A Systematic Review of Head, Neck and-Facial Injuries in Cricket

Authors
Dulan Kodikara[1], Dara M. Twomey[1], Mandy S. Plumb[1, 2]

Affiliations
1 Federation University Australia, School of Science, Psychology and Sport, Ballarat, Australia
2 Central Queensland University, School of Health, Medical and Applied Sciences, Rockhampton, Australia

Key words
cricket, injury, head, neck, face

received 10.04.2021
accepted 27.10.2021
published online 02.11.2021

Bibliography
Int J Sports Med 2022; 43: 496–504
DOI 10.1055/a-1684-9033
ISSN 0172-4622

Georg Thieme Verlag, Rüdigerstraße 14,
70469 Stuttgart, Germany

Correspondence
Mr. Dulan Kodikara
Federation University Australia
School of Science
Psychology and Sport
P O Box 633
3353 Ballarat
Australia
Tel.: + 61/353/278 495, Fax: + 61/353/279 704
d.kodikara@federation.edu.au

Supplementary Material is available under
https://doi.org/10.1055/a-1684-9033

ABSTRACT

This systematic review was conducted to identify the incidence, nature and mechanisms of head, neck and facial (HNF) injuries in cricket and the reported use of helmets. Five databases were searched up to 30th November 2020. From peer-reviewed cricket injury studies published in English, studies reporting on HNF cricket injuries as per the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines were selected. Twenty-nine studies were included. HNF injuries had a cumulative total of 794/5,886 injuries equating to 13 % of all injuries. Non- specified HNF injuries (n = 210, 26 %) were the most prevalent type of injury followed by non-specified head injuries (n = 130, 16 %), other non-specified fractures (n = 119, 15 %) and concussions (n = 60, 8 %).The impact of the ball was reported as the most common mechanism for sustaining HNF injuries in cricket. The use of helmet was reported in only three studies (10 %). From studies reporting on HNF cricket injuries, facial fractures, and concussions were the most common specified-types of injury. There is little evidence on reporting of HNF cricket injuries as per the international cricket consensus injury definitions, as well as the use of helmets at the time of injury.

Introduction

Injury surveillance studies play a crucial role in understanding and preventing injuries. In order to minimise injury risk, it is vital to identify the incidence and prevalence of injuries associated with specific sport [1]. In cricket, guidelines on data collection, injury diagnosis, injury definitions and reporting were first published in a consensus statement in 2005 [2]. Over the last decade, cricket injury surveillance studies have been primarily conducted in Australia, the United Kingdom, South Africa, New Zealand and India [3]. With T-20 cricket gaining its popularity globally, the number of matches played during a calendar year has increased thereby leading to a steady increase in the prevalence of injuries [3]. Among all cricket participants, bowlers generally present with the highest number of injuries and more than two thirds of all cricket injuries are acute in nature [3]. It has been reported that players younger than 24-years of age are more prone to bowling-related and overuse injuries when compared to their older counterparts [4]. During the past decade hamstring strains have emerged as the most commonly reported injury with lumbar stress fractures being the most prevalent type of injury in both men's and women's cricket [5–7]. Finger injuries while batting and fielding and shoulder injuries while throwing and bowling have been the common presentation of injuries as per the playing role [3]. Overall, overuse and impact injuries have been widely reported in recent cricket injury literature [3]. Despite the catastrophic nature of head injuries, they are not as clearly reported and as well understood as injuries to other body parts.

For many years cricket has been considered a minimum contact, low risk sport in comparison to sports such as rugby, Australian Rules Football and ice hockey [8]. However, there are instances of fatal and career-ending head injuries in cricket [8]. A recent review

reported 36 craniofacial injuries in cricket between 1870–2015, out of which five were fatal and nine were career-ending injuries [9]. The cause of most of those injuries was due to being hit by the speeding ball, with the ball penetrating through the gap between the peak and faceguard of the helmet in seven cases [9]. The most recent on-field incident that led to the sudden death of Australian test cricketer Phillip Hughes in 2014 highlighted the need for further research on helmet safety to minimise the potential of fatal head injuries in cricket [8].

Since the introduction of helmets in cricket over 40 years ago, fatalities have gradually decreased [8]. The first helmet in cricket was worn by an Australian cricketer, in 1978, similar to a full-faced motorcycle helmet in its design [9]. Since then, helmet designs have evolved and the modern day helmets must comply with British standards (BS7928:2013 + A1:2019) as required by the International Cricket Council (ICC) [10]. Yet, the modifications in helmet design over the last four decades have not eliminated players from getting hit and sustaining injuries [11]. Despite recently reported catastrophic incidents in cricket, the ICC only recommends helmets, but the implementation of mandatory helmet wearing remains with the governing bodies of each cricketing nation [10]. Discrepancies in rules regarding the use of helmets may result in some participants opting not to wear a helmet and hence putting themselves at the risk of sustaining a head, neck or facial (HNF) injury. Therefore, a thorough understanding of the use of helmets, especially at the time of sustaining a HNF cricket injury would not only provide useful information to helmet makers, but also to policy makers to make cricket a safe sport for all.

Given the catastrophic nature of HNF injuries and potential for effective preventative measures, a greater understanding of HNF injuries in cricket is important. At present, there are no systematic reviews that clearly presents HNF injuries in cricket. Therefore, this study aimed to (i) describe the incidence of HNF injuries to explore on age, gender and level of play; (ii) identify the most common nature and mechanisms of HNF injuries in cricket; (iii) explore the use of cricket consensus statement injury definitions in reporting HNF injuries; and finally, (iv) determine if helmet use is reported in cricket injury surveillance studies.

Materials and Methods

Search strategy

A preliminary search of the major clinical databases was conducted. The preliminary search identified a large number of irrelevant studies involving cricket insects and cadaveric or in vitro investigations; consequently, the search terms were updated to exclude articles with cadaver or 'in situ' or 'in vitro' or 'insects' in the title and/or abstract. Sport and injury terms were used in the final search strategy. The sports terms consisted of "cricket', "cricketer", 'cricketers", "cricketing" AND injury terms included "injury", "injured", "injure", 'injuring", "injuries", "hurt", "trauma". Five online databases including PubMed (Public Medline), Web of Science, Cochrane, CINAHL (Cumulative Index to Nursing and Allied Health Literature), and SPORTDiscus were systematically searched. These databases were chosen as they are widely used in sport injury prevention studies [12–14] as well as sports injury epidemiological studies [15–17]. Reference lists of the included papers were hand searched for any further papers of importance to ensure that every possible study related to cricket injuries was considered. The articles were managed in EndNote X9 (Clarivate Analytics, 2018). The Population, Intervention/Indicator, Comparator/Control, and Outcome (PICO) concept was used to synthesis the inclusion/exclusion criteria (▶ **Table 1**) [18].

Study selection

Titles and abstracts were screened for eligibility, and full- text articles were retrieved and screened relative to the inclusion/exclusion criteria. A secondary search of the reference lists of included articles, citations and a search of the Google Scholar database was also performed. This was undertaken using backward citation tracking (to manually search the reference list of a journal article), and forward citation tracking (scanning a list of articles that cited a given paper since it was published) [19]. When additional studies that met the inclusion criteria were identified, they were included in the final pool of studies.

Eligibility criteria

The screening process on all articles was completed independently by two authors, DK and MSP. Following title and abstract screening, the full text of all potentially eligible articles was retrieved. Any

▶ **Table 1** Inclusion and exclusion criteria used for the study selection.

	Inclusion criteria	Exclusion criteria
Publication type	Peer-reviewed original research articles only.	Non-peer-reviewed articles, newspapers, opinion pieces, systematic reviews and meta-analysis, editorials, commentaries and letters to the editor, conference proceedings/abstracts, book chapters.
		Grey literature including reports, policy literature, working papers, newsletters, government documents, speeches, white papers.
Language	English language.	Non-English.
Publication date	Inception to 30th November 2020.	Publications post November 2020.
Study design	Multi-centre studies, randomised control trials, cohort studies, case-controlled studies and cross-sectional studies, descriptive studies, case studies/series.	Literature reviews, editorials
Gender and age	All genders of any age.	None
Playing level	Participating in cricket at any level (both training and games).	None
Sport	Injury must be sustained while playing cricket.	Studies including the insect "cricket".

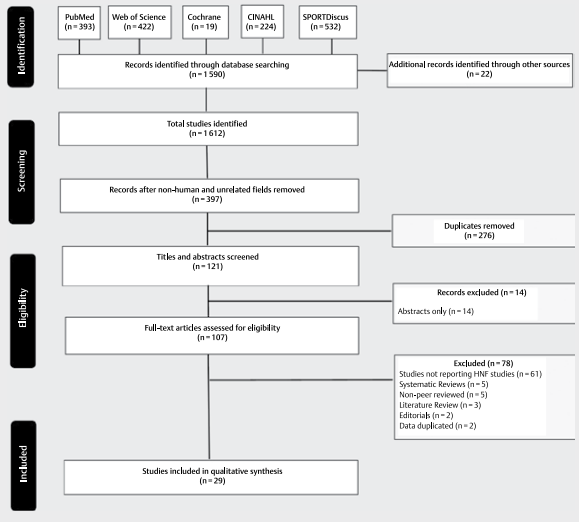
title and abstract screening disputes were resolved through the consensus of all authors, DK, DMT and MSP. Full-text articles of the relevant studies were retrieved and screened to remove the duplicates. All stages of study selection, from the initial search to ascertaining the ultimate set of studies, is presented in ▶ **Fig. 1**.

Data extraction

Data extraction procedures followed best systematic review practice guidelines [20]. One author (DK) extracted data from the eligible articles and Microsoft Excel was used to record data. The extracted data was stored in an electronic database, that included the following information: Background details (author, year of publication and country), study population details (age, sex, type, number), study design and period, injury definition, mechanism of injury, anatomical location and injury incidence and nature. The initial data extraction was reviewed by a second author (MSP) for accuracy.

Critical appraisal

Of the 107 cricket injury full-text studies that were assessed for eligibility 29 studies reporting HNF cricket injuries were appropriate for critical appraisal. Appraisals of the 26 cohort studies were completed as per the Newcastle-Ottawa quality assessment scale for cohort studies [21]. A star rating was allocated to each eligible item by two independent assessors (DMT and DK) according to the quality of each cohort study. A three-point rating scale of "good", "fair", and "poor" was used to specify the quality of each included study as per the thresholds for converting the Newcastle-Ottawa scales to Agency for Healthcare Research and Quality (AHRQ) standards [21]. Cohort studies with five stars or above were rated as good quality. The remaining three case studies were assessed using the critical appraisal tool for case reports [22]. A rating of "1" or "0" was allocated for each item by the same assessors for the case study quality assessment. A three-point rating scale of poor, fair and good was used to rate the three case studies. The studies rated seven points or above were rated "good", five to seven "fair" and below 5 as "poor". Once the independent assessment was completed between the two assessors, discrepancies in rating was discussed and a consensus reached on the final rating. The quality ratings for each study are presented in ▶ **Table 2** and the complete details of the quality assessment in Supplementary Table 1 and 2.



▶ **Fig. 1** Flow chart illustrating the search and selection process of studies as per Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Results

The screening identified 107 publications related to cricket injuries. Of these, 29 studies met all inclusion criteria and were retained for analysis. The characteristics of the 29 studies are presented in ▶ **Table 2**.

Study characteristics

Nineteen of the 29 studies were prospective studies, nine studies conducted retrospectively, with just one study conducted in a mixed method of three years retrospectively and seven years prospectively [23]. HNF injuries had a cumulative total of 794/5,886 injuries equating to13 % of all injuries. Three studies were excluded during the cumulative calculation as results were reported as per injury incidence rates [5, 7, 23]. A majority of studies (24/29) were undertaken in four cricket playing nations, namely South Africa [4, 24–31], Australia [5, 7, 23, 32–34], United Kingdom [11, 35–38] and New Zealand [39–42]. As little as 11 of the included studies reported definitive age parameters, with eight of those studies reporting on cricketers aged 19 years or younger. Fifteen studies reported on male HNF cricket injuries only, four studies reported injuries in both female and male participants [34, 40, 43, 44] and 10 studies had no clear definition of the gender of the study cohort. More than 50 % of the studies (16/29) included elite level that comprised of international, state or provincial level professional players. Five studies reported on HNF injuries in school cricketers [26, 29, 31, 32, 35] while four reported on community club level participants [33, 42, 44, 45]. Three studies had no clear definition of the level of play [38, 40, 43] and one study reported on all levels of play [41]. Eighteen studies had no clear definition of the match types. Test, one day and T20 match types were clearly defined in only four studies [5, 7, 23, 39]. Three studies reported on test and one day matches only [25, 28, 46], while two other studies reported on one day and T20 [24, 31]. Two separate studies reported injuries in one day cricket only [36, 47].The use of a helmet at the time of sustaining a HNF injury was only reported in three studies [11, 29, 32]. One of the three studies reported 50 % of facial injuries in cricketers were sustained while wearing a helmet with a faceguard [32], while 79 % of the HNF injuries reported in a separate study occurred in batters while not wearing a helmet [29]. A more recent study to report on the helmet use described the occurrence of a substantial amount of HNF injuries among batters despite the use of helmets [11].

Injury definitions, reporting and incidence rates

With the exception of eight studies [4, 28–30, 37, 38, 42, 45], all other studies in this review were published after the first cricket injury surveillance guidelines with injury definitions were introduced in 2005 [2]. Of the 21 studies that are published post 2005, just nine studies used the "international cricket consensus injury defi-

▶ **Table 2** A summary of study characteristics of the 29 HNF cricket injury studies included in this systematic review.

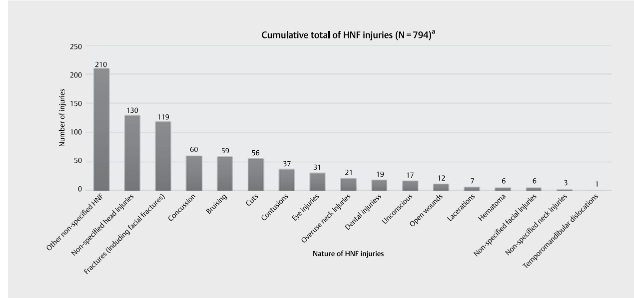
Author Year of publication	Study Type	Cohort details (Number, Gender, Age)	Level of Play	Match type	Country	Injury definition as per consensus statement	HNF injury incidence	Reporting of helmet use	Quality rating
Hill et al. 2019 [34]	Descriptive epidemiological study	N = 555 Male = 351, Female = 204 Age not specified	Elite	Not specified	Australia	Not defined	Total injuries = 37 (100 %) Total HNF injuries = 37 (100 %)	No	Good
Sadiq et al. 2017 [44]	Descriptive case series	N = 20 Male = 19, Female = 1 11–78 years	Community	Not specified	Pakistan	No	Total injuries = 20 (100 %) Total eye injuries = 20 (100 %)	No	Good
Orchard et al. 2016 [5]	Retrospective cohort study	Male Gender and age not specified	Elite	Test, One day and T20	Australia	Yes	Total injury incidence per 1000 days of play = 640.1 HNF injury incidence per 1000 days of play = 19.8	No	Good
Das et al. 2014 [48]	Prospective cohort study	N = 112 Male Under-19 years	Elite	One day	Malaysia	Yes	Total injuries = 24 (100 %) Total HNF injuries = 1 (4 %)	No	Fair
Stretch 2014 [24]	Retrospective cohort study	N = 2080 Male Under-18 and Under-15 years	Elite	One day and T20	South Africa	Yes	Total injuries = 658 (100 %) Total HNF = 12 (1.8 %)	No	Fair
Frost & Chalmers 2014 [39]	Prospective cohort study	N = 248; Male Age not specified	Elite	Test, One day and T20	New Zealand	Yes	Total injuries = 415 (100 %) Total HNF = 11 (2.6 %)	No	Good
Ranson et al. 2013 [11]	Case series	N = 35 Gender and age not specified	Elite	Not specified	United Kingdom	No	Total injuries = 35 (100 %) Total HNF injuries = 35 (100 %)	Yes	Good
Ranson et al. 2013 [36]	Prospective cohort study	N = 76 Gender and age not specified	Elite	One day	United Kingdom	Yes	Total injuries = 97 (100 %) Total HNF = 3 (0.2 %)	No	Fair
Stretch & Trella 2012 [31]	Retrospective cohort study	N = 1292 Male Under-18 and Under-15 years	School	One day and T20	South Africa	No	Total injuries = 425 (100 %)	No	Fair
Stretch & Raffan 2011 [25]	Prospective cohort study	N = 36 Male Age not specified	Elite	Test and One day	South Africa	Yes	Total injuries = 113 (100 %) Total HNF = 8 (7.1 %)	No	Good
Lee 2011 [40]	Retrospective cohort study	N = 561 Male, Female Any age	Not defined	Not specified	New Zealand	Not defined	Total injuries = 561 (100 %) Total HNF = 40 (7.1 %)	No	Fair

▶ **Table 2** Continued.

Author Year of publication	Study Type	Cohort details (Number, Gender, Age)	Level of Play	Match type	Country	Injury definition as per consensus statement	HNF injury incidence	Reporting of helmet use	Quality rating
Ellapen et al. 2010 [26]	Prospective cohort study	N = 234 Male 15–17 years	School	Not specified	South Africa	No	Total injuries = 188 (100 %) Total HNF = 21 (11.2 %)	No	Fair
Walker et al. 2010 [41]	Retrospective cohort study	Number, gender and age not specified	All levels	Not specified	New Zealand	No	Total injuries = 511 (100 %) Total HNF = 114 (22.3 %) Total injuries = 47 (100 %) Total HNF = 6 (13 %)	No	Fair
Finch et al. 2009 [32]	Prospective cohort study	N = 411 Male Under-16 and Under-12	School	Not specified	Australia	No		Yes	Good
Orchard et al. 2010 [7]	Retrospective cohort study	Number, gender and age not specified	Elite	Test, One day and T20	Australia	Not defined	Total injury incidence = 190.8[a] HNF injury incidence = 5.2[a]	No	Good
Jagger et al. 2009 [35]	Prospective cohort study	N = 411 Male 16–18 years	School	Not specified	United Kingdom	Not defined	Total injuries = 269(100 %) Total HNF injuries = 269(100 %)	No	Poor
Shaw & Finch 2008 [33]	Prospective cohort study	Number and gender not specified Under-8 to Under-16	Community	Not specified	Australia	Not defined	Total injuries = 155 (100 %) Total HNF = 42 (27 %)	No	Good
Wani et al. 2008[43]	Prospective cohort study	Number not specified Male, Female <18 years	Not defined	Not specified	India	Not defined	Total HNF injuries = 21(100 %) Total HNF injuries = 21(100 %)	No	Fair
Milson et al. 2007 [27]	Retrospective cohort study	N = 196 Gender and age not specified	Elite	Not specified	South Africa	Yes	Total injuries = 67 (100 %) No HNF injuries	No	Fair
Orchard et al. 2006 [23]	Retrospective/ prospective cohort study	Male Number and age not specified	Elite	Test, One day and T20	Australia	Yes	Total injury incidence = 162.8[a] HNF injury incidence = 4.8[a]	No	Good
Mansingh et al. 2006 [46]	Prospective cohort study	Male Number and age not specified	Elite	Test and One day	West indies	Yes	Total injuries = 67 (100 %) Total HNF injuries = 6 (9 %)	No	Good
Stretch 2003 [4]	Prospective cohort study	N = 436 Gender and age not specified	Elite	Not specified	South Africa	No	Total injuries = 812 (100 %) Total HNF injuries = 33 (1.4 %)	No	Good
Stretch 2001 [28]	Prospective cohort study	N = 88 Gender and age not specified	Elite	Test and One day	South Africa	No	Total injuries = 163(100 %) Total HNF injuries = 7 (4.3 %)	No	Good
Upadhyay 2000 [42]	Retrospective cohort study	Number, gender and age not specified	Community	Not specified	New Zealand	Not defined	Total injuries = 60 (100 %) Total HNF injuries = 16 (26.7 %)	No	Fair

▶ **Table 2** Continued.

Author Year of publication	Study Type	Cohort details (Number, Gender, Age)	Level of Play	Match type	Country	Injury definition as per consensus statement	HNF injury incidence	Reporting of helmet use	Quality rating
Leary & White 2000 [37]	Retrospective cohort study	N = 54	Elite	Not specified	United Kingdom	No	Total injuries = 990(100 %) Total HNF injuries = 56 (5.7 %)	No	Fair
Stretch 1995 [29]	Prospective cohort study	N = 116 Male Age not specified	School	Not specified	South Africa	No	Total injuries = 57(100 %) Total HNF injuries = 11 (19.3 %)	Yes	Fair
Murthy et al. 1994 [45]	Case study	N = 1 Male 46 years	Community	Not specified	India	Not defined	Total injuries = 1 (100 %) Total HNF injuries = 1 (100 %)	No	Fair
Stretch 1993 [30]	Prospective cohort study	N = 183 Male Age not specified	Elite	Not specified	South Africa	No	Total injuries = 88(100 %) Total HNF injuries = 8 (9.1 %)	No	Fair
Jones et al. 1986 [38]	Case Study	N = 5 Male 15–49 years	Not defined	Not specified	United Kingdom	Not defined	Total injuries = 5(100 %) Total HNF injuries = 5 (100 %)	No	Poor



▶ **Fig. 2** Bar graph of HNF injury types (a Only studies that reported number/percentage of HNF cricket injuries as per nature of injury were included in calculating the cumulative total.).

▶ **Table 3** Summary of mechanism of injury reported.

Study	Mechanism of injury
Hill et al. 2019 a[34]	Impact by ball, hit by bat, collision with a player or object
Ranson et al. 2013 [11]	Ball impact to either the helmet faceguard and peak (n = 18, 52 %)
	Ball hitting back of the shell or temple protector (n = 11, 31 %)
	Ball penetrating the gap between the helmet peak and faceguard (n = 4, 11 %)
	Ball hitting Occiput/neck—no helmet contact (n = 2, 6 %)
Lee 2011 b[40]	Impact by ball (55 %)
	Collision with player (5 %)
	Hit by instrument (2.5 %)
Stretch 2003 [4]	Batting for a long period of time (n = 9, 27.3 %)
Murthy et al. 1994 [45]	Ball impact on the chin (n = 1, 100 %)
Jones 1986 [38]	Impact by ball (n = 5, 100 %)

nitions" in their reporting. [5, 23–25, 27, 39, 46–48] Almost all studies (26/29) reported the number of injuries, with three studies reporting injury incidence rates per 10,000 playing hours or per 1,000 player days (▶ **Table 2**) [5, 7, 23].

Body regions nature and mechanism of injury

Eight studies reported all HNF injuries in combination [4, 11, 27–30, 33, 37], and five studies each reported results only under head injuries [24, 31, 34, 43, 47] and facial injuries [32, 38, 40, 44, 45]. A cumulative total of each type of HNF injury is provided in ▶ **Fig. 2**. Non- specified HNF injuries (n = 210, 26 %) were the most prevalent type of injury followed by non-specified head injuries (n = 130, 16 %), other non-specified fractures (n = 119, 15 %) and concussions (n = 60, 8 %). Head injuries including concussions and facial fractures are more common when compared to other types of HNF cricket injuries. There was also a substantial number of superficial soft tissue HNF injuries including cuts, bruises, and lacerations reported.

Six studies reported on the specific mechanism of injury (▶ **Table 3**) [4, 11, 34, 38, 40, 45]. The impact of the ball was reported as the most common mechanism for sustaining HNF injuries in cricket [11, 34, 38, 40, 45], and head hitting the ground while fielding, collision with another fielder and collision or hit by an object were the least common mechanisms [34].

Critical appraisal

The details of the critical appraisal of all studies is presented in Supplementary Table 1 and 2. Thirteen of the included studies were rated as "good" quality, fourteen as "fair" and two as "poor".

Discussion

Given the potential catastrophic nature of HNF injuries in cricket, a strong, evidence-based understanding of those injuries is vital for successful injury risk minimisation and prevention strategies. Cricket has been played for over a century around the world. However, the scientific evidence in this review has mainly come from four countries who have played the game over many years, namely Australia, South Africa, United Kingdom and New Zealand. These four countries share similar sports science and sports medicine support structures that collect routine cricket injury surveillance data [49]. Only five studies in this review are from the eight other countries with ICC test status, with five of those being Asian sub-continent countries where popularity and participation in cricket is very high [50]. Knowledge and understanding of the differences between playing conditions (e. g., type, size of the grounds, materials used for boundary lines), availability of protective equipment (e. g. helmets which comply British Standards), resources and education available for cricket injury prevention will be beneficial to determine whether there are differences in HNF injuries between the countries and hence the need for tailored injury prevention strategies.

Traditionally, cricket injury epidemiological data has been largely limited to elite level, adult, male cricketers [5] and the findings of this review on HNF injuries were similar. However, in the last decade the participation rates among youth at community level cricket and the participation among female cricketers have significantly increased [50]. As per the Cricket Australia census for 2017/18, players aged from 5–12 years constituted 60 %, 13–19 years comprised 19 % and 19 years and above 21 % of the total participation for that cricket season [51]. From the results of this review, authors who clearly defined age parameters commonly included 15–18 year old, male, school level players. When HNF injury incidence rates were compared between the elite and community level studies, it is evident that the reported HNF injury incidence rates were higher at community level. Therefore, it is important for future studies to consider all age groups, especially those from 5–19 years, all levels of play and female cohorts to gain more knowledge and understanding of the similarities and differences in HNF injury epidemiology. It is acknowledged that qualified medical personnel are frequently available only at the elite level and hence, routine injury surveillance at sub-elite level is difficult. Nonetheless, the importance of an evidence base in those large playing populations remains.

Differences in injury definitions and injury incidence reporting can lead to different results and make it difficult to compare across studies. Although the majority of studies included in this review were published following the introduction of the international consensus statement on cricket injury surveillance in 2005 [2], there are discrepancies in using injury definitions, injury incidence and prevalence measures as well as defining the study cohorts. Additionally, 28 % of the studies reported HNF cricket injuries in combination. Injuries sustained to the head, face and neck can be quite different in nature and therefore, reporting them as a combination limits the ability to target prevention strategies. The nature of HNF cricket injuries can range from a simple graze/laceration to serious injuries including head injuries, concussions, fractures. In the reviewed literature, fractures and concussions were the most common types of HNF injuries, while a greater proportion of reported HNF injuries were non-specified. The Orchard Sports Injury Classification System (OSCIS-10) has been used in cricket epidemiological research to report the specific nature of injury at elite level but seldom in sub-elite level cricket [52]. The recently revised Orchard Sports Injury and Illness Classification System (OSIICS version 13.4) provides injury reporting codes for the head, including face (n = 96) and neck (n = 40), that describes the diagnosis (concussion, fractured tooth, Whiplash/neck sprain), tissue type (nervous system, bone, ligament/joint capsule) and pathology (nerve injury, fracture, ligament) [53]. Use of this coding system in future will enable researchers to accurately classify HNF cricket injury diagnoses, maintain diagnostic details, permit simple grouping into parent classifications for summarising data and create databases from which particular injuries can be extracted for research as well as surveillance purposes.

Impact of an object and collision have been reported as the two main mechanisms of sustaining acute injuries in cricket [54]. As per the findings of this review, the direct impact of the cricket ball is reported as the typical mechanism for sustaining serious HNF injuries. While collision with a player or an object are less frequently reported in literature as mechanisms of sustaining HNF injuries, these together with helmet features and the compliance of players with the use of helmets needs to be explored in the future. A recent systematic review on medical-attention injuries in community cricket suggested that inappropriate fitting of helmets and strict rules not being implemented on the use of helmets, particularly during training sessions, could be contributing to the existence of HNF cricket injuries [55]. Previous literature reported that batters found to have altered the grille of the helmet due to hindrance of sighting the ball and listed it as the reason for the adjustment [9]. The increased gap between the helmet peak and faceguard resulted in a greater risk of sustaining a HNF injury as a result of the ball passing through the gap [9]. Other previously reported helmet deficiencies included insufficient protection to the neck and back of the head or the lack of strength in the grill leading to deformation and compression upon impact were highlighted following Phillip Hughes' death [9]. Since this tragic incident, the manufacturers have conducted extensive testing and improved helmet designs as per the British standards (BS7928:2013), that were recommended by the ICC with effect from the 1st of January 2017 [10]. These recommendations include a fixed grille and neck protectors, aiming to prevent catastrophic HNF cricket injuries.

In the last decade, global T20 tournaments have increased which has resulted in batters generating high bat speeds, bowlers exerting more pace and bounce, fielders putting extra effort on the field [49]. This increase in short format tournaments has resulted in 50–100 % more increased physical demands in T20 cricket compared to test matches [49]. However, HNF injury results specific to match types were evident in only the two studies that reported on one day matches only [36, 47]. It will be useful to differentiate HNF injury profiles between different match types to inform targeted in-

jury prevention measures for each playing format. Additionally, it is critical to look at the use of helmets at the time of sustaining a HNF injury. Just three studies included in this review reported on the use of helmets at the time of sustaining a HNF cricket injury [11, 29, 32]. All three studies were conducted prior to the ICC introducing British standards (BS7928:2013 + A1:2019) for helmet safety. Findings of these three studies indicate that irrespective of the use of helmets a considerable amount of HNF injuries would occur, especially in batters [11, 29, 32]. Prior to helmet design modifications in 2013, many facial injuries have occurred despite wearing a helmet with a faceguard [32]. The most recent study to report on helmet use at the time of sustaining an injury recommended further improvements in helmet design and safety standards to minimise HNF cricket injuries [11]. However, a recent Australian study on traumatic cricket-related fatalities in Australia [8] reported a huge reduction in fatalities due to head injuries in cricket after the introduction of helmets in 1980s at higher levels of club cricket as well as at junior cricket. Similarly, another study conducted among a junior cricket cohort within Australia reported a reduction of HNF injuries to batters from 62 % in 2002/03 to just 4 % in 2003/04 once helmet use was made compulsory by the Sutherland Shire, NSW [33]. From the 2019/20 season onwards, Cricket Australia has made it mandatory that all community cricketers wear BS7928:2013 + A1:2019 compliant helmets at all times when batting, wicket keeping up to the stumps and fielding in close [56]. As highlighted by Tripathi et al. in 2016 [9], it is important not only to make strict rules to minimise HNF cricket injuries by making helmet wear mandatory but also to make those high quality, improved helmets readily available at an affordable cost to participants at every level. Increased reporting of the extent and use of helmets and the helmet details at all levels will provide invaluable information for future design and prevention strategies.

Limitations of the study

This review included any cricket epidemiological study that reported HNF injuries either exclusively or within a broad spectrum of cricket injuries. It is still possible that there were data from other studies reporting on all sport injuries including sport injury hospitalisation that could have reported on HNF cricket injuries within a subgroup analysis. These types of studies were not considered for this review but could have provided additional insights.

Conclusions

This paper presents a comprehensive review of the current body of literature reporting on HNF cricket injuries. A considerable number of studies reported HNF injuries only in elite, male cricketers. There were a substantial number of non-specified injuries but facial fractures, and concussions were the most specified injury types. Being hit by the ball was the most commonly reported injury mechanism. There is little evidence on reporting of HNF cricket injuries as per the international cricket consensus injury definitions, as well as the use of helmets at the time of injury. Reporting of helmet use at the time of injury requires further investigation to guide education on the benefits of helmets use or inform design modifications if barriers to use are identified.

This review has also identified the lack of evidence on HNF injuries across ages, levels of play and different populations, discrepancies in injury definitions, injury specific mechanisms. Therefore, future investigations targeting cohorts of all ages, gender and levels of play would provide valuable information for the implementation of effective injury prevention strategies. Finally, a benefit of future studies reporting on the incidence, type and nature of HNF cricket injuries as per consensus statement and OSIICS injury classification will enable valuable comparisons across studies.

Acknowledgements

DK was supported by Federation University Australia via its Postgraduate Research Priority Area (RPA) scholarship scheme.

Conflict of Interest

This systematic review was conducted in accordance with ethical standards of the International Journal of Sports Medicine [57]. The authors declare that they have no conflict of interest.

References

[1] Finch C. A new framework for research leading to sports injury prevention. J Sci Med Sport 2006; 9: 3–9

[2] Orchard J, Newman D, Stretch R et al. Methods for injury surveillance in international cricket. J Sci Med Sport 2005; 8: 1–14

[3] Pardiwala DN, Rao NN, Varshney AV. Injuries in cricket. Sports Health 2018; 10: 217–222

[4] Stretch R. Cricket injuries: a longitudinal study of the nature of injuries to South African cricketers. Br J Sports Med 2003; 37: 250–253

[5] Orchard JW, Kountouris A, Sims K. Incidence and prevalence of elite male cricket injuries using updated consensus definitions. Open Access J Sports Med 2016; 7: 187–194

[6] Perera NKP, Kountouris A, Kemp JL et al. The incidence, prevalence, nature, severity and mechanisms of injury in elite female cricketers: A prospective cohort study. J Sci Med Sport 2019; 22: 1014–1020

[7] Orchard J, James T, Kountouris A et al. Changes to injury profile (and recommended cricket injury definitions) based on the increased frequency of Twenty20 cricket matches. Open Access J Sports Med 2010; 1: 63–76

[8] Brukner P, Gara TJ, Fortington LV. Traumatic cricket-related fatalities in Australia: a historical review of media reports. Med J Aust 2018; 208: 261–264

[9] Tripathi M, Shukla DP, Bhat DI et al. Craniofacial injuries in professional cricket: no more a red herring. Neurosurg Focus 2016; 40: E11

[10] International Cricket Council, ICC Introduces New Helmet Regulations 2017 (15 January 2017). On the internet: https://www.icc-cricket.com/news/311699 status: date of online access 21 June 2021

[11] Ranson C, Peirce N, Young M. Batting head injury in professional cricket: a systematic video analysis of helmet safety characteristics. Br J Sports Med 2013; 47: 644–648

[12] Schneider KJ, Leddy JJ, Guskiewicz KM et al. Rest and treatment/rehabilitation following sport-related concussion: a systematic review. Br J Sports Med 2017; 51: 930–934

[13] Moran RW, Schneiders AG, Mason J et al. Do Functional Movement Screen (FMS) composite scores predict subsequent injury? A systematic review with meta-analysis. Br J Sports Med 2017; 51: 1661–1669

[14] Lai CC, Ardern CL, Feller JA et al. Eighty-three per cent of elite athletes return to preinjury sport after anterior cruciate ligament reconstruction: a systematic review with meta-analysis of return to sport rates, graft rupture rates and performance outcomes. Br J Sports Med 2018; 52: 128–138

[15] Bromley SJ, Drew MK, Talpey S et al. A systematic review of prospective epidemiological research into injury and illness in Olympic combat sport. Br J Sports Med 2018; 52: 8–16

[16] Doherty C, Delahunt E, Caulfield B et al. The incidence and prevalence of ankle sprain injury: a systematic review and meta-analysis of prospective epidemiological studies. Sports Med 2014; 44: 123–140

[17] Waldén M, Hägglund M, Ekstrand J. The epidemiology of groin injury in senior football: a systematic review of prospective studies. Br J Sports Med 2015; 49: 792–797

[18] Higgins JP, Thomas J, Chandler J et al. Cochrane Handbook for Systematic Reviews of Interventions. 2021; On the internet https://training.cochrane.org/handbook/current status: date of online access 21 June 2021

[19] Shields N. Everything you want to know about systematic reviews but were afraid to ask. In: Liamputtong P (Ed). Research Methods in Health: Foundations for Evidence-Based Practice. South Melbourne, Vic: Oxford University Press; 2010: 301–314

[20] Furlan AD, Pennick V, Bombardier C et al. 2009 updated method guidelines for systematic reviews in the Cochrane Back Review Group. Spine (Phila Pa 1976) 2009; 34: 1929–1941

[21] Wells G, Shea B, O'Connell D et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. http://www.ohri.ca 2014; 17–18

[22] Roever L, Ocke, Reis P. Critical appraisal of a case report. Evidence Based Medicine and Practice 2015; 1: 1

[23] Orchard JW, James T, Portus MR. Injuries to elite male cricketers in Australia over a 10-year period. J Sci Med Sport 2006; 9: 459–467

[24] Stretch R. Junior cricketers are not a smaller version of adult cricketers: A 5-year investigation of injuries in elite junior cricketers. S Afr J Sports Med 2014; 26: 123–127

[25] Stretch RA, Raffan RP. Injury patterns of South African international cricket players over a two-season period. S Afr J Sports Med 2011; 23: 45–49

[26] Ellapen TJ, Essack F, Noorbhai H et al. The cost of school boy cricket in Kwa Zulu Natal, South Africa. The Shield-Research Journal of Physical Education & Sports Science 2010; 7: 37–49

[27] Milson N, Barnard JG, Stretch RA. Seasonal incidence and nature of cricket injuries among elite South African schoolboy cricketers. S Afr J Sports Med 2007; 19: 80–84

[28] Stretch R. Incidence and nature of epidemiological injuries to elite South African cricket players. S Afr Med J 2001; 91: 336–339

[29] Stretch RA. The seasonal incidence and nature of injuries in schoolboy cricketers. S Afr Med J 1995; 85: 1182–1184

[30] Stretch R. The incidence and nature of injuries in first-league and provincial cricketers. S Afr Med J 1993; 83: p 339–342

[31] Trella C. A 3-year investigation into the incidence and nature of cricket injuries in elite South African schoolboy cricketers. S Afr J Sports Med 2012; 24: 10–14

[32] Finch CF, White P, Dennis R et al. Fielders and batters are injured too: a prospective cohort study of injuries in junior club cricket. J Sci Med Sport 2010; 13: 489–495

[33] Shaw L, Finch CF. Injuries to junior club cricketers: the effect of helmet regulations. Br J Sports Med 2008; 42: 437–440

[34] Hill T, Orchard J, Kountouris A. Incidence of concussion and head impacts in Australian elite-level male and female cricketers after head impact protocol modifications. Sports Health 2019; 11: 180–185

[35] Jagger RG, Vaithianathan V, Jagger DC. A pilot study of the prevalence of orofacial and head injuries in schoolboy cricketers at eight private schools in England and Australia. Prim Dent Care 2009; 16: 99–102

[36] Ranson C, Hurley R, Rugless L et al. International cricket injury surveillance: a report of five teams competing in the ICC Cricket World Cup 2011. Br J Sports Med 2013; 47: 637–643

[37] Leary T, White JA. Acute injury incidence in professional county club cricket players (1985–1995). Br J Sports Med 2000; 34: 145–147

[38] Jones N, Tullo A. Severe eye injuries in cricket. Br J Sports Med 1986; 20: 178–179

[39] Frost WL, Chalmers DJ. Injury in elite New Zealand cricketers 2002–2008: descriptive epidemiology. Br J Sports Med 2014; 48: 1002–1007

[40] Lee K. Cricket related maxillofacial fractures. J Maxillofac Oral Surg 2012; 11: 182–185

[41] Walker H, Carr DJ, Chalmers D et al. Injury to recreational and professional cricket players: Circumstances, type and potential for intervention. Accid Anal Prev 2010; 42: 2094–2098

[42] Upadhyay V, Tan A. Cricketing injuries in children: from the trivial to the severe. N Z Med J 2000; 113: 81–83

[43] Wani AA, Ramzan AU, Tariq R et al. Head injury in children due to cricket ball scenario in developing countries. Pediatr Neurosurg 2008; 44: 204–207

[44] Sadiq SN, Ali A, Usmani B et al. Bowled over by cricket: impact of tape-ball injuries on the eyes. Asia Pac J Ophthalmol (Phila) 2017; 6: 50–53

[45] Murthy P, Bandasson C, Dhillon R. Temporomandibular joint dislocation and deafness from a cricket ball injury. J Laryngol Otol 1994; 108: 415–416

[46] Mansingh A, Harper L, Headley S et al Injuries in West Indies cricket 2003–2004. Br J Sports Med 2006; 40: 119–123

[47] Das NS, Usman J, Choudhury D et al. Nature and pattern of cricket injuries: the Asian Cricket Council under-19, Elite Cup, 2013. PLoS One 2014; 9: e100028

[48] Ranson C, Young M. Putting a lid on it: prevention of batting helmet related injuries in cricket. Br J Sports Med 2013; 47: 609–610

[49] Soomro N, Strasiotto L, Sawdagar T et al. Cricket injury epidemiology in the twenty-first century: what is the burden? Sports Med 2018; 48: 2301–2316

[50] Bullock GS, Panagodage-Perera NK, Murray A et al. Relationship between cricket participation, health and well-being: scoping review protocol. BMJ Open 2019; 9: e032070

[51] Cricket Australia. National Cricket Census 2017-18 2018 (6 September 2018). On the internet: https://www.cricket.com.au/news/cricket-australia-national-cricket-census-participation-ceo-james-sutherland/2018-09-06 status: date of online access 21 June 2021

[52] Rae K, Orchard J. The orchard sports injury classification system (OSICS) version 10. Clin J Sport Med 2007; 17: 201–204

[53] Orchard JW, Meeuwisse W, Derman W et al. Sport medicine diagnostic coding system (SMDCS) and the orchard sports injury and illness classification system (OSIICS): revised 2020 consensus versions. Br J Sports Med 2020; 54: 397–401

[54] Finch CF, Elliott BC, McGrath AC. Measures to prevent cricket injuries. Sports Med 1999; 28: 263–272

[55] McLeod G, O'Connor S, Morgan D et al. Medical-attention injuries in community cricket: a systematic review. BMJ Open Sport Exerc Med 2020; 6: e000670

[56] Cricket Australia. Australian Cricket Concussion & Head Trauma Policy (23 May 2019). On the internet: https://www.cricketaustralia.com.au/cricket/rules-and-regulations status: date of online access 21 June 2021

[57] Harriss D, MacSween A, Atkinson G. Ethical standards in sport and exercise science research: 2020 update. IntJ Sports Med 2019; 40: 813–817