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Concussion knowledge and attitude of English youth rugby players: the RUCKAS-YOUTH survey

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ABSTRACT

Objective This cross-sectional study describes the concussion knowledge and attitudes of male and female 14–18 year-old school rugby union players in England.

Methods Data from 515 (male 421, female 94) players from 19 schools were collected via the specifically designed Rugby Union Concussion Knowledge and Attitude Survey (RUCKAS-YOUTH) between 2019 and 2022. Knowledge and attitude questions were grouped into themes and analysed against primary cohorts of sex, school status and age group and secondary cohorts of stated Rugby Football Union (RFU) education conduction, concussion history and rugby experience. Associations between knowledge and attitudes were then explored.

Results No association between total concussion knowledge and attitude was found. Mean concussion knowledge was 79.3% (26.2/33±2.9). The mean concussion attitude safety score was 76% (129.3/170±14.8). RFU 'Don't Be a HEADCASE' module completion was low (16.9%) and was not associated with concussion knowledge. Private school participants reported significantly safer attitudes towards concussion (77.8%, 132.2±14.0) than state school pupils (74.5%, 126.6±15.1), but not greater concussion knowledge. Male and female participants held similar knowledge and attitudes towards concussion, as did participants across the age spectrum. Concussion attitude safety was significantly greater in players with 7–15 years of playing experience than in the younger cohort (U=27 563.0 p=0.005).

Conclusion The RUCKAS-YOUTH survey provides a detailed description of UK youth rugby concussion knowledge and attitudes. The survey results indicate that attitudes towards concussion, particularly those that influence symptom disclosure, should be a primary focus of concussion risk reduction interventions once key gaps in knowledge are addressed.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Concussion knowledge and attitudes heavily influence community rugby player safety, and in turn, symptom disclosure incidence.
⇒ Published studies have been small-scale, population-specific, dated and concussion knowledge-dominated investigations.

WHAT THIS STUDY ADDS

⇒ Large scale understanding of school age rugby player concussion knowledge and attitudes.
⇒ Insight into concussion knowledge/awareness differences between male and female, age groups, experience level and school status participants.
⇒ Understanding of perceived engagement with Rugby Football Union (RFU) head injury education provision.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Concussion education should focus on attitude and behaviour safety over knowledge retention.
⇒ Understanding the influences on symptom disclosure is an essential pillar of youth rugby concussion safety.
⇒ The results form a benchmark from which to assess the efficacy of future concussion education interventions, including the March 2023 Department for Culture, Media and Sport United Kingdom Concussion Guidelines for Grassroots Sport.

INTRODUCTION

Rugby union is a common component of sports provision in schools worldwide.[1] Despite this, rugby union participation among 11–16 in the UK has declined since 2014/2015.[2] Recently, public concern that injury risks may be too high has grown, particularly in the context of sports-related concussion (SRC).[3] As head injuries can have catastrophic outcomes if not identified or managed appropriately, particularly in young people,[4] injury risks may contribute to falling engagement and present a distinct and continued threat to sporting participation. Rugby governing bodies have sought to mitigate injury and SRC risks while maintaining the core tenets of the game.

Educational initiatives have become a key element.[5] Programmes have targeted player knowledge, attitudes and the social norms of the environment.[6] Such programmes have been influenced by a small but growing research base initiated by the 2006 Sye *et al* investigation of New Zealand high

school rugby players.[7] More recent research from New Zealand,[8 9] South Africa[10 11] and the UK and Ireland[12 13] has begun to reveal the links between knowledge, attitude and symptom disclosure intention, commonly influential in pitch-side player safety outcomes.[14] Supported by this limited but grown evidence base, community-level educational initiatives have been employed by the major rugby playing nations.[15–17] Initially their design focused on increasing SRC knowledge and awareness,[18] and more recently, player attitudes and intentions.[19 20] However, the efficacy of such interventions has been questioned.[21]

Validating education impact is not simple. Conventionally, risk reduction interventions are assessed by monitoring injury frequency before and after the intervention.[22] A fall in incidence reflecting intervention success. However, reported concussion rates at community youth levels vary from 0.2 to 22/1000 hours[23 24] and concussion definitions have not been consistent. In addition, SRC injury disclosure may increase following an intervention designed to increase disclosure, but may be interpreted as heightened injury risk, despite unchanged prevalence. To gauge education risk reduction initiatives, adjunctive means of intervention evaluation are required.[20] To address this shortfall, this study employed the novel Rugby Union Concussion Knowledge and Attitude Survey (RUCKAS-YOUTH) survey to establish concussion knowledge and attitudes in youth rugby union players. It could then be used to establish the efficacy of UK SRC education interventions.

METHODS

Participants

Directors of rugby/sport from schools that offer rugby union were invited to take part in September 2019. Study information and consent documents were sent via the school to parents of under 18 players. The email contained links to opt-in online consent declaration and study withdrawal pages. Approval was obtained from the St. Mary's University Ethics. 534 14–18 year-old competitive rugby playing students from 19 English schools (male 421, female 94) completed the survey between 2019 and 2022. Seven participant data omissions due to non-parental consent occurred. Participants who did not complete the survey in its entirety were excluded (n=12). This resulted in a total sample size of 515.

The survey

The RUCKAS-YOUTH survey was designed specifically for the purposes of this study with reference to the Consensus-based Checklist for Reporting of Survey Studies.[25] A pilot review of the survey comprising three female and seven male participants was conducted prior to the study launch. The pilot established the average survey completion time of between 10 and 12 min and led to minor wording changes. The survey includes questions from previously developed concussion surveys[7 12 13 26] either verbatim or modified. The survey included three sections, demographics, concussion knowledge (CK) and concussion attitudes (CA) and used questions from the youth rugby surveys of Kearney and See,[13] Baker *et al*[12] and Sye *et al*.[7] CA questions were grouped into themes; prevention strategies, disclosure consequences, disclosure triggers and disclosure norms, return to play (RTP) timing, coach lead RTP, physio lead RTP intention and pressure to play. Themes reflect those used within the Rosenbaum Concussion Knowledge and Attitudes Survey-Student Version (ROCKaS-ST) survey[26] and the Rugby Footbal Union (RFU) 'Don't Be a HEADCASE' (DBaH) content, an online concussion education programme RFU affiliated stakeholders are asked to direct players to[17] (see online supplemental materials 1and 2). The survey was conducted at a school overseen by teaching staff.

Data handling

Primary cohort groups were defined by sex, private (self-funded) or state school (state-funded) and age group (14–16 and 17–18) (table 1). Secondary cohort groups were defined as those who had/had not completed the DBaH online concussion education module, and based on previous concussion history and rugby experience (≤6 years' experience and 7–15 years' experience). Cronbach α scores were calculated to assess CA theme internal consistency with scores of >0.7 considered acceptable. Concussion Knowledge Index (CKI) was defined by the number of correct answers to each knowledge question which scored one point (maximum score 33) and then expressed as a percentage. Two Validity Scale questions modified from the ROCKaS-ST[26] were included which no participant failed. For the Concussion Attitudes Index (CAI) in Likert format, responses deemed the safest attitude scored 5, with the least safe scoring 1. Where appropriate, questions were reverse-coded to convert initial numerical inferiority. Attitude scores ranged from a possible 34 to 170.

Data analysis

Individual knowledge responses within paired cohort groups were assessed with independent samples t-tests. Differences in CKI and CAI scores by cohort were assessed with Mann-Whitney U tests. Cohort associations between knowledge and attitude indices variables were established through Pearson's tests. Differences in mirrored attitude statements prefixed with either 'Most players', or 'My teammates' that were modified from the ROCKaS-ST[26] by Kroshus *et al*,[27] were established with independent samples t-tests. Ordinal logistic regression was used to assess the predictive influence of CKI themes and theme questions that demonstrated individual association with CAI scores. Despite insignificant overall scores, post hoc testing of individual components was used to identify specific areas of difference.

RESULTS

The majority of participants were male (82%, aged 14–16 (78%), with an even distribution between state (53%) and

Table 1 Participant demographics, concussion history and concussion education

	Female	Male	State	Private	17–18	14–16	Total
All	**94 (18%)**	**421 (82%)**	**273 (53%)**	**242 (47%)**	**113 (22%)**	**402 (78%)**	**515**
Female			82 (87%)	12 (13%)	16 (17%)	78 (83%)	**94 (18%)**
Male			191 (45%)	230 (55%)	97 (86%)	324 (77%)	**421 (82%)**
Rugby experience (years)							
0–3	56 (60%)	118 (28%)	138 (51%)	36 (15%)	11 (10%)	163 (41%)	**174 (34%)**
4–6	28 (30%)	98 (23%)	62 (23%)	64 (26%)	25 (22%)	101 (25%)	**126 (25%)**
7–9	9 (10%)	106 (25%)	40 (15%)	75 (31%)	25 (22%)	90 (22%)	**115 (22%)**
10–12	1 (1%)	80 (19%)	24 (9%)	57 (24%)	33 (29%)	48 (12%)	**81 (16%)**
13–15	–	19 (5%)	9 (3%)	10 (4%)	19 (17%)	–	**19 (4%)**
'Don't Be a HEADCASE' online module completion - yes	15 (16%)	72 (17%)	31 (11%)	56 (23%)	35 (31%)	51 (13%)	**87 (17%)**
Previous concussion history							
No	71 (76%)	201 (48%)	156 (57%)	116 (43%)	34 (13%)	238 (88%)	**272 (53%)**
Yes, once	13 (14%)	102 (24%)	66 (57%)	49 (43%)	32 (28%)	83 (72%)	**115 (22%)**
Yes, twice	4 (4%)	62 (15%)	23 (35%)	43 (65%)	21 (32%)	45 (68%)	**66 (13%)**
Yes, three times or more	6 (10%)	56 (13%)	28 (45%)	34 (55%)	26 (42%)	36 (58%)	**62 (12%)**

Bold typeface indicates all data combined in each particular category.

private school attendance (47%). Table 1 shows participant demographics, concussion history and concussion education findings.

Concussion knowledge and attitude associations

No association between overall CKI and CAI was found ($r(513)=0.139$, p=0.889). When reviewing the potential influence of individual knowledge theme components on total CAI, ordinal logistic regression identified the true or false CK section as having the only significant positive predictive effect on attitude safety ($\chi^2(2)=17.359$, p=0.027). When further subdivided, the only individual knowledge response to represent a positive predictive effect on CAI safety was answering correctly 'Symptoms of concussion can last for several weeks' ($\chi^2(2)=10.089$, p=0.001).

Concussion knowledge

Overall mean CKI was 79.3% (26.2±2.9, maximum score 33) (figure 1 and online supplemental materials 3). Youth rugby players were largely aware of the selected Concussion in Sport Group defined signs and symptoms of concussion[28] in a rugby context (82.5% 6.6±1.3 maximum score 8). In addition, participants commonly stated that understanding concussion is essential as a rugby player (91.7% 4.6±0.7). Despite this, knowledge of current graded return to play (GRTP) guidelines with regards to minimum rest periods (55.5%±0.5) and that, at the time of the study, a 'GP/Doctor' was recommended to perform a medical review/assessment of a player before a return to contact-based rugby following concussion (49.3%±0.6) were low. Similarly, a notable percentage of youth rugby players were unaware that they may be more susceptible to concussion than adults (46.6% correct) and incorrectly responded that concussion can only occur from a hit to the head (41.9% correct). Just under a quarter of players were not aware that there is a possible risk of death if a second impact occurs before the first has resolved (76.6% correct).

Concussion attitudes

When 5-point Likert questions were totalled the overall CA score was 129.3±14.8 (maximum score 170) (online supplemental materials 4). Most players were aware that tackle technique is important in reducing concussion (mean 4.6±0.8) and that they would stop playing and report my symptoms if they (1) sustained an impact that caused them to vomit or feel nauseous, (mean 4.3±0.8) or (2) experienced dizziness or balance problems (mean 4.3±0.8). Conversely, most players incorrectly stated that gumshields and headguards may prevent concussion (mean 2.2±1.1 correct) and were less aware of how appropriate warm-ups may reduce concussion risk (mean 3.2±1.1). Players appeared more likely to disclose observable symptoms over cognitive deficits with being held out of games and training the most prominent drivers behind potential symptom non-disclosure (online supplemental materials 6). Players cited placing more pressure on themselves to return to play while still symptomatic (3.7±1.2) than from external sources such as coaches (mean 4.2±1.0), parent/guardians (mean 4.2±1.0) or teammates (4.2±1.1) (online supplemental materials 7). No significant differences were found between any attitude statements prefixed with either 'Most' or 'My teammates'.

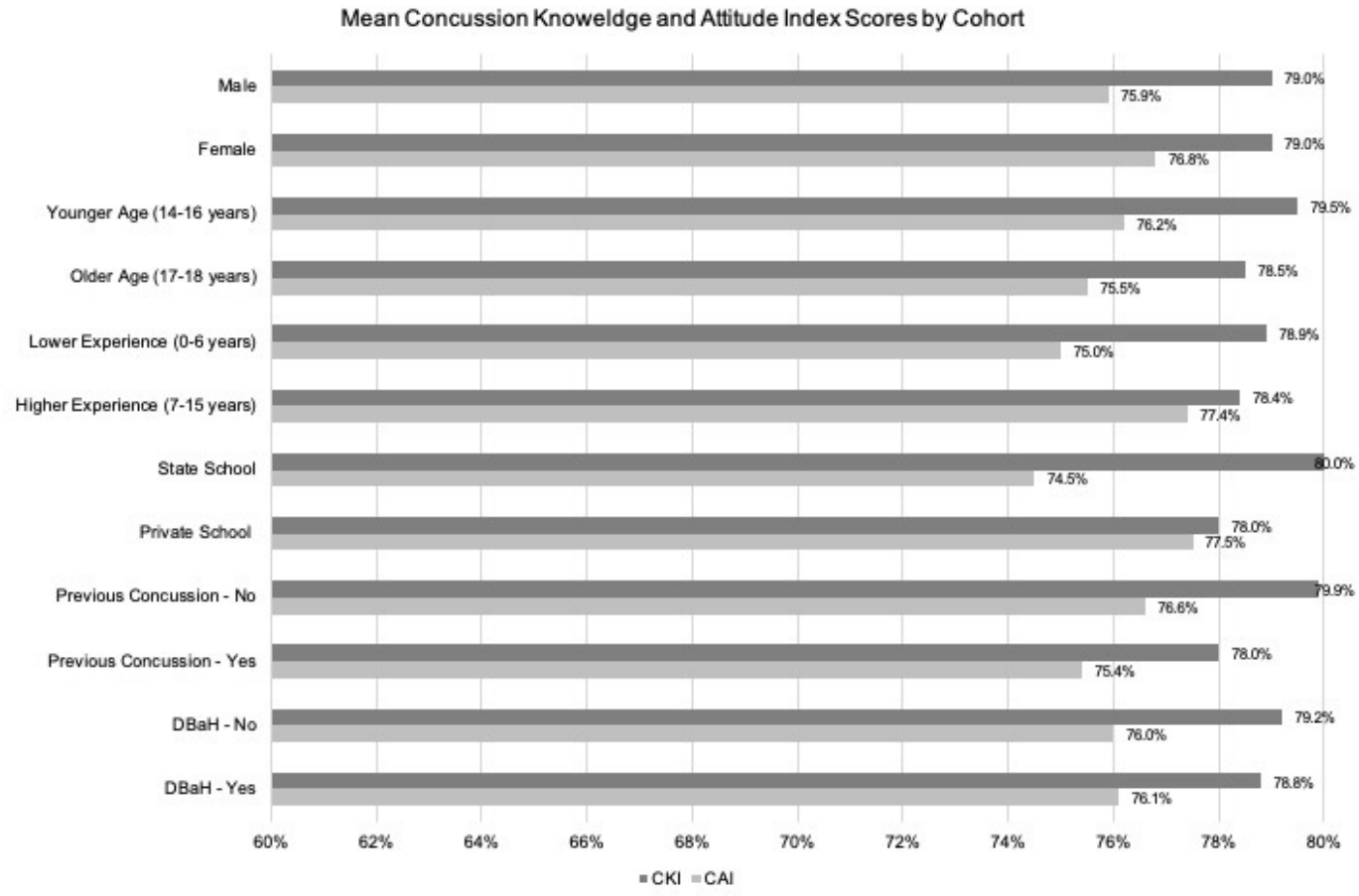

Figure 1 Mean Concussion Knowledge and Attitude Index scores by cohort. DBaH, Do not Be a HEADCASE.

Sex comparisons

Females had less rugby experience and less previous concussion history compared with males. There were no differences in overall CKI or CAI scores between the sexes. Of the few differences observed in attitude themes, male participants demonstrated significantly more agreement with unsafe attitudes surrounding the symptom disclosure consequences theme than females ($t(513)=3.1$, p=0.002). Most notably the statement, 'If I report what I suspect might be a concussion, I will not be allowed to start training and playing when I think I am ready' ($t(513)=3.1$, p=0.002) (online supplemental materials 6). Conversely, females recorded significantly less-safe attitudes when stating that 'If all the symptoms of concussion have gone, you can safely return to contact rugby' ($t(513)=2.9$, p=0.004). Despite low overall scores, male participants (58.4% 0.6±0.5) scored significantly higher than female counterparts (38.3% 0.4±0.5) $t(138)=2.2$ p=0.032) when asked to identify the recommended minimum rest period following concussion for both youth and adult players before a graded return to rugby can start (14 days).

Age and experience comparisons

CK and attitude scores did not differ by age group or sex. Older participants were, however, significantly more likely to report putting themselves under pressure to return to play while symptomatic than younger participants. CA safety was greater in players with 7–15 years of playing experience (77.4% 131.6±15.0) compared with 0–6 years' experience(75.1% 127.6±14.5) (U=27 563.0 p=0.005). No differences in CK or attitude were observed in participants who had and had not, experienced concussion in the past.

School status comparisons

No observed differences in CK between state and private school participants were found. A small but significantly greater mean attitude score was identified in private school attending participants (77.8%, 132.2±14.0) over state school counterparts (74.5%, 126.6±15.1) (U=26 141.5 p=0.00001).

DBaH completion

The majority of participants (83.1%) stated that they had not completed the RFU DBaH online module before. Private school attending participants (23.1%) reported significantly higher DBaH completion than state school counterparts (11.4%) $t(376)=3.6$ p=0.0003). No significant differences in CK or attitude theme scores were observed between participants who had and had not completed the DBaH online module.

Previous concussion

No difference in CK or attitude was observed between participants who had and had not experienced previous concussion.

DISCUSSION

No association between total CKI and total CAI was found suggesting that greater CK does not directly lead to a proportional increase in CA safety, as previously reported.[29 30]

Concussion knowledge

The overall mean CKI score of 79.3% suggest CK was similar to that reported in adults and higher than previously reported youth cohorts.[13] 'Don't Be a HEADCASE' module completion cannot, however, be considered responsible as stated completion among the respondents was low and CKI scores were not different between those who had, or had not, completed the module. The low reported DBaH completion might be influenced by poor participant awareness and/or memory of DBaH completion, as the majority of schools reported either onsite completion or directing students to DBaH, as part of school sport policy.

The highest-scoring knowledge questions involved the recognition of the signs and symptoms of concussion, suggesting that youth rugby players are broadly aware of concussion in a rugby context. This contradicts the now dated conclusion that failings in concussion symptom awareness are largely responsible for non-disclosure.[31] Despite this, gaps in participant CK are apparent. The lowest knowledge scores reveal a mixed appreciation of concussion complications and the processes and timings of recommended return to play. Most concerningly, the majority of participants were unaware that they were at greater risk of prolonged and fatal consequences of concussion than adults.[32] If youth rugby players incorrectly perceive that they are no more susceptible to the effects of concussion than adults, they may underappreciate risks when making symptom disclosure decisions. Ensuring that youth rugby players and stakeholders are fully aware of youth concussion risk is essential.

Participants were commonly unaware of the recommended minimum rest period following concussion, and that at the time of the survey, a general practitioner/doctor was recommended to perform a medical review prior to contact-based rugby. This may seem an obvious target for educational intervention, however, the impact of concussion guideline awareness may be more complex. A key finding of this research supports the rationale that a desire for continued rugby participation is a key driver of symptom non-disclosure.[8] Whether increased player awareness of stand-down periods within a complex GRTP promotes greater safety through adherence, or heightens the likelihood of non-disclosure, remains debatable. Until the diagnostic capabilities required for individualised GRTP reach grassroots levels, negating this effect may remain challenging for governing bodies.

Concussion attitudes

The mean total CAI safety score of 76.0% matches reports from adult community rugby club stakeholders.[11] This figure suggests broadly safe attitudes towards concussion but discrepancies are apparent. Understanding regarding prevention is mixed with high attitude safety scores towards the importance of tackle technique (89.0%), contrasted by less safe scores regarding gumshields[33] and headguards[34] not preventing concussion (44.8%), a finding similarly reported by Baker *et al*.[12] If youth rugby participants feel that equipment can reduce concussion risk, it may influence their decision-making and promote risk-taking behaviours.[34] As such, continued education surrounding protective equipment for youth rugby players is imperative. Limited appreciation that suitable warm-ups may reduce concussion risk was found. If pre-activity interventions are to form a key pillar of concussion risk reduction,[35] player awareness should be a primary focus of education interventions.

Within the 'Pressure to Play' theme statements, no differences were observed between participants' attitudes towards external pressure from coaches, teammates and parents. The significant outlier was, 'I have put myself under pressure to play'. This suggests that, if pressure is felt by players, the drive for continued participation is commonly intrinsic, which Kroshus *et al* feel may be a result of the loss of valued commodities such as competitive opportunities, or of social sanctions or social isolation from the team.[36]

The 'Symptom Disclosure Consequences' theme details some of the intrinsic drivers. The lowest scoring safety attitudes were 'If I report what I suspect might be a concussion, I will not be allowed to start training and playing when I think I am ready', and 'If I report what I suspect might be a concussion, I will be held out of games even if it's not a concussion'. This suggests that, not only is being excluded from play the most powerful non-disclosure driver, but participants' personal readiness judgements and desire for self-reliance play a key role.[37] As a result, if players feel that perceived low initial symptom severity is associated with lower secondary risk, they may be more inclined to withhold symptom disclosure if it might lead to exclusion.[38] As the 'Symptom Disclosure Consequences' theme led to the second lowest overall attitude theme safety scores, each of the attitudes towards the five statements should be addressed within concussion behaviour change interventions.

No difference in reported attitudes between statements prefixed 'Most' and 'My teammates' were found suggesting self-predictive behaviour, that is, 'Most' is commensurate with perceived social norms that is, 'My teammates'. This reflects the findings of previous investigations[26 27] and infers behaviour change interventions that focus on collective team attitudes are appropriate within a youth rugby context.

Sex differences

Overall CK and attitude did not differ by sex, but females demonstrated less-safe attitudes than males when stating 'If all the symptoms of concussion have gone, you can safely return to contact rugby'. Despite inclusion within

the attitude section of the survey, answers to this statement could be influenced by less knowledge of GRTP protocols, possibly driven by receiving concussion information from less sources than male athletes, a previously reported difference between sexes within youth concussion symptom disclosure.[39] This could be linked to the only other metric to differ between the sexes, the lower level of rugby experience of female participants. If less experience is associated with less exposure to positive CK and attitude, it should be a focus of concussion education.

A key difference between the sexes was the significantly lower attitude safety scores in male participants with regard to the consequences of disclosure. The lowest-scoring statements in this theme involved being held out of games. As a theme, and for four out of five questions within the theme, male participants demonstrated more agreement with unsafe attitudes surrounding the consequences of symptom disclosure than females. This cannot be explained by SRC knowledge, as this was not different by sex and no association between knowledge and injury disclosure consequence scores was apparent. There is limited literature as to why males demonstrate less-safe attitudes towards SRC RTP, however, Salmon *et al* describe youth female rugby players demonstrating a heightened sense of caution or fear around RTP after a concussion, compared with male players.[9] In addition, the authors speculate that rugby's cultural associations with 'toughness' are commonly intertwined with the notion of 'manliness', both possible drivers.[9] Why young males may value rugby competition more highly and are prepared to take more risks than young females, is debatable. Further research that unpacks the links between perceived sporting importance and disclosure intention is needed to positively influence youth risk/reward decision-making.

Age, playing and concussion experience

As with previous studies,[13 40] no differences in overall CK or attitude were observed between age groups. This suggests that, as long as appropriately designed for youth cohorts, further age specificity of educational interventions is not indicated. It would also suggest that younger age groups are suitable targets for intervention, as they may carry knowledge through a playing career. A greater proportion of older participants stated they were more likely to put themselves under pressure to return to play while symptomatic, than younger participants. In contrast, greater rugby playing experience was associated with safer overall CAI scores. When evaluated collectively, the findings suggest that although rugby experience may heighten awareness of expected norms, increasing age may also heighten the intrinsic drive to play. This, again, reflects the conflict experienced by participants known risks and their drive for continued participation. It may also allude to the discrepancy between expected/stated attitudes and resulting real-world behaviours.[8] Influencing the balance between these drivers is essential in promoting safe behaviours.

The lack of observable association between prior concussion and CK or attitude is counter to previous research suggesting that concussion experience leads to a less-safe attitude towards concussion, and, in turn, reduced concussion disclosure.[38] It has been hypothesised that this may be a result of perceiving no negative consequences after continued symptomatic play, and thus no benefits to injury disclosure.[41] It may be that participants in the RUCKAS-YOUTH survey are more aware of, and influenced by, currently expected behaviour norms than participants of these previous investigations.

School status

No differences in total CK were observed, however, private school attending participants reported safer attitudes towards concussion. Whether the safer CA stated by private school participants are a result of greater participant awareness of expected contextual norms, or do indeed reflect safer attitudes, remains unknown. The differences between the two groups warrants further investigation as targeted interventions may be indicated.

Limitations

An inherent limitation of attitude assessment remains the potential gap between reported knowledge and attitude, and resulting behaviour.[42] The rise in concussion awareness and, in turn, increasing knowledge of expected norms, may compound this. The survey design attempts to mitigate such social desirability bias through indirect questioning as previously studies have employed.[26 30] This study was completed before the introduction of UK government driven graded return to activity and sport guidelines. Understanding of these changes impact on stakeholder CK and attitude should be sought and caution used when generalising results to other populations.

CONCLUSION

The RUCKAS-YOUTH survey provides a detailed description of UK youth rugby CK and attitudes. The survey results indicate that attitudes towards concussion, particularly those that influence symptom disclosure, should be a primary focus of concussion risk reduction interventions once key gaps in knowledge are addressed.

Equity, diversity and inclusion statement

The author group comprises two women and five men from mid-career to renowned researchers of diverse backgrounds within sports medicine. The study participants were of a broad spectrum of UK socioeconomic backgrounds from both state and private schools.

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collection and data management. DS wrote all manuscript drafts, with critical appraisal from KS, RF-B and RM. All authors approved the final version of the manuscript for submission. DS is the guarantor.

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Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by St Mary's University, Twickenham London. SMEC_2016-17_153. Participants gave informed consent to participate in the study before taking part.

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REFERENCES

1 Leahy TM, Kenny IC, Campbell MJ, *et al*. Injury surveillance in school Rugby: A systematic review of injury epidemiology & surveillance practices. *Phys Ther Sport* 2019;38:170–8.
2 Statista. Share of children participating in rugby in the last week in England from 2017/18 to 2021. Sport & Recreation; 2021.
3 Liston K, McDowell M, Malcolm D, *et al*. On being 'head strong': The pain zone and concussion in non-elite rugby union. *Int Rev Sociol Sport* 2018;53:668–84.
4 Halstead ME, Walter KD, The Council on Sports Medicine and Fitness. Sport-Related Concussion in Children and Adolescents. *Pediatrics* 2010;126:597–615.
5 World Rugby. Training and education: online learning modules. 2024. Available: https://www.world.rugby/the-game/training-education/elearning [Accessed 23 Jul 2024].
6 Kroshus E, Garnett BR, Baugh CM, *et al*. Social norms theory and concussion education. *Health Educ Res* 2015;30:1004–13.
7 Sye G, Sullivan SJ, McCrory P. High school rugby players' understanding of concussion and return to play guidelines. *Br J Sports Med* 2006;40:1003–5.
8 Salmon DM, Mcgowan J, Sullivan SJ, *et al*. What they know and who they are telling: Concussion knowledge and disclosure behaviour in New Zealand adolescent rugby union players. *J Sports Sci* 2020;38:1585–94.
9 Salmon DM, Badenhorst M, Walters S, *et al*. The rugby tug-of-war: Exploring concussion-related behavioural intentions and behaviours in youth community rugby union in New Zealand. *Int J Sports Sci Coach* 2022;17:804–16.
10 Kraak W, Coetzee L, Kruger A, *et al*. Knowledge and Attitudes Towards Concussion in Western Province Rugby Union Senior Club Rugby Players. *Int J Sports Med* 2019;40:825–30.
11 van Vuuren H, Welman K, Kraak W. Concussion knowledge and attitudes amongst community club rugby stakeholders. *Int J Sports Sci Coach* 2020;15:297–305.
12 Baker JF, Devitt BM, Green J, *et al*. Concussion among under 20 rugby union players in Ireland: incidence, attitudes and knowledge. *Ir J Med Sci* 2013;182:121–5.
13 Kearney PE, See J. Misunderstandings of concussion within a youth rugby population. *J Sci Med Sport* 2017;20:981–5.
14 Kroshus E, Baugh CM, Daneshvar DH, *et al*. Concussion reporting intention: a valuable metric for predicting reporting behavior and evaluating concussion education. *Clin J Sport Med* 2015;25:243–7.
15 Quarrie K, Gianotti S, Murphy I, *et al*. RugbySmart: Challenges and Lessons from the Implementation of a Nationwide Sports Injury Prevention Partnership Programme. *Sports Med* 2020;50:227–30.
16 Viljoen W, Patricios J. BokSmart - implementing a National Rugby Safety Programme. *Br J Sports Med* 2012;46:692–3.
17 RFU. Headcase. 2019. Available: https://www.englandrugby.com/participation/playing/headcase [Accessed 05 Aug 2019].
18 Mrazik M, Dennison CR, Brooks BL, *et al*. A qualitative review of sports concussion education: prime time for evidence-based knowledge translation. *Br J Sports Med* 2015;49:1548–53.
19 Bosshardt C, England M, Medici A de, *et al*. Does concussion education have an impact in behaviours amongst school-age rugby players? *Br J Sports Med* 2017;51:A15.
20 Salmon DM, Badenhorst M, Brown J, *et al*. Concussion education for New Zealand high school rugby players: A mixed-method analysis of the impact on concussion knowledge, attitudes and reporting behaviours. *Int J Sports Sci Coach* 2024;19:99–112.
21 Kroshus E, Chrisman SPD, Hunt T, *et al*. Stakeholder-Engaged Development of a Theory-Driven, Feasible, and Acceptable Approach to Concussion Education. *Health Educ Behav* 2024;51:197–203.
22 van Mechelen W, Hlobil H, Kemper HC. Incidence, severity, aetiology and prevention of sports injuries. A review of concepts. *Sports Med* 1992;14:82–99.
23 Kirkwood G, Parekh N, Ofori-Asenso R, *et al*. Concussion in youth rugby union and rugby league: a systematic review. *Br J Sports Med* 2015;49:506–10.
24 West SW, Shill IJ, Bailey S, *et al*. Injury Rates, Mechanisms, Risk Factors and Prevention Strategies in Youth Rugby Union: What's All the Ruck-Us About? A Systematic Review and Meta-analysis. *Sports Med* 2023;53:1375–93.
25 Sharma A, Minh Duc NT, Luu Lam Thang T, *et al*. A Consensus-Based Checklist for Reporting of Survey Studies (CROSS). *J Gen Intern Med* 2021;36:3179–87.
26 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* 2010;32:44–55.
27 Kroshus E, Baugh CM, Daneshvar DH, *et al*. Understanding concussion reporting using a model based on the theory of planned behavior. *J Adolesc Health* 2014;54:269–74.
28 The Concussion Recognition Tool 6 (CRT6). *Br J Sports Med* 2023;57:692–4.
29 Anderson BL, Gittelman MA, Mann JK, *et al*. High School Football Players' Knowledge and Attitudes About Concussions. *Clin J Sport Med* 2016;26:206–9.
30 Conway FN, Domingues M, Monaco R, *et al*. Concussion Symptom Underreporting Among Incoming National Collegiate Athletic Association Division I College Athletes. *Clin J Sport Med* 2018;1. Available: http://www.ncbi.nlm.nih.gov/pubmed/29329116%
31 Miyashita TL, Diakogeorgiou E, Hellstrom B, *et al*. High School Athletes' Perceptions of Concussion. *Orthop J Sports Med* 2014;2:1–5.
32 Harmon KG, Drezner JA, Gammons M, *et al*. American Medical Society for Sports Medicine position statement: concussion in sport. *Br J Sports Med* 2013;47:15–26.
33 Schneider DK, Grandhi RK, Bansal P, *et al*. Current state of concussion prevention strategies: a systematic review and meta-analysis of prospective, controlled studies. *Br J Sports Med* 2017;51:1473–82.
34 Barnes A, Rumbold JL, Olusoga P. Attitudes towards protective headgear in UK rugby union players. *BMJ Open Sport Exerc Med* 2017;3:e000255.
35 Eliason PH, Galarneau J-M, 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* 2023;57:749–61.
36 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.
37 Kroshus E, Babkes Stellino M, Chrisman SPD, *et al*. Threat, Pressure, and Communication About Concussion Safety: Implications for Parent Concussion Education. *Health Educ Behav* 2018;45:254–61.
38 Register-Mihalik JK, Valovich McLeod TC, Linnan LA, *et al*. Relationship Between Concussion History and Concussion Knowledge, Attitudes, and Disclosure Behavior in High School Athletes. *Clin J Sport Med* 2017;27:321–4.

39 Golshan F, Bains S, Francisco J, *et al*. Gender differences in concussion-related knowledge, attitudes and reporting behaviors of varsity athletes. *J Sports Med Phys Fitness* 2024;64:588–98.
40 Ferdinand Pennock K, McKenzie B, McClemont Steacy L, *et al*. Under-reporting of sport-related concussions by adolescent athletes: a systematic review. *Int Rev Sport Exerc Psychol* 2023;16:66–92.
41 Chrisman SP, Quitiquit C, Rivara FP. Qualitative study of barriers to concussive symptom reporting in high school athletics. *J Adolesc Health* 2013;52:330–5.
42 McKay CD. *The Mental Impact of Sports Injury*. 1st edn. New York: Routledge, Available: https://www.taylorfrancis.com/books/9781003088936