



# Sport-related concussion in soccer –a scoping review of available guidelines and a call for action to FIFA & soccer governing bodies

Andreas K. Demetriades<sup>a,b,\*</sup>, Imran Shah<sup>b,1</sup>, Niklas Marklund<sup>c,d</sup>, Hans Clusmann<sup>e</sup>, Wilco Peul<sup>a</sup>

<sup>a</sup> Leiden University Neurosurgical Center Holland, HMC-HAGA the Hague & LUMC Leiden, Netherlands

<sup>b</sup> Department of Neurosurgery, Royal Infirmary, Edinburgh, UK

<sup>c</sup> Department of Clinical Sciences Lund, Neurosurgery, Lund University, Lund, Sweden

<sup>d</sup> Department of Neurosurgery, Skåne University Hospital, Lund, Sweden

<sup>e</sup> Department of Neurosurgery, RWTH Aachen University Hospital, Aachen, Germany

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## ABSTRACT

**Introduction:** Sport-related concussions (SRC) have been a concern in all sports, including soccer. The long-term effects of soccer-related head injuries are a public health concern. The Concussion in Sport Group (CISG) released a consensus statement in 2017 and several soccer governing associations have published their own SRC guidelines while referring to it but it is unclear whether this has been universally adopted.

**Research question:** We aimed to investigate whether guidelines published by soccer associations have any discrepancies; and the extent to which they follow the CISG recommendations.

**Materials and methods:** A scoping review of available soccer-specific SRC guidelines was performed via databases PubMed, Google Scholar, and official soccer association websites via web browser Google. The inclusion criteria were soccer-specific SRC guidelines. Comparisons between guidelines were made concerning the following index items: initial (on-site) assessment, removal from play, re-evaluation with neuroimaging, return-to-sport protocol, special populations, and education.

**Results:** Nine soccer associations with available guidelines were included in this review. Guidelines obtained were from official associations in the United Kingdom, United States of America, Canada, Australia, and New Zealand. When compared to each other and the CISG recommendations, discrepancies were found within guidelines regarding the index items. Additionally, major soccer associations in some countries famous for soccer were found to have not published any publicly available guidelines.

**Discussion and conclusion:** SRC guidelines from different soccer associations contain discrepancies which may be detrimental to athletes, both short and long-term. We recommend that all major soccer governing associations publish guidelines that are standardised and accessible to all athletes.

## 1. Introduction

A concussion can be defined as a transient and sudden alteration of consciousness following traumatic biomechanical forces transmitted to the brain either directly or indirectly (Khurana and Kaye, 2012). Sport-related concussion (SRC) has been a growing concern over several years and has been attracting further attention amongst athletes and healthcare professionals due to recently publicised effects on both their immediate and long-term neurological health. Soccer is a sport with

high concussion rates in comparison with others (Pierpoint and Collins, 2021). The injury rates amongst athletes of the National Collegiate Athletic Association (NCAA) being 0.28 and 0.41 per 1000 game exposures for male and female soccer athletes respectively. This is in comparison with other contact sports such as men's wrestling (0.25), American football (0.37), basketball (0.16), ice hockey (0.41); and women's basketball (0.22), gymnastics (0.16), and field hockey (0.18) (Hootman et al., 2007). High concussion rates were also seen in a 2020 study by Vedung et al., where the concussion incidence was 1.19 per

\* Corresponding author. Department of Neurosurgery, Royal Infirmary, Edinburgh, UK.

E-mail address: [andreas.demetriades@gmail.com](mailto:andreas.demetriades@gmail.com) (A.K. Demetriades).

<sup>1</sup> shared first co-authorship with both authors having equally contributed to the realisation of the study.

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1000 game hours (Vedung et al., 2020).

Recent evidence from 2019 (Scotland) and 2023 (Sweden) showed that former elite soccer players are more likely to die from neurodegenerative disease, which was attributed to the frequency of concussions and repetitive heading during their playing days (Mackay et al., 2019; Ueda et al., 2023). There has also been coverage from mainstream media reporting on former athletes that have developed neurodegenerative disease after sustaining SRC's during their playing careers. For example, in an article from 2020, forty ex-soccer players were reported to take legal action against the English Football Association for dementia-related negligence due to brain injuries sustained (PA Media, 2020). Increasing attention has therefore been brought to this issue, which has raised questions on the effectiveness and utilisation of concussion protocols currently in place.

The Concussion In Sport Group (CISG) is a multi-sport organisation established in 2002 that has been involved in the evaluation, management and prevention of SRCs with six international conferences held since then to summarise these recommendations into consensus statements (Concussion in Sport Group, 2023a). Currently, these are endorsed by several sporting organisations such as the International Hockey Federation, the International Olympic Committee, World Rugby as well as the International Federation of Association Football (FIFA), the international governing body of soccer (Patricios et al., 2023). The 5th International Conference on Concussion in Sport took place in Berlin (2016), and a consensus statement was published in 2017 by the CISG summarising the recommendations from this conference (McCroory et al., 2017). Different sporting organisations have since gone on to publish their own concussion protocols based on this consensus statement. So far, there have been studies on the implementation of the CISG recommendations into official guidelines. However, these studies were not soccer-specific and looked at guidelines published by associations of different sports internationally (Davis et al., 2020; Scullion and Heron, 2022). The rationale behind this current project is to summarise concussion guidelines published by different soccer organisations internationally given the enormous popularity of the sport and a lack of clarity whether these guidelines are standardised. A summary of this information would enable detailed comparisons which can then be used as a template to further improve concussion protocols. This would then reduce the risk of long-term adverse effects to athletes. Currently, there are no studies that have specifically analysed SRC soccer guidelines. Thus, the aim of this study was to investigate whether there are discrepancies between SRC guidelines published by soccer associations, and to what extent these guidelines follow the CISG recommendations.

## 2. Methods

This was a scoping review conducted in line with the guidelines from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher et al., 2009), aiming at obtaining a summary of the similarities and differences between different SRC guidelines available.

### 2.1. Eligibility criteria

Guidelines were included if they were published by official soccer associations, based upon the consensus statement released by the CISG in 2017, and if they were publicly available. Guidelines were excluded if they were published by non-official soccer associations, and if they were not soccer specific.

### 2.2. Data sources and search

Searches were performed via web browser Google to identify suitable guidelines published by official soccer associations internationally, that were available on their official websites. An electronic search was also conducted through medical databases including PubMed and Google Scholar. These databases were used as they allowed extensive coverage

of biomedical literature relevant to the topic of concussion. PubMed is one of the most widely used and accessible biomedical resources available, and is known to have an extensive coverage of journals with 91 % of all PubMed content being indexed in MEDLINE, the National Library of Medicine's journal citation database (Ossom Williamson and Minter, 2019). Additionally, we used Google Scholar to identify any relevant studies surrounding sports related concussions that might not have been indexed in PubMed, as Google Scholar has been shown to be a useful supplementary search tool when used with other traditional search methods such as PubMed (Haddaway et al., 2015). Through these searches, we were able to identify guidelines, assessment tools, and articles that were relevant to the medical aspect of sports related concussions in soccer.

The search terms used were "football AND concussion guidelines", "soccer AND concussion guidelines", "soccer AND return to play", "football AND return to play", and "sports related concussion AND soccer". The rationale behind these terms was due to the variety of terms synonymous to "soccer" such as "football", as used by different regions of the world. Due to the specificity of this review, no additional terms were used. This allowed identification of articles and guidelines focusing on concussions occurring specifically within the sport of soccer.

### 2.3. Data extraction and synthesis

Guidelines identified were analysed and compared with each other based on several index items: initial (on-site) assessment, removal from play, re-evaluation with neuroimaging, return-to-sport protocol, special populations, and education.

## 3. Results

The initial literature search revealed various sources of available SRC guidelines. Overall, 35 records were identified; seven records were identified through database searches and 28 records through web searches. When limiting the search to the eligibility criteria, the number of articles meeting the inclusion criteria was limited to 14 (Fig. 1). The most common reason for exclusion was that they were not specific to soccer, or that they were not official guidelines. For example, three studies appeared to meet the inclusion criteria but were excluded as they were related to American football and Gaelic football, but not soccer. The guidelines identified are listed in Table 1, while assessment tools are listed in Table 2.

The CISG consensus statement served as a reference point for the guidelines published by the different soccer governing associations in this review. When comparing the guidelines to each other and to the CISG recommendations, discrepancies were found in the content of the guidelines regarding the following index items:

### 3.1. Initial (On-site) assessment

The SCAT-5 tool lists parameters such as signs, symptoms, balance impairment, behavioural changes, and cognitive impairment in the suspected diagnosis of an SRC. It also gives details regarding on-field assessment (Red flag symptoms, Observable signs, Maddocks questions, GCS examination, Cervical spine assessment, cognitive screening (orientation, immediate memory, concentration) and neurological screening (balance exam) (Echemendia et al., 2017a; Sport concussion assessment tool, 2017). There are similarities and minor differences between the guidelines, especially with regards to which assessment tool they list or recommend (Tables 3 and 4).

### 3.2. Removal from play

The CISG states that players should be removed from play and if a diagnosis of concussion is confirmed, they are not allowed to return-to-play on the same day. The guidelines identified follow this consensus but

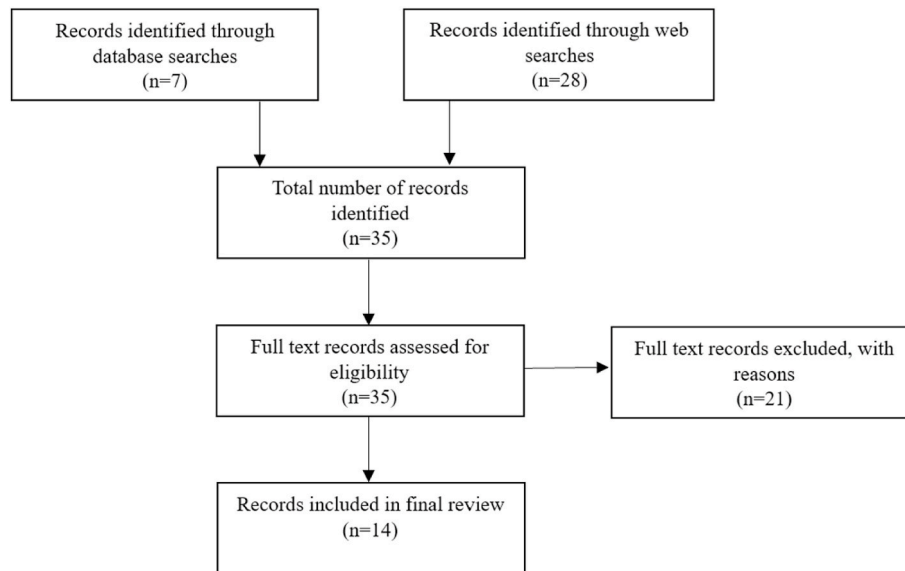


Fig. 1. Selection Process of records.

there are minor differences noted. These differences were mainly the terminology ‘suspected concussion’ and whether players were allowed to return-to-play on the same day.

### 3.3. Re-evaluation with neuroimaging

The CISG consensus statement states that an athlete with a SRC in a follow up examination should be determined as to whether they require neuroimaging to exclude a more severe brain injury. However, only one of the guidelines in this study mentions any use of neuroimaging. Guidelines published by FIFA recommend an initial computerised tomography (CT) scan on the day of the injury if any of the following features are present: “Glasgow Coma Scale score <13 or < 15 after 2 h”, “suspected skull fracture”, “more than one episode of vomiting”, “seizure post-injury”, “loss of consciousness”, “persistent anterograde amnesia”, and “any focal neurological deficit”.

### 3.4. Return-to-sport protocol

The CISG recommend an initial period of rest of 24–48 h as part of the return-to-sport protocol, after which they should be asymptomatic. Following this, a step-wise approach is followed, known as the Graduated Return-to-Sport (GRTS) strategy (Table 6) (McCroory et al., 2017). There are six steps in total, each taking at least 24 h to progress through. A player should only be allowed to progress through these steps if there are no worsening of symptoms. If any concussion symptoms were to occur, the player should move back to the previous stage and only attempt to progress after being asymptomatic for a further 24 h. The CISG also states that the earliest return-to-sport is after one week. The guidelines identified all follow this six-step protocol, but with differences (Table 7).

### 3.5. Special populations in return-to-sport

The consensus statement from the CISG have also considered whether certain populations should be managed differently as regards return-to-sport.

#### 3.5.1. Elite and non-elite athletes

The CISG states that all athletes regardless of playing level, should be managed using the same management principles. However, two associations list a *Standard care pathway* for the public and an *Enhanced care*

*setting* regarding return-to-sport (Table 7). The enhanced care setting is generally used for players in professional clubs and academies. The criteria to progress through this pathway are; available doctor with training and experience in the management of SRC and the presence of a structured concussion management programme.

#### 3.5.2. Children and adolescent athletes

The CISG state that both children and adolescents should be categorised as those aged 5–12 years and 13–18 years respectively. Some of the guidelines have listed different return-to-play time frames based on age (Table 7).

#### 3.5.3. Female athletes

The CISG consensus statement does not list any specific protocol for women regarding initial management or return-to-sport and neither do any of the guidelines in this study.

### 3.6. Education and baseline testing

The CISG have also mentioned the value of education and have encouraged everyone involved in the sport to educate themselves about SRC features, assessment, and return-to-sport principles. They also mention prevention strategies to reduce the prevalence of SRC and made a recommendation for stricter rules for the enforcement of red cards in the event of high elbows in heading duels. Some of the guidelines studied have mentioned education programmes or pre-season baseline testing (Table 8).

## 4. Discussion

### 4.1. Availability of guidelines

When conducting this review, it was found that several nations famous for soccer, such as Brazil, France, Germany, and Spain were found to not have any guidelines published by their respective associations when accessing their official websites (Confederação Brasileira de Futebol, 2023; Française de Football, 2023; Deutscher Fußball-Bund, 2023; Real Federación Española de Fútbol, 2023). Despite this, there are associations such as the German Football Association (DFB) who were found to have listed some links on their website directing us to external guidelines from the Association of Scientific Medical Societies (AWMF) on the management of traumatic brain injuries. These guidelines

**Table 1**  
List of soccer concussion guidelines.

Association	Guideline URLs	Access Date
<b>Concussion In Sport Group</b> (McCrory et al., 2017)	<a href="https://bjsm.bmj.com/content/bjsports/51/11/838.full.pdf">https://bjsm.bmj.com/content/bjsports/51/11/838.full.pdf</a>	24 <sup>th</sup> January 2023
<b>International Federation of Association Football</b> (Fédération Internationale de Football Association (FIFA), 2022)	<a href="https://digitalhub.fifa.com/m/11dc529ca641c307/original/FIFA-Medical-Concussion-Protocol.pdf">https://digitalhub.fifa.com/m/11dc529ca641c307/original/FIFA-Medical-Concussion-Protocol.pdf</a>	14 <sup>th</sup> February 2023
<b>England Football Association</b> (The Football Association, 2019)	<a href="https://www.thefa.com/get-involved/fa-concussion-guidelines-if-in-doubt-sit-the-m-outold">https://www.thefa.com/get-involved/fa-concussion-guidelines-if-in-doubt-sit-the-m-outold</a>	24 <sup>th</sup> January 2023
<b>Scottish Football Association</b> (Scotland, 2018)	<a href="https://sportsotland.org.uk/media/3382/concussionreport2018.pdf">https://sportsotland.org.uk/media/3382/concussionreport2018.pdf</a>	24 <sup>th</sup> January 2023
<b>Football Association Wales</b> (Wales, 2019)	<a href="https://www.faw.cymru/files/9715/7130/3629/FAW_Concussion_G.pdf">https://www.faw.cymru/files/9715/7130/3629/FAW_Concussion_G.pdf</a>	24 <sup>th</sup> January 2023
<b>United States Soccer Federation</b> (Soccer, 2019)	<a href="http://www.recognizetorecover.org/head-and-brain#concussions">http://www.recognizetorecover.org/head-and-brain#concussions</a>	20 <sup>th</sup> February 2023
<b>National Collegiate Athletic Association United States of America</b> (NCAA Sports Science Institute, 2021)	<a href="https://s3.amazonaws.com/ncaaorg/ssi/concussion/2021_Concussion_Safety_Protocol_Checklist.pdf">https://s3.amazonaws.com/ncaaorg/ssi/concussion/2021_Concussion_Safety_Protocol_Checklist.pdf</a>	20 <sup>th</sup> February 2023
<b>Canada soccer</b> (Canada Soccer Sports Medicine Committee, 2018)	<a href="https://canadasoccer.com/wp-content/uploads/2020/11/2018_Concussion_Policy_Digital_EN.pdf">https://canadasoccer.com/wp-content/uploads/2020/11/2018_Concussion_Policy_Digital_EN.pdf</a>	20 <sup>th</sup> February 2023
<b>Football Federation Australia</b> (Football Federation Australia, 2018)	<a href="https://www.footballaustralia.com.au/sites/ffa/files/2018-01/18-0102%20FFA%20Concussion%20Guidelines%20(final).pdf">https://www.footballaustralia.com.au/sites/ffa/files/2018-01/18-0102%20FFA%20Concussion%20Guidelines%20(final).pdf</a>	28 <sup>th</sup> January 2023
<b>New Zealand Football</b> (New Zealand Football, 2018)	<a href="https://fit4football.co.nz/wp-content/uploads/2021/04/NZF-Concussion-Policy-Updated.pdf">https://fit4football.co.nz/wp-content/uploads/2021/04/NZF-Concussion-Policy-Updated.pdf</a>	28 <sup>th</sup> January 2023

Note: International Federation of Association Football (FIFA); England Football Association (England FA); Scottish Football Association (Scottish FA); Football Association Wales (FA Wales); United States Soccer Federation (US Soccer); National Collegiate Athletic Association United States of America (NCAA USA); Football Federation Australia (FFA); New Zealand Football (NZF).

**Table 2**  
List of assessment tools.

Assessment Tool	URL	Access Date
SCAT-5 (Echemendia et al., 2017a; Sport concussion assessment tool, 2017)	<a href="https://bjsm.bmj.com/content/bjsports/early/2017/04/26/bjsports-2017-097506SCAT5.full.pdf">https://bjsm.bmj.com/content/bjsports/early/2017/04/26/bjsports-2017-097506SCAT5.full.pdf</a>	24 <sup>th</sup> January 2023
SCAT-5 Child (Davis et al., 2017)	<a href="https://bjsm.bmj.com/content/bjsports/early/2017/04/26/bjsports-2017-097492childscat5.full.pdf">https://bjsm.bmj.com/content/bjsports/early/2017/04/26/bjsports-2017-097492childscat5.full.pdf</a>	24 <sup>th</sup> January 2023
CRT-5 (Echemendia et al., 2017b)	<a href="https://bjsm.bmj.com/content/51/11/872">https://bjsm.bmj.com/content/51/11/872</a>	28 <sup>th</sup> January 2023
Pocket recognition tool (Concussion in Sport Group, 2013a, 2013b)	<a href="http://bjsm.bmj.com/content/47/5/267.full.pdf">http://bjsm.bmj.com/content/47/5/267.full.pdf</a>	29 <sup>th</sup> January 2023

Note: SCAT-5: Sports concussion assessment tool – 5th edition, CRT-5: Concussion recognition tool 5, Pocket Recognition Tool (PRT).

**Table 3**  
Similarities in initial assessment and management.

Association	Similarities		
	SCAT5 tool	Red flag symptoms	Advice given
<b>FIFA</b>	Yes	Yes	Yes
<b>England FA</b>	Yes	Yes	Yes
<b>Scottish FA</b>	No	Yes	Yes
<b>FA Wales</b>	Yes	Yes	Yes
<b>US Soccer</b>	Yes	Yes	No
<b>NCAA USA</b>	No	Yes	No
<b>Canada Soccer</b>	No	Yes	Yes
<b>FFA</b>	Yes	No	Yes (- no alcohol consumption in first 24 h)
<b>NZF</b>	No	No	Yes

Note: Advice given: should not be left alone for first 24 h, no alcohol consumption in first 24 h and no driving until provided with medical clearance or until free of symptoms.

**Table 4**  
Differences in initial assessment and management.

Association	Differences	
	Assessment tools listed	Other
<b>FIFA</b>	SCAT-5	Mentions an eight-phase systemic approach in the first 72 h after head injury. Also mentions use of the National Institute of Health and Care Excellence (NICE) criteria
<b>England FA</b>	PRT	SCAT-5 used in Enhanced care setting
<b>Scottish FA</b>	None listed	
<b>FA Wales</b>	SCAT-5 PRT	SCAT-5 used in Enhanced care setting
<b>US Soccer</b>	SCAT-5	
<b>NCAA USA</b>	None listed	States that medical personnel with training in the management of acute concussion must be present at all NCAA competitions
<b>Canada Soccer</b>	CRT-5	
<b>FFA</b>	SCAT-5 PRT	Does not list any red flag symptoms, neck or cervical spine injury
<b>NZF</b>	PRT ACC SportSmart Concussion card	Mentions how to manage an unconscious athlete using DR-ABC-S (Danger, Response, Airway, Breathing, Circulation, Send for help)

however, were not specific to soccer and were not published by the DFB themselves (AWMF Online, 2022; Firsching et al., 2015). Some associations have also referenced the use of FIFA’s concussion protocol rather than having published their own guidelines, as seen with the Argentine Football Association (AFA) listing this protocol on its website with a version translated into the Spanish language (Fédération Internationale de Football Association, 2020a; Argentine Football Association, 2022).

Some governing associations of these nations, including FIFA, have also endorsed the use of the SCAT-5 (Fédération Internationale de Football Association, 2020b). The SCAT-5 assessment tool was developed and published in English by the CISG. However, there are a considerable amount of people from other nations that do not speak English as their first language and thus, would limit its use. As far as we are aware, the only other languages that the SCAT-5 tool is available in, are; Czech, Danish, Deutsch, Finnish, French, German, Hebrew, Persian, Portuguese, Russian, and Spanish (Concussion in Sport Group, 2023b). These translations of the SCAT-5 were publicly available on the CISG official website. We have also managed to identify other translations of the SCAT -5, not published by the CISG, that were specifically in Arabic and Swedish (Holtzhausen et al., 2021; Concussion In Sport Group, 2022). However, there are also versions of the SCAT-3 tool available in

**Table 5**  
Differences in Removal from Play after suspected concussion.

Association	Differences	
	Return-to-play on the same day allowed	Note
FIFA	Yes	Players are allowed to return-to-play on the same day if no orange or red flag symptoms are present, but further observation is needed until leaving the sports facilities
England FA	No	
Scottish FA	No	
FA Wales	No	
US Soccer	Yes	If given medical clearance
NCAA USA	Yes	After evaluation by an athletic trainer or team physician with concussion experience
Canada Soccer	Yes	If no concussion symptoms or signs are reported and after being reviewed by a licensed healthcare professional with expertise in concussion management
FFA	Yes	If given medical clearance by a medical practitioner
NZF	Yes	If given clearance by a qualified medical doctor

**Table 6**  
Graduated Return-to-Sport strategy.

Stage	Aim	Activity	Goals
1	Symptom limited activity	Daily activities that do not provoke symptom	Gradual introduction of work or school activities
2	Light aerobic exercise	Walking, jogging at a slow to medium pace, with no resistance training	Increase heart rate
3	Sport specific exercise	Running drills, no head impact activities	Add movement
4	Non-contact training	Passing drills, progressive resistance training	Exercise, coordination and increased thinking
5	Full contact practice	Following medical clearance, participate in normal training activities	Restore confidence and assess functional skills
6	Return to sport	Normal game play	

other languages such as Chinese and German (Yeung et al., 2018; Concussion In Sport Group, 2013a, 2013b) but this version of the SCAT is based on the consensus statement for the 4th International Conference on Concussion in Sport, held in 2012 (Guskiewicz et al., 2013). It would be beneficial for the CISG, FIFA, and its continental counterparts to create translated versions of the SCAT-5 in more languages to be more inclusive. In addition to having their own SRC guidelines, FIFA have also published a first aid booklet. This booklet was designed to act as a manual for non-medically qualified First Aiders and coaches for the management of different types of injuries, not exclusive to only head and neck injuries (Hodgson and Kramer, 2015). This booklet goes into details such as the initial assessment, immediate management on the field of play, management of an unconscious player, and lists the PRT within its booklet. There is also a section that addresses spinal injuries including those of the cervical spine and details how to safely immobilise it during the initial assessment and management of a player with suspected cervical injury. One of FIFA’s continental counterparts, the Union of European Football Associations (UEFA)- was found to have not published any SRC guidelines, but instead has released a concussion “charter” designed for club and national teams taking part in competitions (Union of European Football Associations, 2021). This charter included a head injury procedure as well as a video directed at players, explaining how to recognise, report and remove a player from the field of play after a suspected concussion. The head injury procedure included within this charter does not include any detailed methods on assessing a

**Table 7**  
Differences in Graduated return-to-sport protocol.

Association	Differences		
	Initial rest period	Earliest return-to-sport	Other
FIFA	N/A	N/A	Players should be re-examined by the physician in charge within 72 h after the initial injury and before starting Stage 5.
England FA	Standard care: 14 days Enhanced care: 24 h for adults, 7 days for those under 19 years	Standard care: Day 19 for adults, Day 23 for those under 19 years of age  Enhanced care: Day 6 for adults, Day 12 for those under 19 years of age	Standard care: each stage takes 48 h in those under 19 years of age  Medical clearance required before entering stage 5 of GRTP and recommended before stage 2
Scottish FA	7 days for adults 14 days for those under 19 years of age	Day 12 for adults Day 23 for those under 19 years of age	Each stage takes 24–48 h in adults and 48–72 h in those under 19 years of age
FA Wales	Standard care: 14 days  Enhanced care: 24 h for adults, 7 days for those under 19 years	Standard care: Day 19 for adults, Day 23 for those under 19 years of age  Enhanced care: Day 6 for adults, Day 12 for those under 19 years of age	Standard care: each step takes 48 h in those under 19 years of age  Medical clearance required before entering stage 5 of GRTP and recommended before stage 2
US Soccer	N/A	N/A	Progression from Stage 1–2 of GRTP does not require the athlete be completely asymptomatic Medical Clearance required before progressing to Controlled Contact & Full contact practice
NCAA USA	N/A	Day 6	Return to sport needs to be approved by Team physician or medically qualified physician degree Return to learn should occur first before return-to-sport

(continued on next page)



Table 7 (continued)

Association	Differences		
	Initial rest period	Earliest return-to-sport	Other
Canada Soccer	N/A	N/A	Each stage should take longer than 24 h in those 18 years of age and younger Medical clearance required before entering Stage 3 and Stage 5
FFA	14 days if not managed by a medical practitioner	N/A	N/A
NZF	N/A	N/A	N/A

Note: N/A: No differences to the CISG recommendations.

Table 8  
Education.

Association	Differences		
	Baseline testing	Education programme	Note
FIFA	Yes	No	SCAT-5 tool is recommended for baseline examinations
England FA	Yes	Yes	Both mentioned in Enhanced care setting only
Scottish FA	No	No	Both mentioned in Enhanced care setting only
FA Wales	Yes	Yes	
US Soccer	Yes	No	All athletes receive an annual pre-season baseline testing
NCAA USA	Yes	Yes	Pre-participation baseline concussion assessment and pre-season concussion education plan
Canada Soccer	No	Yes	Baseline testing not recommended
FFA	No	No	
NZF	No	No	

player or any return-to-sport protocol. However, the head injury procedure does state that the initial assessment should take no longer than 3 min unless a more serious injury is suspected, after which, the player should not be allowed to return to play unless given clearance from the team doctor.

#### 4.2. Initial (on-site) assessment

The CISG stated that the SCAT-5 tool was the most well-established tool for side-line assessment of SRC (McCrory et al., 2017) and that it was designed to be used by medical professionals, while the CRT-5 is designed for the use of the general public. While all the guidelines reviewed in this study mention the basic signs and symptoms to identify, some of them do not list any of these two assessment tools. The PRT was released from the CISG in 2013, (Concussion in Sport Group, 2013a, 2013b) not from the latest recommendations, making it an outdated version of the CRT-5. However, it is still listed in four guidelines reviewed (England FA, FA Wales, FFA and NZF).

To adequately assess a suspected SRC, the CISG has stated that the SCAT-5 should take at least 10 min. The minimum time required to properly assess an SRC is not listed in any of the guidelines identified. It

is important to follow this time frame stated as rushing a player back into play may put them at a greater risk. It is unknown whether this is currently being implemented at a professional level but a study done on the 2014 FIFA World Cup showed that the mean time for a suspected concussion assessment was 1 min 47 s, indicating a gap between the current protocol and actual practice (Salvarani et al., 2020).

Most of the guidelines in this study list several red flag symptoms that are important to recognise when assessing a player, however not all of them elaborate further on these symptoms and the possible repercussions that could ensue. On the other hand, the guidelines published by FIFA go into detail about these red flag symptoms and clearly state that these symptoms could be potentially life threatening if not managed appropriately (Fédération Internationale de Football Association (FIFA), 2022). They have also listed additional symptoms, classed as ‘orange flags’, which are less severe than red flag symptoms, but that could potentially cause neurological or musculoskeletal impairment to the player. It would be beneficial for all guidelines to include more information including possible orange flag symptoms within their guidelines, as it could improve the chances of detecting any potentially dangerous injuries to players.

#### 4.3. Removal from play

There are minor discrepancies with regards to return-to-play on the same day after a suspected concussion (Table 5). After being removed from play, some guidelines state that players with a ‘suspected’ concussion would be allowed to return-to-play on the same day if they have been medically cleared to do so while other guidelines state that no return-to-play should happen that day. This discrepancy is an area of concern as one study has identified delayed onset of symptoms in a group of players with a suspected concussion who returned to play on the same day (Guskiewicz et al., 2003). A 2018 study showed that immediate removal from play was associated with less time lost from playing as well as shorter period of symptoms when compared with a delayed removal from play (Asken et al., 2018).

Looking at a scenario where different guidelines were used to decide on removing an athlete from play after a suspected concussion, some guidelines would not allow return-to-play on the same day but other guidelines would. The difference in outcomes between these two scenarios may be vastly different in the long term. In the case where an athlete was not allowed return-to-play that same day, they may be formally assessed by a medical professional much sooner. Their recovery would be closely monitored and a structured approach to rehabilitation followed. Whilst in another scenario, an athlete would continue playing, risking possible aggravation of the initial injury during this period of vulnerability. This could then lead to them having delayed onset of symptoms, delaying the time to be seen by a medical professional, possibly developing more severe symptoms, and having an overall poorer outcome (Guskiewicz et al., 2003; Asken et al., 2018).

More studies need to be done to evaluate whether returning to play on the same day as a ‘suspected’ concussion is safe for an athlete or whether there needs to be a consensus statement stating there should be no return-to-play at all on the same day. However, implementing an immediate removal from play will be challenging due to soccer’s socioeconomic influence. Teams would want their players back on the pitch as quickly as possible. In several reports, removal from play following SRC is common. In addition, athletes have also been found not to disclose their injuries, plausibly since they want to continue the game-play (Asken et al., 2016; McCrea et al., 2004). Additionally, this is also seen at the professional level with one example being at the UEFA Euro 2020 tournament. Whilst UEFA had claimed that protocols were followed, there was controversy where Benjamin Pavard suffered a head injury and was reported to have lost consciousness for a moment, but was allowed to continue playing (Sports, 2021). Another similar incident occurred with Nordin Amrabat in the 2018 World Cup tournament where after sustaining a concussion and subsequent memory loss for 6 h

in one game, was allowed to return to play just 5 days later (Hytner, 2018).

#### 4.4. Neuroimaging

The 2017 CISG recommendations state that neuroimaging should be used to exclude a more severe brain injury on re-evaluation (McCroory et al., 2017). However, they did not specify the type of neuroimaging to be used such as computed tomography (CT) or magnetic resonance imaging (MRI). They have mentioned that there is still insufficient evidence for advanced neuroimaging to be used routinely in the clinical setting. Within this review, only the guidelines issued by FIFA mention the indications of neuroimaging in the management of SRC (Fédération Internationale de Football Association (FIFA), 2022). A study done in 2017 has shown that there is evidence of significantly altered brain structure and function at the time of acute injury and at return-to-play after being imaged with diffusion tensor imaging (DTI), an advanced MRI technique that detects microstructural changes in brain tissue (Churchill et al., 2017). A 2013 study investigated the use of Magnetic Resonance Spectroscopy to detect levels of N-acetylaspartate (NAA) and Creatine (Cr) in the brains of 11 athletes following a concussion. The levels of NAA and Cr are metabolic markers of the functional status of the brain, with lower levels indicating dysfunction (Watanabe et al., 2004). This study concluded that athletes who have suffered a concussion may have decreased cerebral NAA and Cr levels, indicating a longer time for the normalisation of metabolism within the brain (Vagnozzi et al., 2013). As present, imaging tools only serve to rule out more severe brain injury (Patricios et al., 2023; McCroory et al., 2017). More studies need to be done to determine if the use of neuroimaging would improve outcomes in athletes suffering from SRCs before it can be fully implemented routinely and as part of soccer SRC guidelines.

#### 4.5. Return-to-sport protocol

Discrepancies in the Graduated Return-To-Sport (GRTS) protocol within different guidelines were mainly found when looking at the recommended initial rest period, which ranges from 24 h to 14 days. This inevitably affected the earliest time to return-to-play. This large variation can be attributed to the ongoing discussions regarding what the optimal amount of rest is. Some studies have shown that extended periods of rest do not offer any benefits (Thomas et al., 2015). Strict physical rest immediately following a SRC until symptom resolution has also been shown to not be effective (Leddy et al., 2023). Rather, light intensity physical activity such as walking during the initial rest period after suffering an SRC facilitates recovery. In addition, prescribed aerobic exercise is an effective treatment for facilitating recovery and reducing persisting post-concussive symptoms. Athletes should also be advised by the responsible clinician that brief, mild symptom exacerbation during physical activity in this period does not delay recovery.

One of the associations in this study, US Soccer, does not require an athlete to be “completely asymptomatic” to progress from the initial rest period provided there are no increase in symptoms. There was no elaboration as to what “completely asymptomatic” meant which would allow an athlete to progress through this stage. Further clarification is needed from associations regarding this term. The CISG could grade symptoms numerically according to severity, taking SRC and non-specific symptoms into consideration to create a threshold score that an athlete should not exceed to progress through the GRTS.

#### 4.6. Special populations in return-to-sport

There have been considerations for different populations in the management of SRCs. Adolescents are being discussed as to whether they should have separate protocols in place for them. Some guidelines identified have separate GRTS protocols for adolescents with different time frames for progressing through the GRTS (Table 7). The CISG

however, have not listed any specific GRTS protocol tailored towards adolescents and have mentioned that the available literature does not address whether they should be managed differently (McCroory et al., 2017). Guidelines published by FIFA also mention the use of an accelerated return-to-football programme, (Fédération Internationale de Football Association (FIFA), 2022) which should be initiated if any post-injury symptoms or signs are considered as non-specific to concussion; if these symptoms last less than 24 h; and if results of re-evaluation were normal. However, there was no elaboration of a specific timeline for return-to-sport, or if this programme was only reserved for professional athletes.

The discrepancies found in our study could also have several impacts depending on the level of play. For example, some guidelines have separate return-to-sport protocols for professional athletes which list different rest recommendations. The strict physical rest and extended periods of rest suggested for amateur athletes would not offer any benefit to them and may even be detrimental as evidenced by some studies (Thomas et al., 2015; Leddy et al., 2023). This could potentially leave them out from the sport for longer periods of time, impacting their treatment outcome, mental health, and overall well-being. Additionally, amateur athletes would not have the same scope of access to healthcare as professional athletes do, limiting any individualised and specialised care. Thus, the existing discrepancies between guidelines may further affect the quality of concussion management, leading to diverse neurocognitive outcomes.

Currently, none of the guidelines including the CISG recommendations have a separate protocol for female athletes. One study stated that female athletes are at a higher risk of suffering from SRCs especially in soccer, (Hinton et al., 2005) while two other studies have shown that women have prolonged recovery trajectories than male athletes in addition to having worse initial symptoms (Vedung et al., 2020; Baker et al., 2016). Additionally, the discrepancies in guidelines could further contribute to existing lack of clarity in the management of SRCs in female athletes and put them at higher risk of developing poorer outcomes. Further discussion is required on this topic by soccer governing associations to determine whether a specific protocol needs to be developed for female athletes (Musko and Demetriades, 2023).

#### 4.7. Education and baseline testing

There is a lack of education on risk reduction strategies in the guidelines reviewed. One exception is US Soccer that lists information about risk reduction in its guidelines. Methods like the use of soccer-specific headgear have been shown to have no difference in reducing SRC risks and its use is currently not supported (McGuine et al., 2020). Studies have shown that neck strength was a factor in an athlete developing a concussion (Collins et al., 2014; Babbs, 2001). Increased neck strength may lead to reduced head rotation upon impact and thus, reducing the risk for developing a concussion. Although not included in their SRC guidelines, FIFA does have an educational programme to help prevent injuries in various player groups that was initiated in 2009, known as the FIFA 11+ (Bizzini and Dvorak, 2015). Since then, a study was incorporated within the FIFA 11+, which showed that incorporating a neck exercise programme resulted in an increase in isometric neck strength and a decrease in head impact magnitude during heading (Peek et al., 2022). Education on neck strengthening exercises could be made accessible to athletes and implemented into the SRC guidelines as part of a risk reduction strategy.

Baseline testing done during pre-season has become increasingly common in sports, but only some guidelines in this study mention the need for it, with one guideline recommending against it (Table 8). Other notable governing soccer bodies such as the German Football Association (DFB) have also made baseline screening mandatory in its respective professional leagues, stating that any deviations from the baseline obtained pre-season could be used to help diagnose and decide whether an affected player should return to play (Deutsche Fußball Liga, 2019).

Considerations need to be made by the CISG as to whether baseline testing should be mandatory for all athletes to undergo as it could be useful in monitoring the progress of an athlete's recovery post-concussion as well as educating an athlete on SRCs. For example, standardised baseline concussion assessments positively impacted an athlete's perception towards reporting symptoms of concussion and were more likely to sit out when a concussion was suspected (Deuschle et al., 2022).

#### 4.8. Guideline contents

In addition to the current SRC soccer guidelines, further discussion is needed. Topics covered within the CISG consensus statement but not present within the soccer guidelines analysed in this study could be added. For example, details on management of players with persistent post-concussive symptoms, defined as players who remain symptomatic beyond the expected time frames for recovery, which are 10–14 days in adults and more than 4 weeks in children (McCroory et al., 2017). Risk reduction strategies mentioned in this manuscript could also be included into future guidelines as it would be beneficial to not only the medical staff, but for the education of athletes themselves. For uniformity, soccer associations should follow one standardised guideline. There have been studies done looking at trends in clinical practice with regards to standardisation of clinical practice with guidelines to increase the efficiency of managing patients and improving their outcomes (Schoenbaum and Sundwall, 1995). However, there are also studies suggesting that some degree of variation and customisation from guidelines is beneficial when taking into the account the individuality of each patient and their clinical presentation (Musko and Demetriades, 2023; Woolf et al., 1999; Van Haitsma et al., 2020).

#### 4.9. Limitations

This review only included guidelines that were published in the English language as identification of guidelines from non-English speaking countries faced challenges due to linguistic limitations. This was due to our manual search strategy which was used. Guidelines from non-English speaking countries were not identified on our selected databases nor available publicly on official association websites that were screened. For example, no guidelines were found when specifically screening official websites of soccer associations from countries such as Brazil, France, Germany, and Spain (Confederação Brasileira de Futebol, 2023; Française de Football, 2023; Deutscher Fußball-Bund, 2023; Real Federación Española de Fútbol, 2023). This limitation could potentially impact our study's ability to capture the global perspective on the assessment and management of sports related concussions in soccer. We recognise the importance of looking at literature from a global perspective to eliminate language bias. In future research, strategies could be put in place to incorporate a broader range of international guidelines such as using multilingual medical databases, collaborating with concussion experts from all parts of the world, and reaching out to representatives of regional soccer associations in non-English speaking countries. The search specifically looked at guidelines for soccer and therefore if generic sport guidelines only included soccer in a small portion in the text, it may have been missed. Generic guidelines were also not specifically screened for more relevant components and did not come up in the search.

### 5. Conclusion

This scoping review identified discrepancies between soccer-specific SRC guidelines published by different official bodies. The major discrepancies identified were found in the timeframes for the return-to-sport protocol; the time recommended for the initial rest phase; and the decision to allow same day return-to-play after a suspected concussion. Possible implications of these discrepancies are that athletes

could be managed in vastly different ways without any clarity on which guidelines would be best. This could lead to outcomes where, for example, athletes could be rested for too long or the opposite where athletes could be rushed back into play prematurely. Furthermore, the discrepancies could be putting certain populations at a higher risk of subsequently poorer neurocognitive outcomes after sustaining a concussion; for example, amateur athletes that do not have access to facilities like an individualised management plan with close monitoring of their progression through the different steps of the return-to-sport protocol. Due to the lack of studies in this area, it is unclear whether these discrepancies are detrimental to athletes and whether they may pose a risk, both at short-and long term. Soccer is one of the most popular sports in the world and SRCs continue to be a relevant issue. This is a field of growing interest amongst healthcare professionals and considerations for additional specific information about risk prevention and the use of neuroimaging should be made to include them within future guidelines.

It is fortunate that the most recent update from the CISG was concluded with the 6th International Conference on Concussion in Sport, held in 2022 (Patricios et al., 2023). This consensus statement was only just published in June 2023 and includes updated strategies for return-to-sport and material such as the Sport Concussion Assessment Tool-6 (SCAT-6), the Child SCAT-6, the Concussion Recognition Tool-6 (CRT-6), the Sport Concussion Office Assessment Tool-6 (SCOAT-6), and the Child SCOAT-6. These updates provide a fresh opportunity for soccer associations to update their guidelines in a consistent and collaborative manner.

#### 5.1. A call to FIFA for action

FIFA is the international governing body for the sport of soccer and is the authoritative figure in making, regulating, and implementing policies. As soccer is one of the most famous and widely played sports in the world, FIFA has the responsibility of implementing policies where player safety is prioritised, both on and off the pitch. Moving forward, specific strategies could be put in place to develop a more standardised approach to SRC guidelines. FIFA could facilitate further international collaboration amongst its continental counterparts and medical experts in the field of concussion to develop more standardised SRC guidelines. We recommend that FIFA, its continental counterparts, and all major international soccer governing bodies collaborate and jointly publish updated guidelines based on the 6th International Conference on Concussion in Sport. We propose that these guidelines specifically address and provide clarity on the following key areas where discrepancies were identified: initial rest period, timeframes for return-to-sport, specific protocols for amateur and female athletes, education on risk reduction strategies, and whether return-to-play on the same day as a suspected concussion should be allowed. Clarity on these issues from FIFA in an updated guideline would help create a consensus on SRC management in soccer and help facilitate a broader use in amateur leagues with more translations of guidelines into different languages.

#### Declaration of competing interest

The authors declare no financial conflicts of interest.

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## References

- Argentine Football Association, 2022. Health and well-being of the players during the world Cup. Offic. Site Argentine Football Assoc. <https://www.afa.com.ar/es/posts/salud-y-bienestar-de-los-jugadores-durante-el-mundial>.
- Asken, B.M., McCrea, M.A., Clugston, J.R., et al., 2016. "Playing through it": delayed reporting and removal from athletic activity after concussion predicts prolonged recovery. *J. Athl. Train.* 51 (4), 329–335. <https://doi.org/10.4085/1062-6050-51.5.02>.
- Asken, B.M., Bauer, R.M., Guskiewicz, K.M., et al., 2018. Immediate removal from activity after sport-related concussion is associated with shorter clinical recovery and less severe symptoms in collegiate student-athletes. *Am. J. Sports Med.* 46 (6), 1465–1474. <https://doi.org/10.1177/0363546518757984>.
- AWMF Online, 2022. Leitlinienreport - Das Schädel-Hirn-Trauma im Kindes- und Jugendalter, AWMF Online. [https://register.awmf.org/assets/guidelines/024-018m\\_S2k\\_Schaeldel-Hirn-Trauma-Kinder-Jugendliche-SHT\\_2022\\_02.pdf](https://register.awmf.org/assets/guidelines/024-018m_S2k_Schaeldel-Hirn-Trauma-Kinder-Jugendliche-SHT_2022_02.pdf).
- Babbs, C.F., 2001. Biomechanics of heading a soccer ball: implications for player safety. *Sci. World J.* 1, 281–322. <https://doi.org/10.1100/tsw.2001.56>.
- Baker, J.G., Leddy, J.J., Darling, S.R., Shucard, J., Makdissi, M., Willer, B.S., 2016. Gender differences in recovery from sports-related concussion in adolescents. *Clin. Pediatr.* 55 (8), 771–775. <https://doi.org/10.1177/000922815606417>.
- Bizzini, M., Dvorak, J., 2015. Fifa 11+: an effective programme to prevent football injuries in various player groups worldwide—a narrative review. *Br. J. Sports Med.* 49 (9), 577–579. <https://doi.org/10.1136/bjsports-2015-094765>.
- Canada Soccer Sports Medicine Committee, 2018. CONCUSSION POLICY PLAYERS' HEALTH AND SAFETY FIRST. *Canada Soccer*. [https://canadasoccer.com/wp-content/uploads/2020/11/2018\\_Concussion\\_Policy\\_Digital\\_EN.pdf](https://canadasoccer.com/wp-content/uploads/2020/11/2018_Concussion_Policy_Digital_EN.pdf).
- Churchill, N.W., Hutchison, M.G., Richards, D., Leung, G., Graham, S.J., Schweizer, T.A., 2017. Neuroimaging of sport concussion: persistent alterations in brain structure and function at medical clearance. *Sci. Rep.* 7 (1), 8297. <https://doi.org/10.1038/s41598-017-07742-3>.
- Collins, C.L., Fletcher, E.N., Fields, S.K., et al., 2014. Neck strength: a protective factor reducing risk for concussion in high school sports. *J. Prim. Prev.* 35 (5), 309–319. <https://doi.org/10.1007/s10935-014-0355-2>.
- Concussion In Sport Group, 2013a. Sport concussion assessment tool—3. Auflage, Bundesinstitut für Sportwissenschaft. [https://www.bisp-sht.de/SharedDocs/Downloads/DE/SHT/SCAT3.pdf?\\_\\_blob=publicationFile&v=2](https://www.bisp-sht.de/SharedDocs/Downloads/DE/SHT/SCAT3.pdf?__blob=publicationFile&v=2).
- Concussion In Sport Group, 2013b. Pocket CRT. *Br. J. Sports Med.* 47, 267, 2013.
- Concussion In Sport Group, 2022. Scat 5 Sport Concussion Assessment Tool - 5: E Utgåvan - rf.Se. <https://www.rf.se/download/18.4b47d66118498cdd98bc81/1669037363171/scat5-rf-2017-sport-concussion-assessment-tool.pdf>.
- Concussion In Sport Group, 2023a. Resources - Concussion in Sport Group (CISG), *Concussion In Sport Group (CISG) - the New Generation Of Sports Concussion Tools*. <https://www.concussioninsportgroup.com/resources/>.
- Concussion In Sport Group, 2023b. Concussion in Sport Group (CISG) - the New Generation of Sports Concussion Tools. <https://www.concussioninsportgroup.com/scat-tools/>.
- Confederação Brasileira de Futebol, 2023. CBF, *Confederação Brasileira de Futebol*. <http://www.cbf.com.br/>.
- Davis, G.A., Purcell, L., Schneider, K.J., et al., 2017. The Child sport concussion assessment tool 5th edition (Child SCAT5): background and rationale. *Br. J. Sports Med.* 51 (11), 859–861. <https://doi.org/10.1136/bjsports-2017-097492>.
- Davis, G.A., Makdissi, M., Bloomfield, P., et al., 2020. Concussion guidelines in national and international professional and elite sports. *Neurosurgery* 87 (2), 418–425. <https://doi.org/10.1093/neuros/nyaa057>.
- Deuschle, C., Keith, J., Dugan, K., Williams, M., Taravath, S., Lecci, L., 2022. Baseline concussion testing increases agreement with favorable concussion safety decisions in hypothetical scenarios. *Health Educ. Behav. : Offic. Pub. Soc. Pub. Health Educat.* 49 (4), 732–739. <https://doi.org/10.1177/10901981211003509>.
- Deutsche Fußball Liga, 2019. Baseline Screening Obligatory from 2019-20 Season Onwards, *DFL Deutsche Fußball Liga*. <https://www.dfl.de/en/news/baseline-screening-obligatory-in-the-bundesliga-and-bundesliga-2-as-of-the-2019-20-season/>.
- Deutscher Fußball-Bund, E.V., 2023. German Football Association, *DFB*. <https://www.dfb.de/en/en-start/>.
- Echemendía, R.J., Meeuwisse, W., McCrory, P., et al., 2017a. The sport concussion assessment tool 5th edition (SCAT5): background and rationale. *Br. J. Sports Med.* 51 (11), 848–850. <https://doi.org/10.1136/bjsports-2017-097506>.
- Echemendía, R.J., Meeuwisse, W., McCrory, P., et al., 2017b. The concussion recognition tool 5th edition (CRT5): background and rationale. *Br. J. Sports Med.* 51 (11), 870–871.
- Fédération Internationale de Football Association, 2020a. Protocolo Médico de la FIFA de Conmociones Cerebrales Sospechar y proteger. <https://digitalhub.fifa.com/m/fbc9c58973a04e7/original/Protocolo-medico-de-la-FIFA-de-conmociones-cerebrales.pdf>.
- Fédération Internationale de Football Association, 2020b. *REGULATIONS FIFA World Cup 2022™*. <https://digitalhub.fifa.com/m/517ef2ad2bc3665e/original/ytkbpxnyvqhx6bebesv-pdf.pdf>.
- Fédération Internationale de Football Association (Fifa), 2022. FIFA Medical Concussion Protocol Suspect and Protect, FIFA Medical Concussion Protocol. <https://digitalhub.fifa.com/m/11dc529ca641c307/original/FIFA-Medical-Concussion-Protocol.pdf>.
- Firsching, R., Rickels, E., Mauer, U.M., et al., 2015. Kurzversion Leitlinie Schädel-Hirn-Trauma im Erwachsenenalter, *AWMF-Register*. [https://register.awmf.org/assets/guidelines/008-001k\\_S2e\\_Schaeldelhirntrauma\\_SHT\\_Erwachsene\\_2016-06-abgelaufen.pdf](https://register.awmf.org/assets/guidelines/008-001k_S2e_Schaeldelhirntrauma_SHT_Erwachsene_2016-06-abgelaufen.pdf).
- Football Federation Australia, 2018. FFA Concussion Guidelines. [https://www.footballaustralia.com.au/sites/ffa/files/2018-01/18-0102%20FFA%20Concussion%20Guidelines%20\(final\).pdf](https://www.footballaustralia.com.au/sites/ffa/files/2018-01/18-0102%20FFA%20Concussion%20Guidelines%20(final).pdf).
- Française de Football, Fédération, 2023. Football for Health. French Football Federation. <https://uk.fff.fr/15-football-for-health.html>.
- Guskiewicz, K.M., McCrea, M., Marshall, S.W., et al., 2003. Cumulative effects associated with recurrent concussion in collegiate football players: the NCAA Concussion Study. *JAMA* 290 (19), 2549–2555. <https://doi.org/10.1001/jama.290.19.2549>.
- Guskiewicz, K.M., Register-Mihalik, J., McCrory, P., et al., 2013. Evidence-based approach to revising the SCAT2: introducing the SCAT3. *Br. J. Sports Med.* 47 (5), 289–293. <https://doi.org/10.1136/bjsports-2013-092225>.
- Haddaway, N.R., Collins, A.M., Coughlin, D., Kirk, S., 2015. The role of Google scholar in evidence reviews and its applicability to grey literature searching. *PLoS One* 10 (9), e0138237. <https://doi.org/10.1371/journal.pone.0138237>.
- Hinton, R.Y., Lincoln, A.E., Almquist, J.L., Douguhui, W.A., Sharma, K.M., 2005. Epidemiology of lacrosse injuries in high school-aged girls and boys: a 3-year prospective study. *Am. J. Sports Med.* 33 (9), 1305–1314. <https://doi.org/10.1177/0363546504274148>.
- Hodgson, L., Kramer, E., 2015. FIFA First Aid Manual and Related Healthcare Issues for Football, vols. 89–116. <https://digitalhub.fifa.com/m/579897f5746b783c/original/ihtx6q5c8pxibk9ihhzp-pdf.pdf>.
- Holtzhausen, L.J., Souissi, S., Sayrafi, O.A., et al., 2021. Arabic translation and cross-cultural adaptation of the sport concussion assessment tool 5 (SCAT5). *Biol. Sport* 38 (1), 129–144. <https://doi.org/10.5114/biolSport.2020.97673>.
- Hootman, J.M., Dick, R., Agel, J., 2007. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. *J. Athl. Train.* 42 (2), 311–319.
- Hytner, D., 2018. FIFA: Morocco decision to play Nordin Amrabat after concussion 'questionable'. *Guardian*. Available at: <https://www.theguardian.com/football/2018/jun/21/morocco-nordin-amrabat-concussion-questionable-fifa-world-cup>.
- Khurana, V.G., Kaye, A.H., 2012. An overview of concussion in sport. *J. Clin. Neurosci. : Offic. J. Neurosurg. Soc. Australasia* 19 (1), 1–11. <https://doi.org/10.1016/j.jocn.2011.08.002>.
- Leddy, J.J., Burma, J.S., Toomey, C.M., Hayden, A., Davis, G.A., Babl, F.E., Gagnon, I., Giza, C.C., Kurovski, B.G., Silverberg, N.D., Willer, B., Ronskley, P.E., Schneider, K.J., 2023. Rest and exercise early after sport-related concussion: a systematic review and meta-analysis. *Br. J. Sports Med.* 57 (12), 762–770. <https://doi.org/10.1136/bjsports-2022-106676>.
- Mackay, D.F., Russell, E.R., Stewart, K., MacLean, J.A., Pell, J.P., Stewart, W., 2019. Neurodegenerative disease mortality among former professional soccer players. *N. Engl. J. Med.* 381 (19), 1801–1808. <https://doi.org/10.1056/NEJMoa1908483>.
- McCrea, M., Hammeke, T., Olsen, G., Leo, P., Guskiewicz, K., 2004. Unreported concussion in high school football players: implications for prevention. *Clin. J. Sport Med. : Offic. J. Canadian Acad. Sport Med.* 14 (1), 13–17. <https://doi.org/10.1097/00042752-200401000-00003>.
- McCrory, P., Meeuwisse, W., Dvorák, J., et al., 2017. Consensus statement on concussion in sport—the 5<sup>th</sup> international conference on concussion in sport held in Berlin, October 2016. *Br. J. Sports Med.* 51 (11), 838–847. <https://doi.org/10.1136/bjsports-2017-097699>.
- McGuine, T., Post, E., Pfaller, A.Y., et al., 2020. Does soccer headgear reduce the incidence of sport-related concussion? A cluster, randomised controlled trial of adolescent athletes. *Br. J. Sports Med.* 54 (7), 408–413. <https://doi.org/10.1136/bjsports-2018-100238>.
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., PRISMA Group, 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med.* 6 (7), e1000097. <https://doi.org/10.1371/journal.pmed.1000097>.
- Musko, P.A., Demetriades, A.K., 2023. Are sex differences in collegiate and high school sports-related concussion reflected in the guidelines? A scoping review. *Brain Sci.* 13 (9), 1310. <https://doi.org/10.3390/brainsci13091310>. PMID: 37759911; PMCID: PMC10526868.
- NCAA Sports Science Institute, 2021. Concussion Safety Protocol Checklist. [https://s3.amazonaws.com/ncaaorg/ssi/concussion/2021\\_Concussion\\_Safety\\_Protocol\\_Checlist.pdf](https://s3.amazonaws.com/ncaaorg/ssi/concussion/2021_Concussion_Safety_Protocol_Checlist.pdf).
- New Zealand Football, 2018. NZF concussion & head injury policy. <https://fit4football.co.nz/wp-content/uploads/2021/04/NZF-Concussion-Policy-Updated.pdf>.
- Ossom Williamson, P., Minter, C.I.J., 2019. Exploring PubMed as a reliable resource for scholarly communications services. *J. Med. Libr. Assoc. : JMLA* 107 (1), 16–29. <https://doi.org/10.5195/jmla.2019.433>.
- PA Media, 2020. Forty ex-footballers set to take legal action over dementia links in 2021. *Sky Sports*. <https://www.skysports.com/football/news/11095/12157935/forty-ex-footballers-set-to-take-legal-action-over-dementia-links-in-2021>.
- Patricios, J.S., Schneider, K.J., Dvorak, J., et al., 2023. Consensus statement on concussion in sport: the 6<sup>th</sup> international conference on concussion in sport—amsterdam, october 2022. *Br. J. Sports Med.* 57 (11), 695–711. <https://doi.org/10.1136/bjsports-2023-106898>.
- Peek, K., Andersen, J., McKay, M.J., et al., 2022. The effect of the FIFA 11 + with added neck exercises on maximal isometric neck strength and peak head impact magnitude during heading: a pilot study. *Sports Med.* 52 (3), 655–668. <https://doi.org/10.1007/s40279-021-01564-0>.
- Pierpoint, L.A., Collins, C., 2021. Epidemiology of sport-related concussion. *Clin. Sports Med.* 40 (1), 1–18. <https://doi.org/10.1016/j.csm.2020.08.013>.
- Real Federación Española de Fútbol, 2023. RFEF, *Web oficial de la Real Federación Española de Fútbol*. <https://rfe.es/en>.
- Salvarani, C.P., de Medeiros, L.R., Sapatero, F.H., et al., 2020. Concussion among soccer players in the 2017 Brazilian championship - the gap between protocol and medical

- practice. Concussion (London, England) 5 (4), CNC83. <https://doi.org/10.2217/cnc-2020-0015>.
- Schoenbaum, S.C., Sundwall, D.N., 1995. Using Clinical Practice Guidelines to Evaluate Quality of Care (No. 95. US Department of Health and Human Services, Public Health Service, Agency for Health Care Policy and Research.
- Scotland, Sport, 2018. If in Doubt, Sit Them Out. *Scottish Sports Concussion Guidance: Grassroots Sport And General Public*. <https://sportsotland.org.uk/media/3382/cconcussionreport2018.pdf>.
- Scullion, E., Heron, N., 2022. A scoping review of concussion guidelines in amateur sports in the United Kingdom. *Int. J. Environ. Res. Publ. Health* 19 (3), 1072. <https://doi.org/10.3390/ijerph19031072>.
- Soccer, U.S., 2019. Assessment & Management of Concussion in Soccer. *Recognize to Recover*. [http://www.recognizetorecover.org/s/SOC\\_4266-R2R-Concussion-Management-v3.pdf](http://www.recognizetorecover.org/s/SOC_4266-R2R-Concussion-Management-v3.pdf).
- Sport concussion assessment tool - 5th edition. *Br. J. Sports Med.* 51 (11), 2017, 851–858. <https://doi.org/10.1136/bjsports-2017-097506SCAT5>.
- Sports, Sky, 2021. Benjamin Pavard Concussion in France vs Germany Game “Sickening to Watch,” Says Brain Injury Charity Headway. *Sky Sports*. <https://www.skysports.com/football/news/12025/12334238/benjamin-pavard-concussion-in-france-vs-germany-game-sickening-to-watch-says-brain-injury-charity-headway>.
- The Football Association, 2019. If in Doubt Sit Them Out. <https://www.thefa.com/-/media/files/pdf/my-football/the-fa-concussion-guidelines-2019.ashx>.
- Thomas, D.G., Apps, J.N., Hoffmann, R.G., McCrea, M., Hammeke, T., 2015. Benefits of strict rest after acute concussion: a randomized controlled trial. *Pediatrics* 135 (2), 213–223. <https://doi.org/10.1542/peds.2014-0966>.
- Ueda, P., Pasternak, B., Lim, C.E., Neovius, M., et al., 2023. Neurodegenerative disease among male elite football (soccer) players in Sweden: a cohort study. *Lancet Public Health* 8 (4), e256–e265. [https://doi.org/10.1016/S2468-2667\(23\)00027-0](https://doi.org/10.1016/S2468-2667(23)00027-0).
- Union of European Football Associations, 2021. Protecting Players: UEFA’s Concussion Charter for Club and National Teams. UEFA.com. <https://www.uefa.com/returnto play/news/026f-13d657615f18-c0a169fbbd52-1000-protecting-players-uefa-s-concussion-charter-for-club-and-natio/>.
- Vagnozzi, R., Signoretti, S., Floris, R., et al., 2013. Decrease in N-acetylaspartate following concussion may be coupled to decrease in creatine. *J. Head Trauma Rehabil.* 28 (4), 284–292. <https://doi.org/10.1097/HTR.0b013e3182795045>.
- Van Haisma, K., Abbott, K.M., Arbogast, A., Bangerter, L.R., Heid, A.R., Behrens, L.L., Madrigal, C., 2020. A preference-based model of care: an integrative theoretical model of the role of preferences in person-centered care. *Gerontol.* 60 (3), 376–384. <https://doi.org/10.1093/geront/gnz075>.
- Vedung, F., Hänni, S., Tegner, Y., Johansson, J., Marklund, N., 2020. Concussion incidence and recovery in Swedish elite soccer - prolonged recovery in female players. *Scand. J. Med. Sci. Sports* 30 (5), 947–957. <https://doi.org/10.1111/sms.13644>.
- Wales, F.A., 2019. FAW CONCUSSION GUIDELINES. [https://www.faw.cymru/files/9715/7130/3629/FAW\\_Concussion\\_G.pdf](https://www.faw.cymru/files/9715/7130/3629/FAW_Concussion_G.pdf).
- Watanabe, H., Fukatsu, H., Katsuno, M., et al., 2004. Multiple regional 1H-MR spectroscopy in multiple system atrophy: NAA/Cr reduction in pontine base as a valuable diagnostic marker. *J. Neurol. Neurosurg. Psychiatr.* 75 (1), 103–109.
- Wolf, S.H., Grol, R., Hutchinson, A., Eccles, M., Grimshaw, J., 1999. Clinical guidelines: potential benefits, limitations, and harms of clinical guidelines. *Br. Med. J.* 318 (7182), 527–530. <https://doi.org/10.1136/bmj.318.7182.527>.
- Yeung, E.W., Sin, Y.W., Lui, S.R., et al., 2018. Chinese translation and validation of the sport concussion assessment tool 3 (SCAT3). *BMJ Open Sport Exercise Med.* 4 (1), e000450 <https://doi.org/10.1136/bmjsem-2018-000450>.