

Ankle, knee and concussion concerns: Unveiling injury patterns in highly trained South African netball players

Eirik Halvorsen Wik^{a,b,*}, Nicola Sewry^{c,d}, Wayne Derman^{a,c}, Martin Schwellnus^{c,d},
Maaïke Eken^a

^a Institute of Sport and Exercise Medicine (ISEM), Department of Exercise, Sport and Lifestyle Medicine, Faculty of Medicine and Health Sciences, Stellenbosch University, P.O.Box 19063, Tygerberg, 7505, South Africa

^b Division of Physiotherapy, Department of Health and Rehabilitation Sciences, Faculty of Medicine and Health Sciences, Stellenbosch University, PO Box 241, Cape Town, 8000, South Africa

^c Sport, Exercise Medicine & Lifestyle Institute (SEMLI), Faculty of Health Sciences, University of Pretoria, Burnett Street, Hillcrest Campus, University of Pretoria, Hatfield, Pretoria, South Africa

^d International Olympic Committee (IOC) Research Centre, South Africa

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ABSTRACT

Objectives: To describe the rate and type of netball injuries sustained during women's university-level tournament matches in South Africa.

Design: Descriptive epidemiological study.

Setting: Three editions of the women's Varsity Netball tournament (2021–23).

Participants: Student-athletes representing nine university women's teams.

Main outcome measures: Medical attention match injuries prospectively recorded by team medical staff. Injuries were classified according to the 2020 consensus statement, with the addition of "concussion" as a separate pathology type. The main outcomes are reported as incidence (injuries per 1000h; 95% confidence intervals - CIs), burden (days lost per 1000h; 95% CIs), and frequency (% of all injuries).

Results: Sixty-three injuries were recorded from 48 different players (58.8 per 1000h; 45.2–75.3) and the overall injury burden was 401 days per 1000h (364–440). Injury incidence by pathology type was highest for joint sprains (28.9 per 1000h), tendinopathies (7.5 per 1000h), and concussions (4.7 per 1000h). Joint sprains to the ankle accounted for 49% of the overall estimated days lost.

Conclusions: Ankle joint sprains should be the primary target of injury risk reduction programmes in highly trained netball players. Concussions were reported and efforts should be made to increase awareness among players, coaches and medical staff.

1. Introduction

Netball is a sport played by more than 20 million participants worldwide, ([World Netball](#)) although traditionally more popular in Commonwealth countries and predominantly played by women. In South Africa, netball is one of the most widely played sports and features among the top five sports in terms of participation rates at the university level ([Burnett, 2010](#)). While injuries are considered common in the sport in general, data on high-level players in South Africa from prospective studies applying consensus-recommended methodology are limited ([Downs et al., 2021](#)). This information is important, as we first need to

understand how often injuries happen – and how severe they are – if we are to introduce initiatives that can be effective in reducing their impact on players in the future ([van Mechelen et al., 1992](#)). More specific and standardised epidemiological data would therefore assist in guiding key stakeholders towards the most common and burdensome injuries in their own setting when developing and implementing context-appropriate injury risk reduction measures ([Finch, 2006](#)).

The overall injury incidence reported from prospective studies in netball has ranged from 5.9 to 500.7 injuries per 1000 match and/or training hours, ([Finch et al., 2002](#); [Hume & Steele, 2000](#); [Janse van et al., 2022](#); [Langeveld et al., 2012](#); [McManus et al., 2006](#); [Pringle et al.,](#)

* Corresponding author. Institute of Sport and Exercise Medicine (ISEM), Department of Exercise, Sport and Lifestyle Medicine, Faculty of Medicine and Health Sciences, Stellenbosch University, P.O.Box 19063, Tygerberg, 7505, South Africa.

E-mail address: ewik@sun.ac.za (E.H. Wik).

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1998; Sinclair et al., 2020; Smyth et al., 2020; Smyth et al., 2022; Stevenson et al., 2000; Zulkarnain & Khairullina, 2019) with the large discrepancy between studies likely attributable to differences in design (e.g., tournament vs. seasonal surveillance), recording setting (match vs. training), injury definition (e.g., time loss, medical attention) and playing level (e.g., community level, national level, mixed) (Downs et al., 2021). In South Africa, varying findings have been described in terms of injury incidence, with one study reporting 500.7 training and match injuries per 1000 h (Langeveld et al., 2012) and another recording 33.9 match injuries per 1000 h, (Sinclair et al., 2020) highlighting the need for further examinations. Although methods for classifying and reporting injury locations and types have been inconsistent, lower extremity injuries – to the ankle and knee joints in particular – and joint sprains are reported as the most common both within South Africa (Ferreira & Spamer, 2010; Langeveld et al., 2012; Sinclair et al., 2020) and in studies from other countries (Downs et al., 2021; Whitehead et al., 2021).

Limited data relevant to highly trained netball players are available to guide injury risk reduction measures. Our primary aim was therefore to describe the incidence and nature of injuries at a national university-level women's tournament over three years.

2. Materials and methods

This study was conducted during the 2021, 2022 and 2023 editions of the women's Varsity Netball tournament in South Africa. The tournament is considered one of the most prestigious national tournaments at the university-level, with players best described as “highly trained/national level” (McKay et al., 2022) student-athletes. The injury surveillance programme was endorsed by the tournament organiser (Varsity Sports) and all participating teams were invited to take part. Players were informed about the study through their team manager and medical staff, and could decide not to participate. Only injury details from players who provided informed consent were included in this epidemiological study, for which ethical approval was granted by the University of Pretoria Faculty of Health Sciences Research Ethics Committee (reference number: 154/2021) and Stellenbosch University Health Research Ethics Committee (reference number: N21/03/007_COVID-19). The STROBE-SIIS checklist was used in preparation of the manuscript (Bahr et al., 2020).

Eight teams participated in a given tournament year, playing seven matches in the group stage (one match against each team) followed by a knock-out phase based on teams' ranking on the tournament log. The 2021 edition of the tournament was held during a phase of the COVID-19 pandemic with strict national safety restrictions in place. Matches were therefore played in one location, with players accommodated in a nearby hotel to minimise interactions with members of the public and reduce the risk of viral transmission (i.e., a “tournament bubble”). Matches were played over a ten-day period from 21st through 30th August, with all teams playing nine matches, including two playoff matches for placements (i.e., 7th place, 5th place, 3rd place, final). The subsequent editions were played over five-week periods (17th September through October 17, 2022 and 20th August through September 18, 2023), with 2–3 tournament matches played on consecutive days, followed by 4–5 days without matches. Each match week was hosted by a different university and only the four top-ranked teams proceeded to the knock-out phase. Semi-finals were played one week after the last group stage match and the final was held one week later.

Prior to the tournament, each team's designated medical staff member (physiotherapist or rehabilitation specialist) was invited by the research team to take part in the Varsity Netball Injury Surveillance Programme and asked to attend an open in-person/online information session about the programme. Additionally, a step-by-step handbook was distributed to clarify definitions, terminology and data collection procedures. Injuries were collected electronically, following a “medical attention” definition guided by the International Olympic Committee

(IOC) consensus statement on injury recording in sports (Bahr et al., 2020). An online detailed data collection tool (Questback, Norway) was used in 2021 and 2022, while REDCap (Vanderbilt University, USA) software was used in 2023, applying the same methodology in both systems. Medical staff were contacted regularly throughout the tournament by one of the researchers for data quality assurance purposes and to encourage continued reporting. To further incentivise injury reporting, three lucky draws for a small gift voucher were held after each match week in 2022 and 2023, where all teams with complete injury records were eligible. Lucky draws were not held for the 2021 edition due to the short tournament period.

For each reported injury, medical staff included details regarding the circumstances (injury date, activity type, phase of the match, playing position and starter vs. replacement), recurrence (new, recurrent or subsequent injury), type of onset (acute-sudden onset, repetitive-sudden onset or repetitive-gradual onset), mechanism (facet of play, specific mechanism), severity (discontinuation of play, estimated time loss), and the injury itself (body part, injury type and diagnosis code according to the Orchard Sports Injury Classification System (OSICS) version 10 (Rae & Orchard, 2007)). Definitions and examples were available to the staff in the electronic data entry sheet and followed consensus-recommended categories (Bahr et al., 2020). Specifically, recorders were asked to record a “new injury” when it had never been reported before, a “recurrent injury” when a previous injury had first been resolved and symptoms now returned in the same area and structure, and a “subsequent injury” when a previous injury had first been resolved and symptoms now returned in the same area but to different structures (i.e., it could be related to the first injury) (Bahr et al., 2020). “Acute-sudden onset” referred to an injury caused by an acute precipitating event, “repetitive-sudden onset” to an injury attributed to a specific event but caused by a repetitive mechanisms (e.g., gradual accumulation of load), and “repetitive-gradual onset” as an injury that developed over time with no specific precipitating event (Bahr et al., 2020). Where multiple injuries were reported from the same incident, only the most severe injury – as per the recording medical staff member's opinion – was included in the analysis. Unclear entries were followed up with the medical staff member after each tournament by a member of the research team. Injury types and body parts were converted to the 2020 IOC consensus categories (Bahr et al., 2020) after the observation period, with “Concussion” added as a separate pathology type as more detail on types of head injuries has been called for in netball research (Downs et al., 2021; Whitehead et al., 2021).

As tournament formats differed across the three years, only match injuries were considered for analyses. Detailed individual match minutes were not available and exposure was therefore estimated, based on the matches covered by participating medical staff (i.e., only exposure from matches where injuries could be recorded). The sum of match hours was calculated under the assumption that seven players were on the court at all times and that each match lasted 60 min (4×15 min). Counts and frequencies are used to describe distributions within injury categories, while injury incidence is presented as the number of match injuries (including recurrent and subsequent injuries) per 1000 match hours with 95% confidence intervals (CIs), assuming a Poisson distribution. Injury burden was similarly calculated as the sum of days lost from all injuries combined per 1000 match hours with 95% CIs. Significant differences between categories were assumed if confidence intervals did not overlap and incidence rate ratios (IRR) with 95% CI were calculated using Stata (StataBE v17.0; StataCorp, College Station, TX, USA).

3. Results

Over the three editions of the tournament, medical staff from nine different university teams agreed to take part in the study, with 20 of a possible 24 team tournament appearances included in the study (five teams took part in all three editions, one team took part in two editions

and three teams took part in one edition). The participating team medical staff covered 153 of the 196 team-matches (i.e., one match for one team), equating to a tournament coverage of 78% and an estimated 1071 player match hours (2021: 413 h, 2022: 287 h, 2023: 371 h). Two players declined to have their injury details used for research and were therefore excluded from the study.

Sixty-three medical attention injuries (2021: 23 injuries, 2022: 20 injuries, 2023: 20 injuries) were reported from 48 different players. This resulted in an overall incidence of 58.8 match injuries per 1000h (95% CI: 45.2 to 75.3), with no differences between the three tournament editions (2021: 55.7 per 1000h, 95% CI: 35.3 to 83.6; 2022: 69.7 per 1000h, 95% CI: 42.6 to 107.6; 2023: 53.9 per 1000h, 95% CI: 32.9 to 83.3). The majority of injuries were classified by medical staff as new injuries (35.5 per 1000h, 95% CI: 25.1 to 48.7; 60% of all injuries), followed by recurrent injuries (21.5 per 1000h, 95% CI: 13.6 to 32.2; 37%) and subsequent injuries (1.9 per 1000h, 95% CI: 0.2 to 6.7; 3%). There was a similar incidence of time-loss (≥ 1 day) (27.1 per 1000h, 95% CI: 18.1 to 38.9) and non-time-loss injuries (31.7 per 1000h, 95% CI: 22.0 to 44.4), accounting for 46% and 54% of the recorded injuries, respectively. The majority of injuries (56%) led to the player being removed from the match (27% “forced discontinuation”, 22% “precautionary discontinuation”, 6% “discontinued due to blood”). The mean estimated injury severity was 6.8 days, with an overall match injury burden of 401 days per 1000h (95% CI: 364 to 440). Considering time-loss injuries only, 10% were classified as “Slight” (1 day lost), 28% as “Minimal” (2–3 days lost), 21% as “Mild” (4–7 days lost), 28% as “Moderate” (8–28 days lost) and 14% as “Severe” (≥ 29 days lost).

An overview of injuries by playing position, match quarter, mode of onset and injury mechanism is presented in Table 1. Goal keepers sustained the fewest number of injuries, although this was not considered a significant finding due to broad confidence intervals for position-specific estimates of incidence. Compared to the 1st quarter, injuries occurred more frequently in the 2nd (IRR: 8.0, 95% CI: 2.4 to 41.5) and 3rd (IRR:

Table 1

Match injury circumstances (playing position, match quarter, mode of onset and injury mechanism) in South African university netball players, as reported by team medical staff applying a medical attention definition (n = 63 injuries; 1071 match hours).

	Injury count (%)	Injuries per 1000h (95% CI)
Playing position		
Goal Keeper	3 (4.8%)	19.6 (4.0–57.3)
Goal Defence	12 (19.0%)	78.4 (40.5–137.0)
Wing Defence	8 (12.7%)	52.3 (22.6–103.0)
Centre	12 (19.0%)	78.4 (40.5–137.0)
Wing Attack	10 (15.9%)	65.4 (31.3–120.2)
Goal Attack	8 (12.7%)	52.3 (22.6–103.0)
Goal Shooter	10 (15.9%)	65.4 (31.3–120.2)
Match quarter		
1st Quarter	3 (4.8%)	11.2 (2.3–32.7)
2nd Quarter	24 (38.1%)	89.6 (57.4–133.4)
3rd Quarter	25 (39.7%)	93.4 (60.4–137.8)
4th Quarter	11 (17.5%)	41.1 (20.5–73.5)
Mode of onset		
Acute - Sudden onset	44 (69.8%)	41.1 (29.9–55.2)
Repetitive – Sudden onset	14 (22.2%)	13.1 (7.1–21.9)
Repetitive – Gradual onset	5 (7.9%)	4.7 (1.5–10.9)
Injury mechanism		
Landing	17 (27.0%)	15.9 (9.2–25.4)
Contact	13 (20.6%)	12.1 (6.5–20.8)
Twisted	8 (12.7%)	7.5 (3.2–14.7)
Other	6 (9.5%)	5.6 (2.1–12.2)
Deceleration	4 (6.3%)	3.7 (1.0–9.6)
Change of direction/Sidestep	3 (4.8%)	2.8 (0.6–8.2)
Passing/Throwing	3 (4.8%)	2.8 (0.6–8.2)
Slipped	3 (4.8%)	2.8 (0.6–8.2)
Acceleration	2 (3.2%)	1.9 (0.2–6.7)
Diving/Falling	2 (3.2%)	1.9 (0.2–6.7)
Hit by the ball	1 (1.6%)	0.9 (0.0–5.2)
Lunge	1 (1.6%)	0.9 (0.0–5.2)

8.3, 95% CI: 2.5 to 43.1) quarters of the match. Most injuries were the result of non-contact mechanisms (73%), with a greater incidence of acute-sudden onset injuries compared to repetitive-sudden onset (IRR: 3.1, 95% CI: 1.7 to 6.2) and repetitive-gradual onset injuries (IRR: 8.8, 95% CI: 3.5 to 28.4).

An overview of injuries by body region is shown in Table 2. The majority of injuries were to the lower limb, accounting for two-thirds of all injuries. The most commonly injured body parts were the ankle (28.9 per 1000h, 95% CI: 19.7 to 41.1; 49% of all injuries), knee (7.5 per 1000h, 95% CI: 3.2 to 14.7; 13%) and head (6.5 per 1000h, 95% CI: 2.6 to 13.5; 11%), while ligament/joint capsule was the most common tissue type recorded (28.9 per 1000h, 95% CI: 19.7 to 41.1; 49%), followed by muscle/tendon (11.2 per 1000h, 95% CI: 5.8 to 19.6; 19%) and nervous tissue (6.5 per 1000h, 95% CI: 2.6 to 13.5; 11%). The distribution of pathology types by body region is included in Table 2, with joint sprains (28.9 per 1000h, 95% CI: 19.7 to 41.1; 49%), tendinopathies (7.5 per 1000h, 95% CI: 3.2 to 14.7; 13%) and concussions (4.7 per 1000h, 95% CI: 1.5 to 10.9; 8%) as the three most common overall (see Supplementary Table 1 for all body parts, tissue types and pathology types). Specifically, joint sprains to the ankle accounted for 38% of all recorded injuries (22.4 per 1000h, 95% CI: 14.4 to 33.3).

The most burdensome injuries, grouped by body part and tissue type are presented in Fig. 1 (see Supplementary Table 1 for all body parts, tissue types and pathology types). Based on the estimated days lost per body part, ankle injuries were the most burdensome (206 days lost per 1000h, 95% CI: 180 to 235; 52% of all days lost), followed by the knee (122 days per 1000h, 95% CI: 102 to 145; 31%), while ligament/joint capsule (200 days per 1000h, 95% CI: 174 to 228; 50%) and cartilage/synovium/bursa (123 days per 1000h, 95% CI: 103 to 146; 31%) were the most burdensome injuries based on tissue type. The burden of concussions was 34 days lost per 1000h (95% CI: 24 to 47; 8%), making it the third-most burdensome pathology type. Joint sprain to the ankle was the single most burdensome specific injury type (i.e., combination of body part and pathology type), accounting for 49% of days lost (197 days per 1000h, 95% CI: 171 to 225), followed by cartilage injuries to the knee (120 days per 1000h, 95% CI: 100 to 142; 30%).

Table 2

Distribution of match injuries recorded by team medical staff during three editions of a South African university netball tournament, applying a medical attention definition (n = 63 injuries; 1071 match hours).

Body region Pathology type	Injury count (%) of all injuries	Injuries per 1000h (95% CI)
Head and neck		
Concussion	7 (11.1%)	6.5 (2.6–13.5)
Fracture	5 (7.9%)	4.7 (1.5–10.9)
Laceration	1 (1.6%)	0.9 (0.0–5.2)
Upper limb		
Joint sprain	1 (1.6%)	0.9 (0.0–5.2)
Contusion (superficial)	9 (14.3%)	8.4 (3.8–16.0)
Muscle injury	5 (7.9%)	4.7 (1.5–10.9)
Peripheral nerve injury	1 (1.6%)	0.9 (0.0–5.2)
Tendinopathy	1 (1.6%)	0.9 (0.0–5.2)
Trunk		
Bone contusion	3 (4.8%)	2.8 (0.6–8.2)
Muscle injury	1 (1.6%)	0.9 (0.0–5.2)
Peripheral nerve injury	1 (1.6%)	0.9 (0.0–5.2)
Lower limb		
Joint sprain	44 (69.8%)	41.1 (29.9–55.2)
Tendinopathy	26 (41.3%)	24.3 (15.9–35.6)
Cartilage injury	7 (11.1%)	6.5 (2.6–13.5)
Contusion (superficial)	4 (6.3%)	3.7 (1.0–9.6)
Synovitis/capsulitis	2 (3.2%)	1.9 (0.2–6.7)
Bone stress injury	2 (3.2%)	1.9 (0.2–6.7)
Muscle compartment syndrome	1 (1.6%)	0.9 (0.0–5.2)
Muscle injury	1 (1.6%)	0.9 (0.0–5.2)

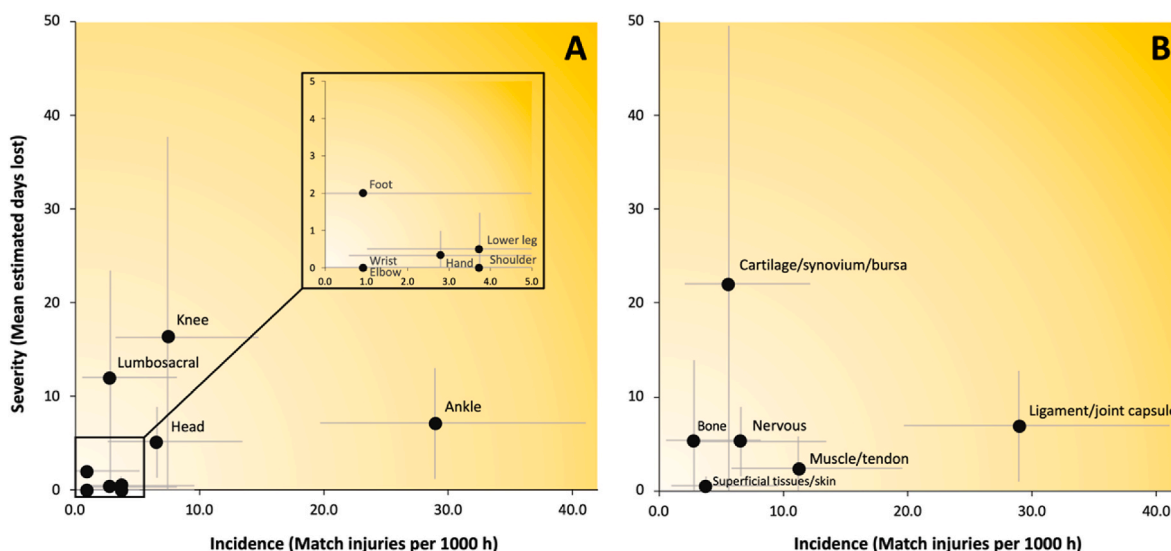


Fig. 1. Risk matrices for body part and tissue type. Injury burden for body part (A) and tissue type (B) during three editions of a South African university netball tournament ($n = 63$ injuries in total; $n = 29$ time-loss injuries). Figures are presented with incidence (match injuries per 1000h with 95% CI) on the X-axis and severity (mean estimated days lost with 95% CI) on the Y-axis.

4. Discussion

This study describes match injuries sustained by high-level netball players participating in a South African university tournament over three years, providing novel insights into injury patterns in an under-researched sporting population. Less than half of the recorded injuries were associated with time loss (≥ 1 day); however, the majority led to the player discontinuing the match. We observed a high frequency of injuries to the lower extremities, with ankle joint sprains accounting for more than a third of all injuries and half of all days lost. The knee was the second most injured body part, with knee cartilage injuries responsible for a third of all days lost. Every tenth injury was to the head, with concussions – the third most burdensome pathology type – emerging as a potential focus area for prevention.

4.1. Match injury incidence in high-level South African players

Our observed match incidence of 58.8 injuries per 1000h implies that teams can expect approximately four match injuries over a nine-match tournament (0.4 injuries per match), with two of these leading to at least one day lost (27.1 time-loss injuries per 1000h; 0.2 per match). With few prospective epidemiological studies conducted in South African netball, it has not been possible to provide a convincing estimate of the extent of injuries within this setting. The incidence reported in our study is higher compared to Sinclair et al. (33.9 per 1000h), (Sinclair et al., 2020) who covered two seasons using a similar injury definition (“medical treatment”), but included a range of age groups from U18 to senior players. On the other hand, our estimate of match incidence was substantially lower than the 500.7 medical attention injuries per 1000h recorded in university and national-level netball players by Langeveld et al. (Langeveld et al., 2012). Differences in calculation of exposure and incidence may explain these discrepancies, highlighting the importance of standardising methods for data collection and analysis to better compare and combine study outcomes.

When comparing our findings to prospective tournament studies from other settings applying a similar methodology, the overall incidence closely matched the 2019 Netball World Cup (54.8 medical attention match injuries per 1000h) (Janse van et al., 2022) but was lower than the Australian Netball National Championships for U17 and U19 players (89.4 and 82.5 injuries per 1000h for the 2018 and 2019 editions, respectively) (Smyth et al., 2020, 2022). The Australian studies

did – in addition to injuries reported by medical staff – include injuries recorded by players themselves using a broader injury definition, likely capturing a larger number of overuse and minor injuries, explaining their higher overall incidence (Clarsen & Bahr, 2014). When only including “sports incapacity” injuries (reduced match duration recorded by medical staff or athlete-reported reduction in participation), their findings (2018: 19.1 per 1000h; 2019: 10.4 per 1000h) did in fact indicate a lower rate of time-loss injuries compared to the present study (27.1 per 1000h). Larger studies covering full seasons are required, both in South Africa and globally, to gain a better understanding of injury patterns throughout a netball season.

The majority of injuries reported in this study did not lead to time loss, which was also the case during the 2019 Netball World Cup (Janse van et al., 2022) and in professional Australian players, (Toohey et al., 2022) where similar injury definitions and medical staff recorders were used. Still, we note that every fifth injury led to medical staff estimating at least one week of absence from netball activities and four injuries were estimated to last at least one month (2 meniscal tears, 1 ankle lateral ligament sprain and 1 ankle syndesmosis sprain). The calculation of injury burden is not widespread in the netball literature, although Toohey et al. reported 156 days of absence due to injury per 365 player days in professional Australian players (Toohey et al., 2022). Using a different denominator, we estimated a total of 401 days lost per 1000 match hours. Future studies should strive to include injury burden as one of their outcomes, as it better represents the impact of injuries compared to proportions and incidence alone, which do not consider the consequence of injuries (e.g., days lost). (Fuller, 2018).

4.2. Ankle and knee injuries remain the primary target for injury risk reduction programmes

A key purpose of epidemiological studies is to highlight the most common and burdensome injuries, which stakeholders, support staff and players can then target in their injury risk reduction programmes. In accordance with findings from systematic and scoping reviews in netball, (Downs et al., 2021; Whitehead et al., 2021) injuries to the lower limb were the most common, with every second injury to the ankle. Joint sprains were the most common pathology type, with joint sprains to the ankle specifically accounting for every fourth injury overall and half of the total estimated days lost. Knee cartilage injuries – although not the most common (5% of the injuries recorded) – were associated

with significant absence from netball (contributing to 30% of total days lost). These may also be associated with treatment costs and potential long-term health consequences, such as knee osteoarthritis (Whittaker et al., 2022). While ankle and knee injuries have been highlighted as a key target for prevention programmes, there is still limited and inconclusive evidence in terms of risk factors and effectiveness of interventions aiming to reduce their occurrence (Downs et al., 2021; Whitehead et al., 2021).

Based on the mechanisms reported by medical staff, most ankle and knee injuries in our study could be attributed to landing (41%) or twisting (20%), and almost all (85%) were classified as non-contact injuries. Landing has previously been identified as a common scenario for anterior cruciate ligament (ACL) injuries in netball through video analysis, (Belcher et al., 2022) and while less is known about ankle injuries, the dominance of non-contact injuries may indicate that injuries to these body parts are somewhat “preventable”. Looking to other team sports where large randomised controlled studies of prevention programmes have been conducted, it seems possible to reduce the incidence of lower limb injuries by approximately 30% through multimodal warm-up programmes (Al Attar & Alshehri, 2019). Practitioners working with netball players should therefore strive to implement netball-specific programmes, such as the KNEE Programme (Netball Australia) and NetballSmart (Netball New Zealand), which have applied similar principles and components. In doing so, it is important to keep in mind that programmes may require further context-specific modifications to be successfully implemented in practice, (O’Brien et al., 2021) especially as it has been shown that few netball coaches use them as intended even if the majority are aware of their existence and almost all are satisfied with the content (Davies et al., 2023).

4.3. Concussions are common and burdensome in high-level netball players

Concussions are receiving attention in sports world-wide due to their potentially severe short and long-term health impacts (Patricios et al., 2023). In parallel, authors reviewing the existing netball literature have called for more detailed information on head injuries and data on the incidence and burden of concussions within the sport (Downs et al., 2021; Whitehead et al., 2021). These concerns are supported by our findings, where every tenth netball injury was to the head and concussion was the second most common pathology type overall. The frequency of head injuries is comparable to previous prospective studies (3–17%), (Finch et al., 2002; Janse van et al., 2022; Langeveld et al., 2012; Sinclair et al., 2020; Toohey et al., 2022) although concussions represented a higher percentage of injuries in our study compared to former investigations (2–6%) (Finch et al., 2002; Janse van et al., 2022; Sinclair et al., 2020; Smyth et al., 2020). A novel finding in our study was that concussion was the third most burdensome pathology type (34 days lost per 1000 match hours) and the second most common combination of body part and pathology type (previous studies have reported on these in isolation, potentially losing out on important nuances relating to specific injuries). Future studies may be able to verify these findings with larger datasets including a higher number of injuries. It should also be acknowledged that the medical staff reporting data in our study were not physicians and no protocols were in place to confirm diagnoses (some staff may have consulted with physicians before recording an injury but it was not a requirement); nevertheless, our results highlight concussions as a potential target for future studies in terms of understanding their extent, risk factors, mechanisms and consequences in netball players. As a first step, it could be suggested that players, coaches, medical staff and tournament organisers should receive some form of education in recognition (e.g., typical signs and symptoms) and management (e.g., on-field, post-match referrals, rehabilitation guidelines) of concussions (e.g., through the online Concussion Awareness Training Tool (Babul et al., 2020)).

4.4. Methodological considerations

Our study is relatively large compared to the existing literature on netball players and included high-level players from nine different teams competing over three tournament editions. We recruited medical staff to record injuries, resulting in valid information regarding pathology types, diagnoses and estimated severity. We employed methods, terminology and classification systems as recommended by the IOC consensus statement on recording and reporting injuries in sport, (Bahr et al., 2020) which will facilitate comparisons between studies within netball and across sports. Still, some limitations must be acknowledged. First, we did not have access to individual match exposure data, potentially affecting estimates of injury incidence and precluding analyses of individual injury risk factors. Second, we used a “medical attention” definition with medical staff who were not directly involved in the research project; this likely influenced the number of non-time-loss injuries recorded (Wik et al., 2019). Although we provided individual post-tournament reports and held lucky draws to encourage consistent recording and minimise this potential bias, our data are inevitably affected by the willingness of each staff member to record injuries occurring in their team. Third, we could not confirm the accuracy of diagnoses or injury mechanisms and our findings therefore represent the information medical staff had available at the time of reporting. Fourth, the first tournament edition was played over a short period during the COVID-19 pandemic, which may have impacted our outcomes and reduces the generalisability of the overall injury patterns even if the overall incidence was similar between editions. Fifth, the injury estimates for many categories have wide confidence intervals and readers should keep this uncertainty in mind when interpreting our results. Finally, severity was estimated and does not necessarily represent the actual days lost associated with each injury. While the severity and burden of specific injuries must be confirmed through longitudinal studies covering full netball seasons, our study provides novel and valuable information that can be used by practitioners and stakeholders to better identify targets for injury risk reduction measures.

5. Conclusion

In South African high-level netball, teams taking part in a nine-match university tournament can expect four match injuries each, whereof two will lead to at least one day lost from netball activities. Two thirds of injuries are expected to be to the lower limb, with ankle joint sprains causing half – and knee cartilage injuries a third – of all expected days lost. Multimodal injury risk reduction programmes should therefore be adopted by team staff, given their effectiveness in reducing lower-limb injuries in other sports and the availability of netball-specific programmes. Concussion was the third-most burdensome pathology type and should receive extra attention in future studies given their potentially serious short- and long-term health impacts.

Submission declaration

This manuscript is not under consideration for publication elsewhere. The publication is approved by all authors.

Ethical statement

Ethical approval was granted by the University of Pretoria Faculty of Health Sciences Research Ethics Committee (reference number: 154/2021) and Stellenbosch University Health Research Ethics Committee (reference number: N21/03/007_COVID-19). Participants provided informed consent to have their data included in this research study.

CRedit authorship contribution statement

Eirik Halvorsen Wik: Writing – original draft, Visualization, Project

administration, Methodology, Investigation, Formal analysis. **Nicola Sewry:** Writing – review & editing, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Wayne Derman:** Writing – review & editing, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization. **Martin Schwellnus:** Writing – review & editing, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization. **Maaïke Eken:** Writing – review & editing, Project administration, Methodology, Investigation, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ptsp.2024.08.002>.

References

- Al Attar, W. S. A., & Alshehri, M. A. (2019). A meta-analysis of meta-analyses of the effectiveness of FIFA injury prevention programs in soccer. *Scandinavian Journal of Medicine & Science in Sports*, 29(12), 1846–1855.
- Babul, S., Turcotte, K., Lambert, M., Hadly, G., & Sadler, K. (2020). Delivering evidence-based online concussion education to medical and healthcare professionals: The concussion awareness training tool (CATT). *The Journal of Sports Medicine*, 2020, Article 8896601.
- Bahr, R., Clarsen, B., Derman, W., et al. (2020). International olympic committee consensus statement: Methods for recording and reporting of epidemiological data on injury and illness in sport 2020 (including STROBE extension for sport injury and illness surveillance (STROBE-SIIS)). *British Journal of Sports Medicine*, 54(7), 372–389.
- Belcher, S., Whatman, C., & Brughelli, M. (2022). A systematic video analysis of 21 anterior cruciate ligament injuries in elite netball players during games. *Sports Biomechanics*, 1–18.
- Burnett, C. (2010). Trends in sport participation at South African universities s research. *African Journal for Physical, Health Education, Recreation and Dance*, 16(si-1), 12–24.
- Clarsen, B., & Bahr, R. (2014). Matching the choice of injury/illness definition to study setting, purpose and design: One size does not fit all. *British Journal of Sports Medicine*, 48(7), 510–512.
- Davies, L., Saad, T., & Smith, M. D. (2023). There is low adoption of injury prevention programs in community netball. *International Journal of Sports Science & Coaching*, 0(0), Article 17479541231185917.
- Downs, C., Snodgrass, S. J., Weerasekara, I., Valkenborghs, S. R., & Callister, R. (2021). Injuries in netball A systematic review. *Sports Med Open*, 7(1), 3.
- Ferreira, M. A., & Spamer, E. J. (2010). Biomechanical, anthropometrical and physical profile of elite university netball players and the relationship to musculoskeletal injuries. *S Afr J Res Sport PH*, 32(1), 57–67.
- Finch, C. (2006). A new framework for research leading to sports injury prevention. *Journal of Science and Medicine in Sport*, 9(1–2), 3–9 ; discussion 10.
- Finch, C., Da Costa, A., Stevenson, M., Hamer, P., & Elliott, B. (2002). Sports injury experiences from the western Australian sports injury cohort study. *Australian & New Zealand Journal of Public Health*, 26(5), 462–467.
- Fuller, C. W. (2018). Injury risk (burden), risk matrices and risk contours in team sports: A review of principles, practices and problems. *Sports Medicine*, 48(7), 1597–1606.
- Hume, P. A., & Steele, J. R. (2000). A preliminary investigation of injury prevention strategies in netball: Are players heeding the advice? *Journal of Science and Medicine in Sport*, 3(4), 406–413.
- Janse van Rensburg, D. C., Bryant, G., Kearney, S., et al. (2022). The epidemiology of injury and illness at the vitality netball world Cup 2019: An observational study. *Phys Sportsmed*, 50(4), 359–368.
- Langeveld, E., Coetzee, F. F., & Holtzhausen, L. J. (2012). Epidemiology of injuries in elite South African netball players. *S Afr J Res Sport PH*, 34(2), 83–93.11.
- McKay, A. K. A., Stellingwerff, T., Smith, E. S., et al. (2022). Defining training and performance caliber: A participant classification framework. *International Journal of Sports Physiology and Performance*, 17(2), 317–331.
- McManus, A., Stevenson, M. R., & Finch, C. F. (2006). Incidence and risk factors for injury in non-elite netball. *Journal of Science and Medicine in Sport*, 9(1), 119–124.
- O'Brien, J., Santner, E., & Kroll, J. (2021). Moving beyond one-size-fits-all approaches to injury prevention: Evaluating how tailored injury prevention programs are developed and implemented in academy soccer. *Journal of Orthopaedic & Sports Physical Therapy*, 51(9), 432–439.
- Patricios, J. S., Schneider, K. J., Dvorak, J., et al. (2023). Consensus statement on concussion in sport: The 6th international conference on concussion in sport—amsterdam, october 2022. *British Journal of Sports Medicine*, 57(11), 695–711.
- Pringle, R. G., McNair, P., & Stanley, S. (1998). Incidence of sporting injury in New Zealand youths aged 6-15 years. *British Journal of Sports Medicine*, 32(1), 49–52.
- Rae, K., & Orchard, J. (2007). The orchard sports injury classification system (OSICS) version 10. *Clinical Journal of Sport Medicine*, 17(3), 201–204.
- Sinclair, C. J., Coetzee, F. F., & Schall, R. (2020). Epidemiology of injuries among U18, U19, U21 and senior elite netball players. *South African Journal of Sports Medicine*, 32(1). v32i31a7577.
- Smyth, E. A., Piriomalli, L., Antcliff, A., et al. (2020). A prospective study of health problems at the 2018 17/U and 19/U Australian National Netball Championships with comparison of surveillance methodology. *Journal of Science and Medicine in Sport*, 23(3), 215–221.
- Smyth, E., Toohey, L., Antcliff, A., et al. (2022). *Health problem surveillance at the 17/U & 19/U Australian national netball championships* (Vol. 1). JSAMS Plus, Article 100003.
- Stevenson, M. R., Hamer, P., Finch, C. F., Elliot, B., & Kresnow, M. (2000). Sport, age, and sex specific incidence of sports injuries in Western Australia. *British Journal of Sports Medicine*, 34(3), 188–194.
- Toohey, L. A., Antcliff, A., Drew, M. K., et al. (2022). Epidemiology of injuries sustained in professional Australian netball: A three season cohort study. *Journal of Science and Medicine in Sport*, 25(4), 294–299.
- van Mechelen, W., Hlobil, H., & Kemper, H. C. (1992). Incidence, severity, aetiology and prevention of sports injuries. A review of concepts. *Sports Medicine*, 14(2), 82–99.
- Whitehead, S., Weakley, J., Cormack, S., et al. (2021). The applied sports science and medicine of netball: A systematic scoping review. *Sports Medicine*, 51(8), 1715–1731.
- Whittaker, J. L., Losciale, J. M., Juhl, C. B., et al. (2022). Risk factors for knee osteoarthritis after traumatic knee injury: A systematic review and meta-analysis of randomised controlled trials and cohort studies for the OPTIKNEE consensus. *British Journal of Sports Medicine*, 56(24), 1406–1421.
- Wik, E. H., Materne, O., Chamari, K., et al. (2019). Involving research-invested clinicians in data collection affects injury incidence in youth football. *Scandinavian Journal of Medicine & Science in Sports*, 29(7), 1031–1039.
- World Netball. Strategic plan 2021. Available at:** <https://secure.viewer.zmags.com/publication/f10bc3b8#/f10bc3b8/4>. (Accessed 13 November 2023).
- Zulkarnain, J., & Khairullina, K. (2019). The pilot study on Down to Earth (D2E) injury prevention program among varsity netball players. *Gazzetta Medica Italiana*, 178(4), 188–194.