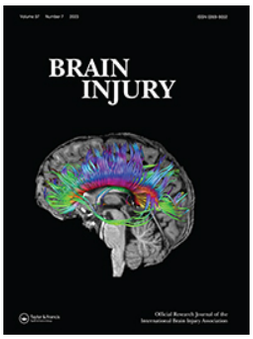

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Factors associated with concussion management behavior in Ladies Gaelic Football players

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ABSTRACT

Background: Sport-related concussion (SRC) management may be poor in community sports such as Ladies Gaelic Football (LGF). This study examined factors associated with SRC management behavior in adult LGF players.

Methods: Participants ($n = 657$) answered an online survey on demographic factors, concussion knowledge, attitudes, and education, and SRC management behavior. Data from participants who reported sustaining an LGF-related SRC during the previous year ($n = 115$) were further analyzed.

Results: Being diagnosed with SRC was the main factor influencing subacute management behavior. Players with diagnosed SRCs had increased odds of following a graded return-to-play (RTP) programme (OR = 4.89), following a medically supervised graded RTP programme (OR = 10.16), and being medically cleared before full RTP (OR = 13.45) compared with those with suspected SRCs. Concussion history was associated with increased odds of informing a coach of a possible SRC (OR = 2.86). Demographic factors, previous use of Ladies Gaelic Football Association concussion education resources, and concussion knowledge and attitudes had minimal or no influence on management behaviors.

Conclusion: Greater access to medical personnel at LGF training and matches is recommended. Due to limited medical resources in community sport, a clear referral pathway for players with SRC and comprehensive SRC education should be introduced to ensure players receive adequate medical care.

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athletic injuries; traumatic brain injury; return to sport; concussion management; female

Introduction

Sport-related concussion (SRC) is a form of mild head injury that occurs when traumatic forces are rapidly applied to the brain during sport, resulting in temporary neurological dysfunction (1). Dysfunction may manifest in diverse clinical presentations involving cognitive, vestibular, ocular, mood and sleep-related symptoms (1). While most adults with SRC are expected to recover symptomatically within fourteen days of injury (1), 3.6–17.3% of female collegiate athletes experience symptoms lasting four or more weeks, which may lead to players having difficulty returning to their previous level of sport and academic activity (2,3). Overall, female athletes may be more likely to sustain an SRC (4), demonstrate a greater symptom burden (5), and experience a longer symptom resolution time than male athletes (6). Similar to other female team sports, SRC is a concern in Ladies Gaelic Football (LGF), with one cross-sectional survey finding that 17.5% of players self-reported a suspected SRC during the previous year (7). A native Irish team sport, LGF is a form of women's football that is similar in style of play to Australian football and is one of Ireland's most popular female sports (8). It is an amateur sport with most athletes playing at a community level and a minority of athletes playing in an elite division (9). Although the Ladies Gaelic Football Association (LGFA) endorses international SRC management guidelines, there is very limited access to medical personnel at the non-elite level (10), no concussion referral pathway exists, and concussion education is not mandatory for players and coaches, which may negatively affect SRC management in players.

SRC management guidelines recommend immediately removing players with a suspected SRC from play (1). Players should take cognitive and physical rest for 24–48 hours, before incrementally re-introducing activity by following a multi-stage standardized return-to-play (RTP) programme (1). A similar protocol exists for returning to academic activities (1). Non-adherence to these guidelines is associated with poorer outcomes (11). Players who are not immediately removed from play take an average of five days longer until cleared to RTP compared with players who do not continue to play following an SRC (11). In LGF, adherence to RTP protocols is poor; approximately half of players with a diagnosed SRC during the previous season reported following an RTP programme, with only 13.7% of those with a suspected, undiagnosed SRC doing the same (7). While players who are diagnosed with SRC by a medical professional are likely supervised during the recovery period in sports with well-developed medical infrastructure, limited access to medical personnel in community sports may mean that follow-up care is lacking, and players may manage SRC poorly in spite of seeking initial medical assistance. Therefore, it is important to expand on current research from North American high school and collegiate sports, which primarily examines reporting behaviour

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(12–15), and investigate multiple aspects of SRC management behaviour in LGF. This may improve SRC care in LGF and the broader community sporting context.

The factors driving behaviour post-SRC are poorly understood. Concussion knowledge and attitude are theorized to influence reporting behaviour, with mixed findings (12–14). A history of SRC (13,15,16), age (13) and number of years playing a sport (17) have also been suggested to affect SRC nondisclosure in high school and collegiate sports, however SRC history is the only one of these factors that has been associated with non-disclosure (12,13). Despite the unique challenges that community sport presents for SRC management, no previous research has examined factors associated with SRC management behaviors in this setting. As medical follow-up may be poor in community sports, there is also a need to investigate the association between these factors and SRC management behaviors beyond reporting (e.g., following a graded RTP programme) in LGF. In addition to the above-mentioned factors, being diagnosed by a medical professional (versus sustaining a suspected, undiagnosed SRC), previous engagement with education resources, and playing level may affect management behaviour among LGF players and should be investigated. Understanding more about why SRCs are poorly managed in LGF will enable the LGFA and clinicians to develop sport-specific interventions that have the potential to improve SRC management and improve the safety of both LGF and female community sport in general. Therefore, the aim of this study was to determine the extent to which these factors are associated with self-reported SRC management behaviors in adult LGF players.

Materials and methods

Survey development

Data were collected using a ten-minute online survey that was developed for a larger research project. The survey was developed by four of the authors, including a PhD researcher, an Assistant Professor in Athletic Therapy and Training, an Associate Professor in Athletic Therapy and Training, and an Assistant Professor in Biomedical Sciences, all of whom had extensive experience in concussion research. The authors performed an initial literature search of factors relating to concussion reporting and management, as well as methods that have been used to examine concussion history, knowledge, and attitudes. This literature search was used to select questions about relevant demographic and sport-related characteristics. Concussion management questions were compiled based on recommended management guidelines outlined in international consensus statements (18). The Rosenbaum Concussion Knowledge and Attitudes Survey (RoCKAS) was selected to measure concussion-related knowledge and attitudes as it has demonstrated acceptable construct validity and test-retest reliability (19). The authors also chose to include a standardized definition of concussion in the survey as this had previously been shown to improve recall of previous potential concussions (20). Once the survey had been compiled, the four authors reviewed it to ensure content validity for an Irish context. Questions were retained if all researchers agreed they were relevant to the study. Two international experts reviewed and approved the final survey. The survey was piloted in twenty LGF players, who provided feedback on the clarity of the questions, survey layout, and time taken to complete the survey.

The survey was open to adult LGF players who had played during the previous season (2019). Screening questions excluded participants who did not meet these criteria. Survey sections relevant to this study assessed (1): demographic characteristics (2), self-reported SRC history (3), SRC management behaviour (answered only if the participant self-reported an SRC sustained playing LGF in 2019) (4), previous use of LGFA concussion education resources, and (5) the RoCKAS (19). Concussion was defined using a standardized definition modified from a previous study: 'Some people have the misconception that concussions only happen when you black out after a hit to the head or when the symptoms last for a while. But, in reality, a concussion has occurred anytime you have had a direct or indirect blow to the head that caused you to have symptoms for any amount of time. These include: blurred or double vision, seeing stars, sensitivity to light or noise, headache, dizziness or balance problems, nausea, vomiting, trouble sleeping, fatigue, confusion, difficulty remembering, difficulty concentrating, or loss of consciousness. Whenever anyone gets a ding or their bell rung, that too is a concussion.' (20)

Participant recruitment

We obtained ethical approval from the Dublin City University Research Ethics Committee (DCUREC/2019/010) and adhered to all university ethical guidelines for human participants. Participants were provided with a plain language statement at the beginning of the online survey and selected checkboxes to provide informed consent. Participants were recruited using convenience sampling from July to December 2020. We contacted LGF clubs via a direct e-mail if contact details were available online (available for 722 out of approximately 1000 clubs nationwide). We also requested that local administrative boards forward our e-mail to all clubs in their jurisdiction and received confirmation from 25 of 32 boards that they had done so. The e-mail contained a brief description of the survey and a link to the online survey. The LGFA promoted the study on their website and social media accounts. At least 190 participants were required to identify the proportion who had sustained an LGF-related SRC in 2019 (alpha <0.05, power $= 0.8$).

Data analysis

Data cleaning and analysis were carried out in RStudio. We calculated RoCKAS Concussion Knowledge Index (CKI), Concussion Attitudes Index (CAI) and Validity Scale scores as outlined by the authors (19). RoCKAS data for participants with a validity score less than two was considered missing (19). We created a new dichotomous ('yes'/'no') variable to indicate prior concussion history (including SRCs and non-SRCs), not including the SRC sustained in 2019. Non-sensical responses and 'Don't remember' or 'N/A' responses to questions about past SRC management were considered missing. Missing data

Table 1. Participant demographic characteristics.

	No Concussion in 2019 Group (N=542)	*Concussion in 2019 Group (N=115)*	*Total Sample (N=657)*
Level of play, % (n)			
Elite	81.7% (443)	69.6% (80)	79.6% (523)
Non-Elite	18.3% (99)	30.4% (35)	20.4% (134)
Age, median (IQR)	23 (7.8)	22 (7.0)	22 (7.0)
Number of Years Playing Experience, median (IQR)	13 (6.0)	12 (7.5)	13 (6.0)
Playing Position, % (n)			
Back	42.8% (232)	40.0% (46)	42.3% (278)
Forward	38.2% (207)	38.3% (44)	38.2% (251)
Goalkeeper	6.8% (37)	7.8% (9)	7.0% (46)
Midfield	12.2% (66)	13.9% (16)	12.5% (82)
Region, % (n)			
Ulster	22.3% (121)	16.5% (19)	21.3% (140)
Leinster	49.1% (266)	46.1% (53)	48.6% (319)
Munster	16.2% (88)	22.6% (22)	17.4% (114)
Connaught	12.4% (67)	14.8% (17)	12.8% (84)
Previous Self-Reported Concussion, % (n)			
Yes	74.2% (402)	73.9% (85)	74.1% (487)
No	25.8% (140)	26.1% (23)	25.9% (170)
Previous Use of LGFA Concussion Education Resources			
Yes	4.2% (24)	14.8% (17)	6.1% (40)
No	95.8% (519)	85.2% (98)	93.9% (617)

IQR: Interquartile range; LGFA: Ladies Gaelic Football Association.

accounted for 0.8–27.8% of values for individual variables and were replaced using multiple imputation via chained equations (MICE) (21). As only participants who had sustained an LGF-related SRC in 2019 were to be included in the analysis of SRC management behavior, we performed multiple imputation via chained equations (MICE) in this group only.

Descriptive statistics were presented for demographic characteristics for the total sample, as well as separately for participants who had sustained a possible SRC in 2019 (Table 1). Participants who had sustained an LGF-related SRC during the previous season were included in the analysis of behaviour following an SRC (n = 115). We selected possible factors associated with SRC management behaviour based on previous literature and clinical experience; these factors included playing level, age, number of years played, concussion history, whether the SRC was diagnosed or suspected, CKI, CAI and previous use of LGFA concussion education material. SRCs were considered 'diagnosed' if participants reported being diagnosed by a medical professional or 'suspected' if participants believed they had met the criteria of the standardized definition of concussion but had not been diagnosed by a medical professional. We considered the following to be acute post-SRC behaviors: time spent continuing to play following the incident, continuing to play, and same day RTP; subacute behaviors included symptomatic RTP, following a graded RTP, following a graded RTP with medical supervision, obtaining medical clearance prior to RTP, and following an RTS programme. We examined univariate associations between factors and SRC management behaviors using multinomial or binary logistic regression analyses ($p < 0.25$) (25). Significant factors were included in explanatory multinomial or binary logistic regression models with concussion management behaviors as the outcome ($p < 0.05$). The number of independent variables in each model was determined using the rule of ten-events-per-variable (24). When the number of significant independent variables exceeded this number, the factors considered the most relevant were selected for inclusion. Final models were assessed to ensure they met test assumptions (linearity of the logit, multicollinearity, and absence of outliers). Likelihood Ratio tests assessed goodness of fit by comparing final models with intercept-only models ($p < 0.05$) and McFadden's pseudo-R2 expressed the proportion of difference in the outcome explained by the model. Odds ratios (ORs) with 95% confidence intervals provided a measure of the effect of individual predictors on the outcomes.

Results

An initial 1049 players answered the survey. After removing participants who had not played LGF in 2019 ($n = 92$), were under eighteen ($n = 156$) and duplicate responses ($n = 144$), 657 responses remained. Of these participants, 9.6% ($n = 63$) and 7.8% ($n = 51$) reported sustaining a diagnosed or suspected SRC while playing LGF during the previous season, respectively. Demographic characteristics of participants are presented in Table 1.

Factors associated with acute concussion management

Time played following a suspected SRC was best explained by a three-factor model (playing level, concussion history, and CAI). CAI was the only significant factor, with lower scores associated with an increased odds of continuing to play for more than fifteen minutes compared with not playing for the rest of the training session or match (OR (95% CI): 0.93 (0.87–0.99), $p = 0.028$; see Table 2). The model explained the data significantly better than an intercept-only model ($p = 0.049$, pseudo-$R^2 = 5.2\%$). Concussion history was significantly associated with telling a coach about a possible SRC in a one-factor model (OR (95% CI): 2.86 (1.22–7.07), $p = 0.018$; see Table 2), which fit the data significantly better than the intercept-only model ($p = 0.016$, pseudo-$R^2 = 3.7\%$). A four-factor model for

Table 2. Factors associated with acute concussion management behavior.

Variable	Beta	Standard Error	Odds Ratio (95% CI)	P-value	Likelihood Ratio Test	Pseudo-R^2
Model 1: Continued to play following a possible concussion					p = 0.049	5.2%
Played for less than 15 minutes						
Elite level (yes)	0.27	0.63	1.32 (0.38–4.52)	0.664	-	-
Concussion history (yes)	−0.91	0.58	0.4 (0.13–1.25)	0.114	-	-
Concussion attitude	−0.02	0.04	0.98 (0.9–1.06)	0.571	-	-
Played for more than 15 minutes						
Elite level (yes)	0.99	0.51	2.68 (0.99–7.27)	0.052	-	-
Concussion history (yes)	−0.25	0.53	0.78 (0.28–2.22)	0.644	-	-
Concussion attitude	−0.08	0.03	0.93 (0.87–0.99)	0.028	-	-
Model 2: Told coach or manager about a possible concussion					p = 0.016	3.7%
Concussion history (yes)	1.05	0.45	2.86 (1.22–7.07)	0.018	-	-
Model 3: Returned to play on the same day					p = 0.016	8.1%
Age	0.04	0.04	1.04 (0.96–1.14)	0.335	-	-
Diagnosis (yes)	−1.00	0.42	0.37 (0.16–0.84)	0.018	-	-
Concussion knowledge	−0.05	0.10	0.95 (0.79–1.14)	0.581	-	-
Concussion attitude	−0.04	0.03	0.96 (0.9–1.02)	0.199	-	-

Table 3. Factors associated with subacute concussion management behavior.

Variable	Beta	Standard Error	Odds Ratio (95% CI)	P-value	Likelihood Ratio Test	Pseudo-R^2
Model 4: Returned to play with symptoms					p = 0.07	2.1%
Concussion attitude	−0.05	0.03	0.95 (0.9–1)	0.078	-	-
Model 5: Followed a Graded Return to Play Programme					p < 0.001	13.3%
Elite level (yes)	0.31	0.45	1.36 (0.55–3.31)	0.500	-	-
Diagnosis	1.59	0.48	4.89 (1.99–13.09)	0.001	-	-
Concussion attitude	0.03	0.03	1.03 (0.97–1.1)	0.315	-	-
Model 6: Followed a Graded Return to Play with Medical Supervision					p < 0.001	15.6%
Elite level	0.23	0.49	1.26 (0.48–3.27)	0.641	-	-
Number of Years Played	0.08	0.05	1.09 (0.99–1.2)	0.087	-	-
Diagnosis (yes)	2.32	0.61	10.16 (3.41–38.53)	0.000	-	-
Model 7: Received Medical Clearance					p < 0.001	14.9%
Elite level (yes)	0.79	0.52	2.2 (0.78–6.22)	0.133	-	-
Diagnosis (yes)	2.60	0.75	13.45 (3.62–74.81)	0.001	-	-
Concussion knowledge	−0.37	0.12	0.69 (0.54–0.86)	0.002	-	-
Model 8: Followed a Return to School Programme					p = 0.07	6.2%
Diagnosis (yes)	1.16	0.69	3.18 (0.91–14.8)	0.092	-	-
Concussion education (yes)	0.84	0.68	2.31 (0.55–8.32)	0.216	-	-

same day return-to-play (RTP) included age, being diagnosed with SRC, CKI and CAI, however only being diagnosed with SRC was significant (OR (95% CI): 0.37 (0.16–0.84), $p = 0.018$; see Table 2). This model fit the data better than the intercept-only model ($p = 0.016$, pseudo-$R^2 = 8.1\%$).

Factors associated with subacute concussion management

A one-factor model including CAI as the independent variable best explained symptomatic RTP (OR (95% CI): 0.95 (0.9–1.0), $p = 0.078$; see Table 3), although it did not fit the data better than an intercept-only model ($p = 0.07$). Following a graded RTP programme, following a graded RTP with medical supervision, and receiving medical clearance before RTP were best explained by three-factor models (Table 3). A diagnosis for the concussion was the only significant factor for following a graded RTP programme (OR (95% CI): 4.89 (1.99–13.09), $p = 0.001$) and following a graded RTP programme with medical supervision (OR (95% CI): 10.16 (3.41–38.53), $p < 0.001$). Both models provided a significantly better goodness of fit than the intercept-only models ($p < 0.001$; pseudo-R^2: 13.3% and 15.6%, respectively). Receiving medical clearance before full RTP was positively associated with a diagnosis for the concussion of interest (OR: 13.45; 95% CI: 3.62–74.81; $p = 0.001$) and negatively associated with CKI (OR: 0.69; 95% CI: 0.54–0.86; $p = 0.002$) in a model that provided a significantly better fit for the data than an intercept-only model ($p < 0.001$; pseudo-R^2: 14.9%). A model containing two independent variables best explained following an RTS programme, however it did not contain any significant factors and did not fit the data better than an intercept-only model ($p = 0.07$)

Discussion

This study aimed to identify factors associated with SRC management behaviors in LGF players. While factors influencing concussion reporting have been examined in previous studies of collegiate and high school athletes (12–16,26), little research has examined other aspects of management behavior, particularly in the subacute phase of injury (e.g. not returning to play on the day of injury and following a graded RTP programme) (27). Our study is the first to examine concussion management behaviors beyond reporting behavior, as well as the first to focus on community sport. We found that being diagnosed with an SRC (versus sustaining a suspected, undiagnosed SRC) was associated with multiple safer behaviors. Players with a previous diagnosed or suspected concussion had increased odds of informing a coach of a possible SRC. However, concussion-related knowledge and attitudes had only a minimal influence on behavior following an SRC, and demographic factors and previous engagement with LGFA concussion

education resources were not associated with management behavior in LGF players.

Being diagnosed with sport-related concussion

Being diagnosed with SRC by a medical professional was the main factor influencing behavior in the subacute injury phase. Players with a diagnosis of SRC had an almost five-fold increased OR of following a graded RTP programme, ten times the OR of following a graded RTP with medical supervision, and thirteen times the OR of obtaining medical clearance before full RTP compared to players with a suspected, unconfirmed SRC. While previous research has not compared management behavior among players with diagnosed and suspected SRCs in other sports, greater access to sports medicine professionals is associated with improved athlete outcomes (21). Unlike elite or collegiate sports, community sports may have limited, inconsistent access to medical personnel, potentially impairing SRC diagnosis and management. Previous research has found that over 40% of Gaelic games players report that they do not 'always' or 'often' have access to medical personnel at matches and more than three-quarters do not 'always' or 'often' have access to medical personnel at training (7). LGF players in our study who did not receive medical care may have been unaware of RTP guidelines and the potential negative consequences of early RTP. By demonstrating that LGF players with diagnosed SRCs are more likely to follow recommended SRC management guidelines than those with suspected SRCs, this study highlights the need for an increased medical personnel presence at all levels of play. This will ensure that players with possible SRCs are immediately removed from play and provided with follow-up care during the RTP process. As resources for non-elite LGF teams may be limited, there is also a need to develop a clear SRC referral path to ensure players and coaches can easily seek medical care for an SRC. This study contributes valuable data on SRC management in the under-researched population of female community sport players generally. In sports with a well-developed medical infrastructure (e.g., professional or collegiate teams), athletes with diagnosed SRCs are supervised by medical personnel throughout the recovery period. However, in community sports there is rarely a designated team medical professional and players may seek medical care from a variety of sources (e.g., general practitioners or a hospital emergency department), making follow-up difficult. Our study is the first to take this into account and demonstrates the importance of seeking medical care post-SRC in community sport. Further research examining facilitators of and barriers to seeking medical care post-SRC is needed in community sport players.

Concussion history

A suspected or diagnosed concussion history was associated with almost a three-fold increase in the OR of informing a coach or manager of a possible SRC in our study. This contradicts most of the existing literature which has shown a negative association between concussion history and reporting behavior (13,16,26). However, the definition of concussion disclosure in these studies included reporting to a coach or medical professional (13,16,26), whereas we only examined reporting to a coach or manager. LGF players with a previous concussion may be better able to recognize the signs and symptoms and may therefore be more likely to inform a coach if they think they have sustained an SRC. However, concussion history was not associated with other management behaviors in LGF players. While reporting a possible SRC to a coach is an important first step in the SRC management process, especially if medical personnel are not present, it is insufficient if additional management steps are not taken. Overall, concussion history does not appear to be an important factor in SRC management behavior, especially beyond the acute stage of injury. There is a need to educate players and coaches on how to manage SRCs beyond the acute stage, such as the importance of engaging with a clinician and RTP guidelines.

Previous use of concussion education resources

Previous engagement with LGFA concussion education resources did not affect management behavior. While engagement with these resources is poor (7) among LGF players, this suggests that current concussion education resources provided by the LGFA are ineffective and require further development. Concussion education programs are frequently recommended to improve concussion reporting and management among athletes, however their effectiveness is unclear (22). Most studies examining their effectiveness have used indirect outcome measures (e.g. knowledge, attitudes or reporting intention) (22) instead of directly measuring behavior, and have only examined short-term effects (22). These programs have traditionally used media such as information sheets, presentations and videos (22,28) to educate individuals and have been criticized for not considering the broader sociological context (29). Recently suggestions have been made to develop interventions that are based on behavioral theories (23,30), target multiple stakeholders (31), and address behavior (29) instead of simply attempting to increase concussion knowledge (29). For example, scenario-based learning approaches that incorporate role-playing scenarios have been used effectively in substance use prevention programs (32) and nursing training (33), and could be adapted to an SRC management situation.

Concussion-related knowledge and attitudes

Concussion knowledge and attitudes contributed minimally to management behavior. Higher CAI scores were associated with a small reduction in the OR of playing for more than fifteen minutes following a possible SRC compared with not continuing to play, while CKI was negatively associated with receiving medical clearance before RTP. Previous studies have reported that concussion knowledge has a minimal (13) or no effect (12,26,34) on concussion disclosure in collegiate and high school athletes, although safer concussion attitudes may be negatively associated with playing with SRC (16). Researchers have examined knowledge and attitudes to increase understanding of why players may choose to engage in unsafe behavior following a possible SRC. These constructs

are also often used as indirect measures of the effectiveness of concussion education programs (22). However, information about the validity of these measures is lacking and it is not known whether they adequately measure the intended constructs. A better understanding of the psychological factors that may influence SRC management behavior is required. This could be achieved though qualitative research of LGF players who have sustained an SRC and not followed recommended management guidelines. Factors identified from qualitative research could then be addressed through behavioral interventions.

Demographic characteristics

Finally, demographic characteristics (playing level, age, and number of years playing LGF), were not associated with significantly increased or decreased odds of following acute or subacute SRC management guidelines. This supports previous research that has found that concussion disclosure does not vary based on age (12,13) or number of years of college eligibility (17). It also expands on previous findings by demonstrating that these characteristics do not appear to influence other SRC management behaviors, such as avoiding same day RTP and following a graded RTP programme. Therefore, our findings suggest that it is not necessary to focus on modifying behavior of specific groups of LGF players based on their demographic characteristics. However, as our study did not include players under eighteen further research is required to determine whether differences exist between underage and adult players.

It is important to note that our study has several methodological limitations. Convenience sampling may have led to self-selection bias, with players with certain characteristics being more likely to participate than those without these characteristics (e.g., players with a history of SRC, who had been diagnosed with an SRC, or who had suffered from more severe symptoms). This may limit the generalizability of the study's conclusions to the wider LGF population. Recall bias may also have been present as the survey required participants to retrospectively report details pertaining to suspected SRCs that occurred during the previous year. Finally, players reported SRCs based on a standardized definition of concussion, and it is not possible to confirm whether or not those who reported suspected, undiagnosed SRCs had actually sustained an SRC. We used a broad standardized definition of concussion to capture as many potential SRCs as possible. However, as SRC presents with highly varied, nonspecific signs and symptoms which may resemble other injuries or illnesses, the number of suspected, undiagnosed SRCs may have been overestimated in this study.

Conclusion

This is the first study to examine factors associated with SRC management behaviors in both LGF and female community sport. Being diagnosed with an SRC, versus sustaining a suspected, unconfirmed SRC, was associated with safer management behavior (e.g., following a graded RTP programme, following a graded RTP programme with medical supervision, and receiving medical clearance before full RTP) among participants. Players with a previous concussion more often told a coach or manager if they thought they might have an SRC than those without a previous concussion, although there were no differences in any other management behaviors based on concussion history. Other factors (concussion-related knowledge and attitudes, age, playing level, number of years playing, use of concussion education) had minimal influence on SRC management behavior. These findings emphasize the importance of strong medical infrastructure in improving care for players. Although it may not be possible for all LGF teams to have medical coverage at all times, the LGFA should strongly consider developing a formal SRC referral pathway which would enable players or coaches to refer potential SRCs for assessment if needed. Further research exploring players' reasons for managing SRCs poorly in community sport is also needed.

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Data availability statement

The data that support the findings of this study are available from the corresponding author, [RL], upon reasonable request.

References

1. McCrory P, Meeuwisse W, Dvořák J, Aubry M, Bailes J, Broglio S, Echemendia, RJ, Engebretsen L, Johnston K, Kutcher, JS, Raftery M, Sills A. Consensus statement on concussion in sport—the 5th international conference on concussion in sport held in Berlin, October 2016. Br J Sports Med [Internet]. 2017 Jun 1 [cited 2020 Feb 14];51:838–47. Available from. https://bjsm.bmj.com/content/51/11/838/

2. Wasserman EB, Kerr ZY, Zuckerman SL, Covassin T. Epidemiology of sports-related concussions in national collegiate athletic association athletes from 2009-2010 to 2013-2014. Am J Sports Med. 44:(1):226–33. [InternetAvailable from], 2016 Jan 1 [cited 2020 Feb 14] doi:10.1177/0363546515610537.
3. Bretzin AC, Esopenko C, D'Alonzo BA, Wiebe DJ Clinical recovery timelines following sport-related concussion in men's and women's collegiate sports. J Athl Train [Internet]. 2021 [cited 2021 Mar 5]; Available from: https://meridian.allenpress.com/jat/article/doi/10.4085/601-20/461695/Clinical-Recovery-Timelines-following-Sport
4. McGroarty NK, Brown SM, Mulcahey MK. Sport-related concussion in female athletes: a systematic review. Orthop J Sport Med. 2020;8(7):1–12. doi:10.1177/2325967120932306.
5. Brown DA, Elsass JA, Miller AJ, Reed LE, Reneker JC. Differences in symptom reporting between males and females at baseline and after a sports-related concussion: a systematic review and meta-analysis. Sport Med. 2015;45(7):1027–40. doi:10.1007/s40279-015-0335-6.
6. Iverson GL, Gardner AJ, Terry DP, Ponsford JL, Sills AKAK, Broshek DK, Solomon GS. Predictors of clinical recovery from concussion: a systematic review. Br J Sport Med 2017;51(12):941–48. [cited 2019 May 13]. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5466929/pdf/bjsports-2017-097729.pdf. InternetAvailable from.
7. Leahy R, Rochfort KD, Whyte E, Kontos AP, Collins MW, O'Connor S. Concussion in Ladies Gaelic Football: Self-reported Hhistory, Clinical Profiles, and Management Behaviour. Clin J Sport Med. 2023;33(2):157–164. doi:10.1097/JSM.0000000000001090.
8. Ipsos MRBI Irish sports monitor annual report 2019. Dublin; 2019.
9. Ladies Gaelic Football Association. Official Guide 2019. 2019.
10. Leahy R, Farrington S, Whyte E, O'Connor S. Concussion reporting, knowledge and attitudes in Irish amateur Gaelic games athletes. Phys Ther Sport. InternetAvailable from. 2020; [cited 2020 Feb 17]. 43: 236–43. 10.1016/j.ptsp.2019.06.004.
11. Barnhart M, Curtis BR, TCV M, Curtis BR, Barnhart M. The influence of timing of reporting and clinic presentation on concussion recovery outcomes: a systematic review and meta-analysis. Sport Med. InternetAvailable from. 2021; [cited 2021 Mar 30]. 51(7):1491–508. 10.1007/s40279-021-01444-7.
12. Doucette MM, Du Plessis S, Webber AM, Whalen C, Garcia-Barrera MA. In it to win it: competitiveness, concussion knowledge and nondisclosure in athletes. Phys Sport. 49:(2):194–202. [InternetAvailable from], 2020 Sep 21[cited 2021 Feb 19] doi:10.1080/00913847.2020.1807886.
13. Anderson M, Petit KM, Wallace J, Covassin T, Beidler E. Factors associated with concussion nondisclosure in collegiate student-athletes. J Athl Train. 2021;56(2):157–63. InternetAvailable from. doi:10.4085/1062-6050-0102-20.
14. Register-Mihalik JK, Guskiewicz KM, Valovich McLeod TC, Linnan LA, Mueller FO, Marshall SW. Knowledge, attitude, and concussion-reporting behaviors among high school athletes: a preliminary study. J Athl Train. 2013; Sep. 48(5):645–53. 10.4085/1062-6050-48.3.20. [cited 2019 Mar 25]. InternetAvailable from.
15. Chinn NR, Porter P. Concussion reporting behaviours of community college student-athletes and limits of transferring concussion knowledge during the stress of competition. BMJ Open Sport Exerc Med. InternetAvailable from. 2016; [cited 2019 Mar 25]. 2(1):e000118. 10.1136/bmjsem-2016-000118.
16. Register-Mihalik JK, Valovich Mcleod TC, Linnan LA, Guskiewicz KM, Marshall SW. Relationship between concussion history and concussion knowledge, attitudes, and disclosure behavior in high school athletes. Clin J Sport Med. 2017 May 1;27(3):321–24. doi:10.1097/JSM.0000000000000349.
17. Weber ML, Suggs DW, Bierema L, Miller LS, Reifsteck F, Schmidt JD. Collegiate student-athlete sex, years of sport eligibility completed, and sport contact level influence on concussion reporting intentions and behaviours. Brain Inj. 2019;33(5):592–97. InternetAvailable from. doi:10.1080/02699052.2019.1568573.
18. McCrory P, Meeuwisse W, Dvořák J, Aubry M, Bailes J, Broglio S, Echemendia, RJ, Engebretsen L, Johnston K, Kutcher, JS, Raftery M, Sills A. Consensus statement on concussion in sport—the 5th international conference on concussion in sport held in Berlin, October 2016. Br J Sports Med [Internet]. 2017 Apr 26 [cited 2019 Mar 25];51:838–47. Available from https://bjsm.bmj.com/content/51/11/838
19. Rosenbaum AM, Arnett PA. The development of a survey to examine knowledge about and attitudes toward concussion in high-school students. J Clin Exp Neuropsychol. 32:(1):44–55. [InternetAvailable from], 2010 Jan 15[cited 2019 Mar 20] doi:10.1080/13803390902806535.
20. Robbins CA, Daneshvar D, Picano JD, Gavett B, Baugh Christine M, Riley DO, Nowinski C, Cantu R, Stern R, McKee A. Self-reported concussion history: impact of providing a definition of concussion. Open Access J Sport Med. [cited 2019 Apr 25]. 2014; 7(5):5–99. 10.2147/OAJSM.S58005InternetAvailable from.
21. Azur MJ, Stuart EA, Frangakis C, Leaf PJ. Multiple imputation by chained equations: what is it and how does it work? Int J Methods Psychiatr Res. 2011 Mar;20(1):40–49. doi:10.1002/mpr.329.
22. Conaghan C, Daly E, Pearce AJ, King DA, Ryan L. A systematic review of the effects of educational interventions on knowledge and attitudes towards concussion for people involved in sport – Optimising concussion education based on current literature. J Sports Sci. 2020;0(00):1–16. doi:10.1080/02640414.2020.1835223. InternetAvailable from.
23. Ernst W, Kneavel ME. Development of a peer education program to improve concussion knowledge and reporting in collegiate athletes. J Athl Train InternetAvailable from. 2020 May 1[cited 2021 Mar 10]: 55(5):0. https://meridian.allenpress.com/jat/article/55/5/448/436792/Development-of-a-Peer-Education-Program-to-Improve.
24. Chowdhury M, Turin TC. Variable selection strategies and its importance in clinical prediction modelling. Fam Med Com Heal 2020;8(1):262. [cited 2021 Jun 30]. InternetAvailable from. http://fmch.bmj.com/.
25. Sperandei S. Understanding logistic regression analysis. Biochem Medica. 2014;24(1):12–18. doi:10.11613/BM.2014.003.
26. O'Connor S, Geaney D, Beidler E. Non-disclosure in Irish collegiate student-athletes: do concussion history, knowledge, pressure to play and gender impact concussion reporting? Phys Sport. 48:(2):186–93. [InternetAvailable from], 2020 Apr 2[cited 2021 Jun 16] doi:10.1080/00913847.2019.1671141.
27. Baugh CM, Kerr ZY, Kroshus E, Lanser BL, Lindley TR, Meehan WP. Sports medicine staffing patterns and incidence of injury in collegiate men's ice hockey. J Athl Train. 2020;55(6):587–93. doi:10.4085/1062-6050-0464.19.
28. Kurowski BG, Pomerantz WJ, Schaiper C, Ho M, Gittelman MA. Impact of preseason concussion education on knowledge, attitudes, and behaviors of high school athletes. J Trauma Acute Care Surg. InternetAvailable from. 2015; [cited 2019 Mar 25]. 79(3):S21–8. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4551109/pdf/nihms679164.pdf.
29. Kerr ZY, Register-Mihalik JK, Haarbauer-Krupa J, Kroshus E, Go V, Gildner P, Byrd KH, Marshall SW. Using opinion leaders to address intervention gaps in concussion prevention in youth sports: key concepts and foundational theory. Inj Epidemiol. InternetAvailable from. 2018; [cited 2021 Aug 26]. 5(1):10.1186/s40621-018-0158-7.
30. Kroshus E, Garnett BR, Baugh CM, Calzo JP. Social norms theory and concussion education. Heal Educ Res 2015;30(6):1004–13. [cited 2019 Mar 25]. Internet https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4668767/pdf/cyv047.pdf.
31. Schmidt JD, Suggs DW, Rawlins MLW, Bierema L, Miller LS, Courson R, Reifsteck, F. Coach, sports medicine, and parent influence on concussion care seeking intentions and behaviors in collegiate student-athletes. J Clin Transl Res. InternetAvailable

from. 2020; [cited 2021 Sep 7]. 5(4):215–26. 10.18053/jctres.05.202004.009.
32. Karatay G, Gürarslan Baş N. Effects of role-playing scenarios on the self-efficacy of students in resisting against substance addiction: a pilot study. Inq J Heal Care Organ Provision, Financ. InternetAvailable from. 2017; [cited 2021 Sep 8]. 54: 1–6. 10.1177/0046958017720624.
33. Yilmaz DU, Palandoken EA, Ceylan B, Akbiyik A. The effectiveness of scenario-based learning to develop patient safety behavior in first year nursing students. Int J Nurs Educ Sch. InternetAvailable from. 2020; [cited 2021 Sep 8]. 17(1):10.1515/ijnes-2020-0011.
34. Rawlins MLW, Suggs DW, Bierema L, Miller LS, Reifsteck F, Schmidt JD. Examination of collegiate student-athlete concussion reporting intentions and behavior. J Clin Trans Res Trans Res. InternetAvailable from. 2020; [cited 2021 Feb 26]. 5(4):186–96. 10.18053/jctres.05.202004.005.