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Prevalence and incidence of injuries among female cricket players: a systematic review and meta-analyses

Jolandi Jacobs

Dissertation submitted to the Faculty of Health Sciences,

University of the Witwatersrand, Johannesburg, South Africa,

in fulfilment of the requirements for the degree of

Masters of Physiotherapy

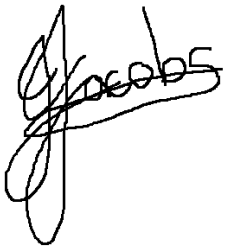
Submitted: June 2021

Declaration

I, Jolandi Jacobs, state that the work included in this research manuscript is my own, except to the degree stated in the acknowledgements section.

This manuscript is being submitted for the degree of Masters of Physiotherapy, at the University of the Witwatersrand, Johannesburg, South Africa.

This dissertation has not been submitted to this or any other institution for any other degree or examination.



Jolandi Jacobs

MSc Candidate

Signed

03 June 2021

Dedication

To all female cricketers, keep raising the bar!

Contributions of authors to the study

As part of the declaration, I acknowledge the work of the following individuals as part of this research dissertation: Jolandi Jacobs (JJ), Dr. Muhammad Dawood (MD), Prof. Benita Olivier (BO) and Dr. Nirmala Perera (NP). All the authors of this study are researchers with a special interest in the field of cricket. These authors contribute to the prevention and/or reporting of injuries in both men's and women's cricket.

Jolandi Jacobs: First author, Lead reviewer, Conceptualisation, Original draft of protocol, dissertation and article design, Methodology (study selection, critical appraisal, data extraction and data analysis). **Benita Olivier:** Supervision, Second author, Third reviewer, Conceptualisation, Expert Opinion, Reviewing and Editing. **Muhammad Dawood:** Supervision, Third author, Second reviewer. **Nirmala Perera:** Fourth author, Expert Opinion, Reviewing.

This author (JJ) was responsible for drafting all published work, including the protocol, manuscripts (first and final drafts) and all relevant publications. All co-authors reviewed and approved the editing changes to the drafts before the manuscripts were published or submitted to the school or faculty.

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Publications arising from this study

1. Jacobs J, Olivier B, Dawood M, Perera N. 2021. The prevalence and incidence of injuries among female cricket players: a systematic review protocol, JBI Evidence Synthesis (published online).

2. Jacobs J, Olivier B, Dawood M, Perera N. 2021. The prevalence and incidence of injuries among female cricket players: a systematic review and meta-analyses, JBI Evidence Synthesis (article under review).

Abstract

Cricket, a bat-or-ball sport, is growing in popularity among women of all ages and abilities around the world. Cricket participation, on the other hand, carries an injury risk. Injuries have a negative impact on sport participation, performance, as well as short- and long-term health and well-being. Injury prevention is thus the key to long-term safe cricket participation as a physical activity goal. Epidemiological data is required to support evidence-based injury prevention strategies.

The objective of this systematic review is to describe the prevalence and incidence of injuries among female cricket players. Female participants of all ages, participating in all levels of cricket were included in the review, including studies that report data by sex. Studies with insufficient data, female cricket injury data not distinguished from males or other athletes, male only data and case studies were excluded. A systematic review and meta-analyses were conducted according to Joanna Briggs Institute (JBI) and PRISMA guidelines. MEDLINE, SPORTDiscus, Physiotherapy Evidence Database (PEDro), EBSCOhost MasterFILE Premier, EBSCOhost CINAHL Complete, ProQuest Health and Medical Complete, SCOPUS and Science Direct were systematically searched from inception to August 2020. Additionally, Cochrane Controlled Trials Register and ClincalTrail.gov, were searched. OpenGrey (SIGLE), WorldCat, Grey Matters, Grey Literature and Google Scholar were searched for grey literature.

A total of 3,349 studies were found after duplicates removed and 20 studies met the inclusion criteria. Full-text articles which met the inclusion criteria were critically appraised using JBI critical appraisal instruments. Nineteen studies had a low risk of bias. Data were extracted using JBI data extraction instruments. Data was synthesized in a narrative summary and tabular forms using JBI SUMARI software. Meta-analyses were conducted using Comprehensive Meta-Analysis 3.0 for injury incidence rate (injury IR), injury incidence proportions (injury IP) and injury prevalence proportions (injury PP). The random effects model and the I^2 statistic was used to assess the heterogeneity. The weighted injury IR was 72.1 (95% CI 30.4-113.8) per 1,000 player hours and scored low heterogeneity. The injury IP was 90.8 (95% CI 89.0-92.5) per 1,000 participants, however this meta-analysis has high heterogeneity and should be interpreted with caution. The injury PP was 63.1% (95% CI 47.7-78.5) and scored low

heterogeneity. The most prevalent body regions injured were the shoulder, knee, and ankle, foot and toes, and injuries to these areas were most frequently sustained by fast bowlers. Injuries to the hand, wrist and fingers had the highest incidence compared to other body areas and injuries to these areas were most frequently sustained by fielders.

This review highlights that the prevalence and incidence of injuries sustained by female cricket players are high. The quantitative findings from this study will provide stakeholders (including players, coaches, clinicians, administrators and policymakers) with level 1 evidence to implement injury prevention and appropriate female cricket players management strategies. This review identified gaps in the existing literature that should be filled through future research to advance women's cricket as a professional sport.

Systematic review registration number: The PROSPERO International prospective register of systematic reviews registration ID: CRD42020166052 (https://www.crd.york.ac.uk/PROSPERO/).

Acknowledgements

It was such an honour to be involved in a small part of the evolution of women's cricket research. Cricket has been a part of my life since I can remember and completing this research work feels like I am giving back to sport for all the joy that it has brought to my life.

To Dr. Nirmala Perera, thank you for your guidance and excellent research expertise during this journey. You have done great research groundwork for women's cricket, and I hope that other researchers like myself will continue with your excellent work.

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I would like to pay tribute to my friends who have encouraged me on this journey. A big thank you to my family for their support. It has been such a rewarding journey to pursue my dreams and aspirations this early in my career, and I am so excited to see what the future holds!

Thank you, Lord, for every opportunity and talents I am blessed with.

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List of Abbreviations

AE	Athletic Exposure
CI	Confidence Interval
ED	Emergency Department
ICC	International Cricket Council
ICD-10-AM	International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification
IR	Incidence Rate
IP	Incidence Proportions
PP	Prevalence Proportions
IWCC	International Women's Cricket Council
JBI	Joanna Briggs Institute
JBI SUMARI	Joanna Briggs Institute System for the Unified Management, Assessment and Review of Information
LBP	Lower back pain
ODI	One Day International
OSICS-10	Orchard Sports Injury Classification System version 10
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
Q-angle	Quadriceps angle
SE	Standard Error
T20	Twenty20

Operational definitions

The following terms were defined specifically for use in this thesis:

Batter: The player who faces the ball delivered from the bowler (2).

Bowler: Bowlers can be categorised into fast (or pace) and slow (or spin) bowlers. Fast bowlers can be further sub-grouped into ‘fast’, ‘fast-medium’ or ‘medium’ bowlers, and ‘slow’ bowlers as off/finger and/or leg/wrist spin bowlers (3).

Incidence: The total number of new injuries (including recurrent injuries) occurring over a certain period. Incidence is reported with a time denominator (3).

Injury: The instance where a player is not fully available for a match selection or when the player in unable to bat, bowl, field or keep wicket as requested by the team's captain or the rules of the game (3).

Innings: The period where a batter/team can bat in the match before the batter/team is out or their batting turn has been completed (2).

One-innings match*:* Match is played over one day with limited overs per team (4).

Proportions: The number of athletes presenting with an injury divided by the total number of athletes (5).

Prevalence: The percentage of participants/squad members that is injured or ill and not available for match selection at a particular time, divided by the total number of participants/squad members at that particular time (3).

Rate: The number of injuries divided by the number of athlete-exposure time, using an epidemiologic denominator (5).

Two-innings match: Match is played over two days with unlimited overs (4).

Wicketkeeper*:* The player that keeps the wicket. The wicketkeeper stands close to the wickets for slow bowlers and further away from the wickets for fast bowlers (3).

Chapter 1 Introduction

1.1 Background

Cricket is one of the most popular sports in the world. Women have been playing cricket for more than 200 years, with the first women's cricket match played in 1745 in England (6). The Women's Cricket Association, founded in England on 4 October 1926, was the first international women's cricket body (7). Australia, New Zealand and the Netherlands soon followed suit establishing their own national women's cricket bodies. The first women's World Cup was held in England in 1973 (6, 8). In February 1985, the International Women's Cricket Council (IWCC) was established. The IWCC and the ICC (International Cricket Council) united in 2005 thereby combining men's and women's cricket into one international organising entity, the ICC (9). The first women's Twenty20 (T20) match was played between New Zealand and England in 2004 (10). Since the first ever ICC Women's World Twenty20 Championship in England in 2009 (8), there has been a surge in interest and investment in women's cricket and women now have the opportunity to pursue a professional career in cricket.

In recent years, there has been a noticeable increase in the popularity of cricket among women of all ages and level of play (from recreational- to elite-level). For example, women's cricket participation rapidly grew in countries like Australia (11, 12), Bangladesh (13, 14), India (15) and the United Kingdom (16, 17). Public interest in women's cricket grew alongside more than 180 million spectators watching the 50-over One Day International (ODI) Women's World Cup in 2017 (6). The 2020 ICC Women's Twenty20 World Cup became the most watched women's cricket event, setting new broadcasts and viewing records with 136,549 total attendance at the tournament and 1.1 billion digital views (18). An exciting announcement to the women sports fraternity was made in August 2019, with the introduction of women's cricket at the 2022 Commonwealth Games. This is a first for women's cricket, with a minimum of eight teams expected to participate in this upcoming event (19).

There is a propensity for increased injury risk with the increased participation in women's cricket. Injuries negatively affect sports participation, training, performance, short- and long-term health and well-being of the affected players. Sports injuries

contribute to 20% of school absenteeism for at least one day a year (20), which could impact education quality and give rise to depression (21). Long-term health outcomes of sports injuries include early-onset osteoarthritis (22) and a subsequent increased demand for future healthcare. Further, 8% of participants drop out from youth sports annually due to injury or fear of injury (20), which could contribute to the burden of increasing inactivity and obesity.

Maximising training and competition availability have been consistently demonstrated to improve performance and success where injury occurrence is associated with both individual and team failure (23-25). Players sustaining an injury can impact sport careers, with some injuries terminating careers (26). Previous injury is the strongest risk factor for subsequent injury (27). Therefore, female cricket players sustaining injuries in their pre-elite years can influence future injury risk and long-term health consequences. Furthermore, improving injury prevention and management strategies, can increase female cricket players' retention of all levels of play and improve the chance of aspiring female cricket players to progression into elite-level athletes.

The Sequence of Prevention of Sports Injuries (28) and Translating Research into Injury Prevention Practice (TRIPP) framework (29), are established frameworks for sport injury prevention research. The first step sport injury prevention is to define the problem through the systematic collection of information about the magnitude, scope, characteristics, mechanisms and consequences of sport injuries. However, there are no universal injury surveillance system available for men or women's cricket at community or international levels to provide a comprehensive overview of cricket injuries.

Injury profiles, risk factors and mechanisms vary between sports, and throughout an athlete's career. Due to the physiological differences between male and female athletes, injury risk factors and injury patterns vary between athlete sex. Compared to males, injury risk is higher for female athletes completing at similar level (30). There are morphological and physical characteristics such as muscle strength, endurance, and physical abilities that differ between sexes (31). Hormone fluctuations associated with menstrual cycle and joint laxity have an effect on injury risk and sport performance in female athletes (30, 32). Furthermore, due to the variations in factors such as

bowling pace, workload management, match schedules (12, 15) playing skills and response to match and training conditions, it is not appropriate to generalise evidence from male to female players (12, 33). These factors also suggest that the available body of research pertaining to male players is not applicable to injury prevention strategies for female players.

Perera et al. (34) conducted a systematic review and meta-analysis in 2018 and broadened the research field of women's sport with similar injury potentials and categorised them as 'bat-and-ball and ball-and-stick' sport. The authors grouped related sports (baseball, field hockey, cricket, lacrosse, t-ball and softball) with similar injury potential, hence the lack of evidence in women's cricket. Cricket can be identified as a 'bat-and-ball' team sport according to the International Statistical Classification of Diseases and Related Health Problems (ICD-10-AM) (35). Even though Perera et al. (34) presented the first detailed analysis of the injury profile of women who played competitive 'bat-and-ball and ball-and-stick' sports, their review only included two studies on women's cricket (36, 37) and is not a true reflection a true reflection of injuries sustained in women's cricket. Further, data from the two cricket studies (36, 37) were not included in the meta-analyses (34).

Munro and Christie (31) evaluated the existing literature of women's cricket to identify research guidelines for the improvement of women's cricket in 2018. Munro and Christie (31) indicated that more research is needed on different player roles, different levels of play and different formats of the game. Research for anthropometric characteristics, injury prevalence and mechanisms of injury need to be prioritised in women's cricket (31). Munro and Christie (31) concluded that the existing literature primarily focused on elite Australian fast bowlers, and highlighted the dearth of research for women's cricket. Only five studies on injury rates for women's cricket were included in this narrative review. However, the study by Munro and Christie (31) was not subjected to the rigorous methodology associated with systematic reviews; nor did the authors perform a meta-analysis.

In recent years, research into women's cricket has increased alongside popularity of the sport. Searches in the Pubmed database revealed a twofold increase in publications for women's cricket research over the last two decades. Several articles

were published in peer-reviewed journals since the publication of the reviews in 2018 by Munro and Christie (31) and Perera et al. (34). This author (JJ) found several peer-reviewed publications and grey literature that were not included in the previous reviews in 2018 (31, 34) to justify a systematic review exclusively for women's cricket. Also, both reviews (31, 34) conducted in 2018 did not include data from recreational cricket players, yet majority of players participate at recreational level. To avoid duplication, PROSPERO, MEDLINE, the Cochrane Database of Systematic Reviews and the JBI Database of Systematic Reviews and Implementation were provisionally searched to identify any reviews on women's cricket. No current or ongoing systematic reviews on the relevant research subject were found.

Epidemiological data needs to be obtained using injury surveillance systems to provide a solid foundation for the successful prevention of injuries among female cricket players (17, 33). The rise of professional women's cricket leagues increases player workloads and performance therefore increasing the injury risk and it is of critical importance to investigate these implications (3). Understanding the injury prevalence (proportions) and incidence (rate) may inform stakeholders (including players, coaches, clinicians, administrators and policymakers) to adjust existing strategies to enhance player performance, improve workload management and implement injury prevention strategies (33). Amid recent research investments, there is a dearth of formal injury reviews on the surveillance of women's cricket in major cricket countries. Therefore, a systematic review is required to identify, analyse and synthesise the current data to provide a detailed profile of women's cricket injuries at different levels of play. Quantification of injuries will enable directed prevention strategies to be prioritised and developed and can directly impact athlete longevity and performance.

A *priori* review protocol (1) was developed according to the JBI methodology for systematic reviews of prevalence and incidence (38) and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (39) and was published in JBI Evidence Synthesis (1). Information of this review (such as review question, objectives, inclusion criteria, methodology, etc.) were captured in advance in the *priori* review protocol.

1.2 Problem Statement

The prevalence and incidence of injuries among female cricket players can be expected to increase in accordance with the increased participation in the sport. There has been an increase in peer-reviewed publications and grey literature on injuries in women's cricket. As the study designs and populations vary, there is a need to synthesise the results in a systematic review to highlight the current knowledge of injuries in women's cricket and to identify gaps in the literature. Even though recent research findings on women's cricket have been made available, there is no systematic review that reports on the injury prevalence (proportions) and incidence (rate) for women's cricket apart from other sports and/or men's cricket.

1.3 Research Question and Aim

1.3.1 Research question

What is the prevalence and incidence of injuries sustained by female cricket players participating in all levels (recreational to elite)?

1.3.2 Aim

The aim of this study is to determine the prevalence and incidence of injuries sustained by female cricket players participating in all levels (recreational to elite).

1.4 Significance

A systematic review of the current literature is essential for the recognition, analysis and synthesis of established data to obtain a detailed overview of injuries sustained by female cricket players. This systematic review will contribute to women's cricket research on a national and global level by finding all relevant research on injuries in women's cricket and providing evidence-based data for decision-makers and management of the relevant women's cricket bodies. Furthermore, a systematic review will summarise the results of the available studies and provide scientific findings of injury prevalence and incidence of female cricket players on a global scale.

South Africa, like several other major cricket countries, has limited literature available on injuries in women's cricket (8, 31, 40). The burden of injuries can significantly reduce the performance of a team, as injuries prevent player participation and further hinder the success of a sports team (41). Uninjured player availability improves the dynamics of the team and likelihood of success. Injury incidence (rates) and prevalence (proportions) need to be quantified and presented to women's cricket stakeholders with the aim to reduce the injury risk (42)

Quantifying and reporting injury rates are stepping-stones to injury prevention and highlight the importance of injury surveillance and the adequate management of players for optimal sport performance. This systematic review will be the first, not only for South Africa, but the world, to provide quantitative results for prevalence (proportions) and incidence (rate) of injuries for women's cricket exclusively. This research may contribute to the national and international development of women's cricket by providing quantitative evidence-based injury data for stakeholders in women's cricket to influence decision-making with the objective of reducing the injury risk.

1.5 Outline of this Research Dissertation

The outline this research dissertation is displayed in Figure 1.

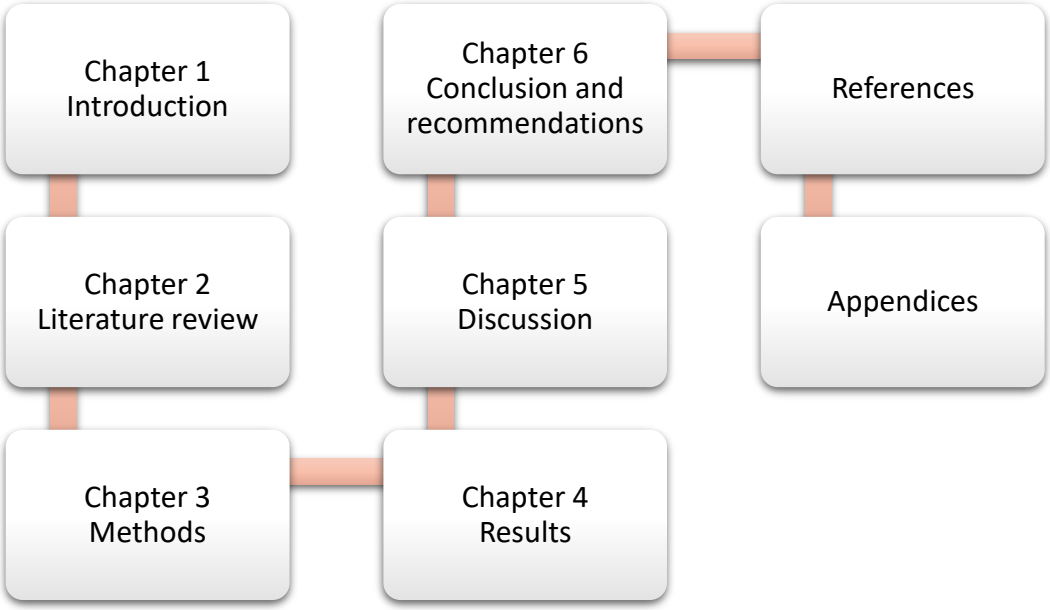


Figure 1: Outline of the dissertation

Chapter 2 Literature Review

2.1 Outline of the Literature Review

The outline of this literature review contains the following sections: search strategy of the literature review, overview of cricket, overview of women's cricket, limitations in women's cricket, injuries in cricket, injury definitions used in cricket, prevalence and incidence of injuries in cricket, the available literature on women's cricket and the conclusion of the literature review.

2.2 Introduction

Cricket is a popular sport played all over the world. Not only is the sport favoured among cricket players, but cricket has a great following of spectators. The popularity of women's cricket has evolved in recent years from casual participation to a professional sport with women participating in international tournaments at the highest level. There is an inherent injury risk when participating in cricket (17, 34, 43, 44). Research in cricket predominantly focuses on male players. Cricket findings for male cricket players cannot be directly extrapolated to female cricket players (12, 15, 31, 33). Research is required to provide quantitative data for women's cricket stakeholders to highlight the extent of injuries sustained by female players in order to gain the same level of recognition as their male counterparts. Women's cricket, being new to the international scene, needs to implement formal injury surveillance systems and research strategies to aid in the professional development of the sport.

2.3 Search Strategy

The searches for this literature review were conducted in the following databases: MEDLINE, SPORTDiscus, EBSCOhost, and Science Direct. The following keywords were searched in all the databases and included, but were not limited to: cricket, female, woman, women, ladies, injury, injuries, injured, and pain. This researcher (JJ) conducted all the searches for the literature review. The searches were altered for each database searched. Where available or appropriate, subject-specific terms such as MeSH were searched. The searches were not limited to a specific time-period in

order to supplement the total results. Filters for ‘human’ and ‘female’ were applied wherever possible. This researcher (JJ) found 78 studies that addressed the research questions of this literature review. Articles which were not relevant to the objectives of this study were excluded as they did not add value to the literature review. The studies were screened, and 35 studies were deemed suitable for inclusion in this literature review.

2.4 An overview of the sport: cricket

Cricket is played by two teams of 11 players each during a competitive match. There are different player roles in each team, categorised as the following: batting, bowling, fielding, and wicketkeeping. Each player role has a different function in a team (45). Player roles are equally important and necessary for a competitive cricket match to take place. All-rounders perform both the bowling and batting player roles (2). During a competitive match the batting team requires two batters and the bowling/fielding team 11 players to be on the field at all time (2).

A bowler is the player who delivers the ball to the batter using a legal bowling action (3). Bowlers are categorised into fast bowlers, fast-medium bowlers, medium bowlers, and spin/slow bowlers (Figure 2). The terms, fast and fast-medium bowlers, can be combined and described as pace bowlers (3). Pace bowlers deliver a ball at a high speed, usually from a longer bowling run-up. Spin or slow bowlers deliver balls at a slower speed, usually from a shorter run-up (46). Medium pace bowlers have a slower bowling speed than pace bowlers but deliver the ball faster than slow/spin bowlers. Previous research indicates that female bowlers have similar run-up speeds to those of male bowlers; however, the mean ball release speed of females is much slower than that for males (47, 48). Findings also suggest that female bowlers deliver the ball at average speeds of up to 120 km/h compared to the male fast bowlers’ speed of 140 km/h (49).



Figure 2: Bowler

The fielding/bowling team has one bowler at a time to bowl six legal balls to conclude an over. The other ten players will be fielding while the balls are being bowled. The wicketkeeper (Figure 3), who plays a dominant role in the fielding team, is the player positioned behind the wickets on the side opposite to the side from which the bowler is bowling (3). The fielders are the players on the field who assist the bowler and wicketkeeper in limiting the number of runs scored by the batter. Fielders and wicketkeepers need to accelerate, jump or dive from their respective positions to field the ball (50). The fielding team members can take wickets by catching the ball on the full or by dismissing a batter during a run out (2).



Figure 3: Wicketkeeper

The term ‘batter’ is recognised as a more sex-inclusive term than the term ‘batsman’ and should rather be used to include both sexes (51). Batters (Figure 4) are players wearing protective clothing and uses a cricket bat to score runs when facing deliveries from the bowler (52). Each batting turn is called an innings, and an innings is concluded when the limit of overs or time is reached, or when the batting team is dismissed. When a bowler, fielder, or wicketkeeper dismisses a batter, a new batter will then step out to the wicket (2). The batting team aims to get as many runs as possible during their innings whereas the bowling/fielding team aims to restrict the batting team from scoring runs and from taking ten wickets to close the innings. Ultimately the team with the most runs wins the match (2).



Figure 4: Batter

There are currently three different formats of cricket being played. Firstly, test match cricket is a two-innings match played for several days with unlimited overs per team (53). Test cricket for men’s cricket extends over a period of five days; however, some of the women’s test cricket matches are played over four days (54). Another format of cricket is a one day international (ODI), a one-innings match with limited overs per team (3). Lastly, twenty20 (T20) match is the most recent format of cricket and brings much excitement to the game. A T20 match is a one-innings match with the teams limited to 20 overs each (55). Table 1 summarises the schedule of matches adapted from Orchard et al. (3) and individualised for women’s cricket.

Table 1: Schedule of matches for female cricket players

	One-innings Match	One-innings Match	Two-innings match
Match between international teams	One-day international (limited to 50 overs)	Twenty20 international match (limited to 20 overs)	Test match (limited to 4 days*)
Match between non-international teams of the same country	Domestic one-day match (limited to 50 overs)	Domestic one-day match (limited to 20 overs)	First class domestic match (limited to 4 days*)
Match between two first-class teams (other)	Other List A one-day match (limited to 50 overs)	Other List A one-day match (limited to 20 overs)	Other first-class match (limited to 4 days*)

Table was adapted from Orchard (3)
**according to Harris (54)*

2.5 Women's cricket

2.5.1 Overview of women's cricket

The first investigations into women's cricket date back to the first match played in 1745. The Women's Cricket Association was the first international women's cricket body found in England on 4 October 1926 (7). Australia, New Zealand and the Netherlands followed suit by establishing national women's cricket bodies. In 1973, the first women's World Cup was held (6, 8) in England. In February 1985, the International Women's Cricket Council (IWCC) was established. The IWCC and the ICC (International Cricket Council) united in 2005 by combining men's and women's cricket into one international organising entity, the ICC (9). In 2004, the first women's T20 match between New Zealand and England was played (10). Together with the men's tournament in England in 2009, the first ICC Women's World Twenty20 Championship was held and brought fresh energy to the development of women's cricket (8).

Cricket has always been considered a 'gentleman's game,' but on the contrary, women have been setting records since it's conception (56). The first person bowling an overarm delivery was a woman, Christine Willes, this in spite of the fact that her brother took credit for her invention (8). Furthermore, women's cricket holds the records for

the first World Cup held in 1973, the first Twenty20 international match in 2004, and the first day/night test match in 2017. Women also hold records for the first five-wicket haul in an ODI World Cup, the first team ever to win the World Cup five times (57) and the first double century scored in cricket. Belinda Clarke achieved the first ever double century in 1997, whereas Sachin Tendulkar, the first male cricket player to score a double century, only achieved this ten years later (57).

There has been considerable increase in women's cricket participation and support in recent years (33). Women's cricket has gained momentum in terms of participation and success and has established itself in almost all countries across the globe. Elite-level cricket includes players competing at national and international levels. Remuneration for cricket players is usually only possible at the elite-levels. The ICC listed ten women's cricket teams that compete in international cricket competitions; Australia, Bangladesh, England, India, Ireland, New Zealand, Pakistan, South Africa, Sri Lanka and West Indies (58). The latest excitement in elite-level cricket lies in the shorter formats of cricket, such as T20 cricket. Twenty20 cricket has become popular among female cricket players as well as among supporters. Recent studies have also shown increased participation of women in the T20 format at club and junior-levels (59, 60).

The literature available for women's cricket is weighted heavily by Australian research as this country has the most published research studies on women's cricket when compared to the rest of the world. Australia is the leading country in women's cricket (18, 58), owing to Cricket Australia's significant investment in female cricket players at all levels, from elite to school-level participation (56, 61, 62). Cricket Australia has reported its objectives for women's cricket in the 2017 Australian Cricket Strategy by addressing certain aspects to promote gender equality, increasing the opportunities for women in all aspects of cricket and supporting the recent development of the sport (63). Investigations from Cricket Australia highlight that girls' and women's cricket is the fastest growing field of cricket in the country. In fact, women's cricket participation in Australia increased by 22% from the 2010-11 to the 2011-12 season (64). Furthermore, Cricket Australia reported on the rapid growth in women's cricket in the 2013-14 season, with another 18% increase in participation. Another significant finding

is that women's cricket in Australia has constituted almost 25% of the entire cricket profile (64).

Club cricket includes individuals who participate as a team in a competitive league (2). Club-level cricket provides female cricket players with opportunities to develop their skills during competitive cricket. It is the cornerstone of the Australian Cricket Talent Pathway, of pathway cricket presented by the England and Wales Cricket Board, as well as of other major cricket countries. Research findings from the United Kingdom have reported more than 63,000 females older than 14 years participating in club-level cricket (65). The Women's County Championship, held in England, is the 50-over tournament played by 36 teams (59).

School or junior-level cricket involves players who compete in school-based competitions or junior club competitions. Cricket participation in recent years grew among the junior-level players. Junior-level cricket involves competitions targeting Under-13, Under-15 and Under-18 age groups in Australia and other major cricket countries. The competitions aim to encourage participation in a fun-filled learning environment for the junior-level cricket players (66). It is a well-known fact that junior and senior cricket players differ in terms of several physiological and skills factors (67-69). Findings on injury rates in junior-level cricketers indicate lower rates than for senior cricketers (70) but higher when compared to other non-contact team sport at the junior level (69).

Recreational cricket exists at the grassroots level with involvement in competitive or non-competitive cricket. Recreational cricket is seen as a social game played for enjoyment or also called the "Spirit of the Game" (71). An aspect of recreational cricket includes indoor cricket. The participation of women in indoor cricket has increased in recent years, with some players competing at the elite level. Indoor cricket provides opportunities for female cricket players to improve their skills and also offers professional pathways to Club and National Indoor Cricket Championships (66).

2.5.2 Women's cricket in South Africa

The South African National team, also called the Proteas Women, is regulated by the South African & Rhodesian Women's Cricket Association (SA&RWCA) (59). The Proteas Women made headway in 1997 when the side reached the quarterfinals for the first time in the Women's World Cup. The Proteas Women also reached the semi-finals in the 2000 World Cup held in New Zealand (8). Another first, was the 2005 Cricket World Cup hosted by South Africa. The Proteas Women continued to impress their supporters when they reached the semi-finals in the 2017 World Cup, and again in the ICC Women's T20 World Cup in 2020. Recent international tournaments, such as the Australian Women's Big Bash League, have also drawn several South African women to play competitive cricket outside the country (72).

The increased participation of females in school, club, and provincial cricket during the cricket season is a key indicator of the development of the sport. School-level cricket includes participation in a variety of competitive leagues in each province or district. Junior-level players in women's cricket can be chosen to represent their respective provinces at the national level. At the end of each cricket season, a National Week is held for each of the Under-13, Under-16 and Under-19 levels. Thereupon, the top-performing players are chosen for the National Girls' team for their respective age group (73).

Apart from junior-level cricket, senior cricket players have the opportunity to play for a franchise and can be chosen to compete at the provincial-level. Cricket South Africa (CSA) hosts individual competitions, including T20, ODI and first-class matches, for both franchises and provincial leagues (73). The national team managers recruit players from these leagues to represent their country on the international platform (59). The Proteas Women is a force to be reckoned with, setting new records and achieving great success in recent series against major cricket countries (74, 75). Exciting times await for South Africa as the country will host the 2023 ICC Women's World Cup (76).

2.6 Limitations in women's cricket

There are several unequal representations in the budgets and support staff for men and women's sports. These representations also relate to cricket, where the budgets

for women's cricket are limited compared to those for men's cricket (77). Attention also needs to be placed on the financial shortfalls for women's cricket. A comparison between the remuneration for male and female cricket players showed that female cricket players still earn considerably less than their male counterparts (78). According to a 2017 survey, the average hourly rate for a male cricket player was 38% higher than that of a female cricket player (79).

Not only the limitations of financial support, but also the lack of exposure and recognition of women's cricket in previous years, may have led to a large gap in the literature pertaining to women's cricket. Research findings are needed to perform evidence-based decisions for medical, player and performance management specifically for women's cricket (80, 81). The fractional assistance of staff from the men's teams to support the women's cricket players, with the same management strategies, is a common issue in cricket. Although this method is well-intentioned, it is not proving to be satisfactory in terms of the recent literature findings on the differences in the injury profile between men and women's cricket. Individualised, evidence-based decision by women's cricket stakeholders would lead to the development of professionalism and increased performance of female cricket players (56).

Among some countries, the women's cricket teams are more successful than the men's teams. However, the public would not even know this as several of the women's cricket matches are not always broadcasted and the numbers of spectators at matches are not well recorded (77). Another significant limitation is the lack of funding and resources for non-elite-levels of cricket, especially when compared to the elite-level (56). These shortcomings have contributed to a significant gap in performance, support and development between elite-level and non-elite-levels of women's cricket.

Female cricket players are usually remunerated only when playing at the elite-level Professional players in several countries are working part-time for financial support. Even so, female cricket players are restricted when exploring meaningful careers other than cricket because of the huge demands associated with training and playing, and the travel commitments for training and match schedules (56). Furthermore, female cricket players point to the fact that the lack of financial support for women's cricket has led to the dominant role that family members and friendships are playing as the

dominant financiers in the player's development and journey to the elite-levels (56, 82). However, in recent years, countries such as Australia, England, New Zealand, and South Africa have provided elite-level female cricket players with full-time contracts. In 2017, Cricket Australia made a five-year financial offer to female cricket players competing in the Women's Big Bash League and/or the Women's National Cricket League (83) to the effect that the salary of the average female cricket player competing in these leagues would increase by nearly 125%. While remuneration has greatly improved over recent years, only a number of female players have been identified as contracted players and are not regarded in terms of offsetting the requirements of a career outside of cricket (56).

2.7 Injuries in cricket

Cricket is a non-contact sport and has a lower injury risk when compared to contact sports (3). However, physical participation in sport activities poses injury risks to participants (84). Three particular aspects of cricket, namely bowling, catching and fielding, are associated with high injury risk (85).

2.7.1 Injury definitions

In 2005, cricket experts from various countries came together to discuss the definitions of injury and to report on standards for injury surveillance in cricket (3). The council developed the guidelines for this purpose which they called the International Consensus Statement (3). This statement establishes consistent injury definitions and guidelines as the gold standard for cricket injury comparisons. The term 'injury' refers to an incident or medical condition that prevents a player from being eligible for selection in a match, or restricts a player from batting, bowling, or keeping wicket as required by the captain or by the rules of the match (3). Ten years later, the researchers met again in 2016 to update the International Consensus Statement (3). They updated the definitions of injury and proposed that further consensus is needed for categories such as amateur and junior-level cricketers and specifically for women's cricket (3).

The 2016 International Consensus Statement provided specific definitions of injuries as a standard for conducting and reporting cricket research (3). The term 'medical

attention injury' is defined as an injury that restricts the player, causes missed training or match time, and requires medical care. Medical attention injuries include both time-loss and non-time-loss injuries (3). A ‘time-loss-injury’ refers to the circumstance when a player is unavailable for a match selection or during a match on account of his/her not being able to bat, bowl, or keep wicket, as required by the match rules or as requested by the captain. Medical attention injuries that are not listed as ‘match time-loss’ can be considered as ‘non-time-loss’ injuries (3). A 'time-loss' injury is described as any injury causing a player to be ruled unfit for a match, regardless of the scheduled match or training session (3). Finally, the term ‘player-reported injury’ is defined as any injury that is reported by the player or other individuals without an official medical diagnosis (3).

2.7.2 Injury surveillance

The availability of uninjured players contributes significantly to the success of all competitive sports, as injuries prevent the participation of the players and hinder the success of the sports team (41). The availability of uninjured players improves the dynamics of the team and the likelihood of success. In order to minimise medical attention or general time-loss injuries, injury prevention strategies are needed (42). Injury prevention is an important focus as injury brings about missed training or match time and interferes with player and team performance (42). Injury prevention approaches attempt to recognise the incident, origin, anatomical location, and factors associated with injuries sustained by professional cricketers.

Injury surveillance is the golden standard for adequate injury prevention among players competing in any sport (29, 86). Injury surveillance uses a step-by-step process to identify injury risks, types, causes, as well as associated factors that are relevant to injury. The first step in injury prevention is to develop injury surveillance systems to identify the areas most at risk for injuries (87). Definitions of injury from the International Consensus Statement, as stated above, must be implemented in injury surveillance systems for cricket (3).

The use of standardised injury definitions in research methodologies and standard reporting methods will allow for the comparability of injury data across different sexes

and other sports (88). Injury surveillance will provide a guideline for long-term development, data collection on injuries, and successful injury prevention strategies for cricket. The Orchard Sports Injury Classification System (OSICS) has been implemented for sports medical care and injury diagnosis. The four-character OSICS is used across various international sporting bodies (89). Additionally, the Translating Research into Injury Prevention Practice framework (TRIPP) categorises injury prevention into six different stages (29). The TRIPP model represents outcomes to be incorporated into individual sports, depending on the different demands of the sport. The stages are indicated in Table 2.

Table 2: Six stages of the Translating Research into Injury Prevention Practice

Stages	Interpretation
1	Research on injures
2	Establishing aetiology and injury causes
3	Injury prevention methods
4	Assessing research under ideal circumstances
5	Context for the implementation of injury prevention strategies
6	Evaluating the effectiveness of preventive strategies in the form of implementation

From Finch (29)

2.7.3 Injury prevention and medical management

Continuous injury surveillance provides the basis for effective injury prevention by allowing the nature, risk factors and aetiology of injuries to be established. Several countries lack official sport injury surveillance systems and have shortcomings in terms of their injury diagnosis and medical services which, under satisfactory circumstances would normally allow players to meet the demands of the game (56). The use of injury surveillance is crucial in implementing appropriate medical management for players (87). Medical staff involved with sports teams have an important role to play in managing or preventing player injuries. The limited access to medical staff may delay the diagnosis of the injury and negatively influence player management (34). The

potential focus can be placed on the areas identified by injury surveillance that present the greatest injury risk and on reducing these risks by providing players with adequate medical care (87).

2.8 Differences between sex profiles

Epidemiological findings from several sports activities, such as rugby, lacrosse, soccer and ice hockey, have indicated that the injuries sustained by males and females differ (90, 91). The discrepancies in injury profiles for females are also representative of the fact that the present framework of research for male sports athletes cannot be directly transferred to that for their female counterparts (33). Research findings on the sex disparities in injury profiles for the different types of sports are expected to extend to cricket players as well (33).

Several studies have indicated that the injury profiles of female cricket players are different from those of males (17, 43, 81, 92). Research findings indicate that male and female cricket players have variations in their injury profiles because of differences in their morphological and physical characteristics in terms of muscle strength, endurance, and other physical capabilities (12, 15, 36).

Female athletes have predisposing factors such as joint laxity and hormone levels that affect their sporting performance (30, 32). When compared to the opposite sex, females present with increased ankle inversion-eversion range of motion and lower levels of dynamic postural control (30). Female and male cricket players also vary in the way they play and react to match and training conditions (12, 33). The workloads of female cricket players are lower than those of male cricket players in that, owing to the current developing status of the women's game, their match and training schedules are less frequently spaced. Besides their lower workload, female cricket players still face the same injury risks and hazards than males during competitive cricket matches and training (33).

Recent findings by Inge et al. (93) reported that injuries in female cricket players (5.9%) are lower than those among male cricket players (11.7%). Evans et al. (80) reported that injury occurrence in women’s cricket is generally lower than that for male cricket.

Research findings in men's cricket suggest that the highest injury incidence is hamstring strains, whereas lumbar stress fracture is the most prevalent injury, accounting for 1.9% of players unable to play and 15% of the total match-loss time (3). Despite the lower frequency of lumbar injuries, lumbar stress fractures have caused more missed-game time than hamstring strains (3). In contrast to men's cricket findings, lumbar stress fractures are not frequently reported in women's cricket.

Previous research in sports medicine has shown that female athletes are more likely to sustain overuse injuries than their male counterparts. (94, 95). This may be related to the Relative Energy Deficiency in Sports (RED-S) or also called the female athlete triad (96, 97), where female athletes have predisposing factors such as joint laxity and hormone levels that affect their sporting performance (30, 32). Injury incidence for lower limb injuries were higher for female cricket players than their male counterparts. The incidence of knee injuries was lower in male cricketers and the injury prevalence ranged between 0.5% and 2.5% over a 10-year period (33). Some sports, such as basketball (66, 78), ice hockey (72), soccer (66, 78, 88), have demonstrated that females have a higher knee injury risk when compared to their male counterparts.

Bowling, especially fast bowling, is the only player role that has been compared between the two sexes. Several differences between male and female fast bowlers have been found. Felton et al. (46) implied that relative to male fast bowlers, female fast bowlers present with slower speeds during their run up. Female fast bowlers also show reduced whole-body linear momentum compared to male fast bowlers. The linear momentum in the female fast bowler's body was found to be less adequate in generating ball speed and not equal to that of a male fast bowler (46). Stuelcken, Pyne and Sinclair (12) also found differences in the overall body type, physical characteristics, and overall size between male and female bowlers. Females often have higher fat than muscle proportions and less lean body weight percentages than their male counterparts (12).

Females have a trunk-to-the-furthest-point ratio of 0.77, which indicates a more pronounced collection of subcutaneous fat tissue (15). Research findings indicate that the biomechanical profile of male fast bowlers presents with characteristics that may be favourable for bowling performance and injury prevention when compared to

female fast bowlers (12). As a consequence, the slower ball speed during the female's bowling action has caused females to adopt a technique similar to throwing, where the rotator muscles from the pelvis and torso areas are used to increase the angular momentum of the entire body (46) The technique used by female fast bowlers might possibly contribute to increased bowling injury risks in the shoulder (36, 46), rather than the frequent lower back injuries sustained by male fast bowlers (92, 98).

In previous years, research findings concerning male cricket players have been used for female cricket players. However, it is important to ensure a thorough understanding of the pressure that circumstances place on women's cricket alone and how this impacts on both the injury risk and the success of women's cricket. Understanding the variables between the different sexes can improve on the clinical management, player performance, rehabilitation, injury prevention and return-to-play factors among male and female cricketers (31). The discrepancies in injury profiles for cricket are representative of the fact that the present framework of research for male cricket players cannot be directly transferred to female cricket players (12, 47).

2.9 Prevalence and incidence

As a result of the recent popularity and increased participation in women's cricket on a global scale, it can be expected that the prevalence and incidence of injuries among players will increase accordingly (31, 33). Research on female cricket players is generally constrained, with several of the countries competing at international levels not having injury surveillance or research strategies in place. Major cricket countries such as Australia, New Zealand and South Africa have similar cricket profiles, playing conditions and match scheduling systems. With similar cricket profiles, research findings can be reported as a standard in one country and as predictive of other countries (33). The enhancement of injury data collection and reporting of prevalence and incidence of injuries sustained among women's cricket globally is urgently required.

For the calculations of prevalence and incidence, a cohort of participants should be identified as the population to be investigated and should be referred to as the 'squad'. The size of the squad could include any number of participants. The cohorts for injury

surveillance need to be identified at the beginning of the season, and in order to compare player roles accurately across the different cohorts, each player should have a designated position in a squad (3). Based on the injured and non-injured participants, the injury rates and/or risks would also need to be calculated (3).

Injury prevalence is calculated by dividing the number of the squad members not available for match selection, owing to injury, by the total number of squad members (3). Injury prevalence is presented as a percentage and documented wherever possible with a denominator. Prevalence of injuries for various types of cricket formats, such as ODI, T20 and test cricket, should, wherever possible, be measured separately (3).

Injury incidence refers to the total number of new reported injuries (including recurrent injuries) resulting over a certain period. Injury incidence can be indicated as match injury incidence. Match injury incidence should be calculated and reported with a time denominator (e.g. number of injuries sustained per team per number of days) (3). Injury incidence specifically for batting or bowling should be reported with a time denominator presented as injuries sustained per overs or injuries sustained per balls bowled. Seasonal injury incidence presents the total injuries occurring in a squad over a season. The seasonal incidence should be reported with a time denominator presented as injuries sustained per squad per season (3).

2.10 Available literature on injuries in women's cricket

Most of the literature studies on the prevalence and incidence of injuries sustained by female cricket players were performed on elite-level cricket players in Australia. Stuelcken et al. (12, 36, 37, 99) and Perera et al. (42, 100-102) are the leading researchers in women's cricket research, and each of these authors have published four or more female cricket studies for Cricket Australia. Other countries, such as Bangladesh, and the United Kingdom, have also contributed to women's cricket research in recent years. For this section of the literature review, I have highlighted the studies that have made a significant contribution to women's cricket.

Perera et al. (102) conducted a study in 2016 and analysed self-reported injury data from the 2014-15 women's cricket season. Perera et al. (102) used the Cricket Australia database to recruit national, state and elite-level female cricket players. The authors reported that 109 out of 164 survey respondents had sustained an injury. The breakdown of injuries was as follows: 30.4% were muscle injuries; 27.8% ligament or joint injuries; and 21.7% progressive overuse or onset injuries. The distal lower extremity (24%) and back, neck and spine (5%) were the most frequently injured body regions. The majority of players consulted a physiotherapist (43%), 29.2% managed the injury themselves and 12.5% did not receive any type of treatment. The authors reported the annual injury prevalence as 66.46% and the annual injury incidence as 798.6 injuries per 1,000 participants.

In another study, Perera et al. (101) examined the incidence of injuries sustained by female cricket players that contributed to successful insurance claims in Australia in 2016. The authors found that 82.4% of successful insurance claims were lodged as a result of injuries sustained during competitions, with most injuries occurring during batting (48%). Injuries attributable to fielding accounted for 38% of the total claims. The body regions most injured were the knee (24.1%), the distal upper limb (including the elbow, neck, and fingers) (19.4%) and the teeth (14.8%). The most common aetiology of injury included sprains (24.1%) and fractures (22.2%). The mean annual injury incidence was calculated as 1.26 per 10,000 registered players.

Perera et al. (42, 100) published two more studies in 2019. In one study, Perera et al. (42) explored the prevalence and incidence of injuries sustained over two seasons in elite-level female cricket players In Australia. The nature, severity and mechanisms of injury in these female cricket players were also explored. From the 600 medical-attention injuries reported, more than one type of injury was confirmed by 77.7% of the players. Compared to progressive onset injuries, 79.5% of injuries were acute injuries, 20.2% time-loss (medical attention injuries) and 34.7% were match-time-loss injuries. The most frequent time-loss injuries were of the wrist and hand (19.8%), lower back (16.5%) and the knee (14%). Six players sustained an injury to the lower back, resulting in most days lost (average 110.5 days/injury) on account of the injury. The annual injury prevalence was calculated as 93.3%. The annual injury incidence was calculated as 424.7 per 10,000 player hours (102).

Perera et al. (100) examined the hospital records of female cricket players admitted to hospitals in Australia over 12 seasons. There were 121 hospital admissions, of which 78.5% of patients had a duration of stay of less than two days. The 10-14 year-age range (19.9%) was the cohort that presented most frequently to the emergency department (ED) and to the hospital (16.5% of overall admissions). The mean annual incidence were 1.5 ED-presentations per 1,000 participants and 0.3 hospital admissions per 1,000 participants. The most frequent source of hospital admissions was fractures (47.1%), while the most frequent causes behind ED presentations were dislocations, muscle/joint strains and sprains (36.4%). The head was the anatomical area with the most injuries and 27.8% of ED presentations and 28.1% of hospital admissions were for head injuries (100).

A study done in 2019 reported the injuries sustained by female cricket players in shorter formats cricket. Warren et al. (17) examined the injury profiles in elite-level women's T20 cricket and calculated the prevalence and injury incidence of a professional women's T20 cricket tournament in England over two years. The highest occurrence of injury was in the elbow (1.8 injuries sustained per 100 match days), the lumbar spine (1.7 injuries sustained per 100 match days) and followed by the lower limb (1.7 injuries sustained per 100 match days). The largest prevalence of time-loss injuries was attributed to the hand (1.7%), head/face (0.8%) and thigh (0.6%). All head injuries caused concussion. Fielding (catch and throw) caused most of the time-loss injuries. The highest rate of shoulder injuries was 2.3 injuries in 100 match days. The gradual onset of injuries presented with the highest average incidence as 7.9 injuries sustained per 100 match days.

The repeated use of the shoulder with the hand over the head is a typical characteristic of overhead sports, such as cricket. Findings in women's cricket also indicate that shoulder injuries are frequent among players. Basketter (16) conducted a study in England and Wales in 2014. The author reported that the shoulder region was the most prevalent body region injured. Basketter (16) reported that fast bowlers and are at higher injury risk relative to other player roles. Bipasha et al. (14) found similar findings to that of Basketter (16). Bipasha et al. (14) investigated injuries sustained among Bangladeshi women cricketers aimed to identify cricket injuries and the related

patterns of injury in 2018. The shoulder (39.1%) was found to be the most common body region injured among the 23 bowlers.

Two other studies conducted in Australia, also reported on the high frequency of shoulder injuries among female cricket players. Stuelcken et al. (36) conducted a study in 2008 on female cricket bowlers and reported that the distraction force of the shoulder can be regarded as the leading factor in bowling action, thus contributing to shoulder injury. Stuelcken et al. (99) found that the bowling action, the ratio of eccentric external to concentric internal rotation strength of the shoulder in female cricket players is far below the standard considered sufficient for adequate joint stability and muscle control (99). To prevent shoulder injuries, shoulder-specific strength and conditioning pre-rehabilitation programmes need to be developed specifically for female cricket players (16).

Female cricket players, especially fielders, frequents injure the hand, wrist and finger region. The wrists, hand and fingers are frequently injured during a direct impact of a cricket ball or from impacts with the ground during fielding. Direct impact injuries were usually a result of the high speed of a cricket ball connecting with the body region of a player. The cricket balls used in women's cricket differ from those used in men's cricket in that they are smaller in size and weight (16). The size and weight of the cricket ball in relation to the size of the hand specific to the sex, may be a factor in the high incidence of wrist and hand injuries in women's cricket.

Previous evidence suggests that as opposed to female handball players, female cricket players have less hand-and-eye coordination (103). Female cricket players also presented with slower auditory reaction time, but faster visual reaction time than female handball players. It was reported that certain female cricket players might have adapted strategies to catch or field that predispose them to injuries to the hand and fingers (42). Protective gloves for wicketkeepers and batters need to be worn, and have been indicated to limit the severity of hand, wrist and finger injuries (52). The need for specific skills training for women's cricket needs to be highlighted. Also, further investigations are needed to explore other underlying factors to identify why female cricket players frequently sustain injuries to the wrist, hand and finger regions.

As with all other professional sports, head impacts in cricket have also increased (100, 104, 105). Concussion injuries frequently result from serious head impacts sustained by cricket players during competitive matches (17, 105). Perera et al. (100) found that female cricket players frequently sustained serious head impacts resulting in 27.8% of ED-presentations and 28.1% of hospital-admissions. Players who do not wear helmets are more vulnerable to serious head injuries. Protective gear such as helmets for batters, wicketkeepers and close fielders should be encouraged in order to reduce the severity of head impacts or face injuries (52). Head impacts in women's cricket need to be explored for prevention strategies to be implemented to reduce head injury risks.

2.11 Previous reviews on women's cricket

Munro and Christie (31) published a review in 2018 on the existing literature in women's cricket to identify research guidelines for the development of the sport. The narrative review by Munro and Christie (31) was not subjected to the rigorous methodology associated with a systematic review and no meta-analyses were performed. Munro and Christie (31) reported that there is insignificant research available on women's cricket, specifically in the areas of the physical characteristics of female cricket players, frequency of injury, and the nature of the injury. The authors further recommended that more literature is needed for female cricket players from all areas and for all of the levels of participation (31).

Perera et al. (34) conducted a systematic review in 2018 and broadened the research field of women's sport with similar potentials for injury and categorised them as 'bat-and-ball and ball-and-stick' sport (baseball, field hockey, cricket, lacrosse, t-ball and softball) (ICD-10-AM). The weighted rate of injury per 1,000 persons per day athletic exposure (AE) was 6.15. Perera et al. (34) also reported that the ankle, followed by the hand, wrist and fingers, the knee, and face and head injuries, is the body region most frequently injured. The most serious forms of injury were found to be muscle and ligament injuries. Hence, as only two women's cricket studies (36, 37) were used in the study and neither of these was included in the meta-analyses, these findings cannot be extrapolated to all female cricket players. The review by Perera et al. (34) is a significant milestone for women's cricket and other bat-or-ball sport, as it is the first detailed analysis in women's sport. However, cricket needs to be separated from

the other sport disciplines, and men's cricket in order to perform a thorough review of the prevalence and incidence of injuries sustained specifically by female cricket players.

2.12 Conclusion of the literature review

Women's cricket has been around for several decades. However, the interest and participation in the sport has grown considerably only in recent years. Physical participation in sport activities such as cricket, poses injury risks to participants (17, 34, 43). Injury prevention is key to continued participation in any sport (29, 86). Injury prevention tends to reduce the burden of injuries in a team, such as missed training sessions and matches, and player and/or team performance. Findings on injuries in other sports show the differences in the nature of the injuries sustained by the two respective sexes. Research in cricket has predominantly focused on injury prevention in male cricket players (44, 69, 82, 92, 106). However, it is important to ensure a thorough understanding of the demands put on women's cricket specifically and how this impacts on both the injury risk and the performance of the players.

Literature suggests that the prevalence and incidence of injuries sustained among female cricket players are high. The injuries among female cricket players frequently occur during training sessions as well as during competitive matches (11, 42, 100-102). Body regions, such as the shoulder, seem to be frequently injured (14, 16, 17, 36). Injuries to the wrist, hand and fingers are representative of the most frequent time-loss injuries for women (17, 42, 43), and this body region seem to be overrepresented in women's cricket as opposed to men's cricket.

A comprehensive review of the literature needs to be carried out to define, interpret and synthesise the existing evidence and to provide a reliable review of the data available on injuries experienced by female cricket players. To date, there is no systematic review available on the prevalence and incidence of injuries sustained by female cricket players alone. Quantifying injury rates and informing decision-makers and management staff of the respective women's cricket bodies will contribute to development in women's cricket since, rather than merely being a game for enjoyment, the women's cricket game is developing into a competitive profession.

Chapter 3 Methods

This study was registered with the PROSPERO International Prospective Register of Systematic Reviews. The PROSPERO registration ID: CRD42020166052 was accessed from https://www.crd.york.ac.uk/PROSPERO/. A *priori* review protocol (1) was published in JBI Evidence Synthesis. The systematic review was conducted in accordance with the JBI methodology for systematic reviews of prevalence and incidence (38) and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (39), and described in the following steps:

1. An initial search strategy was built using keywords and MeSH terms.

2. Trial search strategy was conducted in the MEDLINE database.

3. Searches were conducted in all databases (including grey literature databases); reference lists were screened; and records were exported to Endnote X9.3 (Clarivate Analytics, PA, USA).

4. Records were imported into Microsoft Excel 2013 (Microsoft Corp., WA, USA) and duplicates were removed.

5. The titles and abstracts were screened according to inclusion/exclusion guidelines by two independent reviewers.

6. The results were compared by the reviewers for consensus on the included studies. Any discrepancies were resolved through a discussion with a third reviewer.

7. Full text studies for inclusion were retrieved and references uploaded to JBI-SUMARI.

8. Full-text studies were read and based on inclusion/exclusion criteria, excluded by two independent reviewers.

9. A secondary search of all the reference lists was conducted to include any eligible studies.

10. The results were compared for consensus by the reviewers. Any discrepancies were resolved through discussions/consultations with a third reviewer.

11. A critical appraisal of all the included studies was conducted by two independent reviewers who used JBI critical appraisal instruments.

12. The results were compared for consensus by the reviewers. Any discrepancies were resolved through discussions/consultations with a third reviewer.

13. Two reviewers were employed in extracting the data from the included studies using JBI data extraction instruments. Corresponding authors were contacted for any information or for clarifying the results, if needed.

14. A synthesis of the data results was performed; and

15. Findings were reported according to the PRISMA 2015 statement (107).

The steps of the systematic review are elaborated upon in the sections below.

3.1 Study Design

This is a systematic review of prevalence and incidence. The systematic review adheres to the JBI Systematic Review methodology outlined in the JBI Reviewer's Manual for JBI Systematic Reviews of Prevalence and Incidence (108). The Joanna Briggs Institute System for the Unified Management, Assessment and Review of Information (JBI SUMARI) online software system was used for this study.

3.2 Inclusion criteria

3.2.1 Participants

Table 3 summarises the inclusion/exclusion criteria of the review. Studies reporting injury prevalence and incidence of injuries in female cricket players of all ages, participating in all levels of play were included in the review, including studies that report data by sex. Studies with insufficient data, females cricket injury data not distinguished from males or other athletes, male only data and case studies were excluded.

Table 3: Inclusion and exclusion criteria of the participants

Outcomes	Inclusion criteria	Exclusion criteria	Rationale for these criteria
Publication type	Published and non-published (grey literature) studies		Published and non-published studies were included to increase the size of the data samples. Grey literature was included as it might contain epidemiological data for prevalence and incidence.
Language	All languages		All languages were included to reduce selection bias in the review.
Publication date	From inception until August 2020		All publications from inception to August were included to increase the size of the available data sample.
Study design	Cohort, cross-sectional, case-control, descriptive and case series	Systematic reviews, meta-analyses, and case studies	Case studies scored a lower level of evidence score (level 6) compared to other studies (cross-sectional, cohort, case-control, descriptive and case series) that scored level 4 and level 3.
Sex and age	This review considered literature on women cricket players around the globe, regardless of cultural or sub-cultural factors, geographical locations, age and race. Studies including male and female cricket participants were considered, but only female cricket data were included.	Male only studies	The aim of this review was to establish the prevalence and incidence of injuries among women cricket players of all ages.
Sport	An injury must have been sustained while participating in cricket. Injuries sustained by players could be self-reported or diagnosed by a health care professional.	Any sporting activity besides cricket	Any injuries occurring during participation in other sports might lead to publication bias.
Level of play	All levels of participation were included in the review.		The aim of this review was to establish the prevalence and incidence of injuries among women cricket players of all ages and on all levels.

Format of cricket	All formats of cricket (ODI, T20, multiple-day cricket) were included in the review.	The aim of this review was to establish the prevalence and incidence of injuries among all formats of women's cricket.
Outcome measures	*Prevalence* was calculated as the percentage of players injured divided by all the players (injured and uninjured). Prevalence was calculated as a percentage and reported as an annual or general injury prevalence. *Incidence* was calculated with a denominator for match injury incidence or seasonal injury incidence per player or team days of play. Time-loss and non-time-loss injuries, as well as medical attention injuries, were presented where possible.	The aim of this review was to establish the prevalence and incidence of injuries among women's cricket players. The reporting of injuries was in accordance with the International Consensus Statement (3).

3.2.2 Condition

Injuries sustained by female cricket players could be self-reported or diagnosed by health care professionals. Injuries were defined in accordance with the 2016 update of the International Consensus Statement on Injury Surveillance in Cricket (3):

- A "match time-loss" injury is an occurrence that either prevents a cricket player from being fully available for a match selection or during a match, rendering the player to bat, bowl, or keep wicket as necessary by either the rules or the captain of the team.
- A "non-time-loss injury" is a medical attention injuries that did not lead to time-loss from the sport.
- A "medical attention" injury is health-related condition that potentially affect the training or match-play of a player and requires medical attention. Medical attention injuries include both time-loss and non-time-loss injuries.

- A “player-reported” injury is any injury that is self-reported by the player or individuals on the player’s behalf without a medical diagnosis. Player reported injury can be time-loss or non-time-loss injuries.
- A “general time-loss” injury is any injury that results in a player being declared unfit for a match, regardless of the match or training was already planned. General time-loss injury can be medical attention injuries or player-reported injuries. General time-loss injury includes match time-loss injuries, training days missed, off-days and off-season.

3.2.3 Context

Studies that report on the injuries sustained by female cricket players from all levels of play and from across the globe, regardless of cultural or sub-cultural factors, geographical locations, age and race, were included. Injuries sustained by female cricket players participating in recreational and competitive school, club and elite-level cricket during matches and/or training were included.

3.2.4 Types of studies

Prospective and retrospective cohort studies, case-control studies, cross-sectional studies, descriptive studies and case series reporting on injury prevalence or incidence were included. On the other hand, case studies were excluded to improve the quality of the review. Grey literature was also included since there was the possibility that it might contain epidemiological data for prevalence and incidence. Epidemiological data were found in dissertations, vital statistical reports, health care records, prevention records, and reports from government surveillance. Studies published from database inception to August 2020 were also included. All studies identified for inclusion in the review were English and no translation was needed.

3.3 Search strategy

A three-step search strategy was conducted. During the first step an initial search in the MEDLINE database. The title, abstract, MeSH headings and subheadings (includes single words and phrases) and other terms field (which includes author-supplied keywords) were searched. Keywords were also searched in MeSH terms.

The lead author (JJ) trialled and refined the search strategy (Table 4) by adding and/or removing duplicate or inadequate search terms and retesting as necessary to ensure that the search is sufficiently sensitive to identify all relevant studies. For the second step MEDLINE (PubMed), SPORTDiscus (EBSCO), Physiotherapy Evidence Database (PEDro), MasterFILE Premier (EBSCO), CINAHL Complete (EBSCO), Health and Medical Complete (ProQuest), SCOPUS (Elsevier), and Science Direct (Elsevier) databases were systematically searched from inception till August 2020 (see Appendix A for complete search strategy).

Additionally, Cochrane Controlled Trials Register and ClincalTrail.gov, were searched. Premier, OpenGrey (SIGLE), WorldCat, Grey Matters, Grey Literature and Google Scholar were searched for unpublished studies (grey literature). Further known experts were contacted to identify any additional publications. The third step included a secondary search of the reference lists of the selected studies were performed to identify for any additional studies (backward citation tracking) and forward citation tracking via google scholar to identify the list of articles that cited the paper since it was published.

Table 4: Search Terms

Terms connected by OR	Terms connected by OR	Terms connected by OR
"Cricket sport"[MeSH Terms]	"Female"[MeSH Terms]	"Wounds and injuries"[MeSH Terms]
OR Cricket[All Text]	**OR** Female[All Text]	**OR** injur*[All Text]
	OR "Women"[MeSH Terms]	**OR** pain*[All Text]
	OR Women[All Text]	**OR** wound*[All Text]
	OR Woman[All Text]	
	OR Lad*[All Text]	

*All keywords were searched in all texts. Terms that qualified with the Text Word **[tw]** field tag were searched in terms of title, abstract, MeSH headings and subheadings, as well as the other field terms.*

3.4 Study selection

Following on from the search strategy, all found citations were compiled and uploaded to Endnote X9.3 (Clarivate Analytics, PA, USA). The citations were then uploaded to Microsoft Excel 2013 (Microsoft Corp., WA, USA) and all duplicates were removed. Titles and abstracts were screened by two independent authors (JJ and MD) against and *a priori* inclusion and exclusion criteria (See Appendix D and E for rationales for exclusion). Then the full text articles meeting the inclusion criteria were retrieved into the Joanna Briggs Institute System for the Unified Management, Assessment and Review of Information (JBI SUMARI) (108). Full text articles were independently screened by the same two authors (JJ and MD). Any disputes regarding study inclusion/exclusion were resolved by discussion between the two reviewers (JJ and MD), or with the third reviewer (BO). A telephonic conversation was once used to contact the third reviewer to clarify a discussion of an item, whereafter all the three reviewers (JJ, MD and BO) agreed on the score. The search results were reported in detail and summarised in the PRISMA flow-diagram in Figure 6. After the initial screening, potentially relevant studies and their citation information were incorporated into the JBI SUMARI (108).

3.5 Assessment of methodological quality

The authors (JJ and MD) assessed the methodological quality for each study using the JBI critical appraisal instruments (38). Methodological quality for prevalence studies were evaluated using the JBI Critical Appraisal Checklist for Prevalence Studies (Appendix B) provided a numerical score out of a possible nine points. Methodological quality for all cohort studies were evaluated using the JBI Critical Appraisal Checklist for Cohort Studies (Appendix B) provided a numerical score out of a possible 11 points. The JBI Critical Appraisal Checklist for Case Series (Appendix B) provided a numerical score out of a possible 10 points.

The individual items for the critical appraisal tools included ‘yes’, ‘no’ and ‘unclear’ options to each question. For the prevalence studies, there were nine questions with a maximum score of nine. For the cohort studies, there were 11 questions with a maximum score of 11. When disagreement regarding critical appraisal score arose, this was resolved by consulting a third author (BO). The methodological quality

assessment process including the number of items agreed/disagreed upon, and any discussions (in case of disagreement) was documented for each study. The intra-rater agreement was assessed using Kappa squared statistic. Kappa ratings range from 0 to 1 based on the reviewer's score agreement (slight: 0.0-0.4, fair: 0.2-0.4, moderate: 0.4-0.6, substantial: 0.6-0.8, near perfect: 0.8-1).

The items which were discussed between the reviewers in the Critical Appraisal Checklist for Prevalence Studies were items 1, 2, 3, and 7. Regarding item 1 ('Was the sample frame appropriate to address the target population?'), it was decided to consider the sample frame for each study at hand by identifying the obvious confounding factors. For item 2 ('Were study participants sampled in an appropriate way?'), random sampling methods were scored as a 'yes', convenience sampling methods as a 'no', and sampling methods not described were scored as 'unclear'.

For item 3 ('Was the sample size adequate?'), it was decided to calculate sample sizes for studies and then determine an adequate sample size. Studies with a large sample size did not need calculations and scored a 'yes'. Regarding item 7 ('Was the condition measured in a standard, reliable way for all participants?'), a 'no' was attributed to studies that had collected data which did not include reliable or standard methods for the clinical diagnosis of the health outcome or injuries sustained. The studies that did not describe the methods used for data collection were scored as 'unclear'.

Regarding the Critical Appraisal Checklist for Cohort Studies, item 10 presented with several 'not applicable' scores. Several studies did not follow up with the cohorts because the data were collected from injury surveillance records or hospital data. These studies did score a 'no' for item 9 (Was follow up complete?), as "no follow up" items were scored, while item 10 could not be scored, as the questions for items 9 and 10 closely corresponded with each other. No discussions were needed for the items scored by the reviewers using the Critical Appraisal Checklist for Case Series.

3.6 Data Extraction

The full texts of the studies considered for inclusion in the review were uploaded into Microsoft Excel 2013 (Microsoft Corp, WA, USA). Two authors (JJ and MD) used the standardised data extraction instrument from JBI SUMARI (Appendix C) to extract data for each study. The data extracted included article details (authors/year), study design (setting/aim), participants (age/country/level of play), injury data collection methods, injury definitions, prevalence and incidence, and body regions injured. Any disagreements between the two reviewers (JJ and MD) were resolved through discussions with the third reviewer (BO).

3.7 Data synthesis

The pre-specified outcomes of interest for this review were to determine injury prevalence (proportions) and incidence (rate), body region of injury and the player role. Data were qualitatively synthesised in a narrative summary and tabular forms using JBI SUMARI software. Comprehensive Meta-Analysis 3.0 (Biostat Inc, 2015) software was used to perform the meta-analyses. This software was used for this systematic review as it is compatible to calculate rates and risks with a denominator (athletic exposure hours or percentages), as required for standard reporting of research findings for cricket (3).

The random-effects model was included with in-study, as well as between-study variability. This systematic review includes data from different levels of play, therefore the studies included in the meta-analyses were grouped based on level of play (i.e., recreational, school, elite) where possible, and homogeneity between study populations was assumed due to the similarity of study cohorts in each level of play.

To increase the accuracy of the overall estimate of the effect size of the injury prevalence and incidence, the data was pooled from individual studies to perform the meta-analyses. At a minimum, two variables - an effect size (the dependent variable) and its variance (or the standard error squared (SE^2)) are needed to perform a meta-analysis. Effect size can vary owing to the study design, however must follow the following characteristics: 1) must not be a direct function of the sample size 2) must

be a numerical value (to allow effect sizes comparisons across studies) and 3) need sufficient data available for calculation of standard error of the effect size (109).

Based on the data available from studies included in this review, three separate effect sizes were identified: injury incidence rate (injury IR), injury incidence proportions (injury IP) and injury prevalence proportion (injury PP). Heterogeneity was measured using the I^2 statistic and the Chi-square test. The pooled results were presented in forest plots. Meta-analysis 1 included data from elite-level players from different countries. Meta-analysis 2 included elite- to recreational-level players from Australia. Meta-analysis 3 included data from recreational to elite-level players from different countries. Sub-group analyses were performed for meta-analysis 3 for elite- and non-elite-levels of play.

3.7.1 Conversions of data for meta-analyses 1

Cricket player exposure hours were converted in accordance with the International Consensus Statements of 2005 (4) and 2016 (3), as well as Orchard et al. (44) and Soomro et al. (110). In a first-class game or test match, a day of play is equal to six hours (h) (6h/day) of play per day and a one-day match was 6 hours 40 min (6.66 h/day) (3, 44). The T20 format was taken as 2.66 h/day (generalising 40 match overs from 6.66 hrs of 100 overs played in one day cricket) (44, 110). The bowling guidelines of the International Consensus Statement (3) also suggest a similar number of 15 overs/h for T20 (i.e. 40 overs/15 = 2.66 h) (44, 110).

Once the format of play was determined, the conversion rate was used to calculate the exposure hours per format of play. To determine the total exposure hours for all players, the conversion rate was multiplied by 13 per two teams (13 players on the field at any given time, i.e. 11 from the fielding team and two from the batting team) (44, 110). The results of only two studies (17, 43) needed to be converted for meta-analysis 1 and are indicated in Table 5.

Table 5: Calculations for exposure hours for meta-analysis 1

Match format	Matches played*	Duration of match (days)	Conversion rate per two teams(3, 4) (hours)	Total exposure hours
for Goggins et al. (43)				
One Day (50 overs)	28	1	86.6h	2 424.8h
One Day (40 overs)	1	1	69.4h	69.4h
T20 (20 overs)	14	1	34.6h	484.4h
One Day (no overs indicated)	6	1	67.2h*	403.2h
First class match (2 days)	1	2	78h	156h
First class match (3 days)	1	3	78h	234h
First class match (4 days)	1	4	78h	312h
Total	52	-	-	**4 083.8h**
for Warren et al. (111)				
T20 (20 overs)	68	1	34.6h	**2 352.8h**

**average exposure hours per two teams calculated between first class match, 50 overs, 40 overs and 20 overs*

3.7.2 Meta-analyses

3.7.2.1 Meta-analysis 1: Injury incidence rate (injury IR) as the effect size

Injury incidence rate (injury IR) is defined as the total number of injuries sustained dived by the total time athletic exposure in hours. The injury IR was defined as the total number of injuries sustained per 1,000 hours of athletic exposure. The studies that reported adequate data (i.e., total number of injuries and total time of athletic exposure in hours) were considered to be relevant for calculating the injury rate or incidence. The injury IR, standard error (SE), upper and lower limits of the 95% confidence interval (CI) and SE^2 (equivalent to variance) were determined from the data (5). The injury IR per 1,000 player hours were calculated using match incidence and/or training incidence where sufficient data was available (3). The injury IR was calculated using the following formula:

$$\textit{Injury incidence rate (injury IR) per 1,000 exposure hours} = \frac{\textit{Total number of injuries}}{\textit{Total time of athletic exposure in hours}} \textit{ x 1,000}$$

The following formula was used to calculate the Standard Error:

$$\textit{Standard Error} = \frac{\sqrt{\#\ injuries}}{\textit{Sum of athletic exposure in hours}}$$

The estimated 95% Confidence Interval was determined using the following formula:

Estimated 95% Confidence Interval = Injury IR ± 1,96 x Standard Error

The findings were pooled, and the estimates were documented in a forest plot.

3.7.2.2 Meta-analysis 2: Injury incidence proportions (injury IP) as the effect size

The injury incidence proportions (injury IP) was defined as the total number of injuries sustained per 1,000 participants. This meta-analysis was conducted independently from meta-analysis 1, as the studies included in meta-analysis 2 do not indicate the *athletic exposure hours* as required for the calculations in meta-analysis 1. Meta-analysis 2 does not report the injury rate, but rather the clinical incidence ratio or proportion of injuries sustained in a certain population. Meta-analysis 2 cannot be reported as an injury rate (meta-analysis 1), nor as an injury risk (meta-analysis 3), but rather as the clinical incidence ratio or the proportion of injuries sustained over a particular period.

Meta-analysis 2 included articles that indicated adequate data (i.e. total number of participants and total number of injuries) to determine the injury incidence proportions for all of the injuries sustained (34). If the studies provided sufficient data, the number of injuries sustained and the number of respondents, the SE, the upper and lower limits of the 95% CI, and the SE^2 (equivalent to variance) were calculated (5).

$$\textit{Injury incidence proportions (injury IP) per 1,000 participants} = \frac{\textit{Number of injuries}}{\textit{Number of athletes}} \textit{ x 1,000}$$

The following formula was used to transform the 95% CI into a SE (Standard Error):

$$SE\ (injury\ IP) = \frac{Upper\ limit\ of\ 95\%\ confidence\ interval - Lower\ limit\ of\ 95\%\ confidence\ interval}{3{,}92}$$

The following formula was used to measure SE:

$$Standard\ Error\ = \sqrt{\frac{(\ injury\ IP) \times (1 - injury\ IP)}{n}}$$

The following formula was used to measure 95% CI:

$$Estimated\ 95\%\ Confidence\ Interval = Injury\ IP \pm 1{,}96 \times Standard\ Error$$

The SE^2 was subsequently calculated. The findings were pooled, and a forest plot was provided with estimates.

3.7.2.3 Meta-analysis 3: Injury prevalence proportions (injury PP) as the effect size

Meta-analysis 3 calculated injury prevalence proportions (injury PP) and included studies that displayed adequate data (i.e. the number of injured team members and the total number of squad players) to determine the injury PP for all injuries sustained (3). The injury PP, SE, upper and lower limits of the 95% CI and SE^2 (equivalent to variance) were calculated (5). The injury PP was calculated using following formula:

$$Injury\ prevalence\ proportions\ (injury\ PP) = \frac{Number\ of\ squad\ members\ injured}{Total\ number\ of\ squad\ members} \times 100$$

The following formula was used to transform the 95% CI into a SE (Standard Error):

$$SE = \frac{Upper\ limit\ of\ 95\%\ confidence\ interval - Lower\ limit\ of\ 95\%\ confidence\ interval}{3{,}92}$$

The following formula was used to measure SE:

$$\textit{Standard Error} = \sqrt{\frac{(injury\ PP) \times (1 - injury\ \ PP)}{n}}$$

The following formula was used to measure 95% CI:

Estimated 95% confidence interval = Injury PP ± 1,96 x Standard Error

Finally, the SE^2 was calculated. The findings were pooled, and a forest plot was provided with estimates.

3.8 Deviations from the protocol

There were no deviations from the original protocol submitted to JBI Evidence Synthesis entitled: The prevalence and incidence of injuries among female cricket players: a systematic review protocol (1).

3.9 Ethical clearance and plagiarism report

The Human Research Ethics Committee of the University of the Witwatersrand granted ethical clearance to conduct this study (Ref: W-CBP-200529-02) (Appendix F). The declaration of plagiarism is included in Appendix G. The declaration by the student and the co-authors for write-up with published articles is provided in Appendix H. The turn-it-in plagiarism report, which scored a low similarity index for this manuscript, is presented in Appendix J.

Chapter 4 Results

4.1 Study selection

The study selection process was documented in the PRISMA flow diagram (Figure 5). The flow diagram demonstrates the records identified through a systematic search and additional records identified through other sources. Seven databases were searched for published literature and provided 3,974 studies. Five grey literature databases were searched and provided 1,218 studies. The studies were combined (5,192 studies), and 1,843 duplicate studies were omitted. The titles and abstracts of the remaining 3,349 studies were screened by two independent reviewers, whereafter 3,229 studies were omitted against the inclusion/exclusion criteria of the review, with 120 studies eligible for full-text review.

The 120 full-text studies assessed for eligibility were screened by two independent reviewers, and 100 studies were omitted against the inclusion/exclusion criteria. Full-text studies were omitted and documented in Appendix D and E. Studies were excluded for the following reasons: male only studies (n=15), no cricket injuries (n=42), review articles (n=2), case studies (n=2), data pooled with male participants (n=21), conference abstracts (n=2) and insufficient data (n=16). All studies were critically appraised for methodological quality (n=20) and all were included in the review (n=20). There were sufficient studies to be included for meta-analysis 1 (n=3), meta-analysis 2 (n=3) and meta-analysis 3 (n=5). All 20 studies were narratively reviewed and documented in the result tables.

Appendix D lists 16 studies that were excluded from the full-text review due to insufficient prevalence or incidence data. All 16 studies included in Appendix D presented data on injuries sustained by female cricket players. However, the relevant data were not presented and could therefore not be extracted. Most of the studies did not include the total number of participants, nor the total number of injuries required to specifically calculate injury incidence and/or prevalence for this review. This researcher (JJ) contacted these authors via email, including follow-up emails, but received no response. Owing to the scarcity of research material on female cricket injuries, it is important to highlight all available published and unpublished literature.

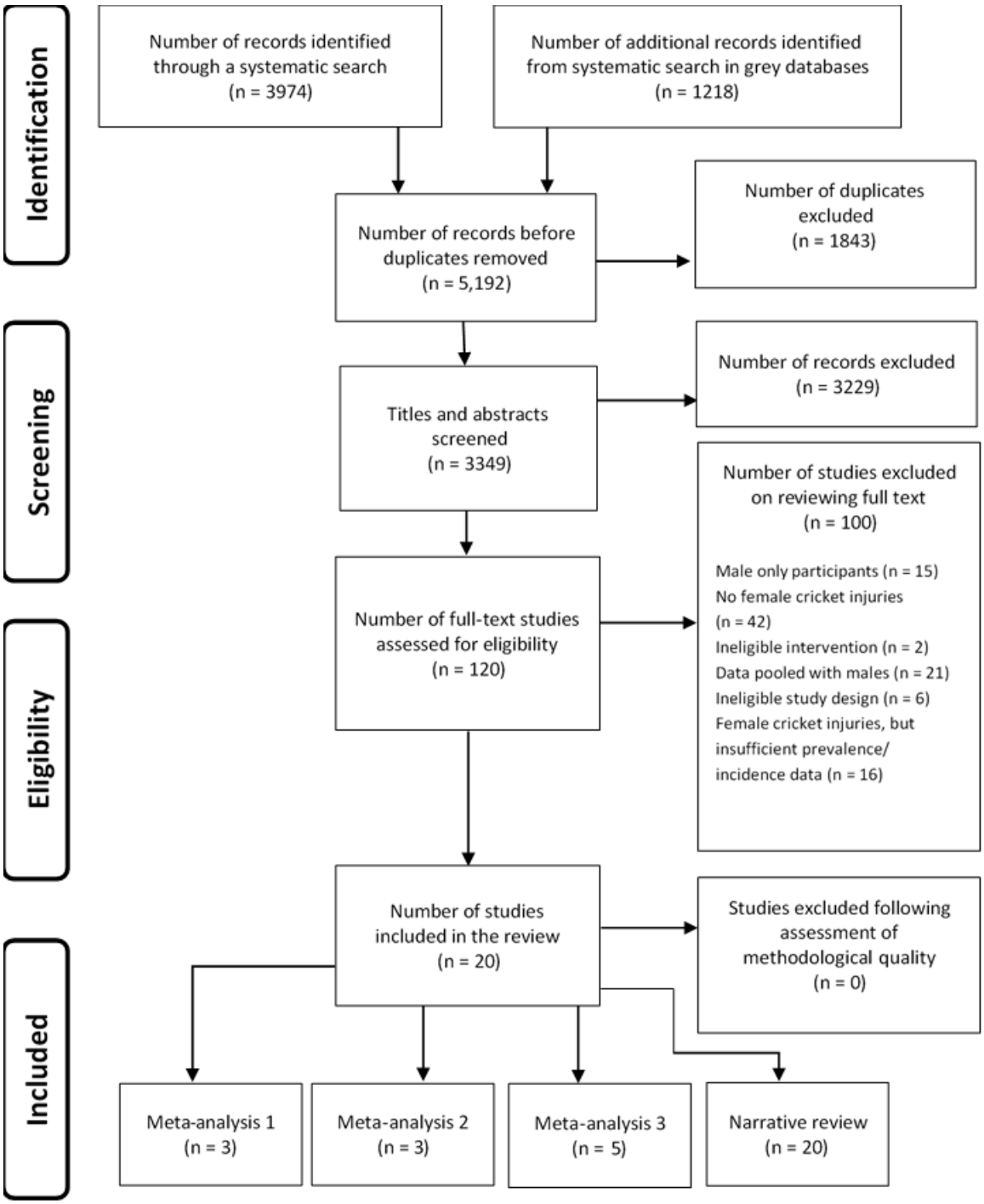


Figure 5: Prisma flow diagram

Several of these studies had large cohorts of female cricket players; for instance, Fernando Berecki-Gisolf and Finch (112) reported 290 female cricket injuries in a retrospective hospital study from 2012 to 2015 in Australia, and King et al. (113) presented 208 female cricket claims from a retrospective hospital study conducted in New Zealand from 2012 to 2016. Grimmer, Jones and Williams (20) conducted research on school-level cricketers and reported the injury risk for 76 female cricket

players. Several other valuable studies were also excluded owing to the inclusion/exclusion criteria and the outcomes of this review, as shown in Appendix D.

4.2 Study designs and methodological quality

The 20 studies included in this review were located from published and unpublished (grey literature) databases. Fifteen (14, 17, 36, 37, 42, 43, 100, 104, 105, 114-119) studies were sourced from published literature, whereas the five (16, 40, 101, 102, 120) unpublished studies were all theses/dissertations located in grey literature databases. None of the grey literature studies included in this review had been published at the date of inclusion, so that there was no possibility of duplicating published and unpublished studies in this review.

The studies included in this review were all observational studies. The observational study designs were as follow: nine cross-sectional designs (JBI level 4b) (14, 16, 36, 37, 102, 114, 115, 117, 120), seven cohort designs (JBI level 3b) (17, 42, 43, 101, 104, 116, 118), two case-series designs (JBI level 4c) (100, 105), one case-control design (JBI level 3d) (119), and one descriptive study design (JBI level 4b) (40). Nine studies included in the meta-analyses, three studies (17, 42, 43) were included in meta-analysis 1, three studies (100-102) were included in meta-analysis 2 and five studies (16, 40, 42, 102, 115) were included in meta-analysis 3. Two studies (42, 102) were included in multiple meta-analyses.

To assess the methodological quality of the included studies, three JBI-critical appraisal instruments were used. The critical appraisal scores of the studies included in the review are summarised in Table 6 (studies reporting prevalence) and Table 7 (cohort studies reporting incidence) and Table 8 (case series reporting incidence). Of the 15 studies (14, 16, 36, 37, 40, 42, 43, 102, 105, 114-117, 119, 120) that reported injury prevalence, six studies (37, 40, 43, 102, 105, 116) scored the maximum score of nine points in the JBI Critical Appraisal Checklist for Prevalence Studies and one study (120) scored the lowest score of five points. The mean score was 7.1 (SD = 1.6) (Table 6). Three cohort studies (42, 43, 116) and one case series (105) were also critically appraised using the JBI Critical Appraisal Checklist for Prevalence Studies as these studies reported prevalence data.

Table 6: JBI Critical Appraisal Checklist for Prevalence Studies

Item	Study (first author and year)														
	Basketter (16)	**Bipasha (14)**	**Bullock (115)**	**Cai (114)**	**Cowan (40)**	**Goggins (43)**	**Hecimovich (119)**	**Murphy (116)**	**Paul (120)**	**Perera (102)**	**Perera (42)**	**Phillips (117)**	**Saw (105)**	**Stuelcken (37)**	**Stuelcken (36)**
1. Was the sample frame appropriate to address the target population?	N	N	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	N	N
2. Were study participants sampled in an appropriate way?	Y	N	Y	Y	Y	Y	U	Y	N	Y	Y	Y	Y	N	N
3. Was the sample size adequate?	N	N	Y	Y	Y	Y	Y	Y	U	Y	Y	Y	Y	N	N
4. Were the study subjects and the setting described in detail?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
5. Was the data analysis conducted with sufficient coverage of the identified sample?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
6. Were valid methods used for the identification of the condition?	Y	Y	Y	Y	Y	Y	Y	Y	U	Y	Y	Y	Y	Y	Y
7. Was the condition measured in a standard, reliable way for all participants?	Y	Y	Y	Y	Y	Y	Y	Y	U	Y	Y	Y	Y	Y	Y
8. Was the statistical analysis method appropriate?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
9. Was the response rate adequate, and if not, was the low response rate managed appropriately?	U	Y	N	N	Y	Y	Y	Y	Y	Y	N/A	N/A	Y	Y	Y
Score	**6/9**	**7/9**	**8/9**	**8/9**	**9/9**	**9/9**	**7/9**	**9/9**	**5/9**	**9/9**	**8/9**	**8/9**	**9/9**	**9/9**	**7/9**

Y = Yes, N = No, U = Unclear, N/A = Not applicable

Table 7: JBI Critical Appraisal Checklist for Cohort Studies

Item	Study (first author and year)			
	Brooks (118)	**Hill (104)**	**Perera (101)**	**Warren (17)**
1. Were the two groups similar and recruited from the same population?	Y	Y	Y	Y
2. Were the exposures measured concurrently to assign people to both exposed and unexposed groups?	N	Y	N	Y
3. Was the exposure measured in a valid and reliable way?	Y	Y	Y	Y
4. Were confounding factors identified?	Y	Y	Y	Y
5. Were the strategies to deal with confounding factors stated?	U	Y	Y	Y
6. Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?	N	Y	N	Y
7. Were the outcomes measured in a valid and reliable way?	Y	Y	Y	Y
8. Was the follow-up time reported and long enough for outcomes to occur?	Y	Y	Y	Y
9. Was follow up complete, and if not, were the reasons for the loss of follow-up described and explored?	N	Y	N	Y
10. Were strategies to address incomplete follow-up utilised?	N/A	Y	N/A	Y
11.Was an appropriate statistical analysis method used?	Y	Y	Y	Y
Score	**6/11**	**11/11**	**7/11**	**11/11**

Y = Yes, N = No, U = Unclear, N/A = Not applicable

Table 8: JBI Critical Appraisal Checklist for Case Series

Item	Study (first author)
	Perera(100)
1. Were there clear criteria for inclusion in the case series?	Y
2. Was the condition measured in a standard, reliable way for all participants included in the case series?	Y
3. Were valid methods used for identification of the condition for all participants included in the case series?	Y
4. Did the case series have consecutive inclusion of participants?	N
5. Did the case series have complete inclusion of participants?	N
6. Was there clear reporting of the demographics of the participants in the study?	Y
7. Was there clear reporting of clinical information of the participants?	Y
8. Were the outcomes or follow up results of cases clearly reported?	Y
9. Was there clear reporting of the presenting site(s)/clinic(s) demographic information?	Y
10. Was statistical analysis appropriate?	Y
Score	**8/10**

Y = Yes, N = No, U = Unclear, N/A = Not applicable

The remaining four cohort studies (17, 101, 104, 118) were appraised using the JBI Critical Appraisal Checklist for Cohort Studies (Table 7). Two cohort studies (17, 104) scored maximum score of 11 and the mean score of all four cohort studies were 8.8 (SD = 2.6). One case series (100) was critically appraised using the JBI Critical Appraisal Checklist for Case Series and scored eight out of a possible 10 points (Table 8).

With regards to the scoring of studies using the Critical Appraisal Checklist for Prevalence Studies, item 1 was the item with the most 'no' scores. Items 6 and 7 from the same instrument were the items with the most 'unclear' scores. For the Critical Appraisal Checklist for Cohort Studies, items 1, 3, 7, 8, and 9 were the items with the most 'yes' scores and items 2, 6, and 9 scored the most 'unclear' or 'not applicable' scores. The two reviewers disagreed on 17 items which were all resolved through discussions. The inter-rater agreement between the two reviewers for all three critical appraisal tools, was substantial (k = 0.6). After the discussion between the reviewers, a 100% similarity was obtained for the critical appraisal scores.

4.3 Study characteristics

Table 9 summarises the characteristics and outcomes of the 20 studies included in the review. The outcomes of the study characteristics include the type of study design, the setting, the participant's age, country, level of play, the format of cricket, the injury data collection methods, injury definitions, prevalence and incidence data and the body region injured.

4.3.1 Participants

There were a total 1,993 injuries reported in this review. Total of 1,139 participants from the 15 studies that reported prevalence (14, 16, 36, 37, 40, 42, 43, 102, 105, 114-117, 119, 120). The studies reporting incidence did not report the total participants in their cohort/case series, but rather the total injuries (including recurrent injuries) sustained by the cohorts/case series during the given period of the study. Study participants raged from 12 to 38 years with a mean age of 23.79 years. From the 20 studies included in the review, 13 studies (14, 16, 17, 36, 37, 40, 42, 43, 100-102, 116, 120) included female cricket participants and seven studies (104, 105, 114, 115, 117-119) included female and male cricket participants.

Table 9: Study Characteristics

First author, year	Study design, aim, setting	Participants, age, level, format	Data collection methods	Injury definition	Prevalence / incidence	Body region injured
Basketter (16)	Cross-sectional study (level 4b) (dissertation) The study aimed to collect information of the rate and injuries sustained during the summer 2013 season in England and Wales	52 female cricket players Age (mean): 21.7 (range 18-45) years Level of play: Multiple (10 elite, 37 county, 5 club) Formats of cricket: Multiple (T20, ODI)	Cross-sectional study using questionnaires to collect information of players and injuries sustained during the summer 2013 season	Own injury definition used, injury was defined as: "problem that caused a player to miss training or playing time"	28 out of 52 female cricket players reported injuries; a total of 40 injuries were reported. Injuries according to player role; batters 14, pace bowlers 7, spin bowlers 3 and wicketkeepers 4. 35 time-loss injuries were reported: 16 (<7 days), 6 (8-30 days), 4 (31-90 days), 9 (>91 days). 5 no time-loss injuries were reported	Shoulder (28%), lower back (15%), wrist and hand (10%), foot (8%), thigh (8%), knee (8%), forearm (3%), elbow (3%), trunk (3%) and neck (3%)
Bipasha (14)	Cross-sectional study (level 4b) The aim of the study was to identify the cricket injuries and related pattern among women cricketers from December 2017 to June 2018 in Bangladesh	51 female cricket players Age (mean): 16.86 ± 2.596; (12-14 years 14, 15-17 years 8, 18-20 years 20) Level of play: more than 6 months professional cricket Formats of cricket: not indicated	A purposeful sampling technique was used, and a face-to-face interview was performed to gather data using an interviewer and formal questionnaire	International Consensus Statement definitions from 2005 with slight modifications	51 female cricket players with injuries were reported Injuries by player roles; bowlers 21, batters 21, wicketkeepers 9	Shoulder (31.4%), elbow (15.7%), ankle (13.7%), meniscus (7.8%), hamstring (7.8%), back pain (7.8%), fractures (5.9%), wrist (3.9%), head (2%), finger (2%) and groin (2%)
Brooks (118)	Retrospective cohort study (level 3b) This study reviewed all cases of hand fractures from the online Athlete Management System from December 2015 to December 2018 in Australia	27 female cricket players (study included male cricket players). Age (mean): 25.4 ± 4.5 years for females Level of play: elite cricket Formats of cricket: not indicated	The Cricket Australia's online Athlete Management System (Fair Play Pty Ltd) cohort was used for this study; data was recorded in a standardised manner by medical staff	Own injury definition used for injuries, return-to-play was categorised as: 1) days injured, where the player was unable to play/participate in matches or training, and 2) the period (days) needed to return to full play	Hand fractures per 100,00 balls per team for female players: 9.67 (batters 6.61; fielders 14.42; wicketkeepers 2.88) Hand fractures per 100,00 balls per female players: 0.74 (batters 0.97; fielders 1.44; wicketkeepers 2.88) Female players had a higher incidence of hand fractures in matches compared to males	27 female cricket participants with hand fractures

First author, year	Study design, aim, setting	Participants, age, level, format	Data collection methods	Injury definition	Prevalence / incidence	Body region injured
Bullock (115)	Cross-sectional study (level 4b) This study was part of the Cricket Health and Wellbeing Study (CHWS), conducted in England and Wales in March 2017 and aimed to investigate the effect of resilience, playing standard, and playing status among cricketers	65 female cricket players (study included male cricket players) Age not indicated for female cricket players Level of play: 32 elite and 27 recreational Formats of cricket: not indicated	Current and retired cricketers from all levels-of-play who were registered on the England and Wales Cricket Board national database were invited to complete an electronic questionnaire	Own injury definitions used: 1) cricket-related injury leading to more than 4 weeks of reduced participation in exercise, training or sport; 2) joint pain and OA; 3) general health and disease prevalence; 4) physical activity; 5) resilience, quality of life and flourishing	36 out of 65 (55%) female cricket players played sport while injured Participants aged older than 30 years; 27 out of 51 (53%) female cricket players played sport while injured.	N/A
Cai (114)	Cross-sectional study (level 4b) This study was part of the Cricket Health and Wellbeing Study (CHWS), conducted in England and Wales in March 2017 and aimed to investigate the effect of resilience, playing standard, and playing status among cricketers	24 female cricketers (study included male cricket players) Age and level of play not indicated for women's cricket Formats of cricket: not indicated	Current and retired cricketers from all levels-of-play who were registered on the England and Wales Cricket Board national database were invited to complete an electronic questionnaire	Own injury definition: joint pain or osteoarthritis was defined as joint-specific doctor-diagnosed osteoarthritis	13 out of 24 (54%) former female cricket players reported joint pain	N/A
Cowan (40)	Descriptive study (level 4b) (dissertation) This study aimed to determine injury rate and anatomical areas among female cricket players during the Women's World Cup of Cricket (March - April 2005) in South Africa	56 female cricket players Age (mean): 25.2 ± 1.10 years Level of play: elite cricket Formats of cricket: World Cup (50 overs)	Data were collected using questionnaires; injuries and training practices during the World Cup were documented, including the 8-month period prior to the World Cup	Own definition was used. Injuries were defined as: an incident that prevents a player from competing in a match or training session, or an incident that needs medical attention. Acute and chronic injuries were distinguished and reported	27 injuries out of 56 players (48.21%) were recorded; a frequency of 0.48 injuries per player; 11 injuries sustained 8 months prior to World Cup; most injuries during World Cup 16 (58%) Injuries sustained per player role: batting 22%, bowling 19%, fielding 25%, catching 15%, throwing 8%, other 4% Time loss injuries: 64% of players sustained acute injuries; 36% were recurrent; playing time loss was 1-3 days (34%) and 4-7 days (35%); these two groups calculated 69% of practice days missed; there were 0% missing practice for 15-21 days, 3 injuries forced players to miss more than 22 days of practice	Lower limb (59%), upper limb (26%), thoracic (15%), lumbar (15%), spine (15%), trunk (15%) injuries reported

First author, year	Study design, aim, setting	Participants, age, level, format	Data collection methods	Injury definition	Prevalence / incidence	Body region injured
Goggins (94)	Prospective cohort study (level 3b) Study aimed to describe injury and illness epidemiology within women's international pathway cricket, understanding the effects on the availability of players in this context, where players were engaged in part-time cricket in England and Wales from April 2015 to March 2019	83 female cricket players included in the study Age (mean): 19.75 ± 4.03 Level of play: elite cricket Formats of cricket: Multiple (First-class, ODI, T20)	Four years of injury data were routinely collected and analysed by England and Wales Cricket Board and a university research partner	International Consensus Statement definitions from 2016 update were used	Overall prevalence was 4.1 per cent (95% CI 2.7-6.2), with 95.9 per cent of players injured when selected on any day of the match Bowling was the player role with the highest annual time loss prevalence (0.6% of 172 players being unavailable); lower back injuries for bowlers caused 1.3% overall prevalence of 0.6% of players fully unavailable for a match on any given day; 8.4% of players were affected by medical complaint injuries; 2.3% of players were unavailable for any given match day The average injury incidence was 7.0 playing time-loss injuries sustained per 1,000 team match days (95% CI 4.6-10.6) and per 1,000 player match days. Fielding (56.4 injuries/100 players per year) accounted for the highest total average and time-loss injury incidence rates Overall, about 8.4% of players were affected (they were unavailable or were unable to play) as a result of medical complaints, with an average of 2.3% of players entirely inaccessible on any day of cricket during the year	The highest average annual complaint body region injured was the lower back (1.3 % total prevalence); 0.6% of players were fully inaccessible for any day during the year, followed by medical illness; and thirdly, injuries to the knee
Hecimovich (119)	Case control study (level 3d) The objective of this article was to investigate the ratio of lumbar lordosis between junior-level cricket players with and without lower back injuries. Data were collected from the Talented Athlete Program (Western Australian Cricket Association) in 2016	26 female cricket players (study included male cricket players) Age: 13-17years, mean: 14.3 ± 1.0 Level of play: junior level cricket (13-17years) Formats of cricket not indicated	Data collected from participants in the Talented Athlete Program (Western Australian Cricket Association)	Own injury definition: participants had to have sustained a lower back injury from bowling, or a similar action, which prevented their involvement in at least one training session or match during the previous cricket season; the lower back injury was self-reported with parent/guardian confirmation	9 out of 26 female cricket players reported lower back injury	9 female cricket players with lower back injury

First author, year	Study design, aim, setting	Participants, age, level, format	Data collection methods	Injury definition	Prevalence / incidence	Body region injured
Hill (104)	Prospective cohort study (level 3b) Prospective analysis of head impacts and concussions using the Cricket Australia database over two seasons (2015-2016 and 2016-2017) of elite-level male and female cricketers	106 domestic and international female cricket players in the 2015-2016 season, 98 female cricket players in the 2016-2017 season (study included male cricket players) Age of participants / formats of cricket are unknown Level of play: elite level cricket (domestic and international)	Prospective analysis of head impacts and concussions using the Cricket Australia online medical database and data from concussion-specific neurological tests performed on postimpact players	Concussion was diagnosed using the Berlin Concussion Consensus, together with a medical diagnosis from a doctor (neurocognitive testing) and a monitoring of the signs and symptoms of players after impact	15 head impacts that resulted in 8 concussions (367 team days of play) in women's matches Overall incidence was 3.7 head impacts (2.0 concussions) per 1000 player days, 0,5 concussions per 1000 player-match hours	15 head injuries with 8 concussions reported
Murphy (116)	Prospective cohort study (level 3b) The focus of this paper was to analyse the factors associated with the risk of dominant-shoulder injury in one season of the Australian Women's National Cricket League (2017-2018)	115 female cricket players Age (mean): 26.0 (4.4) years. Level of play: elite level cricket (domestic) Formats of cricket: not indicated	Prospective study conducted to determine the ratio between physical performance and results from musculoskeletal screening (MSS) tests that were performed on the players	Own injury definition used:, any incident that causes a player to be unavailable to play, throw or perform shoulder movements due to a shoulder injury	14 players developed injuries in the dominant shoulder (12%) throughout the season; shoulder impingement (57%) was the most common diagnosis Throwing (64%) accounted for the most injuries in the shoulder	14 shoulder injuries were reported (authors gave prevalence for each type of shoulder injury).
Paul (120)	Cross-sectional study (level 4b) (dissertation) The purpose of the study was to identify the most common injuries in Bangladeshi cricketers in 2007	57 female cricket players Age (mean): 19.14(± 3.41) years Level of play not specified Formats of cricket: not indicated	For data collection, a questionnaire was used. The study sample group included injured cricket trainees and players among the Bangladeshi Cricketers	No clear injury definition given	359 injuries sustained by 57 players 12 (21.1%) were batters, 14 (24.6%) were bowlers, 24 (42.1%) were all-rounders and 7 (12.3%) were wicketkeepers	Head and neck (9.55%), shoulder (13.48%), elbow (5.9%), wrist, hand and finger (17,98%), back and trunk (9,27%), hip and thigh (15.17%), knee and leg (14.04%), ankle and foot (14.60%)

First author, year	Study design, aim, setting	Participants, age, level, format	Data collection methods	Injury definition	Prevalence / incidence	Body region injured
Perera **(101)**	Cohort study (level 3b) (dissertation) This study investigated the injuries that contributed to successful insurance claims from the 2002–03 to the 2012–13 cricket seasons in Australia	108 insurance claims Age groups: 15 to 19-years (17.6%), 20 to 24-years (16.7%), and 25 to 29-years (15.7%) Level of play not indicated Formats of cricket not indicated	Insurance claims were collected from the JLT-Sport database, including: the injury date; geographical location; association played for; injuries sustained; player role; playing surface; body region injured; nature and description of injury and age/gender of the players	Injury was defined as the result of an incident causing harm to a player and resulting in a JLT Sport insurance pay-out Two independent researchers using the Orchard Sports Injury Classification System version 10 (OSICS-10) independently reported the collected data relating to the body area and type of the injury	108 insurance claims 89 injuries occurred during competition (82.4%) leading to an insurance pay-out and most were incurred during batting (52.5%) Claims related to fielding reflected 38% of female cricket claims	Knee (24.1%), upper distal extremity (including hand, wrist and fingers) (19.4%) and teeth (14.8%) Sprains (ligaments) (24.1%) and fractures (22.2%) were the most common forms of injury
Perera **(102)**	Cross-sectional study using questionnaires (level 4b) This study analysed data from the Injury Surveillance in Women's Cricket in Australia using a survey distributed via Survey Monkey from 2004 to 2013	164 female cricket players (163 outdoor, 37 indoor cricket) Age (mean): 23.7 years (SD ± 7.4) Level of play: Multiple (153 club, 106 state, 18 national and 32.9% professional, 67.1% non- professionals) Formats of cricket: not indicated	Data were collected using questionnaires distributed to cricket players in Australia via Survey Money	Own injury definition: “An injury is any physical problem that may have caused you pain, bleeding, loss of movement or loss of function in a part of your body. It could include the gradual onset of aches, pain, discomfort or stiffness without a specific event responsible for the complaint”	109 players sustained injuries (114) during the 2014–15 season, and 18% (20) sustained more than 3 injuries 798.6 injuries sustained per 1,000 participants	26 distal lower limb injuries (23%) and 5 head, neck and spine injuries (22%) were recorded. 30.4% muscle injuries; 27.8% joint or ligament injuries; and 21.7% progressive onset /overuse injuries were recorded.

First author, year	Study design, aim, setting	Participants, age, level, format	Data collection methods	Injury definition	Prevalence / incidence	Body region injured
Perera (42)	Cohort study (level 3b) Injury data obtained by the Athlete Management System of Cricket Australia on all elite female players over two seasons were analysed in Australia from March 2014 to March 2016	121 female cricket players with 621 injuries reported Age (mean): 24.2 years (SD ± 4.5) Level of play: elite level cricket Formats of cricket: Multiple (ODI, T20, Multi day match)	Cricket injury and health data were prospectively gathered by a team doctors and physio-therapists from elite-level female players (state and national) using the Fair Play AMS 2016 database	Injury was defined as any incident causing a player to seek medical treatment and that affects match or training time; and/or preventing a player from performing his/her player role during a match, as instructed by the captain	600 injuries were suffered by 113 players; 77.7% (94) sustained 1 injury. 477 accidents were acute (79.5%) and 73.2% (439) were recent The most frequent time loss injuries were 121 (20.2%) time loss injuries (94 recent and 27 recurrent), resulting in a total of 3,638 days (average: 30 days) away from cricket Match injury incidence was 424.7 injuries/10,000 hours for all injuries, and 600 medical-attention injuries; 79.3 injuries/10,000 hours for time-loss, with 77.7% of players registering more than one injury. Compared to the progressive onset injuries, there were 79.5% acute injuries, 20.2% of all emergency treatment injuries contributed to time-loss; 34.7% were match-time-loss injuries All injuries amounted to 424.7 injuries/10,000 h and time-loss injuries amounted to 79.3 injuries/10,000h	The most frequently injured areas were the thigh (14.0%), wrist (12.8%), knee (11.3%), shoulder (11.0%) and lumbar spine (10.5%) The most frequent time-loss injuries were wrist and hand (19.8%), lower back (16.5%) and knee (14.9%) injuries Six players experienced injuries to the lumbar spine, causing the most time loss (average 110.5 days/injury)
Perera (100)	A retrospective case series (level 4c) This study investigated the data relating to cricket injuries captured in hospital databases from 1 July 2002 to 30 June 2014, including datasets maintained by the Victorian Injury Surveillance Unit in Australia	668 female cricket cases Age (mean): 10–14-year age group was identified as the most frequently injured group Top three age groups for hospital admissions were 20–24 (19.0%), 10–14 (6.5%), and 30–34 (10.7%), and the top age groups for emergency departments 10–14 (19.9%), 15–19 (15.7%), 20–25 (13.3%) Level of play and formats of cricket not indicated	Data compiled from hospital records of injuries sustained by Victoria, Australia, women's cricketers for the period 1 July 2002 to 30 June 2014	Injuries were diagnosed by health care practitioners and captured in the database of the hospitals	668 cases, emergency departments accounted for 547 cases and hospital-admissions accounted for 121 cases All incidence cases were documented as 1.5 emergency departments-presentations per 1000 participants (95% CI 0.9–3.9) and 0.3 hospital-admissions per 1000 participants (95% CI 0.8–1.5)	<u>Hospital admissions:</u> Head (28.1%), shoulder (5%), elbow (12%) wrist/hand (17.4%), knee/lower leg (22%), ankle/foot (5%), unspecified (10%) <u>Emergency department:</u> Head (27.8%), shoulder (4%), elbow (6%), wrist/hand (29%), ankle/foot (14%), abdominal/lower back/ spine/pelvis (1%), knee/lower leg (12%), unspecified (1%)

First author, year	Study design, aim, setting	Participants, age, level, format	Data collection methods	Injury definition	Prevalence / incidence	Body region injured
Phillips (117)	Cross-sectional study (level 4b) This study reported the incidence of anterior knee pain across different participatory levels, age and gender groups in schools in South Africa in 2007	8 female cricket players (study included male cricket players) Age: 11-17 years old Level of play; school cricket (11-17years) Formats of cricket: not indicated	Injury data were captured using questionnaires that were distributed to 10 to 17-year-old adolescents in 8 primary and 5 secondary schools in South Africa	Own definitions of injury were used; she/he must have indicated on the diagram the origin of the pain on the anterior surface of the knee, listed pain lasting for longer than 1 month, indicated the level of pain as mild to extreme, and indicated that the pain interfered with sports involvement.	6 out of 8 female cricket players reported knee pain	6 female cricket payers reported anterior knee pain.
Saw (105)	A retrospective case series (level 4c) The objective of this study was to explore situational factors consistent with concussion in elite male and female cricket players in Australia from July 2014 to February 2019	183 females with head impacts (study included male cricket players) Age (mean): 26 ± 5 years (range 16–38) Level of play: elite level cricket (domestic or international) Formats of cricket not indicated	Data from the online datasets of Cricket Australia (Athlete Management System and The Cricket Analyst, Fair Play Pty Ltd) were used in the analysis	Concussion was diagnosed using the concussion protocol and consensus concept of the organisation's act by an experienced specialist practising in Sports Medicine	19 head impacts recorded from 183 female cricket players Batting head impacts 11 (1 per 2,266 overs), fielding head impacts 8 (1 per 3,139 overs)	19 head impacts reported
Stuelcken (37)	Cross-sectional study (level 4b) This study investigated lower back pain in elite female fast bowlers. It assessed factors of the lumbar spine and hip motion range, as well as trunk extension from bowlers in Australia with and without a history of low back pain	26 elite female fast bowlers (Male cricket players were included in this study.) Age (mean): 22.5 ± 4.5 Level of play: elite level cricket Format of cricket not indicated	Injury data were captured using a self-administered questionnaire and captured from medical records. Several lumbar spine and hip motion tests were collected using goniometry. Trunk extension was tested using a modification from the Sorensen Test.	Own injury definition used: bowlers with lumbar pain whether self-reported or diagnosed: 1) pain was due to or worsened by cricket skills; 2) pain had been experienced in the previous twelve months; or 3) pain had occurred at some point in the bowling career and could be confirmed by reports maintained by the medical team staff	54% of female fast bowlers (14/26 players) presented with a history of lower back pain (LBP) Out of 14 bowlers, 9 had endured at least one episode of LBP in the previous 12 months and 6 had recorded recurring episodes of LBP in their careers 3 of the 14 female bowlers reported current back pain	14 lower back injuries reported

First author, year	Study design, aim, setting	Participants, age, level, format	Data collection methods	Injury definition	Prevalence / incidence	Body region injured
Stuelcken (36)	Cross-sectional study (level 4b) The goal of this study was to establish the prevalence of shoulder pain and compare the strength and range of motion of female fast bowlers with and without shoulder pain in Australia in 2007	26 female cricket players Age (mean): 22.5 ± 4.5 years Level of play: elite level cricket Formats of cricket: not indicated	A questionnaire was used to determine injury among the bowlers and data on personal details, cricket experience and history of shoulder pain related to or aggravated by bowling or throwing were captured and analysed	Own injury definition used: if a bowler had a history of shoulder pain 1) in the last year or 2) at some point and was documented by the medical staff in the team	12 out of 26 bowlers reported shoulder pain	12 shoulder injuries reported
Warren (17)	Prospective cohort study (level 3b) The goal of this research was to investigate the incidence and prevalence of injuries among female cricket players during a two-year professional T20 cricket tournament in England from 2016-2017	171 (84 players were included in 2016 and 87 in 2017), with 137 injuries recorded. Age: 16–38 years (mean 23.4 ± 4.8) Level of play: elite level cricket Format of cricket: T20	All injuries and illnesses sustained by female cricket players were documented throughout the duration of the tournament	Own injury definitions used: 1) uninjured when a player is available for a match selection; 2) injured, but still available for match selection; 3) injured, but still available for match selection but with modified activity; ;4) when, as a result of an injury, a player is completely unavailable	137 injuries (20 time-loss and 117 non time-loss 2.1 time-loss injuries and 12.2 non-time-loss injuries sustained per 100 match days. The largest rate of injury happened in the elbow (1.8 injuries per 100 match days), the lower back (1.7 injuries per 100 match days) and the knee (1.7 injuries per 100 match days) Fielding-associated injuries have the greatest overall incidence of injury (5.2 injuries in 100 match days), 3.3% of players were fielders missing matches at any given day Throwing (2.3 injuries per 100 match days) and fast bowling (2.1 injuries per 100 match days) accounted for the most injuries, whereas catching injuries caused the most time-loss injuries (2.5% of players missing matches on any given day)	The highest incidence of injuries resulted in the shoulder (1.8 injuries per 100 match days), the lower back (1.7 injuries per 100 match days), and the knee (1.7 injuries per 100 match days) The hand (1.7%), head and face (0.8%) and hip (0.6%) accounted for the most time-loss injuries All head impacts accounted for concussions

4.3.2 Country and level of play

Studies on injuries to female cricket players were differentiated in terms of the different countries. Eleven studies were from Australia (36, 37, 42, 100-102, 104, 105, 116, 118, 119), five studies were from the United Kingdom (16, 17, 43, 114, 115), two studies from Bangladesh (14, 120) and two studies from South Africa (40, 117). The levels of cricket were divided into elite and non-elite levels. Non elite levels of cricket include recreational, school/junior, and club level cricket. Ten studies included elite level players (17, 36, 37, 40, 42, 43, 104, 105, 116, 118), eight studies included a mixture from recreational to elite level players (14, 16, 100-102, 114, 115, 120) and two were from junior (or school) level cricket (117, 119).

4.3.3 Formats of cricket

Nineteen studies were conducted on players participating in outdoor cricket (14, 16, 17, 36, 37, 40, 42, 43, 94, 100, 101, 104, 105, 114-118, 120) and one study included both indoor and outdoor cricket (102). Fifteen studies did not indicate the format of cricket played by the participants (14, 36, 37, 100-102, 104, 105, 114-120). Multiple formats of cricket were reported in three studies (16, 42, 43), one study only included one day cricket (50 overs) (40) and one study only included T20 cricket participants (17). Two studies collected data during international tournaments (17, 40). Four studies collected data during one or over multiple seasons (16, 42, 43, 101) (Table 9).

4.3.4 Data collection methods

Valid data collection methods were used in all 20 studies. Eight studies used self-administered questionnaires (14, 16, 37, 102, 114, 115, 117, 120), four studies from cricket seasons/tournaments (17, 40, 42, 43), three studies from injury surveillance databases (104, 105, 118), two from observational methods (116, 119), one from hospital records (100) and one from insurance claims (101). The observational methods included a study that measured lumbar lordosis to investigate the relationship between lumbar lordosis and lower back pain among junior cricket players (119), while the other study examined the shoulder, using musculoskeletal shoulder tests to examine the relationship between the results of the tests and the physical performance of cricket players (116).

4.3.5 Injury definitions

Injury definitions varied across the studies. Seventeen studies (16, 17, 36, 37, 40, 42, 100-102, 104, 105, 114-119) used their own definitions. Seven studies (16, 17, 40, 42, 43, 102, 120) reported time-loss and non-time loss injuries in accordance with the International Consensus Statement (3). Seven studies (42, 100-102, 104, 105, 118) reported medical-attention injuries. Five studies (14, 16, 17, 40, 118) used a modified injury definition derived from the 2016 International Consensus Statement (3). Three studies (100, 101, 104) used a definition or diagnosis given by health care professionals and/or retrieved from medical health records. Three studies (17, 42, 43) used the exact definition of an injury as defined by the 2016 International Consensus Statement (3). One study (120) did not use an injury definition.

4.4 Injury prevalence

4.4.1 Overall injury prevalence

Data concerning the prevalence of injuries sustained by female cricket players are presented in Table 10. Annual injury prevalence is used for a 365-day period (3). Six studies (16, 40, 42, 43, 102, 105) presented prevalence data as annual injury prevalence and ranged from 7.7% in English international pathway players (43) to 93.3% in Australian elite players (42) over two years. Included in this range; 53,8% annual injury prevalence during a summer season in England (16) and 48,2% annual injury prevalence for eight months prior to and during the 2005 ODI World Cup (40). The self-reported annual injury prevalence was 66,5% for one season in Australia (102).

Two studies reported general injury prevalence using a combination of recreational- to elite-level players from the Cricket Health and Wellbeing Study conducted in the United Kingdom (114, 115). The overall general injury prevalence ranged from 54.2% (114) to 55.4% (115) (Table 10). Bullock et al. (115) reported injury data on participants with a history of injury while playing sport and included 65 female cricket players from the cohort. Using the same cohort, Cai et al. (114) reported injury data on former cricket players older than 30 years and included 24 female cricket players in their study. Both of these studies were included in the narrative review, but only the study by Bullock et al. (115), with the bigger cohort, was included in the meta-analyses to avoid duplication of data.

Table 10: Prevalence and incidence of injuries in women's cricket

Article	All players	Players injured	Injuries recorded	Time loss injuries	Non-time-loss injuries	Medical attention injuries	Prevalence (%)	Incidence
Basketter (16)	52	28	40	87.5% (40% (<7 days), 15% (8-30 days), 10% (31-90 days), 22.5% (>91 days)	12.5%	92.5%	53.8% annual injury prevalence (one season)	
Bipasha (14)	51	51					N/A	
Brooks (118)		27	27			100%		0.7 per 100,000 balls per player, 9.7 per 100,000 balls per team ***hand fractures only**
Bullock (115)	65	36					55.4% general injury prevalence	
Cai (114)	24	13					54.2% general injury prevalence	
Cowan (40)	56	26	27 (11 prior to World Cup, 16 during World Cup)	85% total (34% (1-3 days), 35% (4-7 days), 8% (8-14 days), 8% (22 days)	15%		48.2% annual injury prevalence	
Goggins (43)	83		182.5	4.1% match time loss; 2.3% players unavailable on any given day 31.2 per 100 players per year (mean annual injury incidence)	4.4% injured available 0.7% injured modified activity 151.3 per 100 players per year (mean annual injury incidence)		7.7% annual injury prevalence (4 seasons) 8.4% annual complaint injury prevalence (4 seasons)	7.0 match time loss injuries/per 1,000 player match days; 182.5 per 100 players per year (mean annual injury incidence)
Hecimovich (119)	26	9	9				34.6% ***lower back only**	
Hill (104)	106		15			100%		3.7 head impacts per 1000 player days ***head impacts only**
Murphy (116)	115	14	14				12.2% ***shoulder only**	
Paul (120)	57	57		56.1% total (28.7% (1-7 days), 19.3% (10-20 days), 8.8% (25-45 days)	43.9%		N/A	

Table 10 (continue)

Article	All players	Players injured	Injuries recorded	Time-loss injuries	Non-time-loss injuries	Medical attention injuries	Prevalence (%)	Incidence
Perera (101)			108			100%		1.3 per 10,000 registered players (mean annual injury incidence)
Perera (102)	164	109	114	Training – 19.8% (1-2 sessions), 28.1% (≥5days) Matches - 14% (1-2), 10.3% (≥5)	41.7% (training) 66.4% (matches)	43%	66.5% annual injury prevalence	798.6 injuries per 1,000 participants (mean annual injury incidence)
Perera (42)	121	113	600	20.2% 79.3 per 10,000 player hours	79.8% 345.4 per 10,000 player hours	100%	93.3% annual injury prevalence (2 seasons)	424.7 per 10,000 player hours (mean annual injury incidence, 2 seasons)
Perera (100)			668 (547 emergency department, 121 hospital)			100%		1.5 ED-presentations per 1000 participants (mean annual incidence): 12 seasons 0.3 hospital admissions per 1000 participants (mean annual incidence, 12 seasons)
Phillips (117)	8	6	6				75% ***knee pain only**	-
Saw (105)	183		19			100%	10.4% annual injury prevalence (5 seasons) ***head impacts only**	19 (1 per 2,6 overs) (mean annual incidence, 5 seasons) ***head impacts only**
Stuelcken (37)	26	14	14				53.9% ***lower back only**	
Stuelcken (36)	26	12	12				46.1% ***shoulder only**	
Warren (17)	171		137	14.6% total (4.6% unavailable for match selection) 2.1 time-loss injuries per 100 match days (mean annual injury incidence)	85.4% 12.2 non time-loss injuries per 100 match days (mean annual injury incidence)		4.6% of players were unavailable for match selection.	14.2 total injuries per 100 match days (mean annual injury incidence)

4.4.2 Time-loss injury prevalence

Time-loss injuries were reported from several studies and ranged from 4.1% (43) in county players to 87.5% (16) in international pathway cricket. Included in this range; 85% time-loss injury prevalence was reported during the 2005 ODI World Cup (40) and 14.6% time-loss injury prevalence in T20 cricket (17). The percentage of players missing practice and matches for less than seven days ranged from 28.7% (102) to 69% (40) and players missing more than seven days ranged from 15% (16) to 38.4% (102). The percentage of players unavailable for match selection on any given day ranged from 2.3% (43) to 4.6% (17).

4.4.3 Non-time-loss injury prevalence

Non-time-loss injuries ranged from 0.7% (43) to 79.8% (42). Non-time loss injury prevalence amounted to 12.5% of the sampled group of players over one season in England (16). Non-time-loss injury prevalence affected 4.1% international pathway players that were injured but still available for play while 0.7% of the players participated in modified sports activities (43). Bangladeshi cricket players presented with non-time-loss injury prevalence of 43.9% (120). Self-reported worst injury in Australia was 41.7% non-time-loss injuries for training, and 66.4% non-time-loss injuries for matches (102). Non-time-loss injury prevalence in elite-level cricket players in Australia was 79.8% (42).

4.4.4 Medical attention injury prevalence

Medical attention injuries were reported in eight studies (16, 42, 100-102, 104, 105, 118). Medical attention injuries accounted for 100% of all injuries sustained in six studies (42, 100, 101, 104, 105, 118). The medical attention injuries in two studies ranged from 43% (102) to 92.5% (16) of all injuries sustained (Table 10).

4.4.5 All-complaint injury prevalence

The all-complaint injury definition include injuries and medical illnesses (Table 10). Only one study (43) used the ‘all-complaint’ injury definition and reported annual all-complaint injury prevalence of 8.4%.

4.4.6 Injury prevalence by player role

Injury prevalence for bowlers, in studies that grouped fast and slow bowlers, ranged from 1.1% (43) to 53.8% (37) (Table 11). Injury prevalence for fielders ranged from 2.3% (43) to

18.6% (40). Injury prevalence for batters ranged from 0.9% (43) to 26.9% (16) and injury prevalence for wicketkeepers raged from 0.2% (43) to 8.0% (16). Bowlers were the player role most frequently injured (Table 11). The prevalence of injuries among fast bowlers was higher than that for slow bowlers (16, 17, 100, 102). The prevalence of injuries in fast bowlers only, ranged from 7.7% (17) to 53.8% (37) and the prevalence of injury in slow bowlers only ranged from 1.9% (17) to 5.8% (16). Injury prevalence for fast bowlers was 53.9% (37) specific for lower back pain and 46.2% (36) specific for shoulder injury. The prevalence of lower back pain in junior-level bowlers was 34.6% (119).

Table 11: Injury prevalence for women's cricket by player role

Article	Total players	Batter	Bowler (fast/slow)	Fielder	Wicket keeper	All-rounder
Basketter (16)	52 players	**26.9%**	19.2% (13.5% fast, 5.8% slow)		8%	
Cowan (40)	56 players	10.2%	8.8%	**18.6%** (11.6% field, 7% catch)		
Goggins (43)	83 players	0.9%	1.1%	**2.3%**	0.2%	
Hecimovich (119)	9 players		**34.6%** (knee only)			
Stuelcken (37)	26 players		**53.8%** (fast bowlers, lower back only)			
Stuelcken (36)	26 players		**46.5%** (fast bowlers, shoulder only)			
Warren (17)	171 players	3.9%	9.6% (7.7% fast, 1.9% slow)	**15%**	0.9%	
Distribution of injuries as percentages, not prevalence data - as all cohorts were injured:						
Bipasha (14)	51 players (all cohorts were injured)	**41.2%***	**41.2%***		17.7%*	
Paul (120)	57 players (all cohorts were injured)	21.1%*	24.6%*		12.3%*	**42.1%***

Percentages in bold indicate the highest % per article.

4.4.7 Percentage of injuries distributed by player role

Two studies (14, 120) reported data for injured players only, rather than uninjured players as needed for injury prevalence calculations. The percentage of injuries were distributed among the four player roles: bowlers (24.6% (120) to 41.2% (14)), batters (21.1% (120) to

41.2% (14)), followed by wicketkeepers (12.3% (120) to 17.7% (14)). Further 42.1% injuries were in all-rounders that bat and bowl (120) (Table 11).

4.4.8 Distribution of injuries sustained by body region

The shoulder was the most frequently body region injured and ranged from 3.7% (40) to 31.4% (102). The body ankle, foot and toes were the second most frequent body region injured and ranged from 3.7% (40) to 23% (102). The hand, wrist and fingers ranged from 5.9% (14) to 14.8% (40) and was the third-most-prevalent body region injured. Prevalence of lower back pain ranged from 34.6% (119) in junior-level bowlers to 53.9% (37) in elite-level fast bowlers. The prevalence of knee pain in children playing cricket was 75% (117). The annual injury prevalence for head impacts over a five-year study period was 10.4% (105) (Table 12 and Figure 6).

Table 12: Injury prevalence of women's cricket by body region

*distributed as percentages (%)

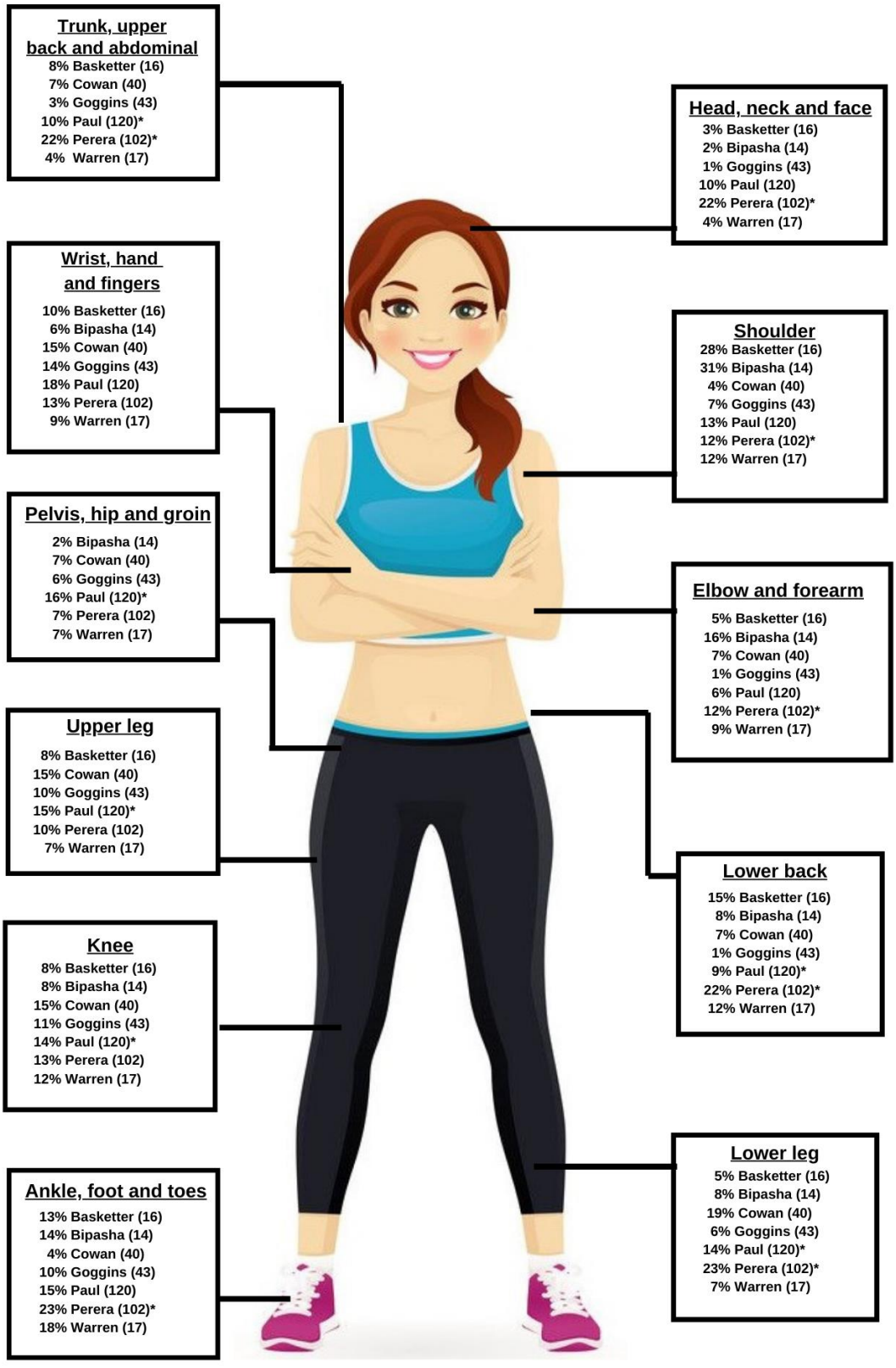
Article	Player role (injured players)	Head/ neck face	Trunk/ back/ abdomen	Shoulder	Elbow/ forearm	Wrist/ hand/ fingers	Lower back	Pelvis / hip/ groin	Upper leg	Knee	Lower leg	Ankle/ foot/ toes
Basketter (16)	All (40)	2.5%	7.5%	**27.5%**	5%	10%	15%		7.5%	7.5%	5%	12.5%
Bipasha (14)	All (51)	2%		**31.4%**	15.7%	5.9%	7.8%	2%		7.8%	7.8%	13.7%
	Bowler			**16.4%**	5.5%		1.8%	3.3%	3.3%	1.8%		3.3%
	Batter			**12.7%**	5.5%		1.8%		8.7%	5.5%		7.3%
	Wicketkeeper	1.8%		1.81%	3.63%	**5.5%**	1.8%	1.8%				
Cowan (40)	All (27)		7.4%	3.7%	7.4%	14.8%	7.4%	7.4%	14.8%	14.8%	**18.5%**	3.7%
Goggins (43)	All (83)	6.9%	2.8%	7%	9.7%	14%	**18%**	5.6%	9.7%	11.1%	5.6%	9.7%
Hecimovich (119)	Bowlers (9)						9 (100%)					
Murphy (116)	All (14)			14 (100%)								

Percentages in bold indicate the highest % per article

Table 12 (continue)

Article	Player role (injured players)	Head/ neck face	Trunk/ back/ abdomen	Shoulder	Elbow/ forearm	Wrist/ hand/ fingers	Lower back	Pelvis/ hip/ groin	Upper leg	Knee	Lower leg	Ankle/foot/ toes
Paul (120)	All (57)	9.6%	*combined with lower back	13.5%	5.9%	**18%**	*9.3%	*15.2%	*combined with hip	14%	*combined with knee	14.6%
	Bowler	2.5%	*combined with lower back	3.9%	1.4%	**4.8%**	*1%	*3.7%	*combined with hip	3.4%	*combined with knee	3.9%
	Batter	1.7%	*combined with lower back	2.8%	2.3%	**3.9%**	*2%	*3.4%	*combined with hip	3.4%	*combined with knee	3%
	Wicketkeeper	2%	*combined with lower back	1.1%	1%	**2.5%**	*1.7%	*1.7%	*combined with hip	1.1%	*combined with knee	2%
Perera (102)	All (14)	*22%	*combined with head/neck	*12	*combined with shoulder	13%	*combined with head/neck	7%	10%	13%	***23%**	***combined with lower leg**
Phillips (117)	All (6)									6 (100%)		
Stuelcken (37)	All bowler (14)						14 (100%)					
Stuelcken (36)	All bowler (12)			12 (100%)								
Warren (17)	All (137)	4.1%	4.4%	**12.4%**	8.8%	8.8%	11.7%	6.6%	6.6%	11.7%	6.6%	17.6%

Percentages in bold indicate the highest % per article



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Figure 6: Injury prevalence of women's cricket by body region

*totals are displayed as percentages of all injuries by body regions, not as prevalence calculations

4.5 Injury incidence

4.5.1 Overall injury incidence

The mean annual injury incidence (over 365 calendar days) ranged from 182.5 injuries per 100 players per year (43) to 424.7 injuries per 10,000 player hours over two seasons (42) (refer back to Table 10). The mean annual incidence of self-reported worst injury was 798.6 injuries per 1,000 participants in Australia (102). The mean annual incidence of hospital treated cricket injuries was 1.5 emergency department (ED) presentations per 1,000 participants and 0.3 hospital admissions per 1,000 participants over 12-seasons in Australia (100). The mean annual incidence of injuries which led to successful insurance claims in Australia was 1.26 injuries per 10,000 players (101). The mean annual injury incidence in professional English players participating in T20 cricket was 14.2 total injuries per 100 match days (17) (refer back to Table 10).

4.5.2 Time-loss injury incidence

The annual incidence of time-loss injuries ranged from 31.2 injuries per 100 players per year in elite-level English pathway cricketers (43) to 79.3 injuries per 10, 000 player hours (42) in elite-level Australian cricketers. The match time-loss ranged from 7.0 match time-loss injuries per 1,000 player-match days (43) to 2.1 time-loss injuries sustained per 100 match days (17) (refer back to Table 10).

4.5.3 Non-time-loss injury incidence

The non-time-loss injuries ranged from 151.3 injuries per 100 players per year (43) to 345.4 injuries per 100,000 player hours (42) (refer back to Table 10). The match non-time-loss injuries was 12.2 injuries per 100 match days (17).

4.5.4 Medical attention injury incidence

Medical attention injuries were reported in four studies reporting incidence (100, 101, 104, 118). All the injuries presented in a detailed case-series were medical attention injuries with a 1.9 injured cases per 1,000 participants over 12-years in Australia (100) The medical attention incidence of hand fractures was 0.7 injuries per 100,000 balls per player (118). The incidence of head impact injuries was reported as 3.7 head

impacts per 1,000 player days (104) and also 1 head impact per 2,633 overs (105). The incidence of successful insurance claims was 1.3 claims per 10,000 registered players over 10-year period (101) (refer back to Table 10).

4.5.5 All-complaint injury incidence

Annual incidence of all-complaint injuries was only reported in one study and accounted for 229.4 injuries per 100 players per year over 5-years in elite-level English pathway cricketers (43). It should be noted that the total 'all-complaint' injuries include injury and medical illnesses (refer back to Table 10).

4.5.6 Injury incidence by player role

The player role with the highest injury incidence was fielders (17, 43, 118) and the percentage of injured fielders ranged from 38% (101) to 74.9% (118). Injury incidence for bowlers, who grouped fast and slow bowlers, ranged from 18.7% (43) to 36.9% (42). Fast bowlers presented with a significantly higher injury incidence than slow bowlers in three studies (17, 42, 102). Injury incidence for fast bowlers only, ranged from 24.8 (17) to 28.9 (42) and the injury incidence for slow bowlers only, ranged from 5.9% (17) to 8% (42). Injury incidence for batters ranged from 10.1% (118) to 57.9% (105). Injury incidence for all-rounders who bowl and bat was 3% (17) to 15% (118) (Table 13).

Table 13: Injury incidence for women's cricket by player role

Article	Player role	Total injury incidence/ Injuries sustained	Distribution of injuries among different player roles (%)
Brooks (118)	Batter	2 per 100,000 balls per team 1 per 100,000 balls per player ***hand fractures only**	10.1% *hand fractures only
	Fielder	14.4 per 100,000 balls per team 1.4 per 100,000 balls per player ***hand fractures only**	**74.9%** *hand fractures only
	Wicketkeeper	2.9 per 100,000 balls per team 2.9 per 100,000 balls per player ***hand fractures only**	15% *hand fractures only
Goggins (43)	Batter	22.7 per 100 players per year	21.8%
	Bowler	19.5 per 100 players per year	18.7%
	Fielder	56.4 per 100 players per year	**54.1%**
	Wicketkeeper	5.6 per 100 players per year	5.3%
Perera (101)	Batter	52 injuries recorded	**48%**
	Fielder	41 injuries recorded	38%
	Wicketkeeper	8 injuries recorded	7%
Perera (102)	Batter	18 injuries recorded	15.8%
	Bowler	38 injuries recorded (31 fast, 9 slow)	35.1% (27.2% fast, 7.9% slow)
	Wicketkeeper	9 injuries recorded	7.9%
	All-rounder	47 injuries recorded	**41.2%**
Perera (42)	Batter	121 injuries recorded	20.7%
	Bowler	216 injuries recorded (169 fast, 47 slow)	36.9% (28.9% fast, 8% slow)
	Wicketkeeper	22 injuries recorded	3.8%
	All-rounder	225 injuries recorded	**38.5%**
Saw (105)	Batter	11 (1 per 2,266 overs) ***head impacts only**	**57.9%** *head impacts only
	Fielder	8 (1 per 3,139 overs) ***head impacts only**	42.1% *head impacts only
Warren (17)	Batter	1.5 per 100 match days	14.9%
	Bowler	3.1 per 100 match days (2.5 fast, 0.6 slow)	30.7% (24.8% fast, 5.9% slow)
	Fielder	5.2 per 100 match days	**51.5%**
	Wicketkeeper	0.3 per 100 match days	3%

Percentages in bold indicate the highest % per article.

4.5.7 Distribution of injuries sustained by body region

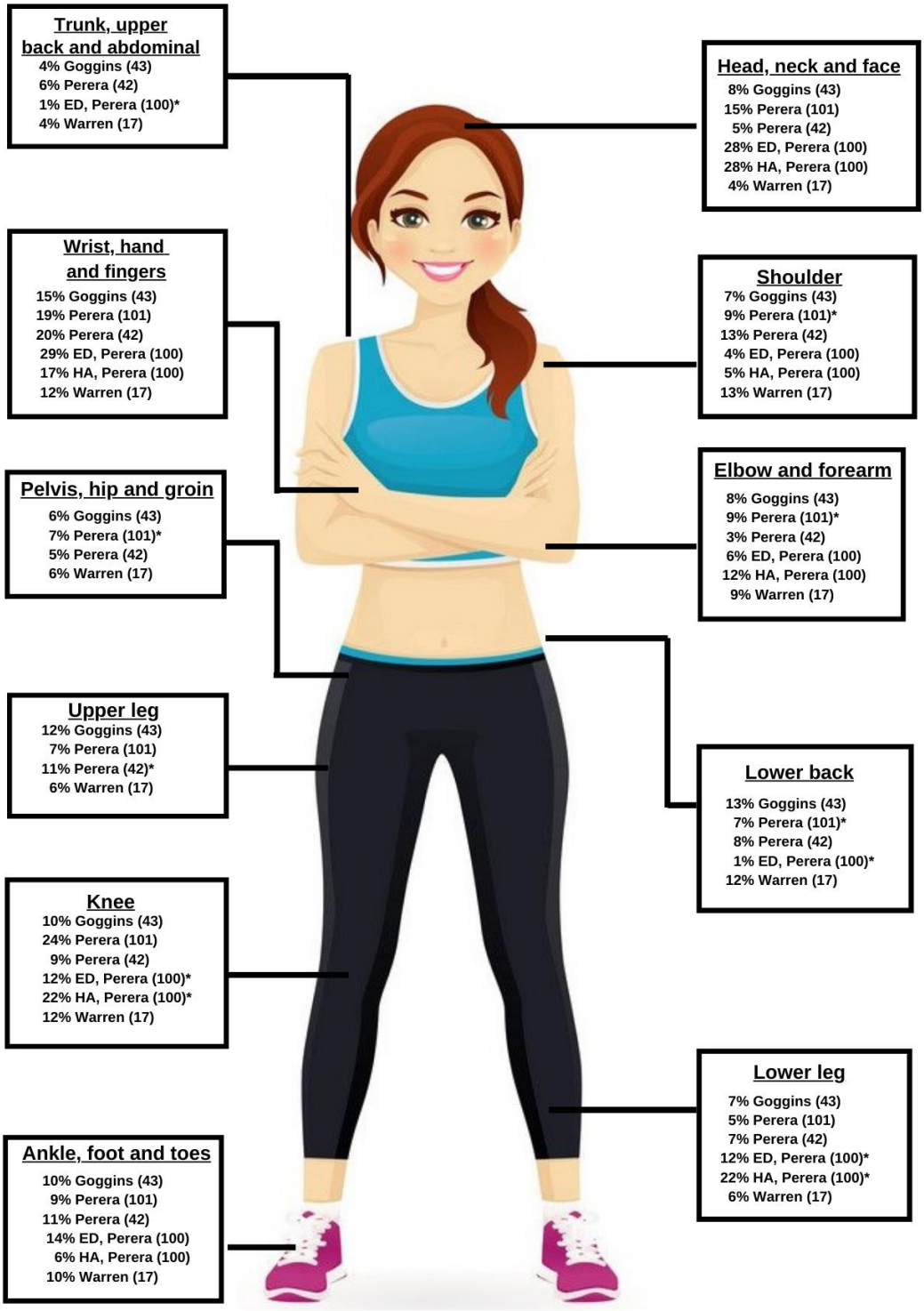
Injury incidence was the highest for wrist, hand and fingers ranging from 12% (17) to 29% (100). The second most frequent body region injured was the knee ranging from 9% (42) to 24% (101) and the third-most-common body region injured was the head, neck and face ranging from 4% (17) to 28% (100) (Table 14 and Figure 7).

Table 14: Injury incidence of women's cricket by body region

*distributed as percentages (%)

Article	Player role (injuries sustained)	Head/ neck face	Trunk/ back/ abdo-men	Shoul-der	Elbow/ forearm	Wrist/ hand/ fingers	Lower back	Pelvis/ hip/ groin	Upper leg	Knee	Lower leg	Ankle/ foot/ toes
Brooks (118)	All (27)					27 (100%)						
Goggins (43)	All (184.4)	7.9%	3.7%	6.5%	7.7%	**15.2%**	13.4%	5.8%	12%	10.3%	7.3%	10.2%
Hill (104)	All (3.7)	3.7 (100%)										
Perera (101)	All (108)	15%		*9%	*com-bined with shoulder	19%	7%	*com-bined with upper leg	*7%	**24%**	5%	9%
Perera (42)	All (351)	5.3%	5.6%	12.5%	2.6%	**20.2%**	8%	5.4%	11.4%	9.1%	6.6%	10.8%
	Bowler		2.3%			1.7%	**3.1%**			2.3%	1.4%	4.3%
	Batter			2%		2.8%	2.8%	1.4%	**4.8%**	2.3%	2.6%	3.1%
	Wicketkeeper					2%			1.4%			**2.8%**
	Fielder	1.4%		9.1%	1.4%	**13.7%**	2%	1.4%	4%	3.7%	2.6%	
Perera (100)	Emergency department (547)	28%	*1%	4%	6%	**29%**	*combined with trunk/abdomen			*12%	*combined with knee	14%
	Hospital admissions (121)	28%		5%	12%	**17%**				*22%	*combined with knee	6%
Saw (105)	All (19)	19 (100%)										
Warren (17)	All (14.2)	4.2%	4.2%	12.7%	9.2%	**12%**	**12%**	6.3%	6.3%	11.9%	6.3%	9.9%

Percentages in bold indicate the highest % per article.



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Figure 7: Injury incidence of women's cricket by body region

*distributed as percentages (%)

4.6 Synthesis of results

4.6.1 Narrative synthesis

A quantitative synthesis of the tabular summaries is provided to explore the review question to determine the prevalence and incidence of injuries among female cricket players. Where appropriate, the information presented in the tables addresses the study outcomes such as prevalence, incidence, body regions injured and injury per player role. To address the secondary aim of the review, the critical appraisal and the methodological quality of the studies are summarised in the tables and narratives are presented to review the findings.

4.6.2 Meta-analyses

Three meta-analyses were conducted and presented in forest plots. Heterogeneity for each meta-analyses were calculated, and the full calculations can be found in Appendix I.

4.6.2.1 Meta-analysis 1: injury incidence rate as the effect size

Three studies (17, 42, 43) were included in meta-analysis 1 (Table 15). The statistical homogeneity was high in all three meta-analyses for injury incidence rate (IR) ($I^2 \geq 98.7\%$) (Appendix I). The pooled estimate overall injury IR was 72.1 (SE 21.3, 95% CI 30.4–113.8, $p<0.01$) injuries per 1,000 player hours (meta-analysis 1a) (Figure 8). Meta-analysis 1a scored low heterogeneity ($I^2 = 8.4\%$). The pooled estimate for the weighted time-loss injury IR was 13.5 (SE 4.4, 95% CI 4.8–22.2) injuries per 1,000 player hours (meta-analysis 1b) (Figure 9). Meta-analysis 1b scored low heterogeneity ($I^2 = 29.1\%$). The pooled estimate of the weighted non-time-loss injury IR was 58.6 (SE 16.9, 95% CI 25.6–91.7 $p<0.01$) injuries per 1,000 player hours (meta-analysis 1c) (Figure 10). Meta-analysis 1c scored low heterogeneity ($I^2 = 2.3\%$).

Table 15: Injury incidence rates for elite women's cricket (meta-analysis 1)

First author, year	Number of squad members (n)	Seasons of play	Total exposure hours	Total number of injuries (n)	Injury incidence rate	95% Confidence Intervals (CI)	Injury incidence rate per 1,000 player hours	95% Confidence Intervals (CI)
Overall injury IR:								
Goggins (43)	83	4	4 083.8	472	0.12	(0.11, 0.13)	115.58	(115.25, 115.91)
Perera (42)	121	2	5 297.7	225	0.04	(0.04, 0.05)	42.47	(42.30, 42.65)
Warren (17)	171	1	2 352.8	137	0.06	(0.05, 0.07)	58.23	(57.92, 58.54)
Pooled total	375	7	**11 734.3**	**834**	**0.07**	**(0.03, 0.11)**	**72.09**	**(30.42, 113.77)**
Time-loss injury IR:								
Goggins (43)	83	4	4 083.8	98	0.02	(0.02, 0.03)	24.00	(23.85, 24.15)
Perera (42)	121	2	5 297.7	42	0.01	(0.01, 0.01)	7.93	(7.85, 8.00)
Warren (17)	171	1	2 352.8	20	0.01	(0.01, 0.01)	8.50	(8.38, 8.62)
Pooled total	375	7	**11 734.3**	**160**	**0.01**	**(0.01, 0.01)**	**13.48**	**(4.79, 22.16)**
Non-time-loss injury IR:								
Goggins (43)	83	4	4 083.8	374	0.09	(0,08, 0.10)	91.58	(91.29, 91.88)
Perera (42)	121	2	5 297.7	183	0.04	(0.03, 0.04)	34.54	(34.39, 34.70)
Warren (17)	171	1	2 352.8	117	0.05	(0.04, 0.06)	49.73	(49.44, 50.01)
Pooled total	**375**	**7**	**11 734.3**	**674**	**0.06**	**(0.03, 0.09)**	**58.62**	**(25.59, 91.65)**

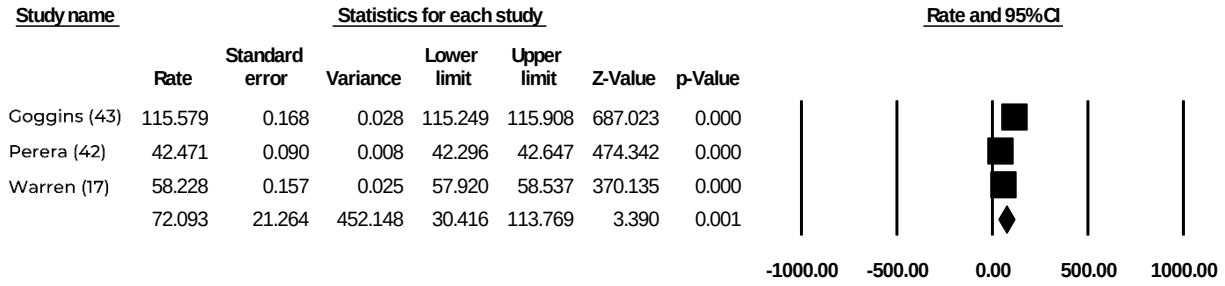


Figure 8: Overall injury IR for elite women's cricket per 1,000 player hours (meta-analysis 1a)

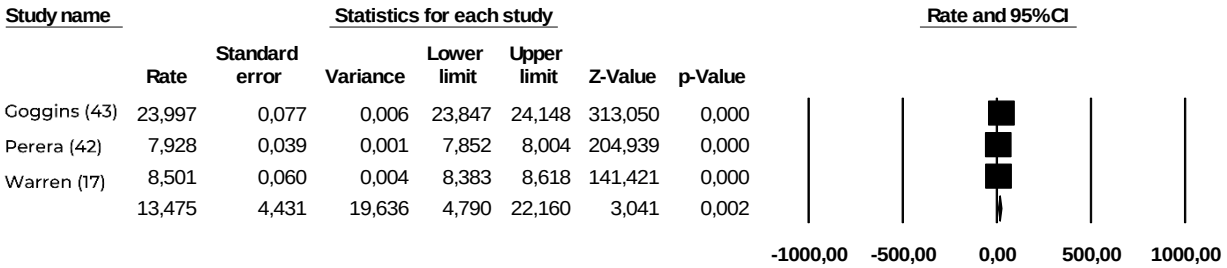


Figure 9: Time-loss injury IR for elite women's cricket per 1,000 player hours (meta-analysis 1b)

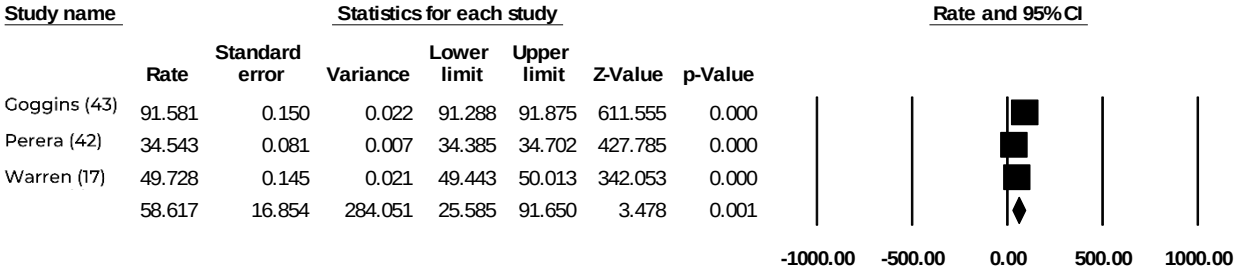


Figure 10: Non-time-loss injury IR for elite women's cricket per 1,000 player hours (meta-analysis 1c)

4.6.2.2 Meta-analysis 2: injury incidence proportions as the effect size

Three studies (100-102) were included in meta-analysis 2 (Table 16). The pooled estimate of the overall injury incidence proportions (IP) was 90.8 (SE 0.9, 95% CI 89.0–92.5, p<0.01) injuries per 1,000 participants (Figure 11). There was considerable heterogeneity for injury IP (I^2 = 99%, p<0.01) (see Appendix I).

Table 16: Injury incidence proportions for women's cricket (meta-analysis 2)

First author, year	Number of squad members (n)	Total number of injuries (n)	Injury incidence per 1,000 participants	95% Confidence interval (CI)	Injury incidence proportions	95% Confidence interval (CI)
Perera (101)	835719	105	0.13	(0.12, 0.13)	0.00019599	(0.000, 0.000)
Perera (102)	164	114	695.12	(691.09, 699.16)	0.69512195	(0.622, 0.763)
Perera (100)	360679	668	1.85	(1.85, 1.86)	0.00185206	(0.002, 0002)
Pooled total	**1196562**	**887**	**90.76**	**(89.03, 92.49)**	**0.114**	**(0.000, 0.681)**

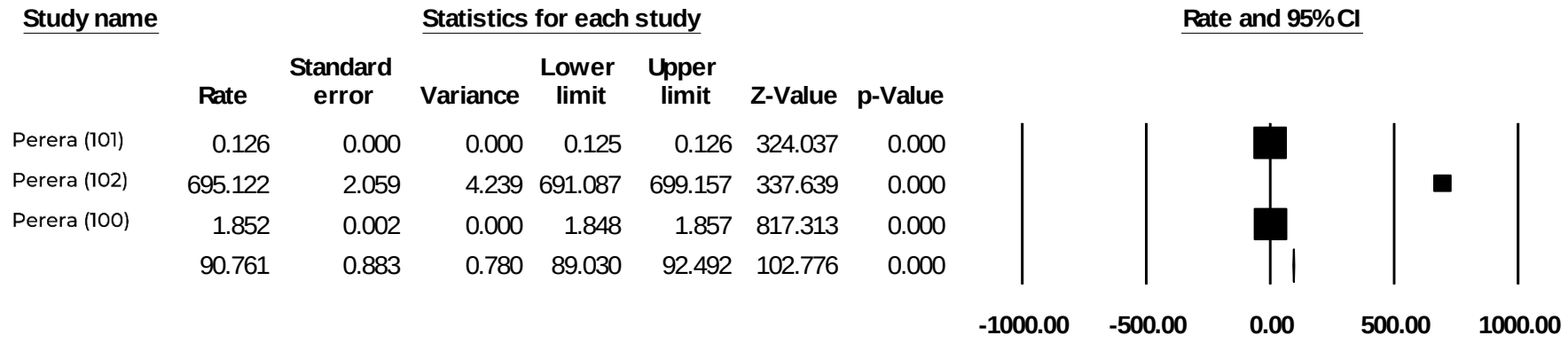


Figure 11: Injury IP for women's cricket per 1,000 participants (meta-analysis 2)

4.6.2.3 Meta-analysis 3: injury prevalence proportions as the effect size

Five studies (16, 40, 42, 102, 115) were included in meta-analysis 3 (Table 17). The pooled estimate of the general injury prevalence proportions (PP) was 63.1% (SE 7.6, 95% CI 47.7–78.5, p<0.01) (meta-analysis 3a) (Figure 12). Meta-analysis 3a scored low heterogeneity (I^2 = 8,7%).

Analyses were also performed per level of play; elite-levels were included in meta-analysis 3b and multiple levels (including recreational cricket) were included in meta-analyses 3c. The injury PP for elite level was 69.9% (SE 23.5, 95% CI 23.9–115.9, p<0.01) and scored low heterogeneity (I^2 = 0%) (meta-analysis 3b) (Figure 13). The injury PP for multiple levels was 58.6% (SE 4.4, 95% CI 50.0–67.2, p<0.01) and scored heterogeneity (I^2 = 0%) (meta-analysis 3c) (Figure 14).

Table 17: Injury prevalence proportion for women's cricket (meta-analysis 3)

First author, year	Number of squad members (n)	Seasons of play	Injured squad members (n)	Injury prevalence proportions	95% Confidence interval (CI)	Prevalence of injuries (%)	95% Confidence interval (CI)
Basketter (16)	52	1	28	0.54	(0.40, 0.67)	53.85%	(51.85, 55.84)
Bullock (115)	65	N/A	36	0.55	(0.43, 0.67)	55.38%	(53.58, 57.19)
Cowan (40)	56	1	26	0.46	(0.34, 0.59)	46.43%	(44.64, 48.21)
Perera (102)	164	1	109	0.67	(0.59, 0.73)	66.46%	(65.22, 67.71)
Perera (42)	121	2	113	0.93	(0.87, 0.97)	93.39%	(91.67, 95.11)
Pooled total	**482**	**-**	**325**	**0.66**	**(0.49, 0.80)**	**63.11%**	**(47.71, 78.50)**

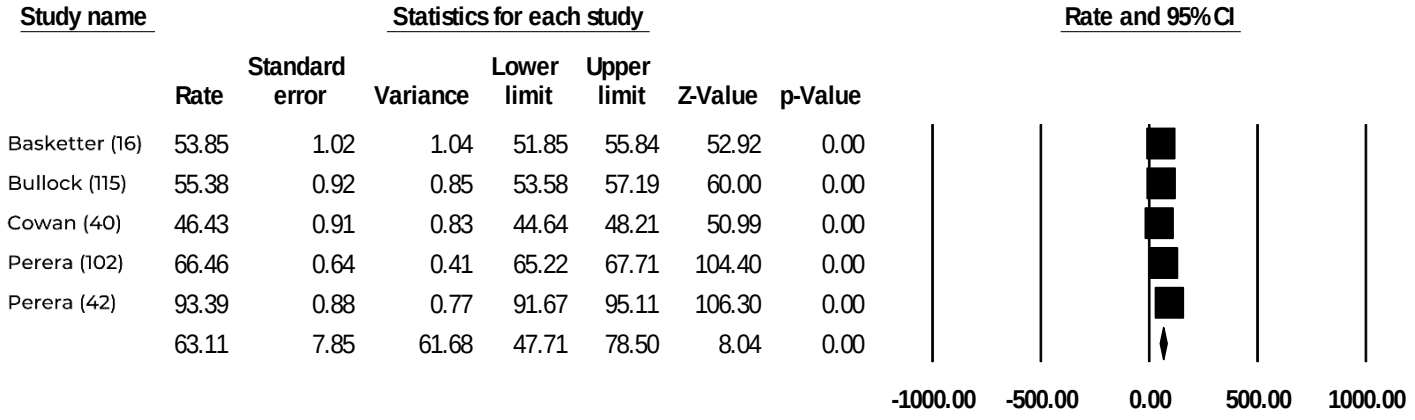


Figure 12: General injury PP for women's cricket (meta-analysis 3a)

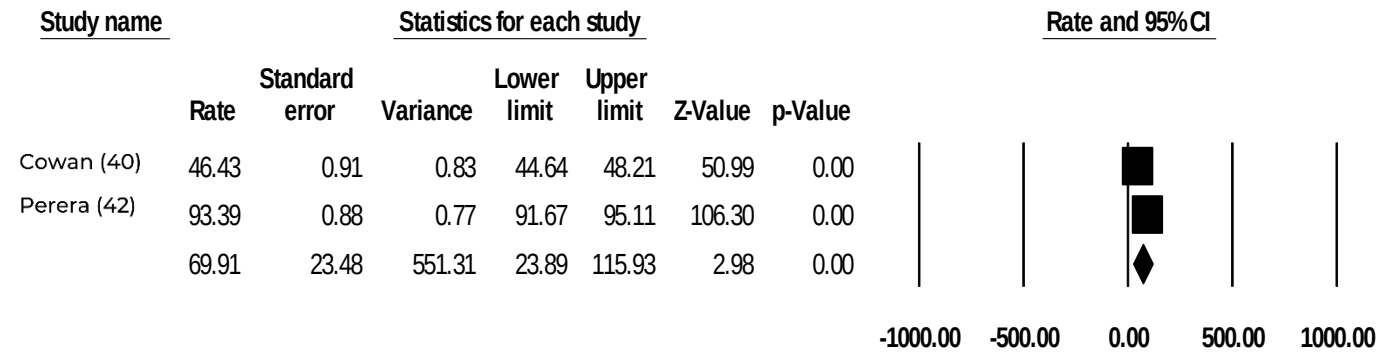


Figure 13: Injury PP for elite women's cricket (meta-analysis 3b)

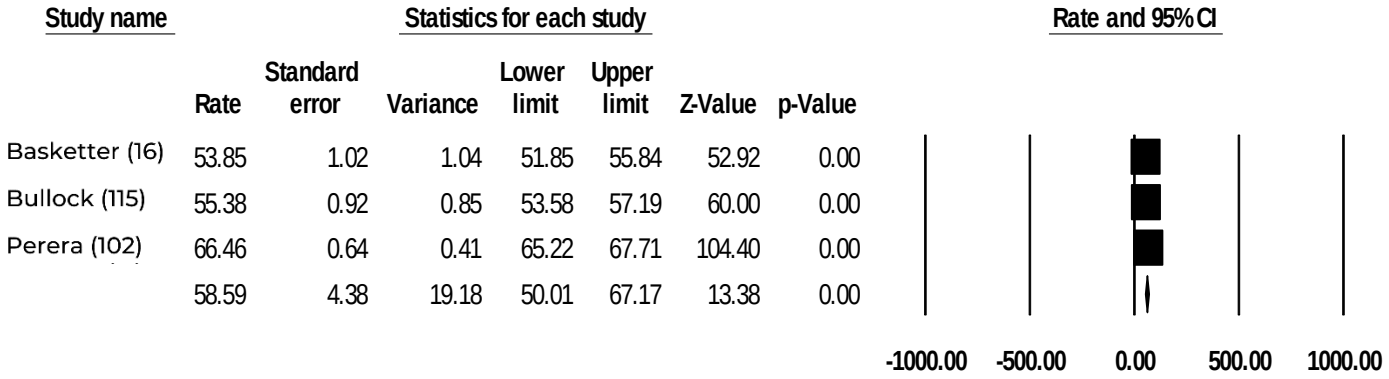


Figure 14: Injury PP for recreational to elite women's cricket (meta-analysis 3c)

Chapter 5 Discussion

The main findings of this study:

1) the overall injury IR for elite women's cricketers was 72.1 (high statistical homogeneity, I^2 = 8.4%, p<0.01) injuries per 1,000 player hours;

2) the time-loss injury IR was 3.5 (high statistical homogeneity, I^2 = 29.1%, p<0.01) injuries per 1,000 player hours;

3) the non-time-loss injury IR was 58.6 (high statistical homogeneity, I^2 = 2.3%, p<0.01) injuries per 1,000 player hours;

4) the overall injury PP was 63.1% (high statistical homogeneity, I^2 = 8.7%, p<0.01) with 69.9% (high statistical homogeneity, I^2 = 0%, p<0.01) for elite level and 58.6% (high statistical homogeneity, I^2 = 0%, p<0.01) for multiple levels (including recreational level) of cricket;

5) hand, wrist and figures had highest injury incidence ranging from 12% (17) to 29% (100);

6) injuries to shoulder (3.7% (40) to 31.4% (102)), knee (9% (42) to 24% (101)) and ankle, foot and toes (3.7% (40) to 23% (102)) were prevalent;

7) fielders reported the highest incidence of injuries per role ranging from 38% (101) to 74.9% (118) of all injuries sustained;

8) prevalence of injuries in fast bowlers was the highest per role ranging from 7.7% (17) to 53.8% (37).

This is the first systematic review to synthesise the injury prevalence (proportions) and incidence (rate) for women's cricket separate from male cricket and other sports. The injury data pooled for the meta-analyses included the injury incidence rate, injury incidence proportions, and injury prevalence proportions. The variety of playing levels and the diverse population of players from several countries included in this review, together with the satisfactory critical appraisal scores and the homogeneous results for meta-analysis 1 and 3, indicate that the evidence from this review is likely to relate to all female cricket players around the world. The high-quality injury data provided by

this review serve as an important means to identify injury rates and proportions, thus prevalence and incidence, to promote evidence-based injury prevention strategies for women's cricket.

5.1 Risk of bias within studies

To minimise publication bias, an *a priori* protocol was conducted for this systematic review. The protocol was reviewed, provisionally accepted and published in JBI Evidence Synthesis (1). No deviations from the study were made from the original protocol. The findings from this review were strengthened by the findings from the meta-analyses and the high level of homogeneity (meta-analyses 1 and 3) in terms of the results. It deserves mention that the results presented in this systematic review may present several limitations that could affect the quality of this review in terms of the risk of bias. In fact, the limitations of each individual study included in this review would of necessity have a direct effect on the limitations of the results reported in this review.

Bias is a systematic deviation from the truth in the results that can manifest due to limitations in study design, collection or analysis. The bias of the included studies can lead to systematic errors in the results, over or underestimating the effect. The credibility of systematic review findings can be jeopardised by combining flawed or biased results from different studies. Although the methodological quality of the included studies was assessed using several JBI critical appraisal tools (38) the risk of bias was not assessed, which is a limitation of our study.

Five studies (16, 40, 101, 102, 120) from grey literature databases were included and added to strengthen the content of this systematic review. A significant aspect of including grey literature in this review was the inclusion of findings from a source not dependent on a peer-review. It has been shown that studies published in peer-reviewed journals are subject to publication bias, as unfavourable results are less likely to be published (121). Consequently, publication bias could reduce the quality of the review as the results reported do not include all evidence available from the literature. The available literature suggest that grey literature might score lower methodological scores than peer-reviewed published studies. All grey literature studies included in this review were individually assessed for their methodological quality: 6/9 (16), 9/9 (40),

9/9 (102), 5/9 (120), and 7/11 (101). All the scores proved to be satisfactory despite literature suggesting that grey literature might score lower methodological scores than published peer-reviewed studies. All grey literature studies were found to have implemented valid data collection methods, and all but one study (120) had provided detailed definitions of injury.

Shortfalls from the study by Paul (120) included the absence of a clear definition of injury, and also a lower critical appraisal score of 5/9. Another serious drawback of the study was that Paul (120) did not accurately report the results in this study. The narrative results differed from the totals presented in the graphs and/or tables. To reduce publication bias, this researcher (JJ) therefore re-calculated the injury data results presented by Paul (120), and compared the results of the calculations from Paul (120) with those of the standard calculations pertaining to injury prevalence and incidence, as provided by the International Consensus Statement (3). The second author (MD) revised these calculations for accuracy of results. Furthermore, as demonstrated by Paul (120), the total figures for injuries sustained per player role and body regions were re-calculated to reach a cumulative total of 100% and not more than this. However, although Paul's study (120) was included in this review, no direct conclusions were made on the basis of its results, and as such, the study by was not included in the meta-analyses.

Cohort studies with long-term follow-ups and large sample sizes are more likely to induce bias in reporting (122). Although some studies identified the reasons for participants dropping out of the studies, other studies did not report any details concerning the missing participants. As several of the studies did not follow up with participants who had dropped out during the study period, this might have caused bias reporting. As such, future research studies should accurately record the number of participants joining and leaving the study cohorts to allow for a follow-up on the loss estimate and for the results to be reported accordingly.

Injury diagnosis from different medical health professionals and/or the scarcity of resources under certain circumstances needed for accurate injury diagnosis might have caused the risk of incorrect diagnosis or documentation of injury data. Correspondingly, several studies did not use the valid injury definitions as set out by the International Consensus Statement (3). As such, the quality of the findings of this

analysis might have been compromised by bias reporting, as certain injuries did not need medical attention, nor was reported as time-loss injuries. This suggests that some injuries, which were not actually severe injuries involving medical care or caused time-loss, might have been underreported. However, the capture of evidence using efficient data collection methods and clear definitions of injuries might have reduced the bias reporting in the relevant studies.

5.2 Methodological discussion

The data collection methods used in all the studies included in this review have been clearly described. They vary across the different studies in that some include self-administered questionnaires (14, 16, 37, 102, 114, 115, 117, 120), data from hospital records and/or insurance claims (100, 101), data from injury surveillance systems (104, 105, 118), and data collected during cricket seasons/tournaments (17, 40, 42, 43). Given that no experimental studies could be located in the initial database searches, all studies included in this review were observational studies with lower-level evidence (level 3 and 4). Provided that the observational studies reported sufficient prevalence and incidence data required for this review, they were appropriate and were therefore included in this study, despite their lower level of evidence. The only limitation of the data collection techniques obtained from the studies included in this review is the nature of the cross-sectional studies. Several studies relied on participants to recall previous injuries and to complete questionnaires, which could have resulted in bias reporting.

All studies were assessed for methodological quality by two independent reviewers (JJ and MD) using the critical appraisal instruments from JBI. The reviewers met several times to discuss the critical-appraisal-scoring criteria, the individualised scores of the studies and to reach consensus on these scores. As both reviewers had received official training from JBI and had met beforehand to discuss the scoring criteria of the critical appraisal tools, a Cohen's kappa score of k=0,6 was achieved, and indicated substantial agreement between the reviewers (123). The critical appraisal scores from the independent studies indicated sufficient methodological quality and, as a result, all studies were included in the review.

5.3 Study characteristics

A significant focus of this review was to describe the study characteristics of the individual studies included in the final review, referring specifically to the type of study design, the setting, the participant's age, country, level of play, the format of cricket, the injury data collection methods, injury definitions, prevalence and incidence data and the body regions injured. The mean age range for female cricket players in this review was calculated, but proved to be an inaccurate representation, as several of the studies had not separated the ages of the female players from those of the male cricket players. Thus, it was difficult to calculate an accurate mean to represent the age of the female cricket players alone.

Several studies included in the review combined the levels of play for women's cricket (e.g., recreational, club and elite-level cricket). Furthermore, six studies did not specify any level of play for female cricket players. It is not ideal to pool data from different levels of cricket as match and training intensity differ. Furthermore, the scheduling of matches for each level of cricket played also differed (45). As a result of the vast levels of participation, and the fact that several studies had not reported on the level of cricket played, it was only possible to group levels of play in meta-analysis 3. It is vital for future studies to report findings for each level of cricket separately, as well as to report on the age of the players. Furthermore, research on non-elite-levels of cricket, such as club cricket, is especially limited for women's cricket. Similarly, junior-level cricket for women is also underreported. With the recent development and popularity of cricket among younger players, research findings for these cohorts are important for the development of junior cricket players and the successful implementation of the sport.

It is well known that junior and senior cricket players differ in terms of several physiological and skills factors. Some of these factors include muscular differences, balance, reaction time and proprioception (124). Despite the importance of separating the literature findings for the different age groups, this review had insufficient data to distinguish between the literature for junior and senior players. Only two studies reported on injuries among junior-level cricket players only (117, 119). None of these studies was included in the meta-analyses as their methodologies and outcomes did not fit the inclusion criteria. The majority of the findings reported in the meta-analyses were based on senior cricket players. This review could not effectively compare junior female cricket players with senior players. It is important to highlight that further

investigations are needed to conduct epidemiological studies for junior cricketers in order to develop a better understanding of the injuries sustained by this cohort.

Elite-level cricket involves participation at the national and/or international levels, whereas non-elite-levels include school/junior, recreational and club-level cricket. The level of cricket participation presented in this review was documented as elite-level, junior/school level, and a combination of elite, club and recreational levels. This review reported that studies tend to focus on elite-level female cricket players. However, apart from the inclusion of most of the studies conducted on elite-level female cricket players in Australia, this review's coverage of the female cricket population is limited. Owing to the limited availability of literature on female cricket players all around the world and the similarities between the infrastructures of major cricket countries and that of Australia, evidence from this review can be globalised for all female cricket players despite the level of participation (33).

For this review, it was a matter of interest to explore which countries are the leaders in conducting research on women's cricket, and which countries do not have research strategies in place. More than half the women's cricket studies have been conducted in Australia. Apart from five studies conducted in the United Kingdom, it is notable that other major women's cricket countries have limited to no published or unpublished research studies on women's cricket. These findings highlight that several major cricket countries do not have research strategies or injury surveillance systems in place for women's cricket; nor do they report on these findings. Furthermore, successful cricket participation is directly related to injury surveillance and prevention (86), and it is, therefore, of utmost importance to address these shortcomings in the relevant countries where women's cricket is played as a professional sport.

Only a handful of the studies included in this review mentioned the various playing formats for women's cricket. Several of the studies failed to mention any of the cricket formats played in spite of the fact that the Consensus Statement and injury surveillance systems encourage researchers to record the injury rates for the different cricket formats independently (3). However, owing to the limited availability of studies reporting injury data for women's cricket in terms of each individual format, the data for the great variety of formats of cricket had to be combined to provide adequate results for analysis. The increased physical demands placed on those players competing in

shorter cricket formats, such as T20 cricket, predisposes the players to a higher injury risk than that posed by the longer formats of cricket (45). Findings of this study suggest that the increased T20 formats could be associated with the increased injury rates experienced in recent years (81).

The increased popularity of women in indoor cricket also predisposes the players to an injury risk. Only one study included in this review (102) reported on injuries sustained while playing indoor cricket. Studies by Forward (125), Routley and Valuri (126) and Fernando, Berecki-Gisolf and Finch (112) were excluded in the final stages of the study selection process of this review and are listed in Appendix E. These studies still contain valuable injury data specifically applicable to women participating in indoor cricket. Future studies on women's cricket should investigate and report on the injury rate independently for each format of cricket, and for indoor cricket for accurate comparisons of injury data.

As compared to the eight studies that reported data on only female cricket players, many of the studies included in this review reported data on female cricket players along with data on male cricket players. For this review, injury data on female cricket players were extracted independently from the data on male cricket players. The exclusion of these studies is unfortunate, as, given the fact that male and female cricket player data were pooled without the author having distinguished between the data for the respective sexes, several important studies were excluded. The table in Appendix D serves to highlight the vast number of studies that could have added significantly to this review - if the authors from those studies had reported the results for the two sexes independently. As previously mentioned, the data for the different sexes need to be independently reported as there are several physiological and skills factors that influence the type and nature of the injuries sustained by female cricket players.

5.4 Definitions of injuries and data collection methods

Valid injury-data-collection methods were described in all of the studies included in this review. The use of valid injury-data-collection methods and standards provided by the International Consensus Statement (3) reduced the possibility of inaccurate reporting. Studies without clear definitions were not included in the meta-analysis. The International Consensus Statement categorised injuries as time-loss, no time-loss and medical attention injuries, as well as general injuries. Since medical-attention injuries

are all serious injuries that require care from health professionals, they were captured and have been reported in the results section but have not been further explored in this review. Considering that time-loss and non-time-loss injuries were reported in only a few studies, it was difficult to pool accurate data from all of the studies to perform meta-analyses for these subgroups. Furthermore, only three studies used the exact injury definition as sourced from the International Consensus Statement (3), whereas several authors used the Consensus definitions to define their 'own injury' definitions for their individual studies.

General injuries include painful, overuse and/or repetitive injuries that might not need medical intervention (3). Repetitive injuries were not investigated in this review; however, a few players did indicate multiple injuries over a season. The exclusion of repetitive injuries could, however, compromise the reliability of the data presented in this review. Furthermore, it should be noted that the injury rate presented in this review might not describe the true burden of injuries sustained by the population of female cricket players, but rather the acute injuries sustained by them. Overuse injuries have been identified in male cricket players and generally attributed to high workloads, high-intensity training, and rigorous match-time scheduling (127). Previous literature studies also suggest that in contrast to male athletes, female athletes are at a higher risk of sustaining overuse injuries (94).

All-complaint injuries in this review included time-loss injuries, non-time-loss injuries, medical illness, and acute and repetitive or overuse injuries. This review included only one study (43) that reported the all-complaint injury definition from the International Consensus statement (3). The all-complaints injury definition is a new term used. As such, several of the studies consulted did not include this definition in their results. All-complaints injury definitions should be used in future research in order to reduce the underreporting of overuse injuries or medical illness which could lead to reporting bias. Future studies should implement the definitions from the International Consensus Statement to standardise their findings and to provide consistency in reporting injury data across a broad platform of cricket research (3).

Injury data collection methods from studies included in this review ranged from self-administered questionnaires, data from hospital records, injury surveillance systems, insurance claims data, injury data collected during cricket seasons or tournaments, to

other observational methods. These observational methods included a study that measured lumbar lordosis (119) and another that on the basis of musculoskeletal shoulder tests, examined the shoulder (116). All observational studies included in this review were considered to be at risk of publication or reporting bias, as were the injury data retrieved from the questionnaires which reported mainly on self-diagnoses made by the participants themselves. This is not an ideal method since unreliable results might be obtained when participants are called upon to recall their past injuries and to diagnose their complaints themselves. On the other hand, however, these methods of data collection from the observational study sources included in this review proved to be valid for reporting injury prevalence and incidence data.

Studies included in this review reported on injuries diagnosed by medical health care practitioners as well as injuries that had been self-diagnosed by individuals other than medical professionals. Nine studies reported clinical diagnoses made by health care professionals and/or injuries reported in health care records. Clinical diagnoses were categorised as medical-attention injuries since the data were collected from hospital settings or captured by medical health professionals during the cricket season. Although a medical diagnosis is the most accurate form of injury data, data extracted from the self-administered questionnaires could not be excluded from this review as these would increase publication bias. On the contrary, skilled medical professionals could also have reported inaccurate injury data in spite of having conducted tests or on the basis of accurate diagnoses and special medical investigations. Furthermore, medical-attention injuries reported from studies could be underreported, as not all injuries require medical care; nor are they treated by medical health professionals. All these factors could contribute to restrictions in terms of the accurate representation of results across all of the studies.

5.5 Injury rates and proportions

Provided that sufficient evidence was available, the studies were pooled to conduct three meta-analyses; injury IR per 1,000 exposure hours, injury IP per 1,000 participants, and injury PP as a percentage. The meta-analyses offer important information for defining and targeting evidence-based injury prevention measures specifically focused on women’s cricket. Conversions of player match days to total exposure hours were needed for meta-analysis 1 and the conversions were carried out in accordance with the International Consensus Statement (3, 4). The weighted overall

annual injury IR was 72.1 injuries per 1,000 player hours (I^2 = 8.4%, p<0.01) in elite female players. The statistical heterogeneity was low and the data from the three studies (17, 42, 43) included in meta-analysis 1 also had low variability. With that in mind, the high incidence of injuries among female cricketers is cause for concern, especially given the short- and long-term impact of injuries. The studies included in meta-analysis 1 (17, 42, 43) were all published in the last five years indicating that injury epidemiology in women's cricket is a new and developing field of research, owing to the sport's increased popularity.

Injury IR for women's 'bat-and-ball and ball-and-stick' sports (from recreational- to elite-level) was 6.2 injuries per 1,000 person-days athletic exposure (34) greater in competition than practice (15.8 vs 3.1), and is lower than for women's cricket reported in this review. Comparing women's cricket to other elite female sports such as soccer, basketball and gymnastics, the injury IR was 8.6 injuries per 1000 hours of athlete exposure (128) is lower than for women's cricket reported in this review. The injury IR for men's cricket (from recreational- to elite-levels) was 5.3 injuries per 1,000 player hours (or 53 per 10,000 hours of play) (110) lower than for women's cricket reported in this review. Another finding for elite men's cricket over 10-seasons (2006 to 2016) in Australia was 64 injuries per 100 players per season or 13.2 injuries per 1,000 player hours (92).

The injury IP as the effect size was determined in meta-analysis 2. Meta-analysis 2 could not be reported as an injury rate (meta-analysis 1), nor as an injury risk (meta-analysis 3), but rather as the clinical incidence ratio or the proportion of injuries sustained over a specific period. Three articles (100-102) were included in meta-analysis 2 and these studies included data from hospital studies, insurance claims and self-reported worst injuries conducted in Australia. The injury IP was 90.8 (I^2 = 99%, p<0.01) injuries per 1,000 participants or 0.1 (I^2 = 99%, p<0.01). The injury IP for women playing competitive 'bat-or stick and bat-or-ball' was 0.4 (34) and is higher than for women's cricket provided in this review. It should be emphasised that the results of meta-analyses 2 included in this review should be interpreted with caution due to the considerable heterogeneity scores (I^2 = 99%).

The high heterogeneity score from meta-analysis 2 could be as a result of the vast population of players included in this review. Data from the three studies (100-102)

included in meta-analysis 2 were a combination of recreational- to elite-level players. Therefore, possible differences of level of play can partly explain this finding. Further, the included data were from hospital admissions (100), successful insurance claims (101) and self-reported worst injury (102). Hospital and insurance claims data were inherently biased towards severe acute traumatic injuries. Therefore, the true magnitude injuries such as less severe injuries were not captured in this review. The data for meta-analysis 2 was pooled but due to the data due to high heterogeneity scores no formal conclusion were made from meta-analysis 2 as it provides low-level evidence. It is important to highlight that heterogeneity in proportional meta-analysis for prevalence and/or incidence reviews must be considered differently from heterogeneity in comparative meta-analysis and typical effectiveness reviews. It is important not to only consider meta-analysis 1 and 3 and exclude meta-analysis 2 from this review. Although meta-analysis 2 is not as significant as the latter provided in this review, it still contributes to the dearth of research in women's cricket.

Meta-analysis 3 included five studies (16, 40, 42, 102, 115) and calculated the overall injury PP. The overall injury PP was 63.11% (I^2 = 8.7%, p<0.01) and 69.9% (I^2 = 0%, p<0.01) for elite-level cricket and 58.6% (I^2 = 0%, p<0.01) for studies who reported on the recreational-level of cricket. The statistical heterogeneity was low and the data from the three studies (17, 42, 43) included in the meta-analyses had low variability. It should be highlighted that the injury PP presented in this review was point or general prevalence and, annual prevalence could not be calculated owing to the constrains of the data available for women's cricket. The injury PP was observed for each level of play. Elite players are more prevalent for injury than players participating in multiple levels of cricket (recreational-levels) (69.9% vs 58.6%). In contrast the average annual injury prevalence rate for elite men's cricket was 12.5% (92) and 47.9% elite female soccer, basketball and gymnastics athletes (128). As previously stated, high injury rates can be attributed to factors such as skill level, bowling speed, physical development, workloads, and match schedules. The significant differences found in the level of play in this review, suggests that elite level players are more likely to get injured compared to other levels of cricket (such as club or recreational).

There is strong epidemiological evidence in team sports such as soccer, basketball, and ice hockey to suggest that injury risks vary between sex (30, 91, 129). Evidence from this review might suggest that injuries sustained by female cricket players are more prevalent than those sustained by male cricket players. This finding can be

explained by physiological differences between female and male players, as well as differences in skill acquisition speed and/or style. Furthermore, factors such as skill level, bowling speed, workloads, and match fixtures differ and may influence injury risk (12, 15, 33) and would need further investigation.

5.6 Body region of injuries

The wrist, hand and fingers was the body region with the highest injury incidence ranging from 12% (17) to 29% (100). Research suggest that the wrist, hand and fingers were also the most frequent body region injured by women playing competitive bat-and-ball and ball-and-stick sports (34). Because of the risk of acute impact from a fast moving ball, sports like cricket and softball pose a high risk of hand, wrist, and finger injury (68, 130). Being hit by a ball, catching or diving to field a ball, and trapping the fingers against the bat handle are all possible injury mechanisms. The cricket balls used in women's cricket differ from those used in men's cricket in that they are smaller in size and weight (16). Injuries to the hand and fingers occur more frequently in female cricket players than in their male counterparts. Protective gloves for wicketkeepers and batters need to be worn, and have been indicated to limit the severity of hand, wrist and finger injuries (52).

Findings from this review indicate that the most prevalent body region injured is the shoulder, ranging from 3.7% (40) to 31.4% (102). Shoulder injuries are common in athletes who participate in overhead striking and throwing sports like tennis, baseball, and handball (131, 132). The frequent use of the shoulder action with the hand over the head is a common feature of injuries sustained when participating in overhead sports (33, 36, 116). This review suggests that shoulder injuries in women's cricket are more prevalent among fast bowlers (3.9% (120) to 46.5% (36)) than slower bowlers or other player roles. Findings in men's cricket also suggest that fast bowlers (20.6% (92)) are more frequently injured than other cricket player roles. Shoulder distraction force, as well as changes in range of motion in body regions; such as the shoulder, trunk, lumbar region, and hip, can all contribute to the injury risk for female fast bowlers (36, 37, 116).

Findings from this review also suggest that lower extremity injuries were commonly injured among female cricket players; injuries to the knee region ranged from 9% (42) to 24% (101) and ankle, foot and toes ranged from 3.7% (40) to 23% (102). Similar

findings were found in women playing competitive bat-and-ball and ball-and-stick sports (34). Lower limb injuries are also frequent in men's cricket, with hamstring strains being the most common injury (81, 92). The risk of hamstring injuries are known to be high in men (133, 134); likely because of running, e.g. sprinting, sudden acceleration or deceleration while running at high speed (such as running between wickets) and jumping (e.g. to field a ball). Cricket includes quick bursts of running, rapid changes of direction, and rebounding while diving to catch or stop the ball, as well as poor neuromuscular control and strength, which have been identified as risk factors for lower limb injuries (135, 136). Females have a greater range of ankle inversion-eversion range, and lower levels of dynamic postural control and decrease neuromuscular performance affecting integrity of the ligament (30, 91) and these factors predispose female athletes to lower limb injuries (30, 31, 91).

The risk of joint pain or injury increases in proportion with match and training intensity, frequent match scheduling, increased workload and joint loading, with repetitive movements during cricket activities (60, 111, 137, 138). Female athletes present with increased ligament laxity when compared to the opposite sex (30, 31, 91), hence they are more likely to sustain joint injuries. Hormonal influences affect the ligament integrity of females participating in other sports and could also present in female cricket players (30). Cai et al. (114) reported that half the former cricket players included in their study presented with joint pain, while more than 30% of former cricketers were diagnosed with osteoarthritis. All-rounders reported greater odds in terms of knee pain than other player roles. Several factors such as the Q-angle and diminished muscle strength could also contributes to the lower limb injury risk among female cricket players (32, 135, 136). Traumatic joint injuries will also raise the risk of post-traumatic osteoarthritis, affecting long-term cricket participation and well-being. In other sports, such as women's basketball, neuromuscular injury prevention programs have reduced the total injuries by 27% and anterior cruciate ligament injuries by 45% (139).

Head, face and neck injuries were frequently sustained by recreational-level and elite-level players included this review, ranging from 4% (17) to 28% (100). Concussion injuries frequently result from serious head impacts (17). As with all other professional sports, head injuries (including concussion) in cricket have increased (104). This review report that female cricket players frequently sustain serious head injuries and have to be rushed to hospital or the emergency department (100). The increased risk and severity of head impacts sustained by batters (104, 105) is a rising concern. Being

struck by a cricket ball during a competitive match or practice can be a potential injury mechanism. Protective gear such as helmets for batters, wicketkeepers and close fielders should be encouraged in order to reduce the severity of head impacts or face injuries (52). Fielders are unlikely to wear helmets when compared to batters and wicketkeepers and may be more vulnerable to serious head injuries. Given the potential severity, use of protective gear such as helmets for batters, close fielders, and wicketkeepers should be encouraged across all level of play (52). Skills training for example in reducing their visual reaction time, could also reduce the risk of injuries resulting from head impacts (104). Research on head impacts in women's cricket needs to be explored and prevention strategies need to be implemented to reduce head injury risks.

5.7 Injuries sustained by player role

Injuries sustained by female cricket players were distributed across all player roles. Most injuries reported in this review were sustained by female bowlers, specifically fast bowlers (16, 17, 36, 37). To intensify the concern relating to injuries among bowlers, three studies included in this review had conducted injury research on bowlers alone (36, 37, 119). Authors from these studies had already identified the high prevalence of injuries in this player role and had further investigated the body regions injured by bowlers, including the shoulder (36) and lumbar spine (37, 119). Two studies investigated the limitations presented in the lumbar spine region to identify injury risk in bowlers (37, 119). Evidence revealed a substantial difference in the lumbar lateral flexion range between bowlers with and without lower back pain on the same side of the bowling arm. Also, when compared to male fast bowlers, female fast bowlers displayed more bilateral hip extension (37). Another finding demonstrated the statistically significant difference between the lower lumbar lordosis of female bowlers who were presenting with lumbar pain and those who were not (37). Evidence suggests significant differences in the shoulder range of motion between elite-level fast bowlers with and without shoulder pain or injury (36).

As discussed previously, shoulder injuries were most prevalent in bowlers. Fast bowling requires repeated irregular shoulder counter-rotation and trunk lateral flexion, extension consistent with side-on, front-on, or mixed bowling actions, which increase injury risk (12, 36, 46, 47, 127). Similar to findings men's cricket; fast bowlers were 20.6% (92) more frequently injured than slower bowlers. Risk factors for male fast

bowlers include factors such as increased bowling workloads and increased tempo in shorter formats of cricket (i.e. test vs T20) (111, 138). Fast bowlers often have higher workloads (45, 137) than other player positions because bowlers cover more distance (20% to 80% of overall distance covered) and have 35% less recovery time between their spells, which can contribute to the increased injury risk (48, 69, 111, 127). Evidence on female fast bowlers suggests that the distraction force of the shoulder can be regarded as the leading factor contributing to shoulder injuries during the fast bowling action (36). Research has also found that during the fast bowling action of female cricket players, the ratio of eccentric external to concentric internal rotational strength of the shoulder is far below the standard considered sufficient for adequate joint stability and muscle control (99).

Players who sustained injuries while fielding ranged from 38% (101) to 74.9% (118). The most frequent body region injured by fielders was the hand, wrist and fingers. Fielders who catch or stop the ball with their hands risk the possibility of being struck by the fast-moving cricket ball, falling or colliding with other players. Research suggest that female cricket players presents with slower auditory reaction time, but faster visual reaction time when compared to female handball players (103). It was reported that certain female cricket players might have adapted strategies to catch or field that predispose them to injuries to the hand and fingers (42). Skills training for fielders needs to be emphasised, also, further investigations are needed to explore the underlying factors to identify why fielders frequently sustain injuries to the wrist, hand and finger regions.

Chapter 6 Conclusion and Recommendations

6.1 Conclusion

The aim of this review was to determine the prevalence and incidence of injuries sustained by female cricket players participating in recreational to elite-level cricket. This review also indicated the most common body regions and the player roles more susceptible to injury for both prevalence and incidence. Level 1 evidence was created through this systematic review and meta-analyses. To this researcher's knowledge, this is the first review apart from male cricket and other sports to report the prevalence and incidence of injuries for women's cricket.

Findings from this review suggest that injury prevalence and incidence are high among female cricket players. The pooled estimate of the overall injury incidence, the overall injury incidence proportions and the overall injury prevalence proportions have demonstrated that a large number of injuries are sustained by female cricket players. This review also reported injury incidence data for time-loss and non-time-loss injuries to determine how the burden of injuries influences player availability and return-to-play after injury. Heterogeneity across the meta-analyses was investigated and the findings provided highly accurate homogeneous results for meta-analyses 1 and 3 (including their sub-analyses), which can be extrapolated to all female cricket populations.

This systematic review highlights that the overall injury IR is 72.1 injuries per 1,000 player hours and the overall injury PP was 63.1%. Elite-level players are more likely to be injured than players at other levels of play. The hand, wrist and fingers (highest incidence) and shoulder (highest prevalence) regions were most commonly injured. Other body regions such as the knee, ankle, foot and toes, and the head were also frequently injured. Fielders (highest incidence) and fast bowers (highest prevalence) were the player roles presenting with the most injuries. The inclusion of data from recreational to elite-level play from around the world, as well as synthesised findings per level of play and body region, is a strength of this study.

The increased participation of women in cricket, the different levels of play, improved player performance, and the increased frequency of match scheduling, together with the intensity of competitive matches, could all contribute to the increased rate and

frequency of injuries reported in this review. This systematic review has produced results that are essential for the recognition, analysis and synthesis of injury data, and in so doing, has made it possible to present a detailed overview of the injuries sustained by female cricket players. This review has provided a baseline of quantitative evidence of the rate of sustaining injuries and their frequency in order to promote the body of evidence available for the identification of injuries sustained by female cricket players. This review also stands to contribute to research on cricket on a worldwide, as well as a national level in that it has reported and highlighted the burden of injuries, and specifically those sustained in women's cricket.

6.2 Clinical/Practical Recommendations

High-quality, injury-free performance is one of the key elements of achieving success in any team. With the number of women's cricket matches and training schedules increasing along with the popularity of the sport, injury awareness, prevention, and management are key factors in optimising the performance of women's cricket. To ensure adequate injury prevention strategies, high-quality research on injury prevalence and incidence rates is needed as a basis from which to promote injury prevention.

The provision by this review of high-quality injury data is an important step in identifying injury rates in order to promote evidence-based injury prevention strategies for women's cricket. This is the first systematic review involving a synthesis of injury rates for women's cricket that can be seen apart from those for male cricket and other sports. This review included a wide range of participants from recreational, junior/school, club and elite level cricket and from several countries across the globe. Meta-analyses 1 and 3 have provided homogeneous results from the studies pooled for both injury incidence rate and injury prevalence proportions. Meta-analysis 2 scored high heterogeneity scores and the results need to be interpreted with caution. No conclusions or recommendations were based on the results provided by meta-analysis 2. However, due to the scarcity of research on women's cricket the results for meta-analysis 2 were still provided.

In this review, fielders and fast bowlers were found to be the player role most frequently injured. The limitations associated with bowlers, such as the changes in their range of motion in the lumbar and bilateral hip regions could also contribute to the injury risk in

female cricket players. Shoulder injuries were found to be common among bowlers. Evidence suggests that as a result of their bowling action, females could be more prone to injuries than their male counterparts. Factors such as shoulder distraction force, alterations in the range of motion in body regions such as the shoulder, trunk, lumbar region and the hip might contribute to the injury risk for female bowlers. Injury prevention measures for female bowlers need to be put in place. Specific strength and conditioning rehabilitation programs, together with bowling technique analysis, need to be implemented to prevent possible time-loss injuries and to reduce the burden of injuries in female bowlers.

The high risk of joint-specific pain or injury in female cricket players was highlighted in this review. It was found that the risk of joint pain or injury increased in correlation with increased match and training intensity, intensified match scheduling, increased workload and repetitive joint loading during cricket activities. Female athletes, including cricket players, have predisposing factors such as hormonal effects, joint laxity and early-onset arthritis that could increase the burden of injuries. As such, great care needs to be given to female players to prevent traumatic or overuse joint injuries. The research found that wrist, hand and finger injuries prevented several female cricket players from being available for match selection. The wrist, hand and fingers were most often injured as a result of the traumatic impact of a cricket ball or from a direct impact with the ground during fielding. When compared to males, and despite the smaller size of the balls used for women's cricket, the wrist, hand and finger region seems by all accounts to be overrepresented in females as a region prone to injury. This review therefore highlighted the need for specific skills training for women's cricket, including visual and auditory reaction stimulation, improved hand-and-eye coordination, and fielding and/or catching skills training to prevent injuries to the wrist, hand and fingers.

Head, face and neck injuries were frequently sustained female cricket players. The severity of head impacts must not be taken lightly as findings in this review reported several players who were admitted to hospital or an emergency department for head impact injuries sustained while playing cricket. The use of protective gear such as helmets for batters, close fielders, and wicketkeepers should be implemented to prevent serious head injuries. Skills training for female cricket players, as for example in reducing their visual reaction time, could also reduce the injury risks resulting from head impacts. The findings from this review can be extrapolated to all women's cricket

management systems across different populations around the world. This review highlighted that several major cricket countries besides Australia and England have neither research strategies nor injury surveillance systems in place for women's cricket specifically. With effective injury surveillance systems, evidence-based decisions for the prevention of injuries in women's cricket can be implemented to promote women's cricket as a professional sport.

Quantifying and reporting injury rates are stepping-stones to injury prevention and highlight the importance of injury surveillance and the adequate management of all players, school to elite-level, for optimal sport performance. Injuries significantly diminish the performance of a team as they prevent players from participating during competitions and thus impede the success of any sports team. The findings from this review will inform stakeholders of the relevant women's cricket bodies about the burden of injuries and their effect on the performance of the players. Stakeholders in junior-level cricket must assess fitness levels, player workloads, skills and techniques, as well as individual player management, in order to identify risk factors for injury in junior cricketers.

6.3 Recommendations for Future Research

Successful cricket participation is directly related to injury surveillance and the prevention of injuries. Countries such as Australia and England are leaders in the research field for women's cricket. This review highlights the shortcomings in the research into women's cricket in many other major cricket countries, the importance of addressing these shortcomings, and of promoting the implementation of injury-prevention strategies. Countries should implement systems to collect data on a longitudinal basis and effectively implement injury surveillance databases. Future research studies should accurately record the number of participants joining and leaving the study cohorts to allow for a follow-up on the loss estimate and to report the results accordingly. Guidelines such as STrengthening the Reporting of OBservational studies in Epidemiology Extension for Sport Injury and Illness Surveillance (STROBE-SIIS) need to be implemented in future research to standardise and improve the quality of the data reported in women's cricket.

Emphasis should be placed on the importance of using appropriate data sampling techniques and minimising the risk of bias during data collection. Using standardised

injury-reporting methods will also reduce the amount of incorrectly reported data or the loss of data during the research process. It is also important to realise that data collection methods such as self-administered questionnaires rely on recall and could increase reporting bias. Cohort studies are less likely to cause bias than cross-sectional studies and would effectively promote the quality of the injury data reported in future studies. Future cricket research should also focus on the collection of data in accordance with the standards set out by the International Consensus Statement (3).

Grey literature has added significantly to the quality of the content of this systematic review, and future studies should aim to include grey literature in their reviews in order to reduce the risk of publication bias. Grey literature includes theses or dissertations, unpublished papers, conference papers, government reports and ongoing research findings that are not featured in many of the major research databases. Future studies should aim to include grey literature in their reviews in order to increase the comprehensiveness of the reports and present broad overviews of the available research on specific research topics.

Future studies should implement the definitions from the International Consensus Statement to standardise their findings and provide consistency in their reporting of injury data across a broad platform of cricket research (3). The injury definitions reported in the studies included in this review were found to be inconsistent, which made it difficult for the reviewers to accurately compare cohorts across the different studies. The International Consensus Statement provided a baseline for the injury definitions that need to be used to report injuries in cricket, including prevalence and incidence data. Incidence data need to be reported with a denominator and these denominators need to be reported with adherence to the standards of the International Consensus Statement to accurately convert and compare injury data across different studies. Also, the ‘all-complaint injury’ definition must be used in women’s cricket research to reduce the underreporting of overuse injuries or medical illness which could lead to reporting bias.

Future studies should investigate the aetiology of the high injury prevalence and incidence rates for female cricket players. There is also a need to accurately identify injury data, risks and the burden of injuries over a wider population of female cricket players. The provision of knowledge relating to injury risk factors, aetiology and injury

mechanisms in women's cricket is outside the scope of this review. As such, these fields should be considered as valuable topics for future research. Furthermore, injury prevention strategies to reduce the burden of injuries in women's cricket could and should be developed by identifying the injury-causing factors.

Anatomical regions that are frequently injured need to be investigated for clear injury aetiologies. The relevant body regions include the shoulder and the ankle, foot and toes for prevalence, and secondly, the hand, wrist and fingers and the knee regions for injury incidence. Future studies should investigate the workload management and risk factors for women's cricket, especially in terms of fielders and fast bowlers. Factors contributing to overuse injuries in women's cricket need to be explored in future research. Future studies need to investigate the contributing factors that might lead to head impacts and to review the quality of the protective gear currently used by batters.

Factors such as skills level, bowling speed, physical strength, morphological characteristics, workload management, and match schedules differ for male and female cricket players. Research findings indicate that male and female cricket players present with variations in their morphological and physical characteristics and independent reports need to be compiled for each gender. This researcher excluded 16 valuable studies from this review (Appendix D), hence the authors of these studies had not differentiated between the results for male and female cricket players. In fact, the exclusion of these studies from the review might give the impression that the injury prevalence and incidence of female cricket players could be greater than what would be expected. As such, future studies should report injury data for male and female cricket players independently to accommodate the need for data extraction for the different sexes.

The studies included in this review predominantly focused on elite-level cricket players. Other levels of cricket, such as club, recreational and school cricket levels were underreported, including findings for indoor cricket. The minority of studies in this review reported findings on junior cricketers, and this shortfall should be highlighted. Epidemiological findings for junior-level cricket are of utmost importance for the future development of the sport. It is suggested that future studies look at junior-level cricket players in women's cricket and investigate the injury rates for these players. Future studies should also investigate the injury rate independently for each format of cricket.

It is vital for future studies to report on their findings for each level of cricket separately and also to consider the ages of all of the women's cricket participants in a study.

6.4 Strengths and Limitations

This systematic review could be affected by limitations that could influence the conclusions drawn from the results provided by this research. Reporting literature findings for cricket brings about great challenges and might contribute to limitations in the accuracy of reporting. There are different formats of cricket matches and during a match, only 13 of the 22 players are present on the field at a time. Another challenge is the method of calculation to determine the player exposure times for cricket, as the game of cricket differ from those used for other sports who only have one player role at a time. Each player role in cricket accounts to different workloads. For example, a wicketkeeper has a different role and workload when compared to a fast bowler. The workload for each player role bring about different physical demands and risks of injury. Several cricket players are all-rounders where they have more than one role to fulfil during a match. Players performing the role of an all-rounder, have an increased workload as opposed to players who only bat or bowl. Reporting findings for cricket is challenging as the game is played in different formats, and the intensity of the matches, together with the burden of injuries for each format are different.

Owing to the limited research studies available on women's cricket, the population represented in this review is limited when compared to the global women's cricket population. Despite this researcher's (JJ) attempts to include all previous and current literature findings for women's cricket, the available literature sources were limited. The majority of findings were from Australia and England, where almost all of these studies focused on elite-level cricketers. There were limited studies available for junior and club-level cricket. Another limitation is the scarcity of literature reporting their findings per match format of cricket played. Several studies that reported injuries sustained by female cricket players were excluded during the study selection process because these studies met the inclusion criteria of the review; however, the results were pooled together with the male cricket players. As such, these studies did not distinguish the injury data between the two sexes. This researcher (JJ) contacted the authors from the relevant studies, including follow up emails, but received no response. Unfortunately, these useful studies had to be omitted as the injury data could not be sufficiently extracted as for each sex.

Several studies included in this review reported insufficient data for extraction purposes. For some studies, the information given, such as participant characteristics, injury definitions, total injuries sustained or total number of participants in the study cohort, was insufficient and could not be extracted. While hospital statistics and injury surveillance could be a useful source of data pertaining to injury, the data recorded and reported did not always include the participant characteristics, player roles nor injury definitions required for data extraction. For the future, the use of standardised injury definitions and reporting would be more effective in producing more accurate data for comparisons across different datasets and for other cricket research findings.

A strength of this study is that the systematic review met all the requirements of the Joanna Briggs Institute (38), 2015 PRISMA statement (107) and adhered to the standards of the International Consensus Statement (3). To this researcher's knowledge, this is the first systematic review to report on the injury rates and proportions for women's cricket apart from other sports and men's cricket. The results provided by this review have proved to be methodologically rigorous. Although no experimental studies were included in this review, level 1 evidence was created through this systematic review and meta-analyses.

While this review brought some limitations to light, the results that it has provided will improve the knowledge base for women's cricket injuries and highlight what was previously unknown. This review served to quantify the injury rates and proportions for women's cricket as the baseline to promote and implement target-oriented evidence-based injury prevention strategies. The rates and proportions of injury for women's cricket could be reduced by developing and implementing injury prevention strategies by the stakeholders of the relevant women's cricket bodies around the globe.

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6.6 Conflict of interest

This researcher declares no conflict of interest relevant to the content of this study.

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Appendix A Search Strategies

MEDLINE® (2020/08/30)

Keywords were searched in all texts (including title/abstract) and MeSH terms.
"Female filter" was applied.
((((cricket*[Text Word]) AND (((((women[Text Word]) OR (woman[Text Word])) OR (female*[Text Word])) OR (lady[Text Word])) OR (ladies[Text Word]))) AND (((injur*[Text Word]) OR (pain*[Text Word])) OR (wound*[Text Word]))) OR (((cricket sport[MeSH Terms]) AND ((women[MeSH Terms]) OR (female[MeSH Terms]))) AND ((wounds and injuries[MeSH Terms]) OR (pain[MeSH Terms])))) AND (female[Filter])
Results: 84

The Cochrane Controlled Trials Register in the Cochrane Library (2020/08/30)

Keywords were searched for in all text words and MeSH terms. Word variations were searched (box ticked). No filters were applied.

ID	Searched for	Results
#1	(women) OR (woman) OR (female*) OR (lady) OR (ladies)	775685
#2	(cricket*)	66
#3	(injur*) OR (pain*) OR (wound*)	256328
#4	#1 AND #2 AND #3	7
#5	MeSH descriptor: [Female] explode all trees	444998
#6	MeSH descriptor: [Women] explode all trees	608
#7	#5 OR #6	445012
#8	MeSH descriptor: [Cricket Sport] explode all trees	2
#9	MeSH descriptor: [Wounds and Injuries] explode all trees	25131
#10	MeSH descriptor: [Pain] explode all trees	48746
#11	#9 OR #10	71302
#12	#7 AND #8 AND #11	0
#13	#4 OR #12	7

Results: 7

Physiotherapy Evidence Database (PEDro) (2020/08/30)

The PEDro search builder provides tabs to be selected / filled out in order to conduct the search. The keyword “cricket*” was searched for in ‘Abstract and Title’ and the other keywords were substituted in the tab options. No filters were applied.

Searched for	**Results**
Cricket*	6
Cricket* AND (injur* OR pain* OR wound*)	2
Cricket* AND (female* OR woman OR women OR lad*)	0
Cricket* AND (injur* OR pain* OR wound*) AND (female* OR woman OR women OR lad*)	0

Results: 0

EBSCOHost (2020/08/30)

A combined search was conducted in the following databases affiliated with EBSCOHost: CINAHL Complete, Masterfile Premier, SPORTDiscus, MegaFile Premier (Academic Search Ultimate, Business Source Ultimate, and Regional Business News. The search was done in all texts; a search in MeSH terms was not available. The following expander was used: ‘Apply related words’, ticked; ‘Also search within the full text of the articles’, ticked; ‘Apply equivalent subjects’, ticked. ‘Sex: female’, ticked.

	Search TX - All Text:	**Results**
S1	TX cricket OR TX cricket sport OR TX cricket game (Narrow by SubjectGender: - female)	267
S2	TX (female or woman or women or females) OR TX lady OR TX ladies (Narrow by SubjectGender: - female)	1957464
S3	TX (injury or injuries or accident or trauma) OR TX (wounds and injuries) OR TX pain (Narrow by SubjectGender: - female) 345590	
S4	S1 AND S2 AND S3 (Narrow by SubjectGender: - female)	156

Results: 156

SCOPUS (2020/08/30)

Keywords were searched in all text words (including title/abstract). The MeSH terms search was not available. No filters or limitations were applied.

The key string was searched in the advanced search option:

(ALL (cricket*) AND ALL (female* OR women OR woman OR ladies OR lady) AND ALL (injur* OR pain* OR wound*) AND NOT ALL (crickets) AND NOT ALL (gryllidae))

Results: 463

Science Direct (2020/08/30)

Keywords were searched in all text words (including title/abstract). The MeSH terms search was not available. No filters or limitations were applied. Science Direct does not support wildcards. Only eight Boolean connectors could be used per search. Search terms were adjusted to include ALL the terms; Two separate searches were conducted, and the search results combined:

Searched for	**Results**
1. cricket AND (female OR females OR woman OR women) AND (injury OR injuries OR pain)	2768
2. cricket AND (lady OR ladies) AND (injury OR injuries OR pain)	341
Search 1 and 2 were combined for the following search results	3109

Results: 3109

ProQuest Health and Medical Complete (2020/08/30)

Searched in all text:

Set No.	**Searched for**	**Results**
S1	(cricket or cricketer or cricketers) OR Cricket OR (cricket sport). Additional limits - Humans; Females	552
S2	female OR woman OR women OR lady OR ladies Additional limits - Humans; Females	615944
S3	injury OR injuries OR wound OR pain OR (wounds and -injuries) Additional limits - Humans; Females	202761
S4	S1 AND S2 AND S3. Additional limits - Humans; Females	155

Results: 155

Grey Literature Databases searched:

WorldCat (2020/08/30)

A full text search option was not available. Searches could only be done in keywords and titles. The search was refined by: 'Formats': articles: all (ticked); books: thesis/dissertation (ticked). Other formats such as video, image, music, etc., excluded. ((kw:female* OR women OR woman OR lady OR ladies) AND (kw:cricket*) AND (kw:injury* OR wound* OR pain*) AND NOT (kw:insect* OR Gryllidae*) AND NOT(kw:poet* OR poem* OR fiction*)) *OR ((ti:female* OR women OR woman OR lady OR ladies) AND (ti:cricket*) AND (ti:injur* OR pain* OR wound*) AND NOT (ti:insect* OR Gryllidae*) AND NOT(ti:poet* OR poem* OR fiction*))

Results: 793

Grey Literature (Greylit.org) (2020/08/30)

The following search was conducted:

((cricket* AND (female* AND woman* AND women* AND lady* AND ladies) AND (injur* AND wound* AND pain*))

Results: 0

The GreyLit search builder provides tabs to be selected / filled for a refined search. No applicable filters or limitations applied. The following keywords were searched:

Cricket*	0
Cricket* AND (injur* OR wound* OR pain*)	0
Cricket* AND (female* OR woman OR women OR lad*)	0

Results: 0

Grey Matters (CADTH) (2020/08/30)

The search builder provides tabs to be selected / filled for a refined search. No applicable filters or limitations applied. The following keywords were searched:

Searched for	**Results**
Cricket*	1
Cricket* AND (injur* OR wound* OR pain*)	1
Cricket* AND (female* OR woman OR women OR lad*)	0
Cricket* AND (injur* OR wound* OR pain*) AND (female* OR woman OR women OR lad*)	0

Results: 0

OpenGrey SIGLE (2020/08/30)

The following search was conducted in all texts: (No filters or limitations were applied) (cricket* AND (female* AND woman* AND women* AND lady* AND ladies) AND (injur* AND wound* AND pain*))

Results: 0

ClinicalTrail.gov (2020/08/30)

The advanced search builder was used by entering different keywords in selected tabs:

1. Condition or disease: Injury; Pain; Wound (synonyms searched)
   Other terms: cricket*
   Sex: Studies with female participants
   Results: 0
2. Condition or disease: Injury; Sports (synonyms searched)
   Other terms: cricket*
   Sex: Studies with female participants
   Results: 0

Google Scholar (2020/08/30)

Due to the limitations in the advanced search function of Google Scholar, multiple searches were performed. Different variations were searched for separately in the boxes “with all of the words” and “with the exact phrase” as shown below:

Search terms anywhere in the article:

with the exact phrase	**Female cricket**	**Women cricket**	**Woman cricket**	**Lady Cricket**	**Ladies cricket**
with at least one of the words	Injur* pain* wound*	Injur* pain* wound*	Injur* pain* wound*	Injur* pain* wound*	Injur* pain* wound*
Without the words	crickets, insect* gryllidae	crickets, insect* gryllidae	crickets, insect* gryllidae	crickets, insect* gryllidae	crickets, insect* gryllidae
Total number of results	179	194	11	7	52

Appendix B Critical Appraisal Instruments



JBI Critical Appraisal Checklist Studies Reporting Prevalence Data

Reviewer _____

Author _____ Year _____ Record Number_____

		Yes	No	Unclear	Not applicable
1.	Was the sample frame appropriate to address the target population?	☐	☐	☐	☐
2.	Were study participants sampled in an appropriate way?	☐	☐	☐	☐
3.	Was the sample size adequate?	☐	☐	☐	☐
4.	Were the study subjects and the setting described in detail?	☐	☐	☐	☐
5.	Was the data analysis conducted with sufficient coverage of the identified sample?	☐	☐	☐	☐
6.	Were valid methods used for the identification of the condition?	☐	☐	☐	☐
7.	Was the condition measured in a standard, reliable way for all participants?	☐	☐	☐	☐
8.	Was there appropriate statistical analysis?	☐	☐	☐	☐
9.	Was the response rate adequate, and if not, was the low response rate managed appropriately?	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info ☐

Comments (Including reason for exclusion)

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JBI CRITICAL APPRAISAL CHECKLIST FOR COHORT STUDIES

Reviewer_____Date_____

Author_____Year_____ Record Number_____

	Yes	No	Unclear	Not applicable
1. Were the two groups similar and recruited from the same population?	☐	☐	☐	☐
2. Were the exposures measured similarly to assign people to both exposed and unexposed groups?	☐	☐	☐	☐
3. Was the exposure measured in a valid and reliable way?	☐	☐	☐	☐
4. Were confounding factors identified?	☐	☐	☐	☐
5. Were strategies to deal with confounding factors stated?	☐	☐	☐	☐
6. Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?	☐	☐	☐	☐
7. Were the outcomes measured in a valid and reliable way?	☐	☐	☐	☐
8. Was the follow up time reported and sufficient to be long enough for outcomes to occur?	☐	☐	☐	☐
9. Was follow up complete, and if not, were the reasons to loss to follow up described and explored?	☐	☐	☐	☐
10. Were strategies to address incomplete follow up utilized?	☐	☐	☐	☐
11. Was appropriate statistical analysis used?	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info ☐

Comments (Including reason for exclusion)

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Appendix C Data Extraction Instrument



JBI Data Extraction Form for Prevalence Studies

Study details

Reviewer –

Study ID/Record Number -
Date –
Study title –
Author –
Year –

Journal –

Aims of the study –

Study Method

Setting –
Study design –
Follow-up or study duration –
Subject characteristics – Dependent
variable -
Outcomes –
Outcome measurements –

Ethical approval –

Method of data analysis -

Results

Prevalence n/N (%)

Proportion and 95% Confidence Intervals

Incidence n/N (%)

Proportion and 95% Confidence Intervals and duration of recruitment or the study

Authors' comments

Reviewer comments

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Appendix D Studies excluded due to insufficient data for extraction

Article (16)	**Reason for exclusion**
Antoun, J.S. and Lee, K.H., 2008. Sports-related maxillofacial fractures over an 11-year period. *Journal of Oral and Maxillofacial Surgery*, 66(3), pp.504-508.	These articles include injury data on female cricket participants but were excluded in the last phase of the study selection process. Most of these studies do not report the total number of participants or uninjured participants in the study population, and only report individual injury cases for female cricket. The injury data reported in these studies could not be extracted due to insufficient data for prevalence or incidence data purposes and were excluded from the review.
Belliappa, P.P. and Barton, N.J., 1991. Hand injuries in cricketers. *Journal of Hand Surgery*, *16*(2), pp.212-214.	
Bristi, S.N., 2015. *Prevalence of sports injuries among female athletes* (Doctoral dissertation, Bangladesh Health Professions Institute, Faculty of Medicine, the University of Dhaka, Bangladesh)	
Fernando, D.T., Berecki-Gisolf, J. and Finch, C.F., 2018. Sports injuries in Victoria, 2012–13 to 2014–15: evidence from emergency department records. *Medical Journal of Australia*, *208*(6), pp.255-260.	
Forward, G.R., 1988. Indoor cricket injuries. *Medical Journal of Australia*, *148*(11), pp.560-561.	
Gregory, P.L., Batt, M.E. and Kerslake, R.W., 2004. Comparing spondylolysis in cricketers and soccer players. *British Journal of Sports Medicine*, *38*(6), pp.737-742.	
Grimmer, K.A., Jones, D. and Williams, J., 2000. Prevalence of adolescent injury from recreational exercise: an Australian perspective. *Journal of Adolescent Health*, *27*(4), pp.266-272.	
King, D., Hume, P.A., Hardaker, N., Cummins, C., Gissane, C. and Clark, T., 2019. Sports-related injuries in New Zealand: National Insurance (Accident Compensation Corporation) claims for five sporting codes from 2012 to 2016. *British Journal of Sports Medicine*, *53*(16), pp.1026-1033.	
Lauder, T.D., Baker, S.P., Smith, G.S. and Lincoln, A.E., 2000. Sports and physical training injury hospitalizations in the army. *American Journal of Preventive Medicine*, *18*(3), pp.118-128.	
Lee, K., 2012. Cricket-related maxillofacial fractures. *Journal of Maxillofacial and Oral Surgery*, *11*(2), pp.182-185.	
Routley, V. and Valuri, J., 1993. *Adult sports injury*. Victorian Injury Surveillance System.	
Stuelcken, M.C., R.E. Ferdinands, and Sinclair, B. *Three-dimensional trunk kinematics and low back pain in elite female fast bowlers.* 2010. 26(1): p. 52-61.	
Walker, H.L., Carr, D.J., Chalmers, D.J. and Wilson, C.A., 2010. Injury to recreational and professional cricket players: circumstances, type and potential for intervention. *Accident Analysis & Prevention*, *42*(6), pp.2094-2098.	
Wang, H., Liu, H., Wu, J., Li, C., Zhou, Y., Liu, J., Ou, L. and Xiang, L., 2019. Age, gender, and etiology differences of sports-related fractures in children and adolescents: A retrospective observational study. *Medicine*, *98*(4).	
Wani, A.A., Ramzan, A.U., Tariq, R., Kirmani, A.R. and Bhat, A.R., 2008. Head injury in children due to cricket ball scenario in developing countries. *Pediatric Neurosurgery*, *44*(3), pp.204-207.	
Wood, J., 2010. *Associations between kinematic and kinetic variables and lower back injury in female bowlers in cricket* (Doctoral dissertation, University of Wales Institute Cardiff).	

Appendix E Studies excluded after full text review

Article	**Reason for exclusion**
Sadiq, S.N., Ali, A., Usmani, B. and Ahmad, K., 2017. Bowled over by cricket: impact of tape-ball injuries on the eyes. *The Asia-Pacific Journal of Ophthalmology*, *6*(1), pp.50-53.	The only female injured was a bystander who was accidentally hit by a ball.
Filbay, S. R., Sanchez-Santos, M. T., Peirce, N., & Arden, N. K. (2018). *Is playing position, playing standard or length of play associated with joint specific osteoarthritis in cricketers? Osteoarthritis*	Conference abstract. Female cricket injury data were available in the abstract but there was no full-text article.
Inge, P. J.: Kountouris, A.: Saw, A.: Sims, K.: Saw, R. Injuries to elite female cricketers in Australia over a four-year period: a comparison to male injury patterns	Conference abstract. Female cricket injury data were available in the abstract but there was no full-text article.
Ranson, E. Four-year injury surveillance of an international women's cricket squad.	Conference abstract. Female cricket injury data were available in the abstract but there was no full-text article.
Kountouris, A., Portus, M. and Cook, J., 2012. *Quadratus lumborum* asymmetry and lumbar spine injury in cricket fast bowlers. *Journal of Science and Medicine in Sport*, *15*(5), pp.393-397.	No female cricket participants.
Street, E.J. and Jacobsen, K.H., 2017. Prevalence of sports injuries among 13- to 15-year-old students in 25 low-and middle-income countries. *Journal of Community Health*, *42*(2), pp.295-302.	No data available on female cricket injuries.
Selhorst, M., Fischer, A. and MacDonald, J., 2019. Prevalence of spondylolysis in symptomatic adolescent athletes: an assessment of sport risk in non-elite athletes. *Clinical Journal of Sport Medicine*, *29*(5), pp.421-425.	No data available on female cricket injuries.
Annear, P.T., Chakera, T.M.H., Foster, D.H. and Hardcastle, P.H., 1992. *Pars interarticularis* stress and disc degeneration in cricket's potent strike force: the fast bowler. *Australian and New Zealand Journal of Surgery*, *62*(10), pp.768-773.	No female cricket participants.
Jones, M.E., Davies, M.A., Leyland, K.M., Delmestri, A., Porter, A., Ratcliffe, J., Peirce, N., Newton, J.L. and Arden, N.K., 2018. Osteoarthritis and other long-term health conditions in former elite cricketers. *Journal of Science and Medicine in Sport*, *21*(6), pp.558-563.	No female cricket participants.
Patel, D.R. and Baker, R.J., 2006. Musculoskeletal injuries in sports. *Primary Care*, *33*(2), pp.545-579.	No data available on female cricket injuries
Forrest, M.R., Hebert, J.J., Scott, B.R. and Dempsey, A.R., 2020. Modifying bowling kinematics in cricket pace bowlers with exercise-based injury prevention: A cluster-randomised controlled trial. *Journal of Science and Medicine in Sport*.	No data available on female cricket injuries
Armsey, T.D. and Hosey, R.G., 2004. Medical aspects of sports: epidemiology of injuries, preparticipation physical examination, and drugs in sports. *Clinics in Sports Medicine*, *23*(2), pp.255-279.	No data available on female cricket injuries
Siesmaa, E.J., Blitvich, J.D., White, P.E. and Finch, C.F., 2011. Measuring children's self-reported sport participation, risk perception and injury history: Development and validation of a survey instrument. *Journal of Science and Medicine in Sport*, *14*(1), pp.22-26.	No data available on female cricket injuries

Article	Reason for exclusion
Delilbasi, C., Yamazawa, M., Nomura, K., Iida, S. and Kogo, M., 2004. Maxillofacial fractures sustained during sports played with a ball. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, *97*(1), pp.23-27.	No data available on female cricket injuries.
Tanaka, N., Hayash, S., Amagasa, T. and Kohama, G.I., 1996. Maxillofacial fractures sustained during sports. *Journal of Oral and Maxillofacial Surgery*, *54*(6), pp.715-719.	No data available on female cricket injuries.
Bruns, W. and Maffulli, N., 2000. Lower limb injuries in children in sports. *Clinics in Sports Medicine*, *19*(4), pp.637-662.	No data available on female cricket injuries.
Bibson, T., 1987. Sports injuries. *Baillière's Clinical Rheumatology*, *1*(3), pp.583-600.	No data available on female cricket injuries.
Shanmugam, C. and Maffulli, N., 2008. Sports injuries in children. *British Medical Bulletin*, *86*(1), pp.33-57.	No data available on female cricket injuries.
Mishra, A. and Verma, A.K., 2012. Sports related ocular injuries. *Medical Journal for the Armed Forces: India*, *68*(3), pp.260-266.	No data available on female cricket injuries.
Theadom, A., Starkey, N.J., Dowell, T., Hume, P.A., Kahan, M., McPherson, K., Feigin, V. and BIONIC Research Group, 2014. Sports-related brain injury in the general population: an epidemiological study. *Journal of Science and Medicine in Sport*, *17*(6), pp.591-596.	No data available on female cricket injuries.
Mourouzis, C. and Koumoura, F., 2005. Sports-related maxillofacial fractures: a retrospective study of 125 patients. *International Journal of Oral and Maxillofacial Surgery*, *34*(6), pp.635-638.	No data available on female cricket injuries.
Drosos, G.I. and Pozo, J.L., 2004. The causes and mechanisms of meniscal injuries in the sporting and non-sporting environment in an unselected population. *The Knee*, *11*(2), pp.143-149.	No data available on female cricket injuries.
Sural, S. and Verma, A., 2015. The clinical profile of musculoskeletal injuries in children attending a major hospital in Delhi, India. *Journal of Clinical Orthopaedics and Trauma*, *6*(1), pp.12-18.	No data available on female cricket injuries.
Finch, C.F. and Boufous, S., 2008. The descriptive epidemiology of sports/leisure-related heat illness hospitalisations in New South Wales, Australia. *Journal of Science and Medicine in Sport*, *11*(1), pp.48-51.	No data available on female cricket injuries.
Wood, A.M., Robertson, G.A., Rennie, L., Caesar, B.C. and Court-Brown, C.M., 2010. The epidemiology of sports-related fractures in adolescents. *Injury*, *41*(8), pp.834-838.	No data available on female cricket injuries.
Wood, A.M., Robertson, G.A., Rennie, L., Caesar, B.C. and Court-Brown, C.M., 2010. The epidemiology of sports-related fractures in adolescents. *Injury*, *41*(8), pp.834-838.	No data available on female cricket injuries.
Aitken, S. and Court-Brown, C.M., 2008. The epidemiology of sports-related fractures of the hand. *Injury*, *39*(12), pp.1377-1383.	No data available on female cricket injuries.
Dane, Ş., Can, S. and Karsan, O., 1999. Sport injuries in right-and left-handers. *Perceptual and Motor Skills*, *89*(3), pp.846-848.	No data available on female cricket injuries.
Shah, S.I.A., Shah, S.A., Rai, P., Siddiqui, S.J., Abbasi, S.A. and Katpar, N.A., 2016. Types of Traumatic Lens Dislocations at Larkana. *Journal of the College of Physicians and Surgeons: Pakistan*, *26*(8), pp.714-715.	No data available on female cricket injuries.

Article	Reason for exclusion
Browne, G.J., Noaman, F., Lam, L.T. and Soundappan, S.V., 2010. The Nature and Characteristics of Abdominal Injuries sustained during Children's Sports. *Pediatric Emergency Care*, *26*(1), pp.30-35.	No data available on female cricket injuries.
Barrett, B.T., Flavell, J.C., Bennett, S.J., Cruickshank, A.G., Mankowska, A., Harris, J.M. and Buckley, J.G., 2017. Vision and Visual History in Elite/Near-Elite-Level Cricketers and Rugby-League Players. *Sports Medicine - Open*, *3*(1), p.39.	No data available on female cricket injuries.
Sapkota, K., Koirala, S., Shakya, S., Chaudhary, M. and Paudel, P., 2006. Visual status of Nepalese national football and cricket players. *Nepal Medical Journal*, *8*(4), pp.280-3.	No data available on female cricket injuries.
Weightman, D. and Browne, R.C., 1975. Injuries in eleven selected sports. *British Journal of Sports Medicine*, *9*(3), pp.136-141.	No data available on female cricket injuries.
Linn, E.W., Vrijhoef, M.M., de Wijn, J.R., Coops, R.P., Cliteur, B.F. and Meerloo, R., 1986. Facial injuries sustained during sports and games. *Journal of Maxillofacial Surgery*, *14*, pp.83-88.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Chaurasiya, M. and Mehta, D., 2018. Effect of core stability exercises in enhancing the upper and lower body strength of women cricket players.	No data available on female cricket injuries.
Nel, D.J., 1979. Die invloed van sportbeserings op sportdeelname en werk. *South African Medical Journal*, *55*(11), pp.426-428.	No data available on female cricket injuries.
Burroughs, A. and Nauright, J., 2000. Women's sports and embodiment in Australia and New Zealand. *The International Journal of the History of Sport*, *17*(2-3), pp.188-205.	No data available on female cricket injuries.
Forrest, M.R., Scott, B.R., Hebert, J.J. and Dempsey, A.R., 2018. Injury prevention strategies for adolescent cricket pace bowlers. *Sports Medicine*, *48*(11), pp.2449-2461.	Review article.
Pandey, C.R., 2012. Cricket-associated sports injuries. In *Sports Injuries* (pp. 1087-1091). Springer, Berlin, Heidelberg.	Review article.
Felton, P.J., Lister, S.L., Worthington, P.J. and King, M.A., 2019. Comparison of biomechanical characteristics between male and female elite fast bowlers. *Journal of Sports Sciences*, *37*(6), pp.665-670.	No data available on female cricket injuries.
Debnath, U.K., Freeman, B.J.C., Gregory, P., De la Harpe, D., Kerslake, R.W. and Webb, J.K., 2003. Clinical outcome and return to sport after the surgical treatment of spondylolysis in young athletes. *The Journal of Bone and Joint Surgery. British Volume*, *85*(2), pp.244-249.	No data available on female cricket injuries.
Carty, H., 1998. Children's sports injuries. *European Journal of Radiology*, *26*(2), pp.163-176.	No data available on female cricket injuries.
Fowlie, J., Eime, R.M. and Griffiths, K., 2020. Barriers to adolescent female participation in cricket. *Annals of Leisure Research*, pp.1-19.	No data available on female cricket injuries.
Ladenhauf, H.N., Fabricant, P.D., Grossman, E., Widmann, R.F. and Green, D.W., 2013. Athletic participation in children with symptomatic spondylolysis in the New York area. *Medicine and Science in Sports and Exercise*, *45*(10), pp.1971-1974.	No data available on female cricket injuries.

Article	Reason for exclusion
Tahoor, A. and Koley, S., 2019. Anthropometric Variables and Physical Fitness Characteristics in Female Cricket Players of Maharashtra and Punjab: A Comparative Study. *International Journal of Health Sciences and Research,* 9(3), pp.1-6.	No data available on female cricket injuries.
Shah, S.R., Horsley, I. and Rolf, C.G., 2017. Anterior internal impingement of the shoulder in rugby players and other overhead athletes. *Asia-Pacific Journal of Sports Medicine, Arthroscopy, Rehabilitation and Technology*, *8*, pp.13-17.	No female cricket participants in this study.
Senington, B., 2019. *An investigation into the spinal kinematics and lower limb impacts during cricket fast bowling and their association with lower back pain* (Doctoral dissertation, Bournemouth University).	No female cricket participants in this study.
Gupta, R., Khanna, T., Masih, G.D., Malhotra, A., Kapoor, A. and Kumar, P., 2016. Acute anterior cruciate ligament injuries in multisport elite players: Demography, association, and pattern in different sports. *Journal of Clinical Orthopaedics and Trauma*, *7*(3), pp.187-192.	No data available on female cricket injuries.
Welch, C., Thomson, M. and Kennedy, R., 2010. ACC claims for sports-related dental trauma from 1999 to 2008: a retrospective analysis. *New Zealand Dental Journal*, *106*(4), p.137.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Chaurasiya, M. and Mehta, D., 2018. A comparative analysis on selected strength variables among female bowlers and female batsmen in cricket.	No cricket injury data available.
Finch, C.F. and Mitchell, D.J., 2002. A comparison of two injury surveillance systems within sports medicine clinics. *Journal of Science and Medicine in Sport*, *5*(4), pp.321-335.	No data available on female cricket injuries.
Beckles, H.M., 1995. A Purely Natural Extension: Women's Cricket in West Indies Cricket Culture.". Liberation Cricket: West Indies Cricket Culture, p.222.	No data available on female cricket injuries.
Aitken, S. and Court-Brown, C.M., 2008. The epidemiology of sports-related fractures of the hand. *Injury*, *39*(12), pp.1377-1383.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Desai, A., 2018. Cricket & conquest: The history of South African cricket retold, 1795-1914, André Odendaal, Krish Reddy, Christopher Merrett and Jonty Winch: book review. *Acta Academica*, *50*(2), pp.145-147.	No data available on injuries specific to female cricket players.
Finch, C. and Cassell, E., 2006. The public health impact of injury during sport and active recreation. *Journal of Science and Medicine in Sport*, *9*(6), pp.490-497.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Chuter, G.S.J., Muwanga, C.L. and Irwin, L.R., 2009. Ulnar collateral ligament injuries of the thumb: 10 years of surgical experience. *Injury*, *40*(6), pp.652-656.	No data available on injuries specific to female cricket players.

Article	Reason for exclusion
Debnath, U.K., Freeman, B.J.C., Gregory, P., De la Harpe, D., Kerslake, R.W. and Webb, J.K., 2003. Clinical outcome and return to sport after the surgical treatment of spondylolysis in young athletes. *The Journal of Bone and Joint Surgery. British Volume*, *85*(2), pp.244-249.	No data available on injuries specific to female cricket players.
Debnath, U.K., Freeman, B.J., Grevitt, M.P., Sithole, J., Scammell, B.E. and Webb, J.K., 2007. Clinical outcome of symptomatic unilateral stress injuries of the lumbar *pars interarticularis*. *Spine*, *32*(9), pp.995-1000.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Driscoll, T.R., Cripps, R. and Brotherhood, J.R., 2008. Heat-related injuries resulting in hospitalisation in Australian sport. *Journal of Science and Medicine in Sport*, *11*(1), pp.40-47.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Drosos, G.I. and Pozo, J.L., 2004. The causes and mechanisms of meniscal injuries in the sporting and non-sporting environment in an unselected population. *The Knee*, *11*(2), pp.143-149.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Finch, C., Valuri, G. and Ozanne-Smith, J., 1998. Sport and active recreation injuries in Australia: evidence from emergency department presentations. *British Journal of Sports Medicine*, *32*(3), pp.220-225.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Forrest, M.R., Hebert, J.J., Scott, B.R. and Dempsey, A.R., 2019. Exercise-based injury prevention for community-level adolescent cricket pace bowlers: A cluster-randomised controlled trial. *Journal of Science and Medicine in Sport*.	No data available on injuries specific to female cricket players. (Only male participants).
Garcia-Byrne, F., Buckley, J.D., Bishop, C., Schwerdt, S., Porter, J., Bailey, D. and Wycherley, T.P., 2020. External and internal workload demands of women's twenty 20 cricket competition. *Journal of Science and Medicine in Sport*, *23*(1), pp.89-93.	No data available on injuries specific to female cricket players.
Giles, K. and Musa, I., 2008. A survey of glenohumeral joint rotational range and non-specific shoulder pain in cricketers. *Physical Therapy in Sport*, *9*(3), pp.109-116.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Harris, A.W., Jones, C.A., Rowe, B.H. and Voaklander, D.C., 2012. A population-based study of sport and recreation-related head injuries treated in a Canadian health region. *Journal of Science and Medicine in Sport*, *15*(4), pp.298-304.	No data available on injuries specific to female cricket players.

Article	Reason for exclusion
Hill, C.M., Crosher, R.F. and Mason, D.A., 1985. Dental and facial injuries following sports accidents: a study of 130 patients. *British Journal of Oral and Maxillofacial Surgery*, *23*(4), pp.268-274.	No data available on injuries specific to female cricket players.
Jones, D., Louw, Q. and Grimmer, K., 2000. Recreational and sporting injury to the adolescent knee and ankle: prevalence and causes. *Australian Journal of Physiotherapy*, *46*(3), pp.179-188.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Khokhar, S., Agrawal, S., Gupta, S., Gogia, V. and Agarwal, T., 2014. Epidemiology of traumatic lenticular subluxation in India. *International Ophthalmology*, *34*(2), pp.197-204.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Finch, C.F., White, P., Dennis, R., Twomey, D. and Hayen, A., 2010. Fielders and batters are injured too: a prospective cohort study of injuries in junior club cricket. *Journal of Science and Medicine in Sport*, *13*(5), pp.489-495.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Fong, L.P., 1994. Sports-related eye injuries. *Medical Journal of Australia*, *160*(12), pp.743-750.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Mitchell, R. and Hayen, A., 2006. Sport- or leisure-related injury hospital admissions: Do we need to get more out of being struck?. *Journal of Science and Medicine in Sport*, *9*(6), pp.498-505.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Mummery, W.K., Schofield, G. and Spence, J.C., 2002. The epidemiology of medically-attended sport and recreational injuries in Queensland. *Journal of Science and Medicine in Sport*, *5*(4), pp.307-320.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Owoeye, O.B., 2010. Pattern and management of sports injuries presented by Lagos state athletes at the 16th National Sports Festival (KADA games 2009) in Nigeria. *British Medical Council: Sports Science, Medicine and Rehabilitation*, *2*(1), p.3.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.

Article	Reason for exclusion
Ramagoni, N.K., 2006. The present status of knowledge regarding sports-related dental injuries their emergency care and the preventive measures to be taken including the use of mouthguards in south Indian urban aesthetically-active high school children (Doctoral dissertation, RGUHS).	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Rice, S., Olive, L., Gouttebarge, V., Parker, A.G., Clifton, P., Harcourt, P., Llyod, M., Kountouris, A., Smith, B., Busch, B. and Purcell, R., 2020. Mental health screening: severity and cut-off point sensitivity of the Athlete Psychological Strain Questionnaire in male and female elite athletes. *British Medical Journal: Open Sport & Exercise Medicine*, *6*(1), p.e000712.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Rishi, P., Rishi, E., Gupta, A., Swaminathan, M. and Chhablani, J., 2013. Vitreous hemorrhage in children and adolescents in India. *Journal of American Association for Pediatric Ophthalmology and Strabismus*, *17*(1), pp.64-69.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Schuring, N., Kerkhoffs, G., Gray, J. and Gouttebarge, V., 2017. The mental wellbeing of current and retired professional cricketers: an observational prospective cohort study. *The Physician and Sports Medicine*, *45*(4), pp.463-469.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Sreekaarini, I., Eapen, C. and Zulfeequer, C.P., 2014. Prevalence of sports injuries in adolescent athletes. *Journal of Athletic Enhancement 3*, *5*, p.2.	Although female cricket players were included in this study, the authors pooled / combined the results. The authors did not differentiate between the results according to the specific sport and gender which made it impossible to separate and extract data related specifically to female cricket players.
Stuelcken, M., Pyne, D. and Sinclair, P., 2007. Anthropometric characteristics of elite cricket fast bowlers. *Journal of Sports Sciences*, *25*(14), pp.1587-1597.	No data available on injuries specific to female cricket players.
Stuelcken, M.C. and Sinclair, P.J., 2009. A pilot study of the front foot ground reaction forces in elite female fast bowlers. *Journal of Science and Medicine in Sport*, *12*(2), pp.258-261.	No data available on injuries specific to female cricket players.
Stuelcken, M.C., Ferdinands, R.E., Ginn, K.A. and Sinclair, P.J., 2010. The shoulder distraction force in cricket fast bowling. *Journal of Applied Biomechanics*, *26*(3), pp.373-377.	No data available on injuries specific to female cricket players.
Mahapatra, S.K., Malhotra, K. and Mendke, R.G., 2018. A three-year prospective study on ocular injuries with tennis or cricket ball while playing cricket: a case series. *Indian Journal of Ophthalmology*, *66*(2), p.256.	No data available on the injuries sustained specifically by female cricket players. (Two of the female participants were bystanders who were injured).
White, P.E., Finch, C.F., Dennis, R. and Siesmaa, E., 2011. Understanding perceptions of injury risk associated with playing junior cricket. *Journal of Science and Medicine in Sport*, *14*(2), pp.115-120.	No data available on the injuries sustained specifically by female cricket players.

Appendix F Ethical Clearance Certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

Human Research Ethics Committee (Medical)

Research Office Secretariat:
Faculty of Health Sciences, Phillip Tobias Health Sciences Building, 3rd Floor, Office 301/2/4, 29 Princess of Wales Terrace, Parktown, 2193
Private Bag 3, Wits 2050
Office email: HREC-Medical.ResearchOffice@wits.ac.za
Website: www.wits.ac.za/research/about-our-research/ethics-and-research-integrity/

Ref: W-CBP-200529-02 29/05/2020

TO WHOM IT MAY CONCERN:

Waiver:	This certifies that the following research does not require clearance from the Human Research Ethics Committee (Medical)
Investigator:	Ms Jolandi Jacobs
Supervisor:	Benita Olivier and Muhammad Dawood
Department:	Physiotherapy
Project title:	The prevalence and incidence of injuries among female cricket players: a systematic review protocol
Reason:	Study will be Literature-Based. No human participants, human data or human tissues will be involved.

Dr CB Penny

Chairperson: Human Research Ethics Committee (Medical)

Copy – HREC (Medical) Secretariat: Ms Zanele Ndlovu, Ms Mapula Ramaila and Mr Rhulani Mkansi

Appendix G Declaration of plagiarism

Faculty of Health Sciences, Postgraduate Office
Phillip V Tobias Building, 2nd Floor
Cnr York & Princess of Wales Terrace, Parktown 2193
Tel: (011) 717 2745 | Fax: (011) 717 2119
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PLAGIARISM DECLARATION TO BE SIGNED BY ALL HIGHER DEGREE STUDENTS

SENATE PLAGIARISM POLICY: APPENDIX ONE

I Jolandi Jacobs (Student number: 2396646) am a student registered for the degree of MSc Physiotherapy by dissertation) in the academic year 2020.

I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.
- I have included as an appendix a report from "Turnitin" (or other approved plagiarism detection) software indicating the level of plagiarism in my research document.

Signature: Jacobs Date: 2020/03/01

Appendix H Declaration by student and co-authors' agreement for write-up with published articles

I, Jolandi Jacobs, student number, 2396646, declare that this Thesis/ these Articles are my own work and that I contributed adequately towards the research findings published in the article(s) stated below which are included in my Thesis.

Signature of Student  Date 2021/02/24

Name of Primary Supervisor……Prof Benita Olivier.....……

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Signature of Co-author …… Date……2021/02/24.....…

Appendix I Calculations for meta-analyses

Meta-analysis 1b

Model	Study name	Statistics for each study							Calculations (Random	Calculations (Random)	Calculations (Random	Calculations (	Calculations (Ran	Calculati	Calculations (Random	Calculations (Ran	Calculatio	Calculations (Ran	Calculatio	Calculations (Random)	Calculations (Random)
		Rate	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Point	Study Variance	Tau^2 Within	Tau^2 Betwe	Total Variance	Q df	I^2	B	K	Summary Point		Group T^2	Group T^2 Variance
	Study001	2,40E+01	7,67E-02	5,88E-03	23,84701362	2,41E+01	313,0495168	0	23,99725746	5,88E-03	58,90310581	0	58,90898201	2	29,12618859	3,981607249	3	13,47504422	19,63559	58,90310581	3883,709479
	Study002	7,93E+00	3,87E-02	1,50E-03	7,852148463	8,00E+00	204,9390153	0	7,927968741	1,50E-03	58,90310581	0	58,9046023	2	29,12618859	3,981607249	3	13,47504422	19,63559	58,90310581	3883,709479
	Study003	8,50E+00	6,01E-02	3,61E-03	8,382701137	8,62E+00	141,4213562	0	8,500510031	3,61E-03	58,90310581	0	58,90671874	2	29,12618859	3,981607249	3	13,47504422	19,63559	58,90310581	3883,709479
Random		1,35E+01	4,43E+00	19,63558921	4,790039478	2,22E+01	3,04E+00	2,36E-03	40,42573623	1,10E-02	176,7093174	0	176,720303	2	29,12618859	3,981607249	3	13,47504422	19,63559	58,90310581	3883,709479

Meta-analysis 1c

Model	Study name	Statistics for each study							Calculations (Random	Calculations (Random)	Calculations (Random	Calculations (	Calculations (Ran	Calculati	Calculations (Random	Calculations (Ran	Calculatio	Calculations (Ran	Calculatio	Calculations (Random)	Calculations (Random)
		Rate	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Point	Study Variance	Tau^2 Within	Tau^2 Betwe	Total Variance	Q df	I^2	B	K	Summary Point		Group T^2	Group T^2 Variance
	Study001	9,16E+01	0,149751553	2,24E-02	9,13E+01	9,19E+01	6,12E+02	0	9,16E+01	2,24E-02	8,52E+02	0,00E+00	852,1580594	2	2,343691214	2,097149475	3	58,61739452	284,0508	852,1356339	793940,6765
	Study002	3,45E+01	8,07E-02	6,52E-03	3,44E+01	3,47E+01	4,28E+02	0	3,45E+01	6,52E-03	8,52E+02	0,00E+00	852,1421543	2	2,343691214	2,097149475	3	58,61739452	284,0508	852,1356339	793940,6765
	Study003	4,97E+01	0,14538109	0,021135661	4,94E+01	5,00E+01	3,42E+02	0	4,97E+01	2,11E-02	8,52E+02	0,00E+00	852,1567695	2	2,343691214	2,097149475	3	58,61739452	284,0508	852,1356339	793940,6765
Random		5,86E+01	16,85380598	284,0507759	2,56E+01	9,17E+01	3,48E+00	5,05E-04	1,76E+02	5,01E-02	2,56E+03	0,00E+00	2556,456983	2	2,343691214	2,097149475	3	58,61739452	284,0508	852,1356339	793940,6765

Meta-analysis 2

Model	Study name	Statistics for each study							Calculations (Random	Calculations (Random)	Calculations (Random	Calculations (	Calculations (Ran	Calculati	Calculations (Random	Calculations (Ran	Calculatio	Calculations (Ran	Calculatio	Calculations (Random)	Calculations (Random)
		Rate	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Point	Study Variance	Tau^2 Within	Tau^2 Betwe	Total Variance	Q df	I^2	B	K	Summary Point		Group T^2	Group T^2 Variance
	Study001	1,26E-01	3,88E-04	1,50E-07	0,124880371	0,126400262	324,0370349	0,00E+00	1,26E-01	1,50E-07	1,791368043	0	1,791368193	2	99,99712527	2890615475	3	90,76080879	0,779847	1,791368043	6,418005862
	Study002	695,1219512	2,058773539	4,238548483	691,0868292	699,1570732	337,6388603	0	695,1219512	4,24E+00	1,79E+00	0	6,029916526	2	99,99712527	2890615475	3	90,76080879	0,779847	1,791368043	6,418005862
	Study003	1,85E+00	2,27E-03	5,13E-06	1,847621005	1,856503715	817,3126697	0	1,85206236	5,13E-06	1,791368043	0	1,791373178	2	99,99712527	2890615475	3	90,76080879	0,779847	1,791368043	6,418005862
Random		90,76080879	0,8830893	0,779846713	89,02998556	92,49163201	102,7764788	0	697,0996539	4,238553768	5,374104129	0	9,612657897	2	99,99712527	2890615475	3	90,76080879	0,779847	1,791368043	6,418005862

Meta-analysis 2 with one study removed

Model	Study name	Statistics for each study							Calculations (Random	Calculations (Random)	Calculations (Random	Calculations (	Calculations (Ran	Calculati	Calculations (Random	Calculations (Ran	Calculatio	Calculations (Ran	Calculatio	Calculations (Random)	Calculations (Random)
		Rate	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Point	Study Variance	Tau^2 Within	Tau^2 Betwe	Total Variance	Q df	I^2	B	K	Summary Point		Group T^2	Group T^2 Variance
	Study001	1,26E-01	3,88E-04	1,50E-07	0,124880371	0,126400262	324,0370349	0	0,125640317	1,50E-07	1,490263893	0	1,490264043	1	0	1	2	0,988849895	0,745133	1,490263893	4,441788695
	Study003	1,85E+00	2,27E-03	5,13E-06	1,847621005	1,856503715	817,3126697	0	1,85206236	5,13E-06	1,490263893	0	1,490269028	1	0	1	2	0,988849895	0,745133	1,490263893	4,441788695
Random		9,89E-01	0,863211022	0,745133268	-0,703012619	2,680712408	1,145548273	0,251982111	1,977702677	5,29E-06	2,980527786	0	2,980533071	1	0	1	2	0,988849895	0,745133	1,490263893	4,441788695

Meta-analysis 3a

Model	Study name	Statistics for each study							Calculations (Random	Calculations (Random)	Calculations (Random	Calculations (	Calculations (Ran	Calculati	Calculations (Random	Calculations (Ran	Calculatio	Calculations (Ran	Calculatio	Calculations (Random)	Calculations (Random
		Point	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Point	Study Variance	Tau^2 Within	Tau^2 Betwe	Total Variance	Q df	I^2	B	K	Summary Point		Group T^2	Group T^2 Variance
	Study001	53,84615385	1,017596658	1,035502959	51,85170105	5,58E+01	5,29E+01	0	53,84615385	1,04E+00	3,08E+02	0,00E+00	308,667587	4	8,73410038	4,802229534	5	63,10563933	61,68214	307,632084	51304,01015
	Study002	55,38461538	0,923076923	0,852071006	53,57541786	5,72E+01	6,00E+01	0	55,38461538	8,52E-01	3,08E+02	0,00E+00	308,484155	4	8,73410038	4,802229534	5	63,10563933	61,68214	307,632084	51304,01015
	Study003	46,42857143	0,910539199	0,829081633	44,64394739	4,82E+01	5,10E+01	0	46,42857143	8,29E-01	3,08E+02	0,00E+00	308,4611657	4	8,73410038	4,802229534	5	63,10563933	61,68214	307,632084	51304,01015
	Study004	66,46341463	0,636604055	0,405264723	65,21569361	6,77E+01	1,04E+02	0	66,46341463	4,05E-01	3,08E+02	0,00E+00	308,0373488	4	8,73410038	4,802229534	5	63,10563933	61,68214	307,632084	51304,01015
	Study005	93,38842975	0,878524447	0,771805205	91,66655348	9,51E+01	1,06E+02	0	93,38842975	7,72E-01	3,08E+02	0,00E+00	308,4038892	4	8,73410038	4,802229534	5	63,10563933	61,68214	307,632084	51304,01015
Random		63,10563933	7,853797689	61,68213814	47,71247872	7,85E+01	8,04E+00	8,88E-16	315,511185	3,89E+00	1,54E+03	0,00E+00	1542,054146	4	8,73410038	4,802229534	5	63,10563933	61,68214	307,632084	51304,01015

Meta-analysis 3b

Model	Study name	Statistics for each study							Calculations (Random	Calculations (Random)	Calculations (Random	Calculations (	Calculations (Ran	Calculati	Calculations (Random	Calculations (Ran	Calculatio	Calculations (Ran	Calculatio	Calculations (Random)	Calculations (Random
		Point	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Point	Study Variance	Tau^2 Within	Tau^2 Betwe	Total Variance	Q df	I^2	B	K	Summary Point		Group T^2	Group T^2 Variance
	Study001	46,42857143	0,910539199	0,829081633	44,64394739	48,21319546	50,99019514	0	46,42857143	0,829081633	1101,813703	0	1102,642785	1	0	1	2	69,90911043	551,3071	1101,813703	2431515,914
	Study002	93,38842975	0,878524447	0,771805205	91,66655348	95,11030603	106,3014581	0	93,38842975	0,771805205	1101,813703	0	1102,585509	1	0	1	2	69,90911043	551,3071	1101,813703	2431515,914
Random		69,90911043	23,47992915	551,3070731	23,88929493	115,9289259	2,977398696	2,91E-03	139,8170012	1,600886837	2203,627407	0	2205,228294	1	0	1	2	69,90911043	551,3071	1101,813703	2431515,914

Meta-analysis 3c

Model	Study name	Statistics for each study							Calculations (Random	Calculations (Random)	Calculations (Random	Calculations (	Calculations (Ran	Calculati	Calculations (Random	Calculations (Ran	Calculatio	Calculations (Ran	Calculatio	Calculations (Random)	Calculations (Random
		Point	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Point	Study Variance	Tau^2 Within	Tau^2 Betwe	Total Variance	Q df	I^2	B	K	Summary Point		Group T^2	Group T^2 Variance
	Study001	53,84615385	1,017596658	1,035502959	51,85170105	55,84060665	5,29E+01	0,00E+00	53,84615385	1,035502959	56,78718736	0	57,82269032	2	0	2	3	58,59024714	19,18342	56,78718736	3500,271967
	Study002	55,38461538	0,923076923	0,852071006	53,57541786	57,19381291	60	0	55,38461538	0,852071006	56,78718736	0	57,63925837	2	0	2	3	58,59024714	19,18342	56,78718736	3500,271967
	Study003	66,46341463	0,636604055	0,405264723	65,21569361	67,71113566	104,4030651	0	66,46341463	0,405264723	56,78718736	0	57,19245209	2	0	2	3	58,59024714	19,18342	56,78718736	3500,271967
Random		58,59024714	4,379887635	19,1834157	50,00582512	67,17466916	13,37711193	0	175,6941839	2,292838688	170,3615621	0	172,6544008	2	0	2	3	58,59024714	19,18342	56,78718736	3500,271967

Appendix J Turn-it-in Report

Turnitin Originality Report

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