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Knowledge, attitude and behaviour around concussion at the FIFA Women's World Cup 2023: part 2 – coaches, performance staff and players

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ABSTRACT

The objective of this observational cross-sectional study was to assess the knowledge, attitude and behaviour of coaches and performance staff (i.e. 'coaching staff'), and players from the 32 teams qualified for the FIFA Women's World Cup 2023 regarding assessment and management of concussion in football. Two online surveys were developed: 1) coaching staff, and 2) players. The results were analysed descriptively. Eighty-four coaching staff and 229 players completed the survey. Concussion knowledge: 39% of coaching staff and 33% of players were aware of concussion protocol(s). Knowledge: concussion symptom onset time was correctly reported by 18% of coaching staff and 11% of players. Knowledge about risks related to sustaining a concussion or returning to play too soon varied in both groups. Attitude: 26% of coaching staff and 31% of players reported being very confident or confident in recognizing a suspected concussion. Half of the players (52%) reported to always report symptoms of concussion if feeling any. One (1%) member of the coaching staff and 24 (10%) players reported feeling that a player can return to play with mild symptoms after a concussion. Behaviour: Most coaching staff reported they would have supportive behaviour if faced with a suspected concussion on the pitch. Among players, 64% stated that they would leave the assessment to their team's medical staff, and 4% would encourage their teammates to keep playing. In conclusion, coaching staff and players showed limited knowledge about concussion. Most coaching staff reported attitudes and intended behaviour towards protecting players' health; whilst players' responses varied.

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Head injury; women's football; national team; coaching staff

Introduction

The Fédération Internationale de Football Association (FIFA) Women's World Cup 2023 showcased the growth of the game with record audiences in the stadiums and broadcast viewers (FIFA 2023). When injuries occur, this imposes a unique pressurizing context for medical staff and players on the pitch, as practice around these is visible to coaches, parents and spectators. Therefore, treating the injured player using evidence-based practice has a dual mission of safeguarding players' health, and establishing standards to viewers. As an example, during the 2019 FIFA Women's World Cup, there were 40 on-pitch medical assessments of potential head injuries in 52 matches (Georgieva et al. 2024). While these numbers suggest that players and coaching staff are often faced with potential concussions on the pitch, little is known about how prepared they are to act appropriately. Recent literature suggest that both football players and coaches have limited knowledge of concussion with some also showing varying attitude towards management best-practices (Williams et al. 2016; Shafik et al. 2022, 2024; Rosenbloom et al. 2022; Bazo et al. 2023).

Early identification and adequate management of concussion is pivotal to decrease the risk of severe and long-term consequences for players, especially for women, who have a higher risk of sustaining a concussion, and are prone to prolonged symptoms of concussion compared to men (McGroarty et al. 2020). Removing a player with a suspected concussion from the pitch and returning a concussed player to play is the responsibility of the team doctors (FIFA). However, the injured player has a crucial role in reporting concussive symptoms to support the correct identification and management of a concussion (Echemendia et al. 2023; FIFA). In turn, players' reporting behaviour may be influenced by their own personal knowledge and attitudes around concussion, as well as other verbal or non-verbal pressure from coaching staff or teammates (Tadmor et al. 2023). Therefore, a better understanding of knowledge, attitudes and behaviours around concussion may have the potential to inform targeted evidence-based strategies for promoting healthy concussion behaviours in women's football.

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The relevance of head injuries in women's football was also highlighted in a recent scoping review (Okholm Kryger et al. 2023), which identified the head and/or face as the second most studied body location (22%; 108 studies). However, only a few studies have investigated concussion knowledge, attitude, and behaviour in women's football (Kurowski et al. 2014; Kroshus et al. 2017; Register-Mihalik et al. 2018; Kim and Connaughton 2021; Shafik et al. 2022, 2024), of which only two were conducted in a professional context (Shafik et al. 2022, 2024). Results revealed coaching staff and players presenting higher level of knowledge compared to previous studies in different sports (Shafik et al. 2022, 2024). However, coaching staff presented lower concussion knowledge scores compared to medical staff, and it was not associated with attitude towards concussion best-practices (Shafik et al. 2024). Among players, previous concussion education was positively associated with greater knowledge, but not attitude (Shafik et al. 2022). Although these are important insights into the intricacies between knowledge and attitudes around concussion of key stakeholders, they represent the elite women's setting of a single country (United Kingdom). A wider overview is warranted to support players' welfare initiatives around concussion globally.

Therefore, the objective of this study was to understand concussion assessment and management knowledge, attitudes, and behaviours of coaches, performance staff and players taking part in the FIFA Women's World Cup 2023.

Methods

This study is part of a larger cross-sectional project aiming at assessing knowledge, attitudes and behaviours of women's football national teams' professionals and players around concussion. A separate survey for team medical staff was also developed, with results published separately (see Part 1). Results were reported according to the checklist for reporting results of internet e-surveys (CHERRIES; Appendix A (Eysenbach 2004)).

Participants

Invitations to take part in this study were sent to all FIFA registered coaches, performance staff (i.e., assistant coaches, goalkeeper coaches, performance analysts, strength and conditioning coaches, nutritionists) and players from the 32 national teams who had qualified for the FIFA Women's World Cup 2023 through a national team representative. Registered participants in the tournament were 263 coaching staff members and 736 players. No minimal response rate was defined.

Ethics was granted by St Mary's University, Twickenham (SMU_ETHICS_2022-23_237). Participants were informed that they were free to withdraw from the research at any time before submitting the survey. They provided informed consent prior to starting the survey. No incentives were offered for participation. All information was de-identified.

Survey development

Two population-specific surveys were developed: one for coaches and performance staff (referred to as 'coaching staff') and

one for players. The surveys were initially developed by CW, KK, AS, AM, AMcC and MF inspired by previous football-specific concussion knowledge, attitude and behaviour surveys (Rosenbaum and Arnett 2010; Rosenbloom et al. 2022), and the FIFA Concussion Protocol (FIFA). Relevance of each question to the proposed aims and respective content validity (Rattray and Jones 2007) were later assessed by all the authors, and changes were made until agreement. Technical functionality was assessed by CW, KK, AS and AMcC.

The coaching staff survey comprised 29 questions (Appendix B), and the player survey comprised 31 questions (Appendix C). In both versions, questions were displayed in eight online sections: 1) Informed consent, 2) participants' demographics, 3) football-specific concussion education, 4) knowledge of a) initial assessment, and b) return to play; 5) attitude towards a) initial assessment, and b) return to play; 6) Practices/Behaviour on a) initial assessment, and b) return to play; 7) suggestions for FIFA regarding concussion-specific initiatives, and 8) confirmation of answer submission (Appendix B and C). Questions 17, 24 and 29 (coaching staff) and 31 (players) exceed the scope of this study and thus are not reported here.

The survey was developed in English and piloted with an A-league women's football team from New Zealand (answers received from six coaching staff and three players), and both versions had no amendments suggested after the pilot study. The final English version was translated by FIFA professional translators into the official FIFA languages: French, Spanish, Portuguese, German, and Arabic, whilst Vietnamese and Japanese were later included upon request from Member Associations.

Survey distribution

The survey was administered, and data stored in an online survey domain approved by the General Data Protection Regulation (JISC, Bristol, United Kingdom). An e-mail invitation to participate in the study, including its aims, ethical considerations, and the surveys' link, was sent to representatives from each national team attending the FIFA Women's World Cup 2023. They were asked to forward the invitation to respective professionals and players potentially taking part in the tournament for their national team. No password was needed to access the survey. They were opened for responses from 3 April to 31 May 2023. Reminders were sent twice to the national teams' representatives (26 April and 23 May). The FIFA Women's World Cup started on 20 July 2023.

Data analysis

Only complete survey data were stored and analysed. Raw data were exported to Microsoft® Excel® (Microsoft® 365, Redmond, WA). Closed-ended questions were analysed descriptively (count and percentages relative to the number of respondents). Open-ended questions were analysed using content analysis, approached deductively or inductively as follows (Hsieh and Shannon 2005; Patton 2015).

Questions where respondents were expected to provide answers matching evidence-based consensus statement

(Walden et al. 2023) or guideline (FIFA), followed a directed approach of analysis. Specifically, the initial codes for question 15 from both coaching staff and players' surveys, was defined by two researchers (CW and KK). Questions about respondents' experiences and opinions (i.e., 13, 26 and 27 from coaching staff's survey; 28, 29 and 30.a. from players' survey) were analysed using an inductive content analysis. Codes relative to each answer were progressively combined or amended until saturation by CW and later discussed with KK. Questions 22 (coaching staff), 26, 27 and 30 (players) were not analysed due to observed misinterpretation from responses to their open-ended sections. Question 20 (players) was amended during the survey development phase (resulting in question 21) and therefore was also not analysed.

Results

Participant demographics

A total of 84 members of the coaching staff completed the survey (Table 1), which corresponded to 32% of all coaching

staff registered in the FIFA Women's World Cup 2023 (total registered $n = 263$). Among players, 229 completed the survey (31% of the 736 players registered in the tournament; Table 1). The distribution of coaching staff and players among confederations is described in Appendix D.

Three quarters (76%, $n = 64$) of coaching staff reported to be employed full time in their national teams, 21% ($n = 18$) were employed part-time, 4% ($n = 1$) reported to be voluntary, and 4% ($n = 1$) reported to have other employment agreements than the previous listed. Among players, 83% ($n = 189$) reported to be employed full time, from which 97% ($n = 184$) reported to be professionals and 3% ($n = 5$), amateurs. Among the 17% ($n = 40$) of all players reporting to be employed part-time in women's football, 60% ($n = 24$) reported to be professionals and 40% ($n = 16$), amateurs.

Having previously observed a suspected concussion during football training or match-play was reported by 61% ($n = 51$) of the coaching staff (Table 1). Among players, 57% ($n = 130$) had observed another player sustaining a suspected concussion on the pitch and 21% ($n = 49$) reported having sustained a concussion themselves during football (Table 1).

Table 1. Number of respondents, respective experience in elite women's football, awareness of sports-related concussion protocols, participation in football-specific concussion education.

	Coaching staff	Players
	n (%)	n (%)
Number of respondents	84	229
Manager/Head Coach	29 (35%)	-
Assistant coach	22 (26%)	-
Goalkeeper coach	2 (2%)	-
Performance analyst	16 (19%)	-
Strength and Conditioning coach	10 (12%)	-
Sports Scientist	4 (5%)	-
Years in international women's football at senior level		
Less than 1 year	11 (13%)	29 (13%)
1–4 years	36 (43%)	61 (27%)
4–8 years	23 (27%)	65 (28%)
More than 8 years	14 (17%)	74 (32%)
Had ever experienced a concussion (from a/another player)		
Yes	51 (61%)	130 (57%)
No	28 (33%)	74 (32%)
Not sure	5 (6%)	25 (11%)
Had ever sustained a concussion		49 (21%)
1 concussion	-	29 (59%)
2 concussions	-	11 (22%)
3–4 concussions	-	9 (18%)
Less than 1 year since last concussion	-	20 (41%)
More than 1 year since last concussion	-	24 (49%)
Time since last concussion not specified	-	5 (10%)
Aware of any sports-related concussion protocol(s)		
Total	33 (39%)	76 (33%)
FIFA Concussion protocol	7 (21%)	3 (4%)
Consensus statement on concussion in sport	1 (3%)	0 (0%)
Sport Concussion Assessment Tool (Cezarino et al. 2020)	0 (0%)	7 (9%)
Confederation's protocol	3 (9%)	5 (7%)
National Association's protocol	4 (12%)	2 (3%)
Other sports' organisations	3 (9%)	1 (1%)
Protocol not specified	16 (48%)	59 (78%)
Past football-specific concussion education		
Total	18 (21%)	69 (30%)
Within 1 year or less from response	7 (39%)	44 (64%)
More than one year before the response	10 (56%)	18 (26%)
Not sure/not specified	1 (6%)	7 (10%)

*Percentage calculated from total number of respondents ($n = 84$ and $n = 229$), except for rows not in bold under 'Had ever sustained a concussion', 'Aware of any sports-related concussion protocol(s)', and 'Past football-specific concussion education' and. For these, the number on these rows or from the 'Total' row within the topic was used.

Awareness of concussion protocol

Approximately two in five of the coaching staff (39%, $n = 33$) and a third of players (33%, $n = 76$) reported to be aware of at least one concussion protocol (Table 1). Among those, the FIFA concussion protocol was the most cited by the coaching staff (21% of those who reported to be aware, $n = 7$), whilst the Sport Concussion Assessment Tool (Cezarino et al. 2020) was the most cited by players (9% of those who reported to be aware, $n = 7$; Table 1).

Football-specific concussion education

Previous attendance of football-specific concussion education was reported by 21% of coaching staff ($n = 18$) and 30% of players ($n = 69$; Table 1). More than 80% of respondents reported to be interested in education on on-field assessment and diagnosis, return to play and long-term impact (Table 2). Beyond these themes, how to prevent concussion; mechanisms of concussion; relationships between concussion and genetics, and relationship between concussion and injuries were also raised as topics of interest. The team doctor was considered the best person to provide education by most respondents (71–94%; Table 2).

Knowledge of symptoms

Both coaching staff and players correctly identified on average 12 ± 2 out of the 16 signs and symptoms listed (Figure 1a). Most coaching staff (58%, $n = 49$) and players (54%, $n = 123$) reported an incomplete concussion onset time (either immediate only or with an incorrect delay range, Figure 1b). Additionally, 24% ($n = 20$) of coaching staff and 35% ($n = 80$) of players were not sure or did not specify the onset time.

Knowledge of who has the decision responsibility around concussion

Team doctors were not identified as responsible for the final say about whether a player with suspected concussion should be removed from the pitch by 18% ($n = 15$) of coaching staff and 32% ($n = 74$) of players (Figure 2), who named other stakeholders. Regarding the return to play management, 13% ($n = 11$) of coaching staff and 29% ($n = 66$) of players did not identify the doctors' responsibility on these decisions (Figure 2).

Knowledge of risks related to concussion

Risks related to players sustaining a concussion and the possible complications of returning to play too soon after a suspected concussion was correctly identified by more than half of coaching staff (from 57%, $n = 48$ relative to 'increased likelihood to have another concussion after a first one' to 92%, $n = 77$ to 'risk to long-term health and wellbeing from multiple concussions'), except for the false risk of paralysis (17%, $n = 14$; Table 3).

Players' correct answers varied between 43% ($n = 99$, 'increased likelihood to have another concussion after a first one' and "a concussion can only occur if there is a direct hit to the head) and 81% when asked about the complications following a concussion ($n = 185$, 'Reduced sports performance'; Table 3). Correct answers to the false risk of paralysis were also lower (14%, $n = 32$; Table 3).

Confidence in recognising a suspected concussion

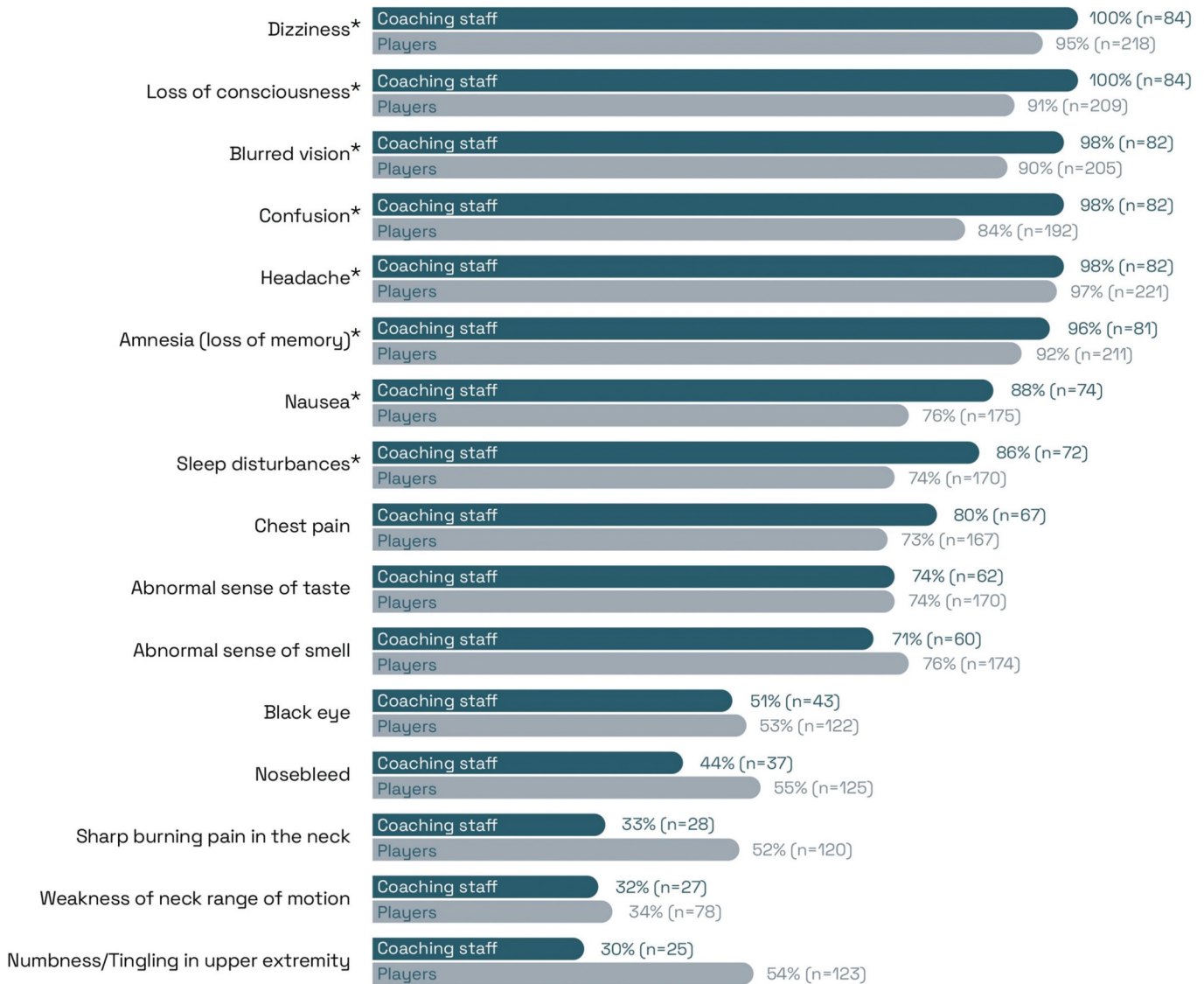
Feeling neither confident nor unconfident to recognise a player with a suspected concussion was the most reported option by the coaching staff (45%, $n = 38$; Figure 3). Among players, 45% ($n = 103$) reported feeling very confident or confident in recognising themselves with a suspected concussion, though the

Table 2. Coaching staff and players' interest in concussion-specific education and perception of the best suited person to provide information.

	Coaching staff						Players					
	On-field assessment and diagnosis		Return to play		Long-term impact on players' health		On-field assessment and diagnosis		Return to play		Long-term impact on players' health	
	%	n	%	n	%	n	%	n	%	n	%	n
Interest in receiving education on concussion topics												
Very Interested	46%	39	60%	50	55%	46	38%	86	44%	101	51%	117
Somewhat interested	39%	33	30%	25	35%	29	47%	107	41%	93	35%	81
Not interested	14%	12	11%*	9	11%	9	16%	36	15%	35	14%	31
Best person to provide education												
Medical doctor	89%	75	81%	68	86%	72	85%	194	71%	162	73%	168
Physiotherapist	6%	5	8%	7	1%	1	3%	6	14%	31	7%	15
External expert	4%	3	8%	7	11%	9	5%	11	5%	11	11%	28
Psychologist	0%	0	0%	0	0%	0	1%	2	1%	3	2%	5
Coach	0%	0	0%	0	0%	0	3%	8	6%	14	2%	5
Strength and Conditioning coach	0%	0	1%	1	0%	0	0%	0	0.40%	1	0%	0
Other players that have sustained a concussion	0%	0	1%	1	1%	1	2%	4	1%	3	1%	3
Staff member who have experienced a player concussed in the team	1%	1	0	0	1%	1	1%	3	1%	3	2%	4
Someone else	0%	0	0%	0	0%	0	0.40%	1	0.40%	1	0.40%	1

*Sum of responses = 101% due to reduction in decimals. Exact numbers' sum = 100%.

a Which of the following are considered signs and symptoms of a suspected concussion?



b How long can it take for concussion symptoms to appear? (please provide the full range)

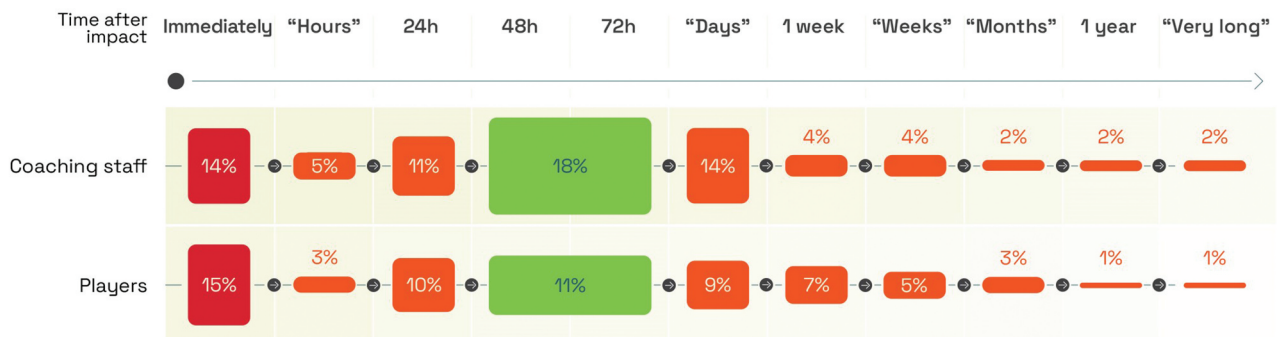


Figure 1. Knowledge of A) observable signs and symptoms of concussion. *Indicates legitimate sign or symptom; and B) time of symptoms onset of coaching staff and players.

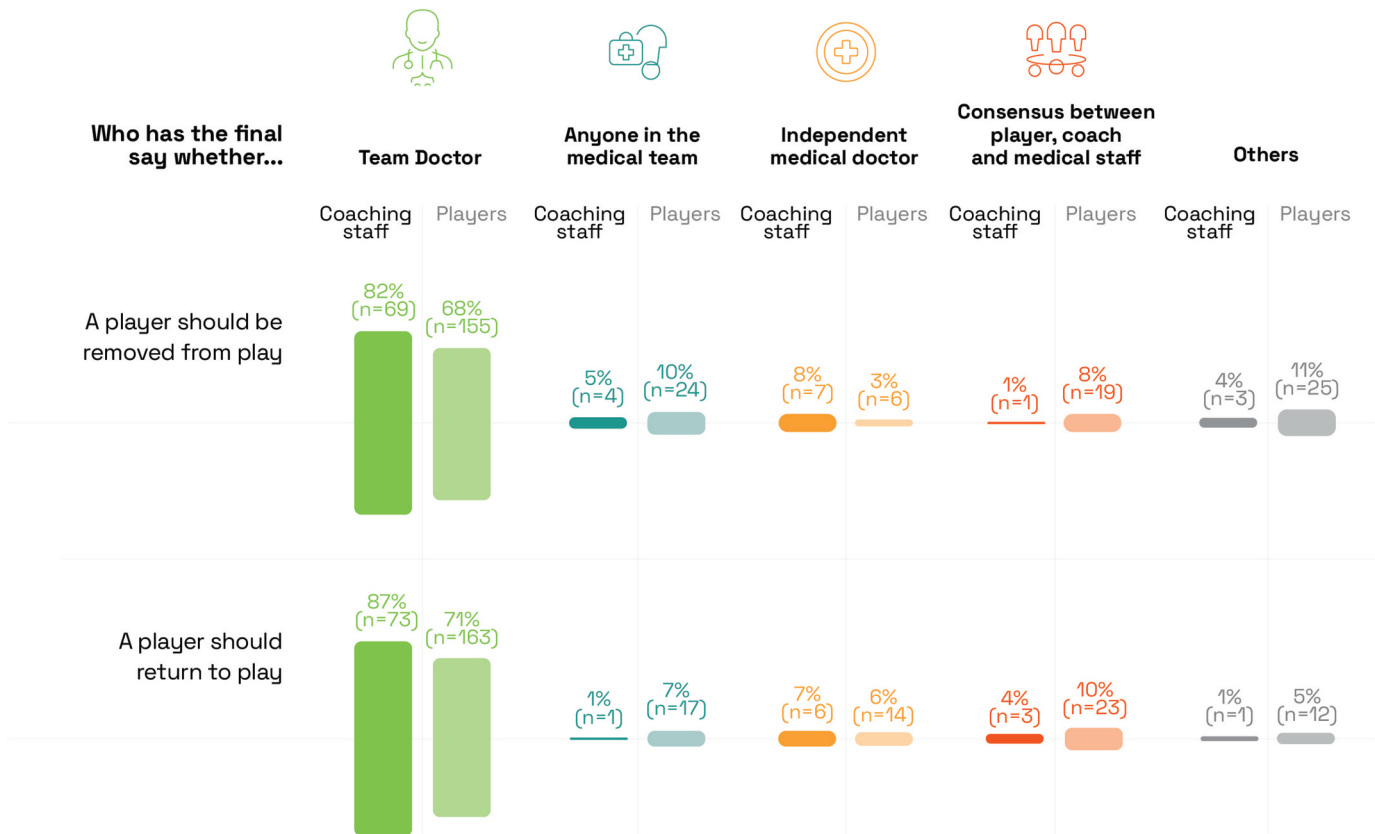


Figure 2. Knowledge of responsibility over concussion-related decisions. Answers to the questions ‘who has the final say about whether a player with suspected concussion should be removed from play?’, and ‘who has the final say about the return-to-play management of a concussed player?’ from the coaching staff and players.

Table 3. Knowledge of risks related to concussion (percentage and number of answers to each item).

	Coaching staff						Players					
	Correct		Incorrect		Not sure		Correct		Incorrect		Not sure	
	%	n	%	n	%	n	%	n	%	n	%	n
Risks related to sustaining a concussion												
There is a possible risk of death if a second concussion occurs before the first one has healed. (correct = true)	61%	51	6%	5	33%	28	51%	116	5%	11	45%	102
People who have had one concussion are more likely to have another concussion. (correct = true)	57%	48	25%	21	18%	15	43%	99	19%	44	38%	86
A concussion can only occur if there is a direct hit to the head. (correct = false)	61%	51	21%	18	18%	15	43%	99	34%	78	23%	52
There is a risk to long-term health and well-being from multiple concussions. (correct = true)	92%	77	1%	1	7%	6	81%	186	4%	10	14%	33
Risks related to complications of returning to play too soon after a suspected concussion												
No complications exist (correct = false)	81%	68	6%	5	13%	11	71%	163	5%	12	24%	54
Increased risk of further injury (correct = true)	73%	61	14%	12	13%	11	73%	167	5%	12	22%	50
Paralysis (correct = false)	17%	14	37%	31	46%	39	14%	32	34%	77	52%	120
Brain damage (correct = true)	77%	65	2%	2	20%	17	71%	163	3%	8	25%	58
Reduced sports performance (correct = true)	88%	74	5%	4	7%	6	81%	185	4%	9	15%	35
Concussion symptoms persisting long term (correct = true)	83%	70	1%	1	15%	13	71%	163	3%	8	25%	58

most reported option for recognising a suspected concussion in another player was ‘neither confident nor unconfident’ (43%, $n = 98$; Figure 3).

Attitude of players towards reporting symptoms

Half of the players (52%, $n = 118$) reported to always report symptoms of concussion if feeling any, whereas 10% ($n = 22$) reported

that they would rarely or never report if feeling any symptoms (Figure 4).

Attitude towards decision-making on concussion assessment and return to play

Coaching staff and players were presented with the following statement and asked how they felt about it: ‘The best

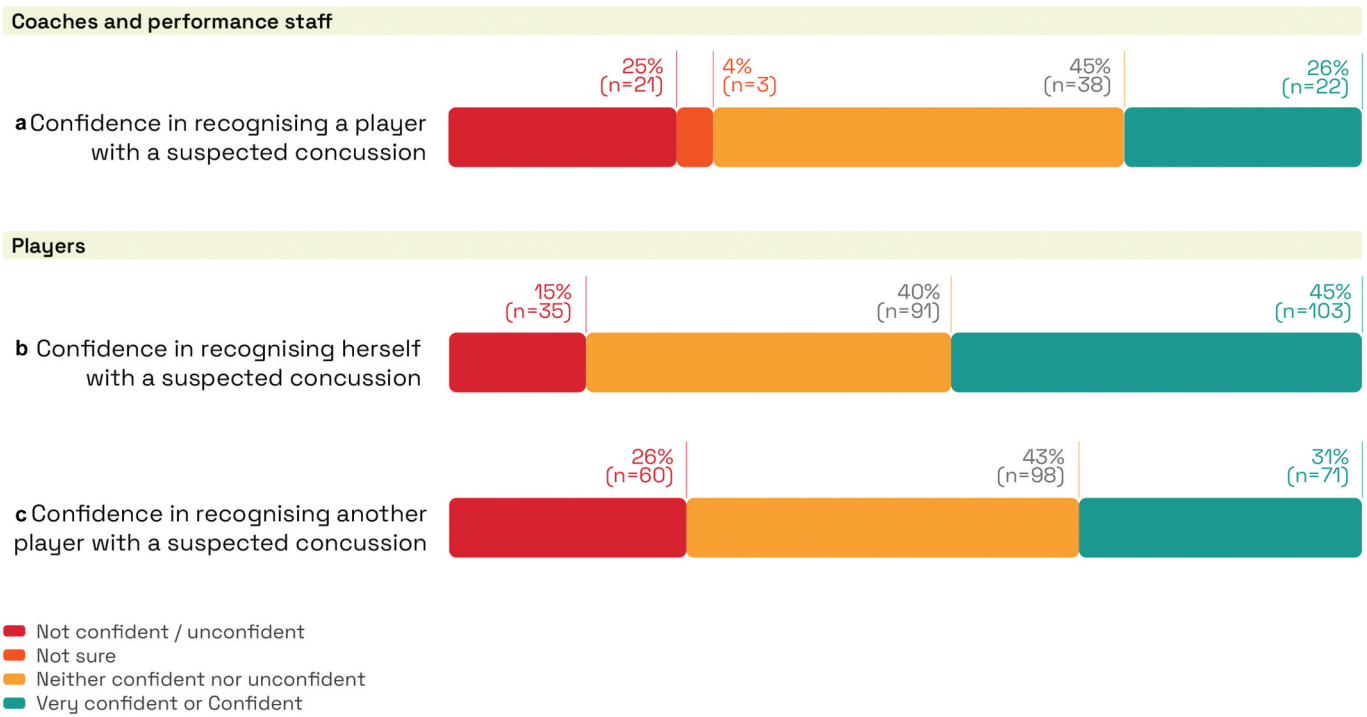


Figure 3. Coaching staff and players' confidence in recognizing a suspected concussion on the pitch.

If you were a player with a suspected concussion, would you report concussion symptoms on the pitch?

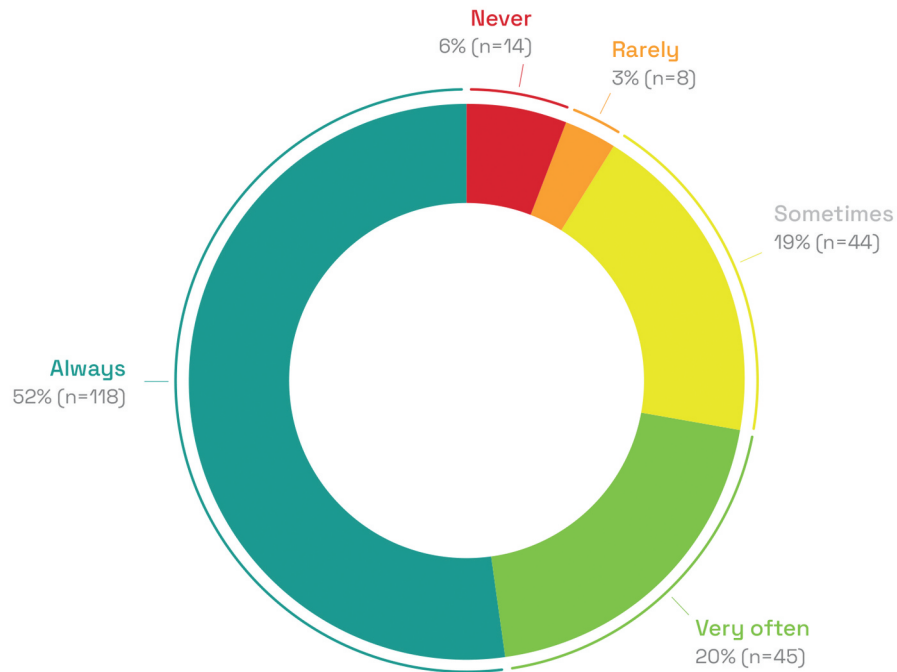
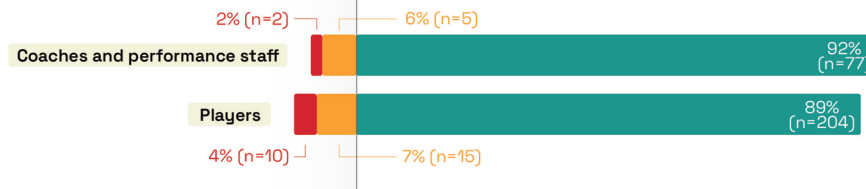


Figure 4. Players' attitude towards reporting concussion symptoms, if they were feeling any.



I feel that a doctor makes the right decision to substitute a player even if it may interfere in the team's result



Most players would feel that the doctor made the right decision to substitute the player.

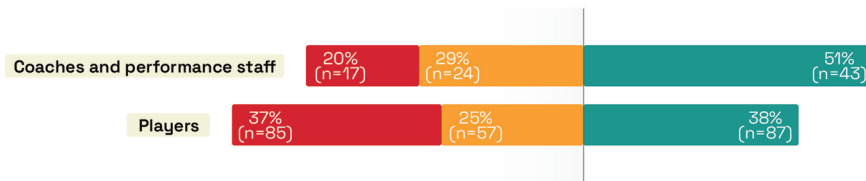


Players who have had a confirmed concussion can return to play as soon as they have been cleared by team doctor.



Legend: Disagree (red), Not sure (orange), Agree (green)

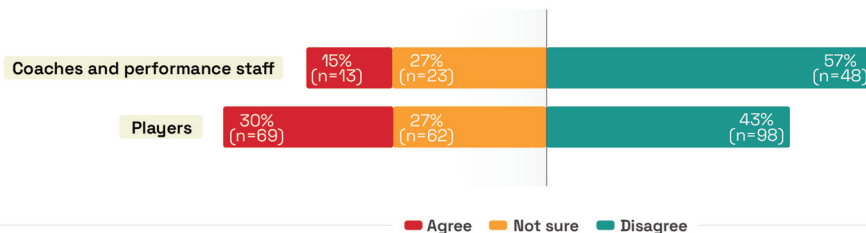
As long as a player is symptom free, I feel it is ok for her to return to play regardless of the time (days) after a concussion.



As long as a player only shows mild symptoms of concussion, I feel it is ok for her to return to play regardless of how many days after a concussion.



I believe that a player who sustains a concussion should not be allowed to return to play in the tournament.



Legend: Agree (red), Not sure (orange), Disagree (green)

Figure 5. Attitudes of coaching staff and players on decision-making over concussion assessment and return to play.

Table 4. Codes identified in (A) coaching staff perceived role if faced with a suspected concussion, and (B) coaching staff and (C and D) players' answers to what would they do in case they did not agree with the medical doctor's decision to remove a player from the pitch due to a suspected concussion.

Categories of codes	%	n
A) Coaching staff: perceived role if faced with a suspected concussion		
Notify the medical staff to assess the player	20%	17
Follow directions and decisions from the medical doctor	33%	28
Prepare a substitute if needed	17%	14
Provide video footage of the impact to medical staff	8%	7
Seek medical attention on a hospital	2%	2
Take part in players' assessment and decision	1%	1
Would not have any role in the situation	14%	12
Unclear statement	4%	3
B) Coaching staff: in case they did not agree with the medical doctor's decision to remove a player from the pitch		
Accept the doctor's decision	67%	56
Accept the doctor's decision and discuss the case after the match	4%	3
Seek further assessment/information before accepting doctor's decision	4%	3
Argue/inquire, without stating whether to accept decision or not	4%	3
Challenge doctor's decision	2%	2
Would not do anything	14%	12
Not specified	4%	3
Not sure	2%	2
C) Players: if disagree with the medical doctor's decision to remove herself from the pitch		
Accept the doctor's decision	63%	145
Accept the doctor's decision after arguing	4%	10
Argue/inquire, without stating whether would accept decision or not	11%	25
Be distressed, without stating whether would accept decision or not	2%	5
Challenge or not follow the doctor's decision	8%	18
Not specified	5%	11
Not sure	7%	15
D) Players: if disagree with the medical doctor's decision to remove a teammate from the pitch		
Accept the doctor's decision	63%	145
Accept the doctor's decision – support doctor's decision	9%	20
Argue/inquire, without clear statement whether to accept decision or not	6%	14
Be distressed, without clear statement whether to accept decision or not	2%	4
Argue with the coach to intervene	2%	5
Challenge or suggest her teammate not to follow the doctor's decision	4%	10
Not specified	8%	18
Not sure	6%	13

player in the team suffers a head impact during the opening game of the FIFA Women's World Cup. The player says she "feels fine", but the doctor believes she has a suspected concussion and decides to substitute her. Their team loses the game'. Most coaching staff (92%, $n = 77$) and players (89%, $n = 204$) agreed that the doctor made the right decision to substitute the player (Figure 5). When asked if they felt most players would feel that the doctor made the right decision to substitute the player, 73% ($n = 168$) agreed (Figure 5).

Regarding the return to play criteria, one (1%) member of the coaching staff and 24 (10%) players reported feeling that a player can return to play with mild symptoms after a concussion, whilst 8% ($n = 7$) of coaching staff and 19% ($n = 43$) of players were not sure (Figure 5). If the player is not feeling any symptoms, 20% ($n = 17$) of coaching staff and 37% ($n = 85$) of players reported feeling it would be ok that she returns to play, regardless of how many days after a concussion (Figure 5).

Intended behaviour around on-pitch assessment

Role if faced with a suspected concussion

The most frequent answer to what would be the coaching staff's role if they were faced with a suspected concussion on the pitch was to follow directions and decisions from the

medical doctor (33%, $n = 28$; Table 4A). One (1%) member of the coaching staff (a head coach) reported their role to be both taking part in players' assessment and following directions and decisions from the medical doctor (Table 4A; 'To assess the player and follow the advice from the doctor who is in charge of this case').

Among players, 36% ($n = 82$) did not select the option stating that they would leave the assessment to their team's medical staff, 33% ($n = 76$) reported they would try to help their teammates regardless of the medical team being called in, and 4% ($n = 10$) would encourage their teammate to keep playing (Figure 6).

Intended behaviour if disagreeing with the doctor's decision to remove a player due to suspected concussion

If disagreement occurred with the doctor's decision to remove a player due to a suspected concussion, most coaching staff (67%, $n = 56$) would accept the doctor's decision, and 2% ($n = 2$) would challenge the doctor's decision ('Get a second opinion'; 'To ask the team doctor to assess her after the game'; Table 4B).

If the players did not agree with the medical doctor's decision to remove them from the pitch due to a suspected concussion, most reported that they would accept the decision (63%, $n = 145$), whereas 8% ($n = 18$) reported they would challenge or not follow the doctor's decision (e.g. 'Ask for a re-test',

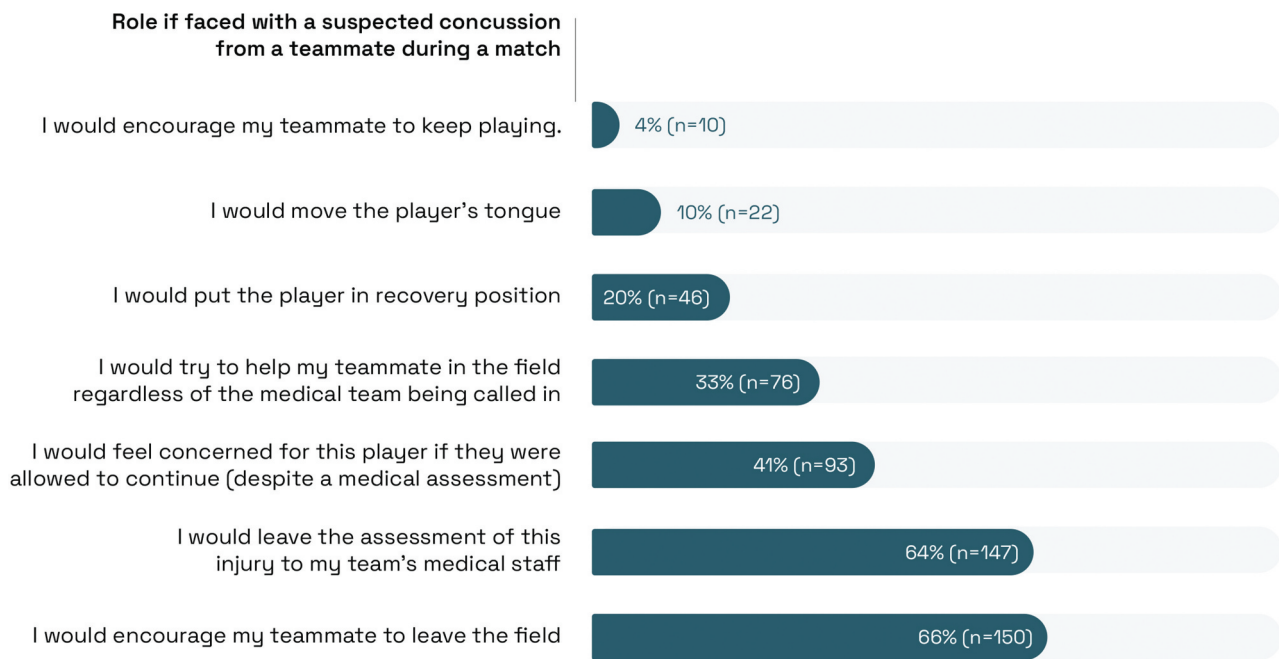


Figure 6. Players' self-reported role if faced with a suspected concussion from a teammate.

'Speak to my coach', 'I would decide based on how am feeling'; Table 4C).

In case disagreement of players occurred on the doctor's decision to remove a teammate due to a suspected concussion, 63% ($n = 145$) of players reported they would accept it, and 9% ($n = 20$) specified they would also support the doctor's decision (e.g. 'advise my teammates to listen to the doctor', 'I would encourage my teammate to comply'; Table 4D). In contrast, 4% ($n = 10$) reported they would challenge or suggest her teammate not to follow the doctor's decision (e.g. 'To tell them how to treat that person', 'I can encourage my teammates to keep playing'; Table 4D).

Intended behaviour around return to play (coaching staff)

The majority (90%, $n = 76$) of coaching staff reported they would not suggest accelerating a players' return to play after concussion even if they considered her to be important for the next match. The remaining 10% ($n = 8$), including three head coaches, three assistant coaches, one strength and conditioning coach and one sport scientist reported they would do so. Reasons for this included seeking a second opinion; for team's performance; to argue, stating that if not accepted would ultimately follow the doctor's decision.

Discussion

The objective of this study was to assess concussion knowledge, attitudes and behaviours among coaching staff and players participating in the FIFA Women's World Cup 2023. There were large variations in knowledge of concussion among both coaching staff and players (e.g., correct identification of approximately 75% concussive of symptoms on average, though more than 80% of participants were unaware of

correct symptoms' onset time). Most coaching staff reported attitudes and intended behaviour towards protecting players' health, though two reported they would challenge doctors' decisions on assessment and eight would suggest accelerating players return to play. Players' attitudes and intended behaviours varied between protective and dangerous to themselves and their teammates, including not always reporting symptoms of concussion and challenging doctors' decisions. These results suggest that protecting players' welfare in cases of suspected or confirmed concussion is not yet an established behaviour among key stakeholders in elite women's football. Concussion education aimed at a wide audience, and initiatives focused on attitude change among coaching staff and players are thus warranted to promote a culture of health protection among stakeholders and spectators of the game.

Knowledge of concussion

The correct symptoms associated with concussion were identified by most coaching staff and players. However, 40% of the coaching staff and 50% of players either did not report any delayed onset symptoms or reported to be unaware of the onset time of concussion symptoms. Other knowledge limitations were observed on risks related to sustaining a concussion, with correct answers ranging from 43% to 61% in three out of four statements selected from RoCKAS (Rosenbaum and Arnett 2010). These are lower results than that observed previously in elite female players in the UK answering to the same statements (61%–84%) (Shafik et al. 2022). This difference and the overall limitations in key stakeholders' knowledge on concussion found in this study can be related to the low rate of participation in football-specific concussion education from coaching staff (21%) and players (30%). For instance, in that same study, players that reported previous concussion

education showed higher knowledge index compared to those with no previous concussion education (Shafik et al. 2022). In addition, concussion education has been associated with improved knowledge of coaches and players in different sports (Mrazik et al. 2015; Gouttebarga et al. 2021; Conaghan et al. 2021). Therefore, continuous concussion education to coaching staff and players offers a solid foundation towards developing a protective culture in cases of suspected and confirmed concussion in women's football. Importantly, most of the coaching staff and players recognised the team doctors' lead in concussion education, and thus should be considered to deliver the team's concussion-related information sessions.

Attitude and intended behaviour towards on-pitch assessment and return to play

Around 90% of the respondents agreed that a doctor should remove a player from the pitch even if it may interfere with the team's results, indicating an attitude to prioritising players' health over results. This is in line with most participants recognising the team doctors' autonomous responsibility in decision-making around concussion, as stated in the FIFA concussion protocol (FIFA).

From the coaching staff perspective, a tendency of most participants to prioritize players' health in case of concussion was consistent throughout the attitude and intended behaviour sections of the survey. This was evidenced by most of them reporting their supportive role for the doctor if faced with a suspected concussion and acceptance that it is the doctors' decision to remove a player (even if they did not agree). These statements are particularly reassuring towards developing a protective culture, given the influence coaches may have on players' behaviours (McKay et al. 2014; Hendricks and Lambert 2020).

On the contrary, a minority of the coaching staff demonstrated unsafe intended behaviours, by challenging the doctor's decision on removing a player with suspected concussion and suggesting accelerating the return-to-play, justified by match or player importance and to ensure a positive team result. These motivations for unsafe attitudes were consistent with previous reports of players (Williams et al. 2016; Tadmor et al. 2023). The high pressure for results, along with the large responsibility placed over coaches, may aggravate such attitudes and behaviours. Developing a collaborative work culture between the coaches, performance, and medical staff within a team may assist offloading the perceived pressure from the coaches, as well as increasing their perceived confidence in the team doctors' decision over players' health.

Players showed inconsistencies to health-driven attitudes both towards themselves and their teammates. For example, only 52% of players reported they would always declare concussion symptoms, and some indicated they could overrule the doctor's lead during on-pitch assessments (i.e., would try to actively help their teammates by moving their tongue if faced with a suspected concussion or would challenge the doctors' decision to remove herself or a teammate from the pitch). Although the limitations found in concussion knowledge of players in this study

could be a potential explanation for these attitudes, not reporting or under-reporting symptoms have been observed in both women's and men's elite football (Broglio et al. 2010; Williams et al. 2016; Shafik et al. 2022), even with good knowledge index (Shafik et al. 2022). Additionally, fewer players reported to challenge the doctors' decision to remove the player from the pitch if faced with a suspected concussion from their teammates than from herself (4% would challenge the doctors' decision to remove a teammate vs 8% to remove themselves). Willingness to keep playing was the most cited justification in both cases of reporting symptoms and attitudes if disagreeing with doctor's decisions, which is also in line with previous studies (Williams et al. 2016).

Effective strategies to influence players' attitudes and behaviours regarding concussion are yet to be understood. For instance, recent reviews support education effectiveness on improved knowledge, though suggest limited effects on attitudes around concussion (Mrazik et al. 2015; Conaghan et al. 2021). However, different strategies for education (i.e., collaborative, interactive vs informative) should be further explored. Importantly, more than 80% of all respondents reported to be interested in receiving concussion education, suggesting increased motivation and engagement if presented with an education campaign. This opens an important opportunity for football organisations at all levels to partner with research institutions to educate women's football stakeholders and assess the program's effectiveness.

Strengths and limitations

This is the first study to assess knowledge, attitudes and intended behaviours of elite women's football coaching staff and players within a national team context. Respondents represented all confederations; however, we have not asked whether they work or play in their countries' domestic leagues, and therefore cannot confirm that the results represent concussion background in all continents. In addition, the response rate was 31% and 32% for players and coaching staff, respectively, introducing the possibility of response bias, particularly to individuals interested or aware of the topic.

Some questions were misunderstood by responders, leading to unused answers. This can be prevented in future studies with further piloting and validation. Additionally, given the survey was distributed before the deadline for Teams' registration in the FIFA Women's World Cup 2023, we cannot guarantee all staff and players in fact participated in the tournament. Finally, strictly de-identifiable information was collected to avoid perceived pressure disengaging participation. This removed the possibility to prevent double answers, though no identical response was identified.

Conclusion

Both coaching staff and players participating in the FIFA Women's World Cup 2023 showed limited knowledge about symptoms, risks, and the management of concussion. Only a minority feel confident in recognizing a concussion on the

pitch. Most coaching staff reported attitudes and intended behaviour towards protecting the players' health, such as respecting medical staff's decision on assessment and return to play. Most player responses also suggest that they respect the doctor's decisions related to diagnosis and management of a suspected concussion, though only half would always report concussion symptoms on the pitch.

Practical application

Results from this study shows concussion knowledge, attitudes and behaviour of both coaching staff and players in professional women's football can be improved, and the high rate of concussion-education interest supports the implementation of knowledge transfer programs globally.

Some results from this study were presented to the national team doctors during the FIFA Women's World Cup 2023 pre-tournament meeting, where they were encouraged to reinforce key messages with their team staff and players. A population-specific, global concussion awareness and education program with content tailored towards sensitive findings of this study's results is also being developed by FIFA. To be effective globally, confederations, national teams, stakeholders' unions, academic institutions, and clubs are invited for a joint effort towards safeguarding players' health.

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author.

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