Journal of Science and Medicine in Sport xxx (xxxx)

Contents lists available at ScienceDirect

Journal of Science and Medicine in Sport

journal homepage: www.elsevier.com/locate/jsams

Original research

I won't let you down; why 20% of Men's and Women's Super League players underreported suspected concussions

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ARTICLE INFO

Article history:
Received 30 August 2022
Received in revised form 27 June 2023
Accepted 18 September 2023
Available online xxxx

Keywords:
Concussion
Rugby
Rugby league
TBI
Diagnosis
Player welfare

ABSTRACT

Objectives: Quantify and identify factors associated with concussion underreporting in Super League rugby league players.
Design: Cross sectional survey.
Methods: During the 2022 season preseason, 422 Men's and Women's Super League players completed an online survey quantifying player demographics, rugby playing history, concussion history, prevalence of, and reasons for underreporting concussion, concussion knowledge and long-term implications and perceptions of concussion.
Results: Overall, 20% of respondents stated they did not report concussion-related symptoms to medical staff during the 2020 and 2021 seasons. The two most common reasons for underreporting concussion were '*didn't want to be ruled out of a match*' (35%) and '*didn't want to let down team*' (24%). 65% of players reported an appropriate level of knowledge about concussion and potential long-term implications at the start of their senior rugby career, versus 89% now. In relation to concussion knowledge, symptoms were correctly identified on 74% of occasions. 57% of players surveyed were concerned about the potential long-term implications from concussion, and 11% of players would encourage their/family members' children to not play rugby league.
Conclusions: The proportion of Super League players who did not report concussion symptoms was similar to rugby league players in Australia. The main reasons for not reporting concussion appeared to be due to perceptions of what is beneficial for the team, suggesting both performance and medical staff should collectively encourage players to report concussion. A player's attitude towards concussion is potentially an individual modifiable risk factor and should be considered within the concussion management of players.

Practical implications

- In practice, clinicians should be aware that 1 in 5 rugby league players did not report concussion-related symptoms to medical staff, most commonly due to 'didn't want to be ruled out of a match' and 'didn't want to let down team', therefore during training and matches medical practitioners should increase their clinical suspiciousness.

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https://doi.org/10.1016/j.jsams.2023.09.015

Please cite this article as: D. Tadmor, K. Till, G. Phillips, et al., *I won't let you down*; why 20% of Men's and Women's Super League players underreported suspected concussions..., Journal of Science and Medicine in Sport, https://doi.org/10.1016/j.jsams.2023.09.015

- Eighty-nine percent of players reported they have an appropriate level of knowledge about concussion and the potential long-term implications now, which was higher than at the start of their senior rugby career (65%), and players could identify concussion symptoms correctly on 74% of occasions. Therefore, ongoing education and awareness of concussion symptoms and interventions beyond player education are also required.
- Given over half of rugby league players were concerned about the potential long-term implications and approximately 1 in 10 players would encourage their/family members' children to not play rugby league, at a policy level the findings from this study can be used to ensure all stakeholders (inclusive of coaching and medical staff) are involved in any concussion-related interventions for the overall benefit of the sport.
- The findings of this study agree with similar studies, therefore global and cross-sport collaboration should be at the heart of concussion in sport.

1. Introduction

Professional rugby league is played predominantly in Australasia and Europe by men and women in the National Rugby League (NRL) and Super League (SL) competitions. Rugby league is a physically demanding full-contact sport, with a relatively high risk of head collisions, head injuries and concussion.[1,2,40] Reported rates of concussion in rugby league range from 5[3] up to 40[4] concussions per 1000 h. These variable rates are typically due to the nature of reporting, study methodology and/or the study sample. The incidence of concussion is similar or higher than other football codes (e.g., rugby union; 20 per 1000 h[5] and Australian Rules Football 6 per 1000 h[6]). Given the incidence rates of concussion in rugby league, it is important to quantify and identify factors associated with concussion reporting from a player's perspective.

Concussion education initiatives and policies at all levels of rugby league have enhanced concussion awareness,[7] although underreporting of concussion is still prevalent amongst players involved in contact sports.[8–10] In Canadian American football, 82% of players did not seek healthcare advice for suspected concussion symptoms[9]; 28% of rugby union players in the USA[11] and 21% of professional fighters (boxers, mixed martial artists and martial artists) concealed concussion symptoms from medical staff.[10] Within the NRL over the 2018 and 2019 seasons, 17% of male players disclosed they under-reported concussion symptoms, and 22% of these players did not report at least one concussion.[8] The main reason for not reporting concussion symptoms was the risk of missing playing time (57.7%) and not wanting to let down coaches or teammates (23.1%),[8] consistent with National Collegiate Athletic Association athletes.[12] External pressures and performance expectations on professional athletes have been shown to influence professional players' decision to not report head injury symptoms compared to junior athletes.[8,13,14] The reporting of symptoms is fundamental for concussion diagnosis,[15] thus the underreporting of concussive symptoms is a significant player welfare issue. The clinical consequences of underreporting symptoms are missed concussions, persistent symptoms, delayed return to play, altered brain function, and a higher risk of short-term and long-term injury.[8,16] Acute progressive cerebral oedema ("second impact syndrome") may occur if an initial concussion is missed resulting in serious neurological consequences.[16]

The constructs of concussion-related knowledge, attitudes and norms are directly related to one another, yet the dynamics and transferability of such relationships may be complex.[17] Beyond knowledge and attitudes, norms indicate cultural expectations or standards of social behaviour.[17] More specifically related to concussion, these include reporting intentions and prior health-seeking behaviours surrounding concussive injuries,[18] perceived stakeholder support and encouragement for concussion reporting, as well as missing games and training due to a concussive injury.[17] Research into different athlete cohorts will assist with further understanding of these dynamics.

Whilst data on concussion underreporting exists for the NRL,[8] this study should be repeated in a similar cohort with a larger sample size, including female players to establish if the same findings are observed in SL players.[19,20] Therefore, the aim of this study was to determine the rates of concussion underreporting in SL players and establish why players may not report symptoms or suspected concussions, alongside establishing basic concussion knowledge and establishing awareness of the long-term implications of concussion. The findings can help inform governing bodies on targeted player education initiatives.

2. Materials and methods

This cross-sectional study used an online survey based on Longworth et al.[8] to quantify concussion underreporting and factors associated with concussion reporting in rugby league players from the SL. A link to the survey was emailed to all 658 registered men's ($n = 370$) and women's ($n = 288$) players from SL teams by the Rugby Football League (RFL) during the 2022 preseason. Players were informed that completion of the survey was voluntary and anonymised for name, team, and gender. A total of 422 players completed the survey (response rate 64%). Responses from each league were not possible and the anonymous survey was used to reduce fears of being disadvantaged by submitting truthful answers. Not all the participants answered every question in the survey, therefore data are presented relative to the completed responses.

The survey questions and response options are shown in Supplementary Table 1, with modifications from Longworth et al.[8] indicated.

Data analyses were undertaken using Microsoft Excel 2019 (Microsoft Corporation, Washington, USA) and IBM SPSS statistics 27.0 (SPSS Inc., Chicago, USA). Responses were described as percentages. Descriptive analyses and frequency comparisons were performed in SPSS by first splitting the data into categories: players by age, years playing senior elite rugby league, international playing experience and primary playing position; and then comparing to players who did not report a suspected concussion, the reasons for not reporting a concussion, had an appropriate level of knowledge about concussion, are concerned about the long-term implications, and would encourage their/family members to not play rugby league. Correct, incorrect, and unsure answers for concussion symptoms were compared. Statistical comparisons were made using a generalised linear model with binomial distribution, to examine the associations between underreporting of concussion symptoms (overall underreporting response) and player demographics (e.g., concussion education, age, international experience, concussion diagnosis history and years playing). $p < 0.05$ was considered statistically significant.

3. Results

The distribution of players per age categories were 29% <18 years, 35% 19–25 years, 20% 26–30 years, 15% >30 years. The distribution of players who played senior elite rugby league for 0–2 years was 53%, 3–5 years was 14%, and >5 years was 34%. Twenty six percent of players had played international rugby league, and 58% were forwards and 42% were backs.

During or following a match, 29% reported 1–2, 2% reported 3–5 and 1% reported >5 diagnoses of concussion by a doctor in the past two seasons, and 68% of players reported they had not had a concussion. During or following training, 9% of players reported they had been diagnosed with a concussion by a doctor 1–2 times and 91% reported they had not. Outside of rugby, 4% of players had been diagnosed with a concussion by a doctor 1–2 times, and 96% reported that they had not.

Based on the 422 SL players who completed the survey, 20% of players did not report concussion-related symptoms to medical staff during the 2020 and 2021 seasons. During or following a match, 17%

of players responded to not reporting a suspected concussion 1–2 times and 2% responded to not reporting a suspected concussion 3–5 times. During or following training, 6% of players responded to not reporting a suspected concussion 1–2 times and 1% responded to not reporting a suspected concussion 3–5 times during or following training. Outside of rugby, 1% of players responded to not reporting a suspected concussion 1–2 times. Of the players who did not report a concussion (20%), 27% were <18 years, 33% were 19–25 years, 30% were 26–30 years and 10% were >30 years.

Of the players who did not report concussion symptoms to medical staff, this occurred during a match head injury assessment (HIA) (63%), during the return to play following a concussion (26%), at pre-season baseline assessment/medical review (13%), HIA assessment at training (11%), an incident outside of rugby (1%), or other (18%).

Of the 20% of players that did not report a suspected concussion the following reasons were given; didn't want to be ruled out of a match (35%), didn't want to let down team (24%), it occurred during an important match or time of the season (19%), didn't want to let down the coaches (18%), despite the symptoms(s), didn't think the symptoms were significant (17%), fear that having a concussion diagnosis would affect future selection (15%), didn't want to be ruled out of training (13%), and didn't think the symptoms were related to concussion (8%). There were 53 unique multiple combinations provided in the responses, with the most common single answer was 'didn't want to be ruled out of a match'.

Supplementary Table 2 shows the breakdown of player understanding of concussion symptoms. Overall, symptoms of concussion were identified correctly 74 ± 0.2% of times. Potential symptoms of concussion were identified correctly 77% of occasions. Incorrect potential symptoms of concussion were identified correctly 43% of occasions.

Sixty two percent of players reported having annual concussion education at their clubs, 21% reported to not having and 17% reported to not knowing if they did. Less players (65%) reported an appropriate level of knowledge about concussion and the potential long-term implications at the start of their senior rugby career, versus now (89%). Fifty seven percent of players reported that they were concerned about the potential long-term implications from concussion, and 11% of players said they would encourage their/family members' children to not play rugby league. Of the players who responded that they would encourage their/family members' children to not play rugby league, 28% had previously tried to hide concussive symptoms from a doctor, 30% did not report a suspected concussion on 1–2 occasions in the last 2 seasons during a match, 87% were concerned about the potential long-term implications from concussion, and 36% and 23% said they did not have appropriate knowledge at the start of their senior rugby league career or now about concussion.

Fig. 1a shows a heat map depicting the proportion of players in each category (i.e., age, years playing senior elite rugby league, and international playing experience) who responded to questions on not

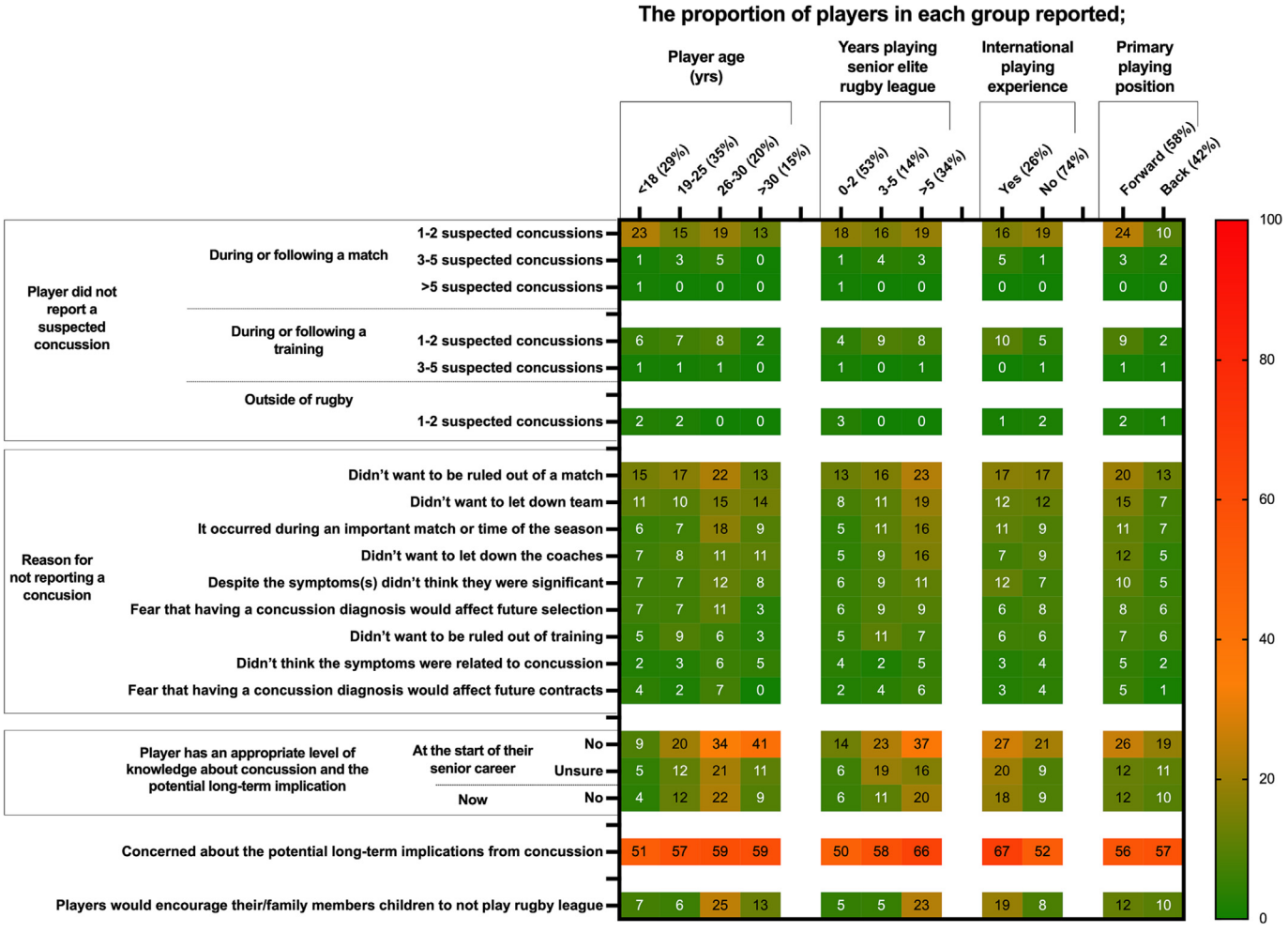

Fig. 1. The proportion (%) of players by age, years playing senior elite rugby league, international playing experience and primary playing position who; did not report a suspected concussion, the reasons for not reporting a concussion, had an appropriate level of knowledge about concussion, are concerned about the long-term implications, and would encourage their/family members to not play rugby league.

reporting a suspected concussion, knowledge about concussion and the potential long-term implications, the potential long-term implications of concussion and whether they would encourage their/family members to not play rugby league. For example, 23% of <18-year-olds stated they did not report a suspected concussion, during or following a match on 1–2 occasions.

Fig. 2 shows a heat map depicting if players responded to questions on not reporting a suspected concussion, knowledge about concussion and the potential long-term implications, the potential long-term implications of concussion and whether they would encourage their/family members to not play rugby league, which category (i.e., age, years playing senior elite rugby league, and international playing experience) they were in. For example, for the players that stated they did not report a suspected concussion, during or following a match on 1–2 occasions, 37% were <18 years old.

There were no statistically significant associations between international playing experience or annual concussion education and underreporting of concussion symptoms. Players aged 26–30 years had higher odds of underreporting concussion symptoms, compared to players >30 years (OR 2.26, $p = 0.03$). Players who had reported at least 1–2 diagnosed concussions in the past two seasons, were less likely to report concussion symptoms to medical staff than players with no previous diagnosed concussion (OR 2.06, $p = 0.03$). Players who had reported at least 3–5 diagnosed concussions in the past two seasons were less likely to report concussion symptoms to medical staff than players with no previous diagnosed concussion (OR 5.60, $p = 0.04$). Players with 0–2 years playing experience were less likely to under-report concussion symptoms, compared to players with >5 years' experience (OR 0.65, $p = 0.04$).

4. Discussion

Recognising, managing, and reducing concussion is a priority for contact sports. This study determined the rates of concussion underreporting in SL players and identified reasons why players may not report symptoms or suspected concussions, alongside an assessment of concussion knowledge and establishing awareness of the long-term implications in the largest cohort to date. A third of all players reported at least one concussion diagnosed by a doctor in the last two seasons. One in five SL players did not report concussion symptoms, similar to the NRL.[8] The two most common reasons for underreporting concussion symptoms were '*didn't want to be ruled out of a match*' and '*didn't want to let down team*'. At the start of their senior rugby league career versus now, there was an improved level of knowledge about concussion and the potential long-term implications. More than half of players surveyed were concerned about the potential long-term implications from concussion, and one-in-ten players would encourage their/family members' children to not play rugby league. As with previous research in the NRL,[8] players in the SL were less likely to report concussion symptoms to medical staff if they had been diagnosed with a concussion previously.[8] The diagnosis of concussion relies on the honest reporting of symptoms by players along with visual and objective clinical signs identified by clinicians.[16,21] Underreporting of concussion symptoms may be a potentially modifiable risk factor, through

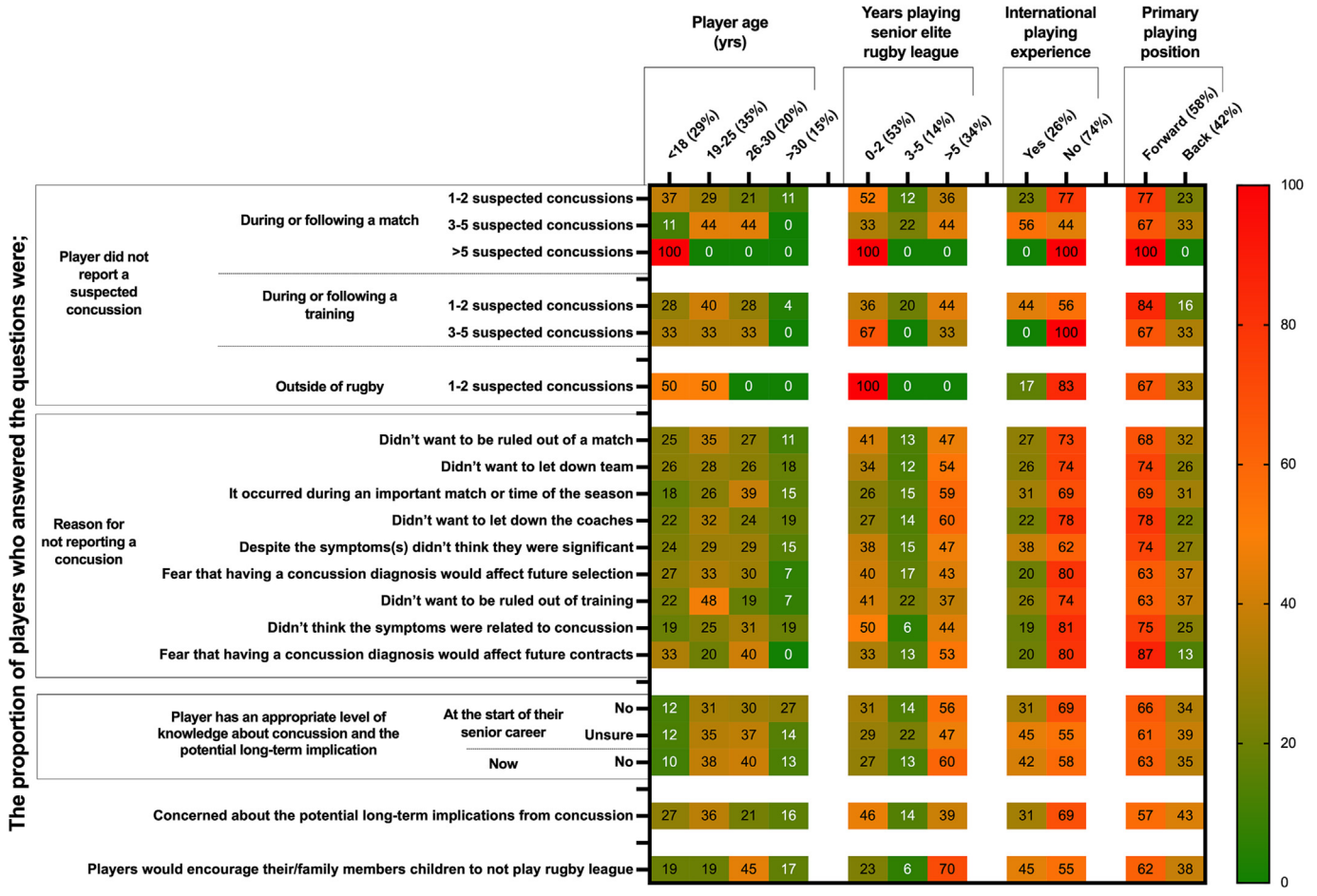

Fig. 2. The proportion (%) of players who; did not report a suspected concussion, the reasons for not reporting a concussion, had an appropriate level of knowledge about concussion, are concerned about the long-term implications, and would encourage their/family members to not play rugby league by age, years playing senior elite rugby league, international playing experience and primary playing position.

appropriate interventions,[22] and should be considered by all rugby league stakeholders. Challenging the misconceptions about injury risk and creating a culture that both reinforces and encourages concussion reporting with clear support from parents, players, staff and coaches, may assist with improving rates of underreporting.[22]

One fifth of players surveyed did not report suspected concussion symptoms in the last two seasons, similar to the NRL[8] and other sports.[10,11,23] Longworth et al.[8] observed 13% of U20s did not report a likely concussion, less than the 27% of <18-year-olds in this study, highlighting the potential pressures young players face.[24,25] Players who had reported at least 1–2 diagnosed concussions in the past two seasons were twice as likely to underreport a concussion to medical staff, similar to NRL findings.[8] Potential objective concussion recognition initiatives (e.g., real-time video, independent doctors, spotters, clear category 1 symptom definitions,[15] electroencephalogram [EEG],[26] biomarkers[27]) may help reduce the reliance on player reporting when objective markers of concussion are not available or evident.

This study found that the main reasons for not reporting concussion were player perceptions of what is beneficial for the team (*not wanting to be ruled out of a match*; 35%, *not wanting to let the team down*; 24%, and *the injury occurring at an important time of the season*; 19%), suggesting referees, coaching, performance, and medical staff should collectively encourage concussion reporting. Similar reasons were also reported in the NRL.[8] These findings are also consistent with professional fighters,[10] rugby union[11] and NCAA athletes.[12] Therefore cross-sport global initiatives, involving coaches and referee education, may also be advantageous in reducing concussion underreporting.[28,29]

Fewer SL players compared to NRL (62% vs 85%) reported having annual concussion education at their clubs at the time of completing the survey.[8] In the present study receiving concussion education was not associated with underreporting of concussion symptoms (OR 1.04, $p = 0.86$). This aligns with the evidence suggesting that education may not have the benefit of changing athlete behaviour and resulting in a reduction in injury.[28,29] Despite the development of concussion education and prevention programmes, there is little evidence to support the effectiveness of such programmes.[28,29] Potentially, targeted education focussing on personal consequences of underreporting, and short- and long-term implications of concussion underreporting may assist with player behaviour change,[30] as well as optimising the environment to ensure players feel there are no negative consequences to reporting potential concussive symptoms.[28]

The participants surveyed in the study identifying the correct and incorrect symptoms of concussion on average 77% and 43% of occasions. Headaches and confusion were correctly identified at the same rates as other contact sports.[31] Fig. 1 shows that the younger players (<18 years) in the study reported good concussion education rates at their clubs, at the start of their careers (86%) and at the time of the study (96%); whereas the older players' rates had a larger percentage difference from the start of their careers to now. This highlights that the current and recent RFL education programmes are reaching youth level rugby league, but the reasons for higher levels of underreporting in this cohort (Fig. 2) should be investigated, along with the differentiation in the age-group reporting rates. This further emphasises that education programmes on their own, may not be the best method to address negative health-associated behaviours.[32,33] Bespoke interventions for players of different ages may be useful in addressing concussion-related behaviours.[28,29,33] Developing and implementing concussion education and prevention measures that target concussion-related norms, may improve concussion related knowledge, attitudes.[17]

Mental health associated symptoms of concussion were the least recognised symptoms in this study. Players with greater mental health literacy have greater health-seeking behaviours, and therefore a better understanding of personal welfare, and reduced risk of prolonged injury.[34] Mental health consequences of concussion could form part of future concussion education initiatives.

This study confirms underreporting of concussion amongst elite rugby league players. Despite the mandated delivery of annual concussion education programmes and the knowledge of the long-term implications, players are still underreporting symptoms and concussions are potentially being missed. A global approach to concussion and changing player perceptions may be beneficial. Concussion diagnosis can be challenging, and the underreporting of symptoms is potentially modifiable. Cultural and behavioural change is not only supported by what the people have learned but also by what they believe.[35] Changing of attitudes is the first step in influencing behaviour change, and shared beliefs will make it possible to change perceptions regarding the severity and long-term consequences of concussions.[35] Advances in objective assessments for concussion diagnosis may lead to a reduced reliance on the self-reporting of subjective symptoms. The uses of instrumented mouthguard technology,[36] EEG monitoring,[26] biomarkers,[27] and MRI imaging[37] may assist in the identification, assessment and diagnosis of concussion. Other contact sports have seen benefit from altering the culture of violence and tough play by rule changes, financial penalties, appropriate education, and changes in governance of the sport.[22] Future cross-sport, and sport-wide education programmes need to target players and coaches and encourage symptom reporting, to assist in the diagnosis of concussion, and safeguard player welfare.

This study is not without its limitations. The use of an anonymous and voluntary survey attempted to reduce bias. It is difficult to assess the generalisability of the study due to potential reporting and sampling bias, however the number of participants is the largest cohort to date ($n = 422$) in comparison to similar studies,[8,10,23] with 64% of the population group completing the survey. The survey reliability was not analysed, as it was based on a questionnaire used in the NRL.[8] A limitation of this study is that the questionnaire did not differentiate between Men's and Women's SL players, therefore gender-specific results were not possible to analyse. Furthermore, not every question in the survey was compulsory, therefore some questions were skipped. In the reasons for not reporting a concussion section, possible answers were given, therefore limiting the full scope of answer that the participant could give. These suggested answers were based on other similar research surveys. This may impact the findings as women have been shown to be more honest reporting concussion symptoms.[38,39] An unconsidered variable in this study is the participant background; future research might benefit from considering the origin of the players and whether it influences their reporting behaviours. For example, some players in this study are from Australia, and therefore may result in cultural differences regarding the reporting of concussion, and reasons why. This study should be replicated in the future, with a differentiation for sex, investigate age-grade and community levels, in addition to evaluating on-going concussion initiatives.

5. Conclusion

One fifth of SL players did not report concussion symptoms or tried to hide a potential concussion from a doctor, similar to the NRL.[8] Clinicians involved in rugby league need to be aware of underreporting, as it could be a contributing factor to missing potential concussion diagnoses. The underreporting of concussion symptoms is potentially an individual modifiable factor. Given the primary reasons for not reporting concussion (e.g., *not wanting to be ruled out of a match* and *not wanting to let the team down*), performance and medical staff should be involved in concussion education to ensure consistency of message and remove any negative perceptions around concussion reporting.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jsams.2023.09.015.

Funding Information

The authors received no funding from an external source.

Confirmation of Ethical Compliance

This project was approved by Leeds Beckett University, Local Ethics Committee (87996).

CRediT authorship contribution statement

Daniel Tadmor: Methodology, Formal analysis, Writing – original draft. **Kevin Till:** Writing – review & editing, Supervision. **Gemma Phillips:** Conceptualization, Project administration, Investigation, Data curation, Writing – review & editing. **James Brown:** Writing – review & editing. **Laura Fairbank:** Conceptualization, Project administration. **Sharief Hendricks:** Writing – review & editing. **Rich D. Johnston:** Writing – review & editing. **Thomas Longworth:** Writing – review & editing. **Keith Stokes:** Writing – review & editing. **Ben Jones:** Conceptualization, Methodology, Investigation, Data curation, Writing – review & editing, Project administration.

Declaration of Interest Statement

DT PhD is part-funded by Leeds Rhinos. KT is employed in a consultancy capacity by Leeds Rhinos. GP and BJ are employed in a consultancy capacity by the Rugby Football League. BJ is employed in a consultancy capacity by Premiership Rugby. GP is a contracted Doctor by a SL club. LF is employed by the Rugby Football League and Rugby League World Cup. TL is a contracted Doctor by a NRL club. KS is employed by the Rugby Football Union.

Acknowledgements

The authors would like to thank all players who completed the survey and Player Welfare managers at Super League clubs for supporting the recruitment.

References

1. Gardner AJ, Iverson GL, Edwards S et al. A case-control study of tackle-based Head Injury Assessment (HIA) risk factors in the National Rugby League. *Sports Med Open [Internet]* 2021;7(84). doi:10.1186/s40798-021-00377-9. Available from.
2. Spiegelhalter M, Scantlebury S, Heyward O et al. The propensity of non-concussive and concussive head contacts during elite-level women's rugby league matches: a prospective analysis of over 14,000 tackle events. *J Sci Med Sport* 2023;26(3):195-201.
3. Fitzpatrick AC, Naylor AS, Myler P et al. A three-year epidemiological prospective cohort study of rugby league match injuries from the European Super League. *J Sci Med Sport* 2018;21(2):160-165.
4. Gardner A, Iverson GL, Levi CR et al. A systematic review of concussion in rugby league. *Br J Sports Med* 2015;49(8):495-498.
5. West SW, Cross M, Trewartha G et al. Trends in match concussion incidence and return-to-play time in male professional Rugby Union: a 16-season prospective cohort study. *Brain Inj* 2021;35(10):1235-1244.
6. Saw R, Finch CF, Samra D et al. Injuries in Australian rules football: an overview of injury rates, patterns, and mechanisms across all levels of play. *Sports Health* 2018;10(3):208-216.
7. King DA, Clark TN, Hume PA et al. Match and training injury incidence in rugby league: a systematic review, pooled analysis, and update on published studies. *Sports Med Health Sci* 2022.
8. Longworth T, McDonald A, Cunningham C et al. Do rugby league players under-report concussion symptoms? A cross-sectional study of elite teams based in Australia. *BMJ Open Sport Exerc Med* 2021;7(1).
9. Delaney JS, Caron JG, Correa JA et al. Why professional football players chose not to reveal their concussion symptoms during a practice or game. *Clin J Sport Med* 2018;28(1):1-12.
10. Bennett LL, Arias JJ, Ford PJ et al. Concussion reporting and perceived knowledge of professional fighters. *Phys Sportsmed* 2019;47(3):295-300.
11. Chance Miller J, Shubin Stein K, Moon TJ et al. Concussion-reporting behavior in rugby a national survey of Rugby Union players in the United States. *Orthop J Sports Med [Internet]* 2021;9(1). Available from: http://www.sagepub.com/journals-permissions.
12. Corman SR, Adame BJ, Tsai JY et al. Socioecological influences on concussion reporting by NCAA Division 1 athletes in high-risk sports. *PLoS One* 2019;14(5).
13. Kroshus E, Garnett B, Hawrilenko M et al. Concussion under-reporting and pressure from coaches, teammates, fans, and parents. *Soc Sci Med* 2015;134:66-75.
14. Torres DM, Galetta KM, Phillips HW et al. Sports-related concussion anonymous survey of a collegiate cohort [internet]. Available from:: www.neurology.org/cp 2013.
15. Tucker R, Raftery M, Fuller GW et al. A video analysis of head injuries satisfying the criteria for a head injury assessment in professional Rugby Union: a prospective cohort study. *Br J Sports Med [Internet]* 2017;51:1147-1151. Available from: http://bjsm.bmj.com/.
16. Patricios JS, Schneider KJ, Dvorak J et al. Consensus statement on concussion in sport: the 6th International Conference on Concussion in Sport-Amsterdam, October 2022. *Br J Sports Med [Internet]* 2023;57(11):695-711. Available from: http://www.ncbi.nlm.nih.gov/pubmed/37316210.
17. Nedimyer AK, Chandran A, Kossman MK et al. Concussion knowledge, attitudes, and norms: how do they relate? *PLoS One* 2023;18(2 February).
18. Register-Mihalik JK, Guskiewicz KM, Valovich McLeod TC et al. Knowledge, attitude, and concussion-reporting behaviors among high school athletes: a preliminary study. *J Athl Train [Internet]* 2013;48(5):645-653. Available from: http://meridian.allenpress.com/jat/article-pdf/48/5/645/1609121/1062-6050-48_3_20.pdf.
19. Goodman SN, Fanelli D, Ioannidis JPA. What does research reproducibility mean? *Sci Transl Med* 2016;8(341):341.
20. Pearce N, Rhodes S, Stocking K et al. Occupational differences in COVID-19 incidence, severity, and mortality in the United Kingdom: available data and framework for analyses. *Wellcome Open Res [Internet]* 2021;6(102). doi:10.12688/wellcomeopenres.16729.1. Available from.
21. Harmon KG, Clugston JR, Dec K et al. American Medical Society for Sports Medicine position statement on concussion in sport. *Br J Sports Med* 2019;53(4):213-225.
22. Cusimano MD, Topolovec-Vranic J, Zhang S et al. Factors influencing the underreporting of concussion in sports: a qualitative study of minor hockey participants. *Clin J Sport Med* 2017;27(4):375-380.
23. O'Connor S, Warrington G, Whelan G et al. Concussion history, reporting behaviors, attitudes, and knowledge in jockeys. *Clin J Sport Med* 2020;30(6):578-584.
24. Kirkwood G, Parekh N, Ofori-Asenso R et al. Concussion in youth rugby union and rugby league: a systematic review. *Br J Sports Med [Internet]* 2015;49:506-510. Available from: https://doi.org/10.1136/bjsports-2014-093774.
25. Pfister T, Pfister K, Hagel B et al. The incidence of concussion in youth sports: a systematic review and meta-analysis. *Br J Sports Med* 2016;50(5):292-297.
26. Conley AC, Cooper PS, Karayanidis F et al. Resting state electroencephalography and sports-related concussion: a systematic review. *J Neurotrauma* 2019;36:1-13. Mary Ann Liebert Inc.
27. Di Pietro V, O'Halloran P, Watson CN et al. Unique diagnostic signatures of concussion in the saliva of male athletes: the Study of Concussion in Rugby Union through MicroRNAs (SCRUM). *Br J Sports Med* 2021;55(24):1395-1404.
28. Fraas MR, Burchiel J. A systematic review of education programmes to prevent concussion in rugby union. *Eur J Sport Sci* 2016;16:1212-1218. Taylor and Francis Ltd.
29. Eliason PH, Galarneau JM, Kolstad AT et al. Prevention strategies and modifiable risk factors for sport-related concussions and head impacts: a systematic review and meta-analysis. *Br J Sports Med [Internet]* 2023;57(12):749-761. Available from: https://bjsm.bmj.com/lookup/doi/10.1136/bjsports-2022-106656.
30. Prien A, Grafe A, Rössler R et al. Epidemiology of head injuries focusing on concussions in team contact sports: a systematic review. *Sports Med [Internet]* 2018;48:953-969. Available from: https://doi.org/10.1007/s40279-017-0854-4.
31. Cournoyer J, Tripp BL. Concussion knowledge in high school football players. *J Athl Train [Internet]* 2014;49(5):654-658. Available from: www.natajournals.org.
32. Verhagen EALM, Van Stralen MM, Van Mechelen W. Behaviour, the key factor for sports injury prevention. *Sports Med* 2010;40:899-906.
33. 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* 2016;2(1).
34. Kola-Palmer S, Lewis K, Rodriguez A et al. Help-seeking for mental health issues in professional Rugby League players. *Front Psychol* 2020;24:11.
35. Macdonald ND, Baumann O. Predictors of concussion reporting intentions in adolescent hockey players. *Curr Psychol* 2023;11:1-7.
36. Jones B, Tooby J, Weaving D et al. Ready for impact? A validity and feasibility study of instrumented mouthguards (iMGs). *Br J Sports Med* 2022;56:1171-1179. doi:10.1136/bjsports-2022-105523. Available from https://bjsm.bmj.com/lookup/doi/10.1136/bjsports-2022-105523.
37. Zimmerman KA, Laverse E, Samra R et al. White matter abnormalities in active elite adult rugby players. *Brain Commun* 2021;3(3).
38. Kieffer EE, Brolinson PG, Maerlender AE et al. In-season concussion symptom reporting in male and female collegiate rugby athletes. *Neurotrauma Rep* 2021;2(1):503-511.
39. McGroarty NK, Brown SM, Mulcahey MK. Sport-related concussion in female athletes: a systematic review. *Orthop J Sports Med* 2020;1:8(7).
40. Eastwood D, Owen C, Phillips G et al. Incidence of concussion in men's Super League, Championship, and Academy rugby league matches between 2016 and 2022. S1440-2440(23)00386-9. *J Sci Med Sport* 2023. doi:10.1016/j.jsams.2023.09.001. Epub ahead of print. PMID: 37718192.