supplementary Appendix 1.

Study Selection

Eligibility criteria were established and agreed upon by all authors based on the concept of population, intervention/indicator, comparator/control and outcome (PICO) (Moher & Tricco, 2008) (for more information please see supplementary Appendix 2).

Thus, to be included in this systematic review and meta-analysis studies had to fulfil the following criteria:

(1) Injury must be defined in terms of time loss (i.e.: injury that results in a player being unable to take full part in future futsal training or match play) (Fuller et al., 2006; Hägglund, Waldén, & Bahr, 2005).

(2) Participants had to be elite or sub-elite futsal players (i.e.: players who belong to teams engaged in first or second national futsal leagues or play international senior competitions) (Cometti, Maffiuletti, Pousson, Chatard, & Maffulli, 2001; Lupo, Tessitore, Minganti, & Capranica, 2010; Mallo, González, Veiga, & Navarro, 2011; Maly, Zahalka, & Mala, 2014).

(3) The study had to be a full-text article published in a peer-reviewed journal before November 2019.

(4) Eligible studies must report either incidence rate or prevalence among the surveyed players or provide sufficient data from which these figures could be calculated through standardized equations.

(5) Eligible studies must comprehend at least a complete season or full tournament.

Studies using injury definitions other than time loss were excluded. Literature reviews, abstracts, editorial commentaries and letters to the editor were also excluded. Finally, some authors were contacted to provide missing data or to clarify if data were duplicated in other publications. Incomplete data, or data from an already included study, were excluded.

Search strategy

A systematic computerized search was conducted up to 31th October 2019 in the databases MEDLINE, PubMed, Web of Science and Scopus. In addition, a complementary search of the reference lists of included articles and a Google Scholar search were also performed. This was done using backward citation tracking (to manually search the reference list of a journal article), and forward citation tracking (scanning a list of articles that had cited a given paper since it was published) (Rodseth & Marais, 2016). Citations were tracked using Google Scholar to make sure that studies were not missed inadvertently. When additional studies that met the inclusion criteria were identified, they were included in the final pool of studies. Relevant keywords were used to construct Boolean search strategies, including terms such as futsal, injury, injuries and epidemiology.

Two reviewers independently (XXX and XXX) selected studies for inclusion in a two-step process. First, studies were screened based on title and abstract. In a second stage, full-text studies were reviewed to identify those studies that met the eligibility criteria. A study was excluded immediately once it failed to meet a single inclusion criterion. Disagreements were resolved through consensus or by consulting a third reviewer (XXX).

Data **extraction**

A codebook was produced to standardize the coding of each study in order to maximize the highest objectivity and each study was codified by two different reviewers. The moderator variables of the eligible studies were coded and grouped into three categories: 1) General study descriptors (authors, year of publication and study design); 2) Study population (sample size, sex and level of play); 3) epidemiological data (injury [including it mains characteristics according to Fuller et al. (2006)] and exposure data). If applicable, the authors of included studies were contacted to provide clarifications or access to raw data. Operational definitions used in this study are shown in supplementary Appendix 3. Supplementary Appendix 4 also displays the moderator variables coded separately by category.

Quality and risk of bias assessment

As suggested by Von Elm et al. (2014) the quality of each of the studies included was assessed using the full version of the "Strengthening the Reporting of Observational Studies in Epidemiology" (STROBE) scale. Three categories for quality assessment were established arbitrarily: high: the study fulfilled more than 80% criteria stated in STROBE; moderate: 50–80% of STROBE criteria were fulfilled; low: if less than 50% criteria could be achieved (Olmos et al., 2008).

Furthermore, to assess risk of bias of external validity quality, an adapted version of the Newcastle Ottawa Scale (NOS) for cohort studies was used. The NOS was adapted to fit the purpose of this review, as undertaken in previous publications (López-Valenciano et al., 2019; Ruiz-Pérez et al., 2019; Saragiotto et al., 2014; Zeng et al., 2013). Thus, two of the eight items were deleted. Item 2 was excluded because a selection of the non-exposed cohort was irrelevant as long as the total study population was exposed to futsal play and item 5 (comparability of cohorts on the basis of the design or analysis) was excluded because it was linked to item 2. Two new items were added to the original scale (items 1 and 3). Therefore, the criteria adopted to assess risk of bias were: 1) description or type of futsal players, 2) definition of injury, 3) representativeness of the exposed cohort, 4) ascertainment of exposure, 5) demonstration that the outcome of interest was not present at the start of study, 6) assessment of outcome, 7) whether follow-up was long enough for outcomes to occur, 8) adequacy of follow-up of cohorts. An article could be awarded a maximum of one star for each item if appropriate methods had been clearly reported. Thus, a total of eight stars could be given to an article. The higher the number of stars given to an article the lower the risk of bias and studies scoring at least 6 stars were classified as low risk of bias studies (Gao et al., 2018).

The quality of the certainty of the main outcomes was graded (high, moderate, low, or very low certainty) using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach. Four different GRADE factors were used in this meta-analysis: risk of bias (i.e., the methodological quality of the studies), inconsistency (i.e., unexplained inconsistency of results across studies), indirectness (i.e., evidence from different populations than the population of interest in the review) and imprecision (i.e., total sample size of the available studies). The starting point was always the assumption that the pooled or overall result was of high quality. The quality of evidence was subsequently downgraded by one or two levels per factor to moderate, low, or very low when there is a risk of bias, inconsistency, imprecision or indirect results (Prinsen et al., 2018).

The data extraction and quality assessment (including risk of bias of external validity) were carried out by two reviewers (XXX and XXX). For the quantitative moderator variables intraclass correlation coefficients ($ICC_{3,1}$) were calculated, while for the qualitative moderator variables Cohen's k coefficients were applied. On average, the ICC was 0.95 (range: 0.9–1.0) and the k coefficient was 0.97 (range: 0.94–1.0), Inconsistencies between the two coders were resolved by consensus, and when these were due to ambiguity in the coding book, this was corrected. As before, any disagreement was resolved by mutual consent in consultation with a third reviewer (XX).

Statistical analysis

Injury incidence rates per 1000 hours of player exposures were extracted from the included studies. If injury incidence rates were not specifically reported, they were, if possible, calculated from the available raw data using the following formulas:

Incidence = 1000 × (∑injuries/∑exposure hours)

Incidence = n° of injuries / (n° of matches × 5 players × match duration*) × 1000

* Match duration, using the factor 0.67, based on standard 40 min match play.

Separate injury incidence meta-analyses were performed for male and female futsal players. Similar to previous meta-analysis on epidemiology of injuries in sports (Doherty et al., 2014; López-Valenciano et al., 2019), data were modelled by a random effects Poisson regression model, as previously described (Bagos & Nikolopoulos, 2009). The response variable in each meta-analysis was the number of observed injuries, offset by the log of the number of exposure hours. A random effects term was included to account for the correlation arising from using multiple rows of data from the same study. Factors of interest were included as random effects. A weighting factor used was: study exposure time (hours) / mean study exposure time (hours). For injury incidence data, the overall estimated means for each random effect factor were obtained from the model and then back-transformed to give incidence rates, along with 95% CIs (CIs that showed negative values were adjusted to 0 for better interpretability). A forest plot was also constructed for each meta- analysis. Heterogeneity was evaluated using the I^2 statistic, which represents the percentage of total variation across all studies due to between-study heterogeneity (Higgins & Thompson, 2002). I^2 values of <25%, 25-50%, 50-75% and >75% indicated no, small, moderate and significant heterogeneity, respectively (Higgins, Thompson, Deeks, & Altman, 2003).

Sub-analyses separately by sex were carried out when there were at least three incidence rates (cohorts) coming from a minimum of two different studies and the sum of the number of players involved was higher than 30 players to determine the pooled effects regarding overall, match and training injuries, injuries sustained during national leagues (clubs) and international tournaments (national teams), location (lower extremity, trunk, upper extremity, head and neck), type (fractures and bone stress, joint [non-bone] and ligament, muscle and tendon, contusions, laceration and skin lesion, central/peripheral nervous system and undefined/other) and severity (slight/minimal [1–3 days], minor/mild [4–7 days], moderate [8–28 days], major/severe [>28 days]) of injuries. All statistical analyses were performed using the statistical software package R V.2.4.1 (The R Foundation for Statistical Computing) and the 'metafor' package (Viechtbauer, 2010).

Comparisons between factors were then made using a spreadsheet for combining effect statistics (Hopkins, 2007), whereby the incidence rate ratio (and its associated confidence limits) were assessed against predetermined thresholds. An incidence rate ratio of 0.91 represented a substantially lower injury risk, while an incidence rate ratio of 1.10 indicated a substantially higher injury risk (Hopkins, 2010). An effect was deemed unclear if its confidence interval overlapped the thresholds for substantiveness; that is, if the effect could be substantial in both a positive and negative sense. Otherwise the effect was clear and deemed to have the magnitude of the largest observed likelihood value. This was qualified with a probabilistic term using the following scale: <0.5%, most unlikely; 0.5–5 %, very unlikely; 5–25%, unlikely; 25–75%, possible; 75–95%, likely; 95–99.5%, very likely; >99.5%, most likely (Batterham & Hopkins, 2006; Hopkins, 2007).

RESULTS

Study selection

Of the 479 studies found via our electronic and manual searching of the databases, finally six (Álvarez Medina et al., 2016; Angoorani et al., 2014; Hamid et al., 2014; Junge & Dvorak, 2010; Ribeiro et al., 2006; Ruiz-Pérez et al., 2019) were included in this systematic review and meta-analysis (14 cohorts). Details of exclusion and reason for exclusion are provided in figure 1.

The studies were carried out between 2006 and 2019 and comprised male (Álvarez Medina et al., 2016; Angoorani et al., 2014; Hamid et al., 2014; Junge & Dvorak, 2010; Ribeiro et al., 2006) and female (Angoorani et al., 2014; Hamid et al., 2014; Ruiz-Pérez et al., 2019) futsal players from both International tournaments (Junge & Dvorak, 2010; Ribeiro et al., 2006) and national futsal leagues in different countries (Spain (Álvarez Medina et al., 2016; Ruiz-Pérez et al., 2019), Iran (Angoorani et al., 2014) and Malaysia (Hamid et al., 2014)). A summary of included studies is presented in table 1.

Figure 1 Flow chart of the selection of studies for the meta-analysis.

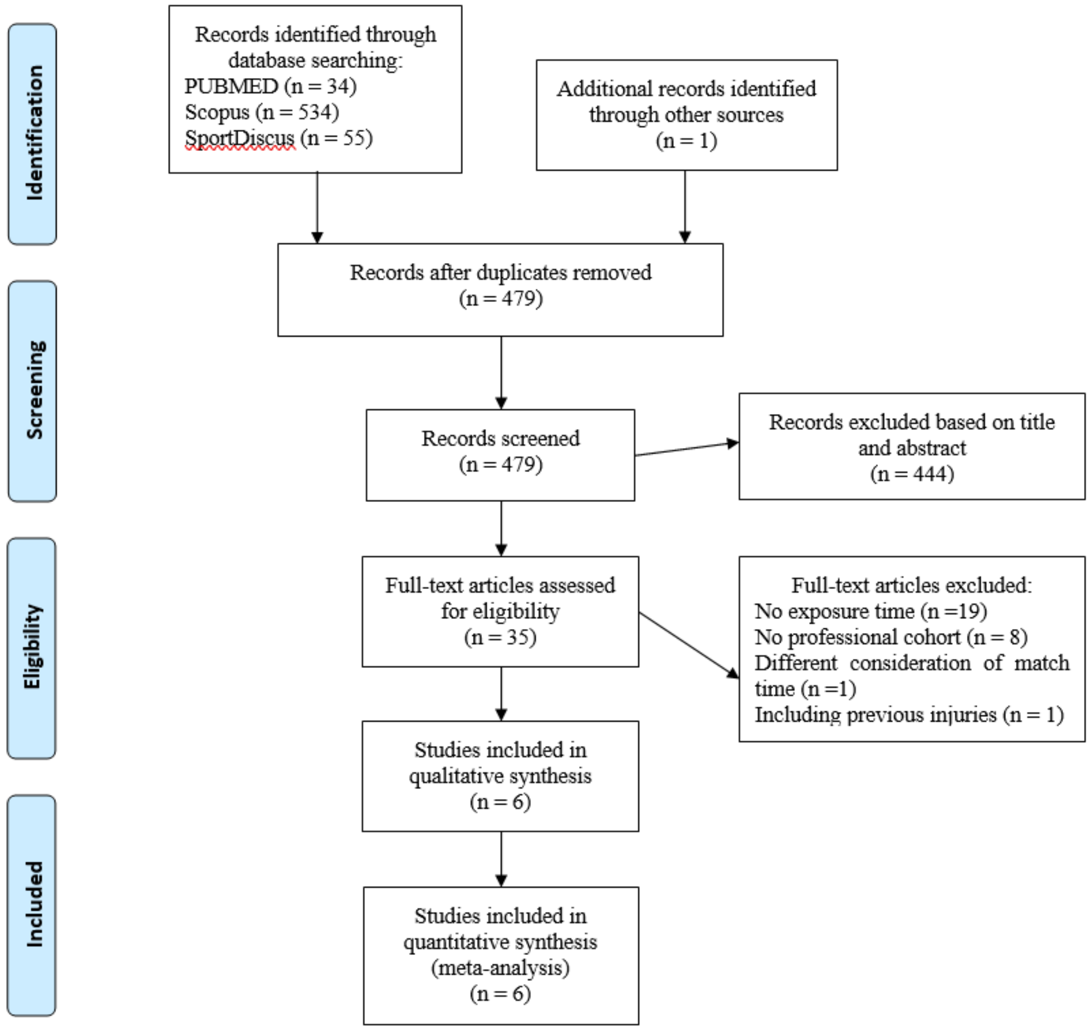

Table 1. Characteristics of the studies included in this systematic review and meta-analysis

Reference	Study	Nº Teams	Exposure (hours)			Injuries			Incidence			STROBE	NOS
Country / Tournament	Duration*	(Players)	Overall	Training	Match	Overall	Training	Match	Overall	Training	Match	reporting quality	Rosk of bias
Ruiz-Pérez et al. (2019)+ [a] ♀ Spain NL – 2015-16	36	1 (14)	1506.7	1413.3	93.3	8	0	8	5.3 (1.6 - 9.0)	5.7 (1.7 - 9.6)	0.0 (0.0- 0.0)	19 (High)	7 (High)
Ruiz-Pérez et al. (2019)+ [b] ♀ Spain NL – 2016-17	36	1 (14)	1328.8	1222.1	106.7	12	11	1	9.0 (3.9- 14.1)	9.0 (3.7 - 14.3)	9.4 (0.0 – 27.7)	19 (High)	7 (High)
Ruiz-Pérez et al. (2019)+ [c] ♀ Spain NL – 2017-18	36	1 (13)	1610.7	1500.7	110	10	9	1	6.2 (2.4 - 10.0)	6.0 (2.1 – 9.9)	9.1 (0.0 – 26.9)	19 (High)	7 (High)
Hamid et al. (2014)+ [a] ♂ Malaysia NL – 2010	24	16 (238)	-	-	466.7	-	-	11	-	-	23.6 (9.6 – 37.5)	19 (High)	7 (High)
Hamid et al. (2014)+ [b] ♀ Malaysia NL – 2010	24	16 (230)	-	-	473.3	-	-	14	-	-	29.6 (14.1 – 45.0)	19 (High)	7 (High)
Angoorani et al. (2014)+ [a] ♀ Iran NT – 2011-12	76	1 (17)	6714.6	5787.8	930.2	28	18	10	4.2 (2.6 - 5.7)	3.1 (1.7 – 4.6)	10.7 (4.1 – 14.4)	19 (High)	7 (High)
Angoorani et al. (2014)+ [b] ♂ Iran NT – 2011-12	76	1 (15)	8888.9	8108.1	819.7	8	3	5	0.9 (0.3 - 1.5)	0.4 (0.0 – 0.8)	6.1 (0.7- 11.4)	19 (High)	7 (High)
Angoorani et al. (2014)+ [c] ♂ Iran NT – 2011-12	76	1 (23)	8695.6	7262.6	1436.8	18	13	5	2.1 (1.1 - 3.0)	1.8 (0.8 - 2.8)	3.5 (0.4 – 6.5)	19 (High)	7 (High)
Álvarez-Medina et al. (2016)+ [a] ♂ Spain NL – 2004-05	40	1 (12)	5477	-	-	108	-	-	19.7 (16.0 - 23.4)	-	-	13 (Moderate)	5 (Low)
Álvarez-Medina et al. (2016)+ [b] ♂ Spain NL – 2011-12	40	1 (12)	4931	-	-	26	-	-	5.3 (3.2 - 7.3)	-	-	13 (Moderate)	5 (Low)
Junge & Dvorak (2010)[a] ♂	2	16	-	-	220	-	-	17	-	-	77.2	19	7

Guatemala / WC – 2000		(224)									(40.4 - 113.9)	(High)	(High)
Junge & Dvorak (2010)[b] ♂ Chinese Taipei / WC – 2004	2	16 (224)	-	-	266.7	-	-	18	-	-	67.5 (36.3 - 98.7	19 (High)	7 (High)
Junge & Dvorak (2010)[c] ♂ Brazil / WC – 2008	3	20 (280)	-	-	356.7	-	-	32	-	-	89.9 (58.8 - 121.0)	19 (High)	7 (High)
Ribeiro & Costa (2006)♂ Brazil U20 NC - 2004	1	10 (180)	-	-	153.4	-	-	11	-	-	71.7 (29.3 - 114.1)	18 (High)	7 (High)

+ Study was implemented according to the 2006 consensus statement for epidemiological studies in soccer.

(a);(b);(c): indicate different cohorts in the same study.

*: study duration expressed in number of weeks.

NT: national team; WC: world cup; NC: national cup; NL: national league

U: under

STROBE: Strengthening the Reporting of Observational Studies in Epidemiology

NOS: Newcastle Ottawa Scale

Quality and risk of bias assessment of the studies selected

With regard to the reporting quality of the studies selected in this systematic review and meta-analysis, five out of the six studies achieved STROBE scores that were categorized as high (18 (Ribeiro et al., 2006), 19 (Angoorani et al., 2014; Hamid et al., 2014; Junge & Dvorak, 2010) and 20 (Ruiz-Pérez et al., 2019) points out of the 22-maximum achievable) while only one study (Álvarez Medina et al., 2016) demonstrated a STROBE score that was categorized as low (13 points). Regarding the assessment of the risk of bias of external validity quality, all the studies selected obtained seven out of eight stars in the NOS scale, with the exception of the study conducted by Álvarez-Medina et al. (2016) which was awarded only 5 stars. The quality of the certainty of the main outcomes ranged from very low to moderate, with inconsistency the factor that most influenced the process of downgrading in the majority of incidence rates. A detailed description of the results obtained in each study from the STROBE and NOS scales is presented in tables 2 and 3, respectively. Table 4 displays the summary of the findings obtained from the GRADE method.

Meta-analyses

In the meta-analyses carried out, the effect sizes exhibited a moderate to large heterogeneity (based on the Q statistics and the I^2 indices), supporting the decision of applying random-effects models.

Injury incidence: overall, training and match

Two (Álvarez Medina et al., 2016; Angoorani et al., 2014) (four cohorts) and two (Angoorani et al., 2014; Ruiz-Pérez et al., 2019) (four cohorts) studies reported overall injury incidence rates, one (Angoorani et al., 2014) (two cohorts) and two (Angoorani et al., 2014; Ruiz-Pérez et al., 2019) (four cohorts) studies showed training injury incidence rates and four (Álvarez Medina et al., 2016; Angoorani et al., 2014; Junge & Dvorak, 2010; Ribeiro et al., 2006) (seven cohorts) and three (Angoorani et al., 2014; Hamid et al., 2014; Ruiz-Pérez et al., 2019) (five cohorts) studies expressed match injury incidence rates for males and females, respectively. The number of cohorts reporting training injury incidence rates in male players was lower than three and hence, a separate meta-analysis could not be conducted (see method section).

Therefore, for males, the meta-analyses ran reported pooled overall and match injury incidence rates of 6.8 (95% IC = 0.0 – 15.2; I^2 = 99.5%) and 44.9 (95% IC = 17.2 – 72.6; I^2 = 98.1%) injuries per 1000 hours of exposure (figure 2). The random effect models for female injury incidence showed an overall incidence of 5.3 injuries per 1000 hours of exposure (95% CI = 3.5 - 7.0; I^2 = 25.2%), a training incidence of 5.1 injuries per 1000 hours of training exposure (95% CI = 2.7 - 7.6; I^2 = 52.3%) and a match incidence of 10.3 injuries per 1000 hours of match exposure (95% CI = 0.6 to 20.1; I^2 = 85.5%). Figure 3 displays a summary of the reported overall, training and match injury incidence rates in females.

There were non-significant sex-related differences in the overall incidence rates (with a probability of 44.8%). However, males showed a statistically significant 4.3 times higher match injury incidence rate than females futsal players (with a probability of 92.3%).

Table 2. Description of the 22 of STROBE Statement—checklist of items that should be included in reports of observational studies

Item	Item	Ruiz-Pérez et al. (2019)	Ribeiro & Costa (2006)	Hamid et al. (2014)	Junge & Dvorak (2010)	Angoorani et al. (2014)	Álvarez-Medina et al. (2016)
Title and abstract	1	Yes	Yes	No	Yes	Yes	No
Introduction							
▪ Background / rationale	2	Yes	Yes	Yes	Yes	Yes	Yes
▪ Objectives	3	Yes	Yes	Yes	Yes	Yes	Yes
Methods							
▪ Study design	4	Yes	Yes	Yes	Yes	Yes	Yes
▪ Setting	5	Yes	Yes	Yes	Yes	Yes	Yes
▪ Participants	6	Yes	Yes	Yes	Yes	Yes	Yes
▪ Variables	7	Yes	Yes	Yes	Yes	Yes	Yes
▪ Data sources / measurement	8	Yes	Yes	Yes	Yes	Yes	Yes
▪ Bias	9	No	No	No	No	No	No
▪ Study size	10	No	No	No	No	No	No
▪ Quantitative variables	11	Yes	Yes	Yes	Yes	Yes	Yes
▪ Statistical methods	12	Yes	Yes	Yes	Yes	Yes	Yes
Results							
▪ Participants	13	Yes	Yes	Yes	Yes	Yes	Yes
▪ Descriptive data	14	Yes	Yes	Yes	Yes	Yes	Yes
▪ Outcome data	15	Yes	Yes	Yes	Yes	Yes	Yes
▪ Main results	16	Yes	No	Yes	Yes	No	No
▪ Other analyses	17	Yes	Yes	Yes	Yes	Yes	No
Discussion							
▪ Key results	18	Yes	Yes	Yes	Yes	Yes	Yes
▪ Limitations	19	Yes	No	Yes	No	Yes	No
▪ Interpretation	20	Yes	Yes	Yes	Yes	Yes	No
▪ Generalizability	21	Yes	Yes	Yes	Yes	Yes	No

Other information							
▪ Funding	22	Yes	Yes	Yes	Yes	Yes	**No**
TOTAL SCORE		20	18	19	19	19	13
Qualitative interpretation		High	High	High	High	High	Moderate

Table 3. Risk of bias assessment of the studies (Newcastle Ottawa scale)

Study	Criteria for assessing risk of bias								TOTAL
	1	2	3	4	5	6	7	8	
Ruiz-Pérez et al. (2019)	*	*	*	*	*		*	*	7
Ribeiro & Costa (2006)	*	*	*	*	*		*	*	7
Hamid et al. (2014)	*	*	*	*	*		*	*	7
Junge & Dvorak (2010)	*	*	*	*	*		*	*	7
Angoorani et al. (2014)	*	*	*	*	*		*	*	7
Álvarez-Medina et al. (2016)	*		*	*			*	*	5

Criteria for assessing risk of bias: 1) description or type of futsal players, 2) definition of injury, 3) representativeness of the exposed cohort, 4) ascertainment of exposure, 5) demonstration that outcome of interest was not present at start of study, 6) assessment of outcome, 7) was follow-up long enough for outcomes to occur and 8) adequacy of follow-up of cohorts.

*Star(s) awarded for each criterion.

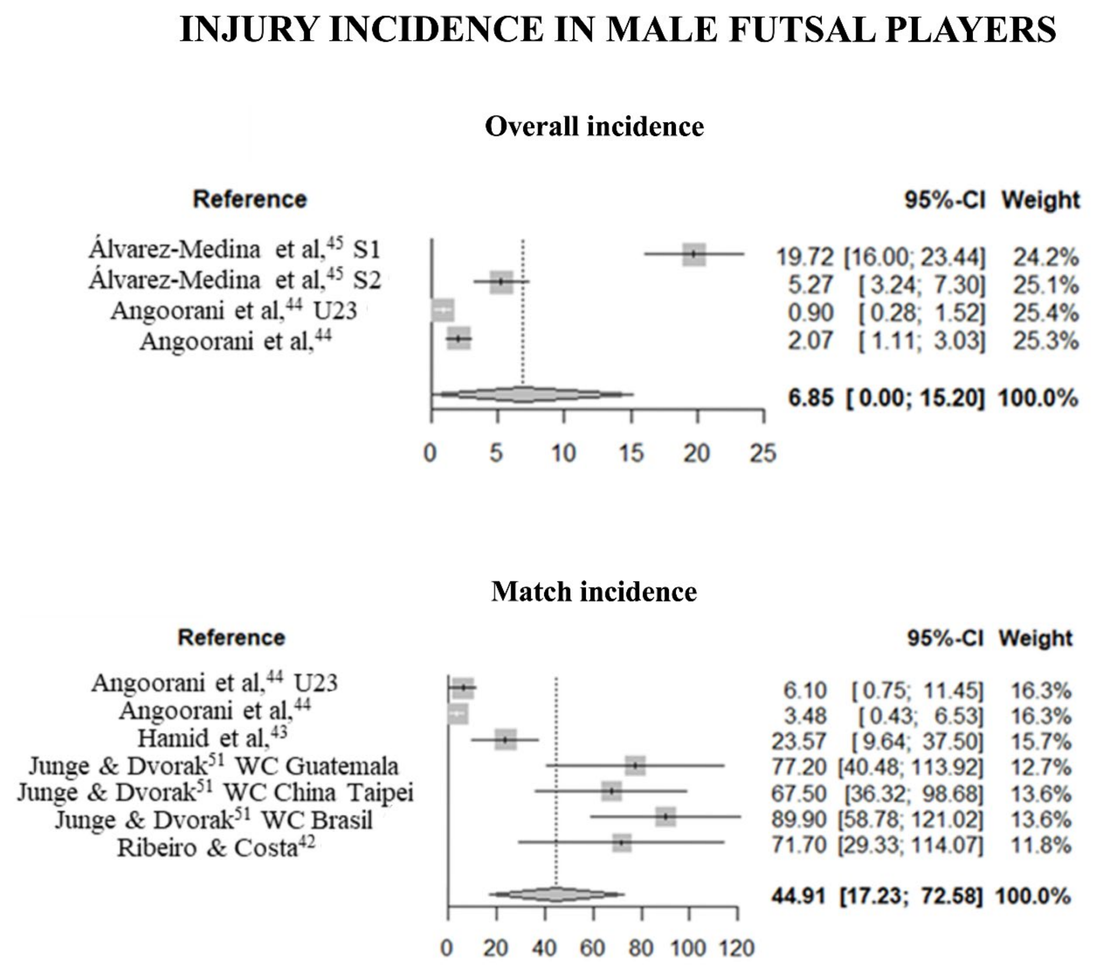

Figure 2 Overall and match injury incidence in male players with 95% confidence intervals.

INJURY INCIDENCE IN FEMALE FUTSAL PLAYERS

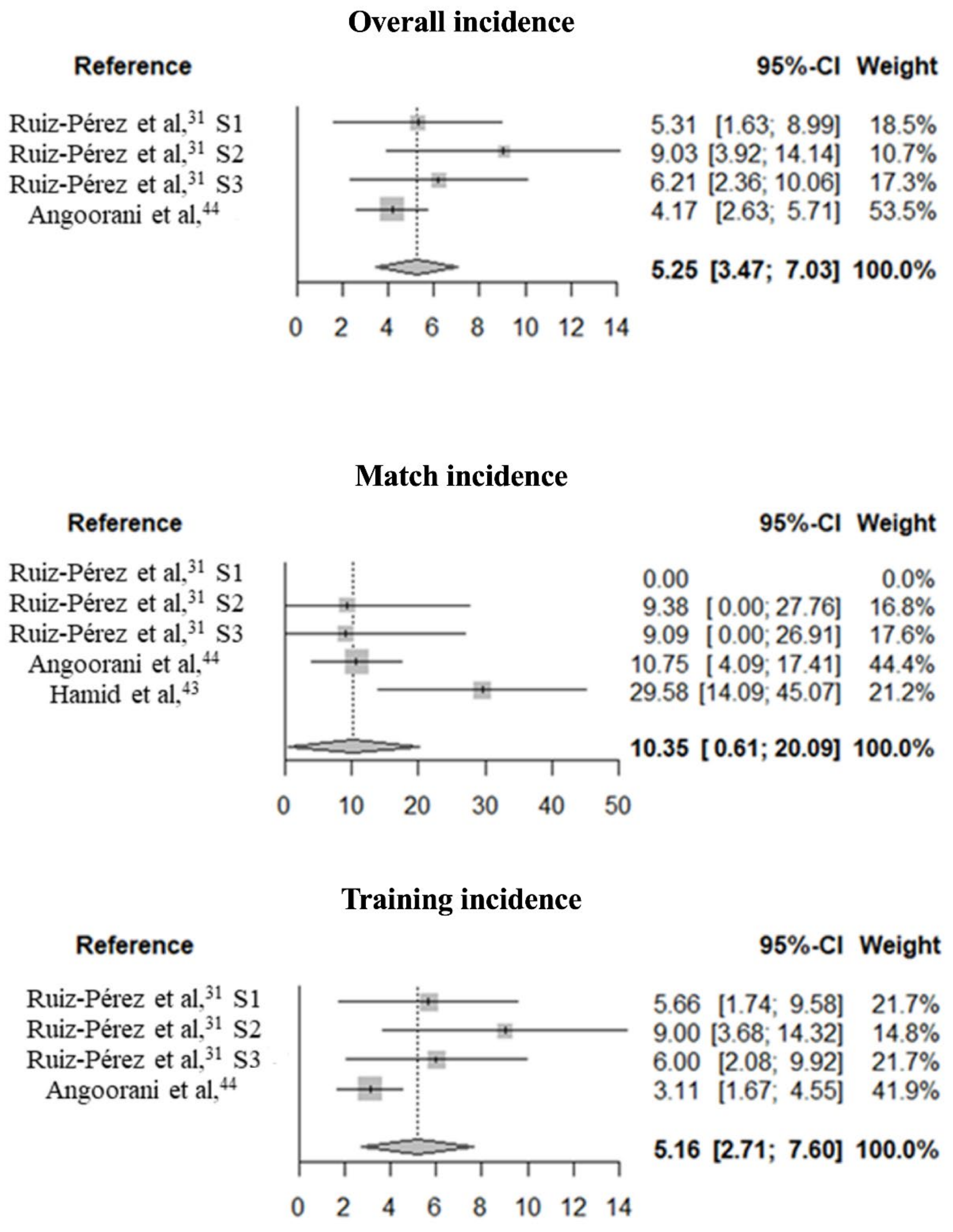

Figure 3 Overall, match and training injury incidence in female players with 95% confidence intervals.

Injury characteristics

National leagues vs. international tournaments

For males, two studies (Junge & Dvorak, 2010; Ribeiro et al., 2006) provided match injury incidence data during futsal international tournaments (three World Cups [Guatemala 2000, China Taipei 2004 and Brazil 2008] and one national cup [Brazil 2004]) and other two studies (Álvarez Medina et al., 2016; Angoorani et al., 2014) reported epidemiological information regarding injuries sustained during futsal match play in different national leagues. Consequently, the seven cohorts that showed match injury incidence rates in male futsal players were grouped into two categories: a) national leagues (three cohorts) and b) international tournaments (four cohorts). Match incidence rates in international tournaments were 8.5 times likely higher (statistically significant with a probability of 93.5%) than in national leagues (77.2 [95% CI = 60.0 - 94.5] vs 9.1 [95% CI = 0.0 – 2.39] for international tournaments and national leagues, respectively) (Figure 4).

Unlike males, no studies were found that reported injury incidence rates for females in international futsal tournaments and hence, this sub-analysis could not be carried out.

MATCH INJURY INCIDENCE IN MALE FUTSAL PLAYERS DURING NATIONAL LEAGUES AND INTERNATIONAL TOURNAMENTS

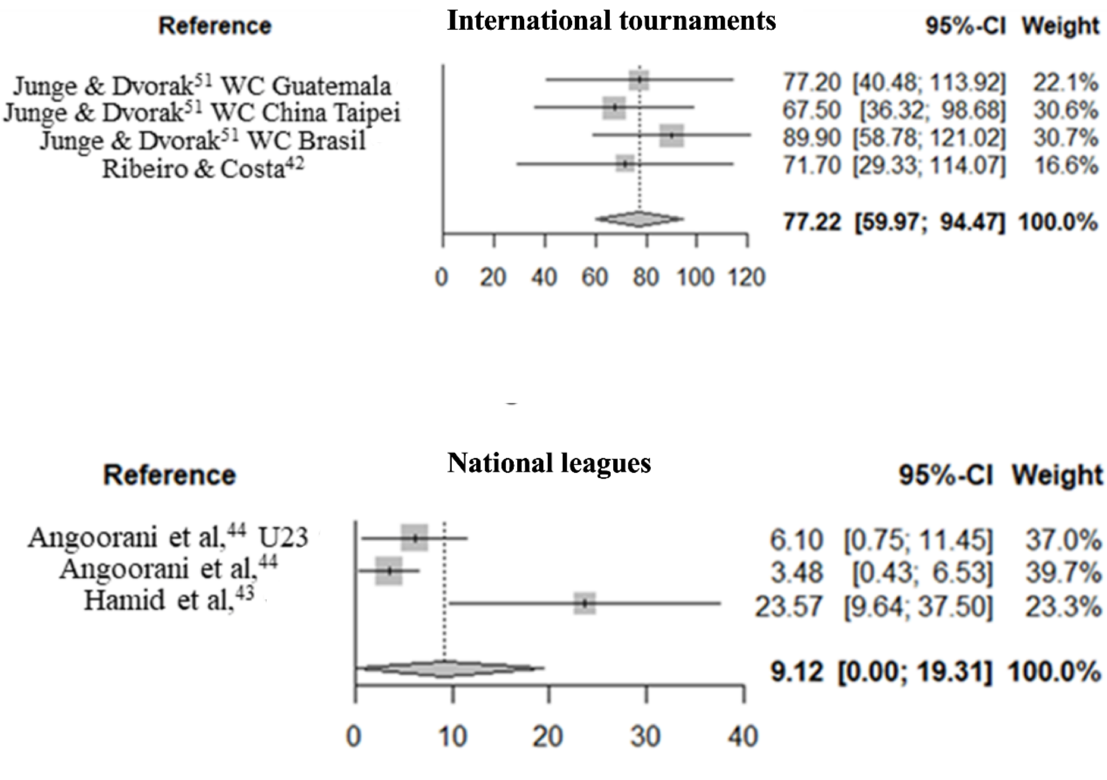

Figure 4 Match injury incidence during male tournaments with 95% confidence intervals.

Table 4. Summary of findings (SoF)

№ of studies	Certainty assessment						Effect			Certainty	Importance
	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Nº of events	Nº of individuals	Incidence		
Overall injury incidence for males											
2 [1,2]	Observational studies	Serious [a]	Very serious [b]	Not serious	Not serious	None	160	80	6.8 (0 to 15.2)	⊕◯◯◯ VERY LOW	CRITICAL
Match injury incidence for males											
4 [1,3,4,5]	Observational studies	Not serious	Serious [c]	Not serious	Not serious	None	204	946	44.9 (17.2 to 72.6)	⊕⊕⊕◯ MODERATE	CRITICAL
Overall injury incidence for females											
2 [1,6]	Observational studies	Not serious	Serious [c]	Not serious	Not serious	None	58	271	5.25 (3.5 to 7)	⊕⊕⊕◯ MODERATE	CRITICAL
Match injury incidence for females											
3 [1,4,6]	Observational studies	Not serious	Very serious [b]	Not serious	Not serious	None	31	288	10.3 (0.6 to 20.1)	⊕⊕◯◯ LOW	CRITICAL
Training injury incidence for females											
2 [1,6]	Observational studies	Not serious	Serious [c]	Not serious	Serious [d]	None	38	58	5.2 (2.7 to 7.6)	⊕⊕◯◯ LOW	CRITICAL
Match incidence during male international tournaments											

2 [3,5]	Observational studies	Not serious	Serious [c]	Not serious	Not serious	None	78	908	77.2 (59.9 to 94.5)	⊕⊕⊕◯ MODERATE	CRITICAL
Match incidence during male national tournaments											
2 [1,4]	Observational studies	Not serious	Serious [c]	Not serious	Not serious	None	21	276	9.1 (0 to 19.3)	⊕⊕⊕◯ MODERATE	CRITICAL

a. Lack of demonstration that outcome of interest was not present at start of study in at least one study

b. Studies showed significant heterogeneity based on I^2 indices

c. Studies showed at least moderate heterogeneity based on I^2 indices

d. Few events in one of the studies

1. Angoorani et al. (2014)
2. Álvarez Medina et al. (2016)
3. Junge & Dvorak (2010)
4. Hamid et al. (2014)
5. Ribeiro & Costa (2006)
6. Ruiz-Pérez et al. (2019)

Location, type and severity of injury

Although some studies provided epidemiological data regarding the location, type and severity of the injuries occurred during futsal (Hamid et al., 2014; Junge & Dvorak, 2010; Ribeiro et al., 2006), only Ruiz-Pérez et al. (2019) and Angoorani et al. (2014) reported incidence rates for these three time loss injury characteristics separately for each of the four cohorts of female futsal players and two cohorts of male futsal players, respectively. As a consequence, sub-analysis for these moderator variables could not be carried out.

DISCUSSION

The main findings of this systematic review and meta-analysis suggest that both male and female elite futsal players have a substantial risk of sustaining an injury. In particular, and for males, the results show pooled overall and match incidence rates of 6.8 and 44.9 injuries per 1000 hours of exposure. These overall and match injury incidence rates are in line with the injury incidences reported in other elite team sports such as football (8.1 [overall] and 36 [match] injuries per 1000 hours of exposure) (López-Valenciano et al., 2019), rugby (from 68 to 81 injuries per 1000 hours of match play exposure) (Gabbett, 2005; Williams et al., 2013) and handball (6.5 [overall] and 22.2 [match] injuries per 1000 hours of exposure to match play) (Mónaco et al., 2019). The current study also demonstrated that female players pooled overall, training and match incidence rates were 5.3, 5.1 and 10.3 injuries per 1000 hours of exposure, respectively. These results are also similar to the incidence rates documented for elite female football (from 5.5 to 9.4, from 3.1 to 4.6 and from 16.1 to 22.7 injuries per 1000 hours of exposure to overall, training and match play) (Faude, Junge, Kindermann, & Dvorak, 2006; Hägglund, Waldén, & Ekstrand, 2009; Junge & Dvorak, 2007; Larruskain, Lekue, Diaz, Odriozola, & Gil, 2018; Le Gall, Carling, & Reilly, 2008; Tegnander, Olsen, Moholdt, Engebretsen, & Bahr, 2008), hockey (3.8 [overall], 2.7 [training] and 9.8 [match] injuries per 1000 hours of exposure]) and basketball players (4.7 injuries per 1000 hours of overall exposure to basketball play) (Bonato, Benis, & La Torre, 2018).

In contrast to the injury incidence data shown in previous epidemiological studies conducted in other team sports (Oliver Faude, Junge, Kindermann, & Dvorak, 2005; Moller, Attermann, Myklebust, & Wedderkopp, 2012; Pasanen et al., 2008), the findings of this systematic review and meta-analysis have documented very similar overall and training incidence rates in female futsal players (5.3 [overall] vs. 5.1 [training] injuries per 1000 hours of exposure). This circumstance may be partially attributed to the fact that one up to the five cohorts used to calculate pooled match injury incidence reported 0 injuries per 1000 hours of exposure, unlike the other cohorts that showed match incidence rates ranging from 9.1 to 29.6 injuries per 1000 hours of exposure. This infrequent but possible situation of no injuries sustained during matches through a season in a single futsal team may reflect the dynamic and multifactorial nature of this phenomenon and, along with the limited epidemiological data currently available, may have led to an underestimation of the match injury rate in female players. Consequently, the overall injury rate may have also been affected so that a relevant reduction in its score could have likely occurred. The possible underestimation of the overall and match injury incidence rates may be corrected in future updates of this meta-analysis as more data on epidemiology of injuries in female futsal will be available and the impact of atypical cases on these two incidence rates would be minimized.

Although the results of the current meta-analysis indicate that male futsal players exhibit a higher match injury incidence rate than their counterpart female players (44.9 [males] vs. 10.3 [females] per 1000 hours of exposure), when the incidence rates reported by the two prospective epidemiological studies carried out in men´s international tournaments (national teams) (Junge & Dvorak, 2010; Ribeiro et al., 2006) were removed from the random model (as the pooled match injury incidence rate obtained for females did not included data from individual epidemiological studies conducted during international tournaments), these documented sex-related differences became non-significant from a sport injury risk standpoint (see method) (9.1 vs. 10.3 injuries per 1000 hours of male and female players exposure to futsal match play, respectively). These findings are not in agreement with the results reported by previous studies comparing injury incidence rates between male and female professional football players (Hägglund et al., 2009; Larruskain et al., 2018). These studies have attributed the presence of sex-related differences in injury risk to the higher number of contact injuries sustained by male football players and that may be due to the higher intensity and number of contact situations that have been observed in male football (Hägglund et al., 2009; Larruskain et al., 2018). Perhaps, and unlike football, the reduced (usually indoor) pitch size (40 x 20 m) and the unlimited possibility to substitute the players during the game may guarantee that most of the physical actions are performed at a very high intensity, making collisions with other players and tackling to keep possession of or to win the ball situations that are very repeatedly observed during matches, independently of the sex of the players. In fact, futsal has been considered one of the most demanding team sports (higher than football, basketball and handball) due to its average heart rate (around 90% of maximum heart rate) and work to rest ratio of 1:1, with a locomotor activities changing every 3.3 seconds with short recovery time intervals (20-30 s) between the high intensity bout sequences (3-4 bouts) (Barbero-Alvarez, Soto, Barbero-Alvarez, & Granda-Vera, 2008; Castagna et al., 2009; Dogramaci, Watsford, & Murphy, 2011).

Other relevant findings of the present study are related with the fact that, for females, and similar to what has been found in other team sports (e.g.: football and handball), match injury incidence (10.3 injuries per 1000 hours of exposure) was significantly higher (almost twice) than the injury rate obtained for training sessions (5.3 injuries per 1000 hours of exposure). Although for males, the epidemiological data available regarding injury incidence during futsal training was insufficient to conduct a meta-analysis, the results of the sole study that provided both match and training incidences in elite male futsal suggest that, and similar to females, most of the injuries occur during matches (Angoorani et al., 2014). Previous studies have attributed these differences in injury incidence rates between match and training to several factors, including the higher physical demands on players during matches in comparison with training sessions, the number of contacts and collisions during matches, and fatigue generated during the course of the match (Bangsbo, Mohr, & Krustrup, 2006; Jan Ekstrand, Hägglund, & Waldén, 2011). Therefore, coaches and sports science specialists, when possible, should include in the training session tasks that reproduce the worst-case scenarios (in terms of physical demands) of futsal match play so that players can be better prepared for competitive match play, which potentially may reduce the risk of injury.

The results of this study also highlight that for male futsal players, the incidence rate during international tournament matches (77.2 [95% IC = 59.9 - 94.5] injuries per 1000 hours of exposure) was 8.5 times higher than during national league matches (9.1 injuries per 1000 hours of exposure). Similar findings were found by López-Valenciano et al. (López-Valenciano et al., 2019) in professional football players, so that during International tournaments, the match injury incidence rate was significantly higher than its counterpart calculated during national leagues (41.1 vs. 32.3 injuries per 1000 hours of match exposure). The higher density of matches played, fatigue levels and the mental stress and anxiety generated in the players have been suggested as contributing factors for this increase in the number of injuries sustained during international tournament matches (Hakan Bengtsson, Ekstrand, & Hägglund, 2013; Håkan Bengtsson, Ekstrand, Waldén, & Hägglund, 2018; Chris Carling, McCall, Le Gall, & Dupont, 2016; J. Ekstrand, Waldén, & Hägglund, 2004). Consequently, during international tournaments the application of effective post-match recovery strategies might help players to alleviate some of the major fatigue-related physical and psychological impairments and this may lead them to a better state to re-perform and to reduce the risk of injury.

Although the epidemiological data available up to date do not allow us to conduct sub-analyses regarding the location, type and severity of the injuries that occur as a consequence of futsal play, the few studies that have provided data in this regard (Angoorani et al., 2014; Junge & Dvorak, 2010; Ribeiro et al., 2006; Ruiz-Pérez et al., 2019) demonstrate that, in both sexes, lower extremity injuries are, by far, the most frequent. Although the most common injury mechanism reported was by non-contact, it should be highlighted that a remarkable number of injuries (around 30%) were caused by a contact mechanism. As mentioned before, the substantive number of high intensity phases observed in elite players during the course of futsal play (Christopher Carling, Le Gall, McCall, Nédélec, & Dupont, 2015; Naser, Ali, & Macadam, 2017) might contribute to generate several contusions and tackling situations and partially explain the fact that contact injuries are more frequent than in other team sports such as football (Hägglund et al., 2009; López-Valenciano et al., 2019) and basketball (McKay, Goldie, Payne, Oakes, & Watson, 2001) in which the number of high intensity phases may be lower (Bloomfield, Polman, & O'Donoghue, 2007; Leite, 2016; McInnes, Carlson, Jones, & McKenna, 1995; Naser et al., 2017). However, more studies examining physical demands (number of accelerations and decelerations, changes of direction, distance covered at high speed running, etc.) of futsal play are needed to look at potential injury mechanisms. Likewise, epidemiological studies also show that the thigh, knee and ankle seem to be the anatomical region of the lower extremity where injuries occurred significantly more in male and female players. In addition, the most common types of injury grouping were ligament (ankle and knee sprains) and muscle/tendon (hamstring, adductors and quadriceps muscle strains) injuries. Fortunately, most of the futsal-related injuries usually have a slight/minimal (1-3 day) or minor/mild severity (4-7 days) and hence, the injury burden seems generally low, but more studies are needed to explore injury burden in futsal-related injuries. Therefore, and for both male and female futsal players, medical and fitness team staff should focus their attention on designing, implementing and then evaluating preventative measures that target the most common knee and ankle ligament and thigh muscle and tendon injuries.

Limitations

Although this novel study was conducted following the international guidelines for systematic reviews and meta-analyses, some limitations should be acknowledged. One of the main limitations of this study was the reduced number of studies that were finally included (n = 6) and that together with the limited sample sizes (< 30 players) present in some of their cohorts may have resulted in a high degree of inconsistency in the injury estimates. However, it should be highlighted that the number of studies and cohorts included in this study was similar than the ones included in previous meta-analyses on sport-related injury incidence (Lystad, Gregory, & Wilson, 2014; Lystad, Pollard, & Graham, 2009; Williams et al., 2013). Another source of inconsistency may have also been the variations in injury definitions and lack of uniform data collection methods found among studies. Other factor that may have also contributed to the high degree of inconsistency could be the differences existing among the national leagues in terms of numbers of matches and in-season breaks, periods of fixed match congestion and level of professionalism. Due to lack of suitable data, sub-analyses regarding location, type and severity of the injuries sustained during futsal play could not be conducted. At elite levels, the number of injuries sustained by players in the same team may exhibit large variations across consecutive seasons as some primary risk factors may be influenced by significant inter-season modifications (e.g.: the workload imposed on players, the quality of internal communication, players' well-being and the head coach´s leadership style) (Ekstrand, Lundqvist, Lagerbäck, Vouillamoz, Papadimitiou & Karlsson, 2018). Consequently, and in order to better reflect the dynamic nature of the injury phenomenon, in our analysis separate incidence rates reported in studies that covered multiple seasons or cups were considered as independent, when multiple comparisons were conducted. For example, the same player may have been counted more than once over the different seasons or cups. However, for each separate incidence rate recorded, the same player was counted only once. A similar approach for managing epidemiological studies covering multiple seasons or cups has previously been adopted in numerous meta-analyses on team sport injury incidence (Doherty et al., 2014; López-Valenciano et al., 2019; Williams et al., 2013).

Future directions

More studies are needed reporting the number of injuries sustained in futsal training sessions and matches separately for males and females, and also the location, type and severity of such injuries per 1000 hours of exposure following standardized injury definitions and data collection procedures. Injury burden (the product of severity and incidence (Bahr, Clarsen, & Ekstrand, 2017)) should also be reported in future epidemiological studies to help interpret injury data from a novel risk management standpoint.

CONCLUSIONS

Elite male and female futsal players are exposed to a substantial risk of sustaining injuries, especially during matches. No sex-related differences were found in the overall futsal injury incidence. For males, this risk of injury during futsal match play is eight times higher during international tournaments than in national leagues. Due to the lack of injury incidence data available for both sexes, future studies are warranted reporting the number of injuries sustained in futsal training sessions and matches separately, and also the location, type and severity of such injuries per 1000 hours of exposure using standardized injury definitions and data collection procedures.

Competing interest
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APPENDICES

Appendix 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist.

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	4
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4

Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	5
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	5
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	5
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	6

Appendix 2. Inclusion/exclusion criteria for futsal literature search.

	Inclusion criterion	Exclusion criterion	Rationale for this criterion
Publication type	Peer-reviewed original research articles only	Non-peer-reviewed articles, newspapers, opinion pieces, systematic reviews and meta-analysis, editorials, commentaries and letters to the editor. Conference proceedings/abstracts.	For reasons of practicality, it was deemed acceptable to include only studies published in peer-reviewed journals.
Language	English, Spanish and Portuguese language	Non-English, Spanish or Portuguese	For reasons of practicality, it was deemed acceptable to include only studies published in English, Spanish or Portuguese.
Study design	Descriptive epidemiological studies	Anecdotal studies. Case studies or expert opinion	Based on the evidence hierarchy as a guide, ONLY study designs ranked at least as 'good' were included in this systematic review and meta-analysis. This was to ensure high methodological rigour and offer reasonable empirical support for the incidence and aetiology of injuries among males and females who play elite futsal.
Age	Male and female futsal players > 16 years participating in a competitive league (matches or training) OR international tournament	Ages <18 years, age unspecified studies	Players aged >18 years were considered as appropriate. The injury profile of players aged >18 years is important given that they participate in elite competition. Studies that reported injuries for players <18 years and >18 years and have data for age groups, but presented separately, were included
Playing level	Elite and sub-elite players	Amateur	

			The physical demands of futsal game may vary across different playing levels and this may led develop different injury patters
Sport	Futsal	Any sport other than futsal	Inclusion of sports with different regulations and physical demands can results in different injury incidence and characteristic
Injury definition	Time loss injuries (injury that results in a player being unable to take full part in future football training or match play)	Other definitions different than time loss injuries	Different injury definitions (i.e. decrease in the performance due physical complaints, needed of going to the hospital to be considered an injury) may result in different incidence rates
Main outcomes	Injury incidence rates per 1000 hours of player exposures	Descriptive epidemiological studies that do not include exposure time.	For reasons of practicality, it was deemed acceptable to include only studies that included exposure time in order to make inter-studies comparisons.

Appendix 3. Operational definitions used to include studies in the meta-analysis.

Term	Definition
Injury	Any physical complaint sustained by a player that results from a futsal match or futsal training, irrespective of the need for medical attention or time loss from futsal activities.
Time loss injury	Injury that results in a player being unable to take a full part in future futsal training or match play.
Recurrent injury	An injury of the same type and at the same site as an index injury and which occurs after a player's return to full participation from the index injury.
Injury severity	The number of days that have elapsed from the date of injury to the date of the player's return to full participation in team training and availability for match selection. Injuries are grouped as: *Slight / Minimal* Absence (1-3 days) *Minor / Mild* Absence (4-7 days) *Moderate* Absence (8-28 days) *Major / Severe* Absence (>28 days)
Match exposure	Play between teams from different clubs.
Training exposure	Team-based and individual physical activities under the control or guidance of the team's coaching or fitness staff that are aimed at maintaining or improving players' futsal skills or physical condition.
Overuse injury	An injury caused by repeated microtrauma without a single, identifiable event responsible for the injury.
Traumatic injury	Injury with sudden onset and known cause.
Injury location	▪ Head and neck (Head/face; Neck/cervical spine) ▪ Upper limbs (Shoulder/clavicula; Upper arm; Elbow; Forearm; Wrist; Hand/finger/thumb) ▪ Trunk (Sternum/ribs/upper back; Abdomen; Lower back/pelvis/sacrum) ▪ Lower limbs (Hip/groin; Thigh; Knee; Lower leg/Achilles tendon; Ankle; Foot/toe)
Type of injury	• Fractures and bone stress • Joint (non-bone) and ligament [Dislocation/subluxation; Sprain/ligament injury; Lesion of meniscus or cartilage] • Muscle and tendon [Muscle rupture/tear/strain/cramps; Tendon injury/rupture/tendinosis/bursitis] • Contusions [Haematoma/contusion/bruise] • Laceration and skin lesion [Abrasion; Laceration]

	• Central/peripheral nervous system [Concussion (with or without loss of consciousness); Nerve injury] • Other [Dental injuries; Other injuries]
Injury incidence	Number of injuries per 1000 player hours ((Σ injuries/Σ exposure hours) ×1000).

Appendix 4. Moderator variables codded.

General study descriptors
▪ Authors
▪ Year of the study
▪ Country / Tournament
▪ Sampling time (number of seasons)
Description of the study population
▪ Sample size
▪ Number of teams
▪ Age
▪ Level of play (club or national team)
Epidemiological descriptors
▪ Injury definition
▪ Number of injuries (total, match and training)
▪ Exposure time (total, match and training)
▪ Incidence (total, match and training)
▪ Injury burden or days lost per injury
▪ Injury location
▪ Type of injury
▪ Severity of injury
▪ Recurrence
▪ Injury mechanism (traumatic or overuse)
▪ Quality of the study (abbreviated STROBE scale)
▪ Risk of bias (adapted NOS scale)