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Concussion knowledge, attitude and reporting intention in rugby coaches and high school rugby players

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Abstract

The aim of this study was to evaluate New Zealand high school rugby union players' and community coaches' concussion knowledge (CK), concussion attitude (CA) and concussion reporting intentions (CRI) and to explore the impact gender, age, ethnicity, socio-economic status, experience, and concussion history had on these outcome measures. This cross-sectional study utilised the Rosenbaum Concussion Knowledge and Attitudes survey to evaluate CK, CA and CRI. The survey and demographic information were completed by 533 high school players (61.5% male, $M = 16.2$ yrs) and 733 community rugby coaches (93.0% male, $M = 42.2$ yrs). Coaches displayed greater awareness, safer attitudes, and stronger reporting intentions towards concussion than players. Among players, differences in CK, CA and CRI were observed by gender, ethnicity, and socio-economic status. Among coaches, differences in CRI were found by age and coaching experience. No differences were observed for age or concussion history in players. Gender, ethnicity, and grade coached were not significant for coaches. Players who identified as Māori or Pasifika and those from schools in low socio-economic areas displayed poorer CK and CA. Years of experience for both players and coaches played a critical role in improving CA and is a factor that should be considered when welcoming new participants to either role. Concussion non-disclosure is a systemic issue and is common across gender, ethnicity and socio-economic status and appears to worsen as the playing season progresses. More work is needed to develop educational strategies that are both culturally responsive, sustainable, and address reporting behaviours.

Keywords

Ethnicity, gender, head injury, rugby union, youth sport

Introduction

Sport-related concussions are a growing concern within rugby union (rugby).[1] Head injuries account for 25% of injuries reported in professional rugby.[2] In New Zealand (NZ), concussions accounted for 3.1% of all injuries in community rugby across all age groups, as reported by the Accident Compensation Corporation (ACC) from 2005 to 2017.[3] From 2012–2016, an increase in moderate-to-severe concussions was observed, making it the third most common ACC injury entitlement claim in rugby.[4] Research in schoolboy rugby reports concussion rates of 6–8 concussions per 1000 player match hours.[5,6] When compared to adults, children and adolescents may be at greater risk of sustaining a concussion, and more likely to

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experience greater symptom severity for a prolonged length of time.[7–10] Previous research also suggests that females are at a higher risk of sustaining a concussion than males.[11,12] As a result, improving concussion prevention strategies and management to reduce risk and enhance player welfare in youth is a priority for many sporting organisations,[13,14] including rugby[15–17] and should explore further the impact of gender.[11,12] A primary difficulty for improving concussion management strategies is the level of injury non-disclosure, which is documented internationally and across numerous sports.[18–21] Studies looking specifically at rugby support this trend.[22–25] Concussion non-disclosure has been attributed to a variety of factors such as a lack of standardized reporting criteria, misunderstanding concussion signs and symptoms,[25] and hesitancy by players to disclose symptoms to avoid being withdrawn from active sport participation (i.e., removed from play).[23,24] Non-disclosure of concussive injuries is a major concern given the potential for sustaining an additional head impact before recovery from the initial event and the documented negative consequences this can have on the initial injury (e.g., second impact syndrome).[26–28] These findings illustrate the need for increased understanding around motivations for non-disclosure and players' reporting behaviour to develop and support interventions and/or policies that are evidence-based and that consider the socioeconomic and cultural difference that may exist within the community rugby context.

When using a systems approach to examining injury prevention strategies, consideration must be given to the most efficacious way to affect change.[29] The socio-ecological framework highlights the interplay of various levels in the sport community and society.[29] As such, it illustrates the importance of a collaborative approach with stakeholders from all levels of the model (players through to national sport organizations) and what interactions from policy down to player-coach conversations have the potential to best facilitate positive outcomes[30] and mitigate risk.[31] With regards to the concussion management process, there is often an over-reliance on health-care professionals to identify and manage injury;[1] however, at the community level where there is often limited medical support, increased responsibility is placed on coaches and other team officials who may not have the expertise to appropriately manage suspected concussion.[32,33] To address this issue New Zealand Rugby (NZR) created RugbySmart in 2001,[34] an injury prevention programme targeting community-level stakeholders.[16] It aims to provide coaches and referees with the basic injury prevention skills and knowledge to help ensure player safety within their community rugby spheres, through a mandatory online and practical course that must be completed at the start of each season.[34] A strong emphasis of the online RugbySmart course is concussion education, which has focussed on: Recognise, Remove, Recover, and Return (https://www.rugbysmart.co.nz/injuries/concussion/). In 2017, NZR conducted a survey with 416 high school players who reported that they received the majority of their concussion education information from the coach and that players overall felt the most comfortable disclosing their symptoms to their coach.[35] While it is recognised that there are many stakeholders that are important to each aspect of the concussion management pathway[36] the stakeholders with the largest capacity to make an on-field impact are players and coaches in the community game.[35]

Increasing concussion knowledge (CK) is an essential step in the concussion management pathway for both coaches and players as it will help to ensure symptom recognition on-field.[18,20,37] However, while CK has not been directly correlated to improving concussion reporting behaviour, attitudes and psychosocial constructs have been shown to influence behaviour.[38] Further, shaping positive and safe concussion attitudes (CA) in these stakeholders is an essential part of this process.[39] CK and CA of rugby players have been investigated internationally in elite/semi-professional,[33,40,41] senior club and university,[24,42–46] and high school players.[44,47–49] CK of elite and semi-professional medical staff, and referees has been investigated.[33] Coaches' CK and CA have been explored in community rugby union,[46] rugby league[50] and across other sporting codes.[51–54] The most common tool utilised in previous studies is the Rosenbaum Concussion Knowledge and Attitudes Survey (RoCKAS), a reliable psychometric measure that provides an understanding of the respondent's knowledge about and attitude towards concussion.[55] The RoCKAS has been previously validated as a reliable measure for CK in collegiate student athletes[56] and has also been used extensively to measure CK and CA in students[55–59] and athletes of various sporting backgrounds including ice hockey,[59,60] soccer,[61,62] and football[54,63].

Concussion reporting intention (CRI) is another important metric for predicting reporting behaviour.[38] Behavioural intention is the "motivational component that spurs an individual to engage in a particular behaviour",[64] or simply put, how likely an individual thinks that he or she may engage in a particular activity. Behavioural intention has been shown to be predictive of behaviour,[64] and is a construct within many social-behaviour theories, including the Theory of Planned Behaviour (TPB).[65] TPB has been used in various applications for health behaviour, including sports injury prevention[66] and concussion management.[29,38,67,68] Kroshus et al.[38] found CRI to be

significantly related to in-season injury reporting with the recommendation it be included when evaluating concussion education initiatives.

In NZ, children and adolescents (ages 4–19 years) comprise 82% of the rugby playing population with over 40,000 players aged 13–20 years (26%) compared with just over 28,000 (18%) in adult competitions (21+) in 2018 (NZR Database, 2019). The high schools' competition alone was comprised of nearly 25,000 players (NZR Database, 2019) and a total of 12,550 coaches registered across all grades in 2018. Currently, data evaluating CK, CA and CRI in NZ high school rugby is lacking with only one published study which examined high school rugby players' CK;[25] thus highlighting the need to gain a better understanding of current CK, CA and CRI among NZR players and coaches. The purpose of this study was to evaluate high school players' and community coaches' CK, CA and CRI using the RoCKAS survey and to examine the role gender, age, ethnicity, socio-economic status, experience, and concussion history plays in self-reported CK, CA and CRI.

Methods

Study design

This cross-sectional survey study used the RoCKAS[55] to investigate CK, CA and CRI of high school players and rugby coaches in NZ during the 2018 season. Purposeful sampling was used to target a select group of schools representing a range of ethnic, socioeconomic, gender, and geographic backgrounds. As part of NZR's RugbySmart Concussion Initiative,[17] participants were invited to complete the paper-based RoCKAS survey before attending a pre-season concussion education session. Registered coaches were invited to participate via email based on the previous year's (2017) coach registration database. If they consented to participate, they were asked to complete an online version of the RoCKAS survey. Ethical approval was obtained from the University of Otago Ethics Review Board.

Procedure

Players. Three geographical regions (Provincial Unions; PUs) were selected and provided locality consent for the schools and players' participation (n = 22 schools, n = 655 players). Before the pre-season, each school was contacted by a PU representative and a meeting was organized between NZR and the school administration to outline the goals and aims of the study.

The survey was administered in conjunction with the NZR concussion education sessions conducted during the 2018 high school pre-season/start of the season. The testing period ran from February to May. All study participants provided informed written consent. For players aged 15 years or younger (n = 162), consent was obtained from parents/caregivers before they engaged in the study. Participation was voluntary and all data were provided anonymously. The survey was administered by a member of NZR team at a convenient and quiet location in each school during the lunch break or before a training session.

Coaches. Two PUs agreed to take part in the study and provided locality consent for their coaches (n = 2015). Before the start of the 2018 RugbySmart courses (February–April), all coaches who were registered in the previous season (2017) were contacted via email and invited to participate in the study. If they consented to participate, they were asked to complete an online version of the RoCKAS survey that was available online from January to February 2018.

Measures. *Concussion knowledge and attitude:* The RoCKAS is a 55–item measure comprised of two subscales: Concussion Knowledge Index (CKI) and Concussion Attitude Index (CAI), totalling 40 items.[55] The remaining 15 items on the survey include a 3–item validity scale and 12 distractor items which were not included in the overall scores. The RoCKAS survey was modified to ensure vocabulary was appropriate for the NZ context. The CKI included 25 items comprised of 17 true/false and 8 symptom recognition questions for a range of 0–25 points; higher scores indicated higher concussion knowledge. The CAI included 15 items (5–point Likert scale; 1 = strongly disagree and 5 = strongly agree) for a range of 15–75 points; higher scores indicated safer attitudes towards concussion. Combining the CKI and CAI items, the overall RoCKAS score ranged 15–100 points. The CAI items were categorized into "safe", "neutral" and "unsafe" responses[44], and reported as a percentage of participants selecting a "safe" response.

Concussion reporting intention: Concussion reporting intention (CRI) was also measured using a single item (3.1) from the CAI that reads "I would continue playing a sport while also having a headache that resulted from a minor concussion." This metric has been used in past research[38] and is "considered to be a face valid proxy for symptom reporting". Responses were scored on a 5–point Likert scale, where a low score (closer to 1) indicates a greater intention to report concussion symptoms, and thereby a safer attitude.

Player and coach demographics characteristics: Players completed a demographic questionnaire alongside the RoCKAS survey that included gender, age, concussion history, rugby experience, and school

decile. Rugby experience was defined as the number of years previously played. In NZ, schools are ranked by decile which is a measure of the relative socio-economic status of the area the school serves. Schools with a decile ranking of 1 represent the poorest 10% of the population and schools with a decile ranking of 10 represent the wealthiest 10% of the population (http://www.education.govt.nz/school/funding-and-financials/resourcing/operational-funding/school-decile-ratings/). Coaches' demographic details obtained from the NZR database included gender, ethnicity, age, rugby coaching experience, and rugby grade coached.

Data analysis. Data were analysed using SPSS (v.23). As described by Rosenbaum and Arnett,[55] a participant's survey was deemed valid if they correctly answered at least two of three validity scale questions and had completed at least 90% of the CKI questions or 90% of the CAI questions. Any participant who failed to complete 90% of the questions for the CKI or CAI section or who did not meet the validity scale requirements responses was removed from the analysis.

Descriptive statistics were calculated for the demographic characteristics and outcome measures: CKI, CAI and CRI. The CKI and CAI items were scored, and percentages of agreement were calculated for both the player and coach groups. The 5–item Likert scale responses (CAI) were dichotomized into "safe" and "unsafe" responses, and neutral responses were not coded.

For each of the outcome measures (CKI, CAI and CRI), frequency, mean scores and 95% confidence intervals were calculated. The following variables were explored to determine their impact on the outcome measures: gender, ethnicity, age, playing/coaching experience, and previous concussion history (players only) and school decile (players only). Players' age was categorised (<14, 15–16, and ≥ 17 years) to reflect age bandings within NZR. When investigating years of playing experience in our player cohort, the females had significantly lower playing experience than males (2.6 ± 3.1 vs 8.7 ± 3.8 years). As a result, for this portion of the analysis, females and males were analysed separately. School decile was split into low (1–3), medium (4–7), and high (8–10).

Independent t-tests examined the impact demographic variables had on CKI, CAI and CRI. The normality and homogeneity of variance within the data were examined using the Kolmogorov-Smirnov test and Levene's tests, respectively, and corrected where necessary. Alpha level was set a priori at 0.05 and was adjusted for multiple comparisons based on the number of independent tests conducted ($p = 0.05/4 = 0.01$) Chi-squared analysis examined the differences in percentages of agreement between players and coaches on individual items contained in the RoCKAS, and paired comparisons were examined using McNemar's test.

Results

A total of 533 players (61.5% male, mean age $= 16.2 \pm 1.4$ years) and 733 coaches (93.0% male, mean age $= 42.2 \pm 9.2$ years) participated in the study. Nine player surveys were removed due to failure to pass the validity scale, resulting in a total of 524 valid player surveys. In addition, 12 players failed to complete the CKI section and six players failed to complete the CAI section to 90%; thus, these players' surveys were removed from those specific analyses, resulting in 512 included in the CK analysis and 518 included in the CA/CRI analysis. All coach surveys were valid and complete. Resulting completion rates were 80% (524/655) for players and 36% (733/2015) for the coaches. The demographic statistics for the two participant groups can be found in Table 1.

RoCKAS

The players and coaches achieved mean scores of 78.0 ± 7.8 (range: 51–95) and 85.3 ± 6.0 (range: 63–98), respectively. Coaches scored higher than players on both CKI ($M = 20.0$ vs. 18.6, $t_{1243} = 12.03$, $p < 0.001$) and CAI ($M = 65.3$ vs. 59.3, $t_{1249} = 17.2$, $p < 0.001$).

Concussion knowledge

The mean CKI scores for players and coaches were 18.6 ± 2.4 (range 10–24) and 20.0 ± 1.8 (range 11–24), respectively. Table 2 shows the percentage of players and coaches who correctly identified the signs and symptoms of concussions. Players and coaches correctly identified 86.2% and 92.9% of concussion symptoms, respectively. The top two symptoms correctly identified by both groups were "dizziness" (players: 97.3%; coaches: 98.1%) and "headaches" (players: 96.9%; coaches: 99.3%). Players were least familiar with identifying "drowsiness" (79.5%) and "feeling in a fog" (67.6%); coaches were least familiar with "feeling slowed down" (83.1%) and "feeling in a fog" (85.8%).

When assessing general CK, players and coaches correctly answered 68.7% and 74.2% of the questions, respectively (Table 3). The most common misconceptions for both groups related to the statements regarding: experiencing a coma while being knocked out (players: 28.9%; coaches: 22.1%); concussion symptoms usually being gone after 10 days (players: 26.8%; coaches: 26.6%); and the visibility of physical damage on brain imaging (players: 26.0%; coaches: 27.7%) Both groups correctly identified that:

Table 1. Player and coach demographics.

	Players			Coaches		
Measure	Total	Male	Female	Total	Male	Female
Gender (Frequency (%))	524	322 (61.5)	202 (38.5)	733	682 (93.0)	51 (7.0)
Ethnicity (Frequency (%))						
NZ European	264 (50.4)	111 (34.5)	153 (75.7)	588 (80.2)	550 (80.6)	38 (74.5%)
Māori	142 (27.1)	105 (32.6)	37 (18.3)	66 (9.0)	61 (8.9)	5 (9.8)
Pacific Islander	104 (19.8)	98 (30.4)	6 (3.0)	40 (5.5)	37 (5.4)	3 (5.9)
Other	14 (2.7)	8 (2.5)	6 (3.0)	39 (5.3)	34 (5.0)	5 (9.8)
Rugby experience[a] (years)						
Mean	6.4	8.7	2.6	4.4	4.5	2.7
SD	4.6	3.8	3.1	3.6	3.7	2.6
Range	0–16	0–16	0–12	1–19	1–19	1–12
Age (years)						
Mean	16.2	16.4	15.8	42.5	42.8	38.4
SD	1.4	1.4	1.4	9.2	9.1	8.8
Range	11–19	11–19	13–18	16–71	16–71	20–61
Previously Diagnosed Concussion						
Yes	170 (33.3)	112 (35.1)	58 (30.4)	–	–	–
No	340 (64.9)	207 (64.9)	133 (69.6)	–	–	–

[a] $n_p = 495$ for Rugby experience.

Table 2. Player and coach knowledge of concussion symptoms.

	% Correct	
Symptom	Players (n = 512)	Coaches (n = 733)
The following are symptoms		
Headache	96.9	99.3
Dizziness	97.3	98.1
Difficulty concentrating	91.0	97.5
Difficulty remembering	91.2	96.7
Drowsiness	79.5	94.8
Sensitivity to light	82.8	87.6
Feeling slowed down	83.2	83.1
Feeling in a "fog"	67.6	85.8
Overall correct identification of symptoms	86.2	92.9

concussion symptoms can last for several weeks (players: 94.7%; coaches: 99.2%); there is a risk of death if a second concussion occurs before the first is healed (players: 91.2%; coaches: 92.0%); and you do not have to be knocked out to have a concussion (players: 91.6%; coaches: 98.6%).

Concussion attitude

The mean CAI scores for players and coaches were 59.3 ± 6.8 (range 35–75) and 65.3 ± 5.4 (range 46–75), respectively. The individual question responses for both players and coaches are summarised in Table 4. Both players (90.0%) and coaches (97.8%) agreed that the coach would have made the right decision to keep a player with a concussion off the field, even though the team lost the game. However, only 56.3% of coaches reported that a player who is knocked unconscious should be taken to the emergency room.

In regards to believing that concussions are less important than other injuries, players had significantly fewer safe responses than coaches (73.4% vs. 96.7%, $R^2(1)=49.4$, $p < 0.001$). Reporting behaviours, as related in a hypothetical scenario to whether they were playing in the first versus the semi-final games (Table 4, items 2.1–2.4), was compared using McNemar's test. Players' personal attitude (*"I..."*) was significantly higher than their perceived attitude (*"Most athletes..."*) during the semi-final game (73.9% vs. 56.6%, $p < 0.001$). This pattern was mirrored in the coaches, with personal attitude being significantly higher than perceived attitude during the semi-final game (97.7% vs. 84.7%, $p < 0.001$). Players' safe agreement rate was significantly lower in the semi-final game compared to the first game for both personal attitude (73.9% vs. 81.3%, $p < 0.001$) and perceived attitude (56.6% vs. 65.3%, $p = 0.02$). Coaches' personal attitude from the first game compared to the semi-final game was not significantly different (98.1% vs. 97.7%, $p = 1.0$). However, the coaches' perceived attitude was significantly lower in the semi-final game compared to the first game (84.7% vs. 88.7%, $p < 0.001$). Overall, the coaches reported significantly

Table 3. Statements and scenarios evaluating the Concussion Knowledge Index (CKI) of the player and coach groups.

	% Correct	
Statements	Players (n = 512)	Coaches (n = 733)
True statements		
1. There is a possible risk of death if a second concussion occurs before the first one has healed.	91.2	92.0
2. People who have had one concussion are more likely to have another concussion.	67.0	66.8
3. Symptoms of a concussion can last for several weeks.	94.7	99.2
4. After 10 days, symptoms of a concussion are usually completely gone.	26.8	26.6
5. Concussions can sometimes lead to emotional disruptions.	88.7	96.2
6. An athlete who gets knocked out after getting a concussion is experiencing a coma.	28.9	22.1
False statements		
7. In order to be diagnosed with a concussion, you have to be knocked out.	91.6	98.6
8. A concussion can only occur if there is a direct hit to the head.	63.3	87.0
9. Being knocked unconscious always causes permanent damage to the brain.	63.3	77.5
10. Sometimes a second concussion can help a person remember things that were forgotten after a first concussion.	81.1	93.6
11. After a concussion occurs, brain imaging (e.g., CAT Scan, MRI, X-Ray, etc.) typically shows visible physical damage (e.g., bruise, blood clot) to the brain.	26.0	27.7
12. If you receive one concussion and you have never had a concussion before, you will become less intelligent.	93.2	98.8
13. After a concussion, people can forget who they are and not recognize others but be perfect in every other way.	40.4	28.9
14. There is rarely a risk to long-term health and well-being from multiple concussions	50.8	88.5
Scenarios		
15. It is likely that Player Q's concussion will affect his long-term health and well-being.	78.7	77.8
16. It is likely that Player X's concussion will affect his long-term health and well-being.	94.5	84.9
17. Even though Player F is still experiencing the effects of the concussion, her performance will be the same as it would be had she not suffered a concussion.	88.1	94.5

safer attitudes than the players for all four scenarios (all $p < 0.001$).

Concussion reporting intention

Concussion reporting intention was assessed by the response to the question "I would continue playing a sport while also having a headache that resulted from a minor concussion". Coaches reported a significantly higher percentage of safe CRI responses than players (92.4% vs. 55.0%, $R^2(1) = 167.14$, $p < 0.001$).

Demographic variable analysis

The player and coach outcome measures (CKI, CAI and CRI) were analysed by the demographic variables (Tables 5 to 7) and statistical analysis was performed (Supplementary Table 1 and Supplementary Table 2).

Players

No significant differences for CKI were found between female and male players. Females scored significantly higher than males on CAI ($M = 60.2$ vs. 58.8, $t_{447} = 2.35$, $p = 0.02$); however, male players reported significantly safer reporting behaviours compared to females ($M = 2.4$ vs. 2.7, $t_{423} = 2.66$, $p = 0.008$). NZ Europeans scored significantly higher than Pasifika players on both CKI ($M = 19.1$ vs. 17.2, $t_{366} = 6.42$, $p < 0.001$) and CAI ($M = 60.1$ vs. 57.7, $t_{191} = 3.29$, $p = 0.001$). Māori players also scored significantly higher than Pasifika players on CKI ($M = 18.6$ vs. 17.2, $t_{202} = 4.07$, $p < 0.001$). When comparing school decile, players from high decile (8–10) schools scored significantly higher than players from low decile (1–3) schools on both CKI ($M = 19.0$ vs. 18.0, $t_{249} = 2.89$, $p = 0.004$) and CAI ($M = 60.1$ vs. 57.8, $t_{273} = 2.85$, $p = 0.005$).

Table 4. Statements and scenarios evaluating the Concussion Attitude Index (CAI) of the player and coach groups.

	% Correct			
	Players (n = 518)		Coaches (n = 733)	
	% Safe	% Unsafe	% Safe	% Unsafe
Statement				
1. I would continue playing a sport while also having a headache that resulted from a minor concussion *(CRI)*	55.0	25.9	92.4	3.8
2. I feel that coaches need to be extremely cautious when determining whether an athlete should return to play.	82.4	4.4	98.5	1.1
3. I feel that concussions are less important than other injuries.	73.4	8.1	96.7	1.1
4. I feel that an athlete has a responsibility to return to a game even if it means playing while still experiencing symptoms of a concussion.	82.0	6.6	97.3	2.5
5. I feel that an athlete who is knocked unconscious should be taken to the emergency room.	85.3	3.9	56.3	36.4
Scenarios				
1.1. I feel that the coach made the right decision to keep a fellow concussed teammate off the field, even though we lost the game.	90.0	5.0	97.8	1.9
1.2. My teammates would feel that the coach made the right decision to keep a fellow concussed teammate off the field, even though we lost the game.	73.0	7.5	84.7	5.6
2.1. I feel that a concussed player should have returned to play during the first game of the season.	81.3	4.4	98.1	1.4
2.2. Most players would feel that a concussed player should have returned to play during the first game of the season.	65.3	10.4	88.7	1.4
2.3. I feel that a concussed player should have returned to play during the semi-final playoff game.	73.9	9.1	97.7	1.4
2.4. Most athletes feel that a concussed player should have returned to play during the semi-final playoff game.	56.6	16.0	84.7	5.9
3.1. I feel that the physiotherapist, rather than the player, should make the decision about a player returning to play.	69.1	11.2	70.7	21.6
3.2. Most players would feel that the physiotherapist rather than the player should make the decision about returning a player to play.	56.8	14.7	69.2	19.1
4.1. I feel that a player with concussion symptoms should tell the coach about the symptoms even if its two hours before the game.	86.3	2.9	98.9	0.8
4.2. Most athletes would feel that a player with concussion symptoms should tell the coach about the symptoms even if it is two hours before the game.	72.6	6.8	81.0	5.6

There were no significant differences in CKI between age groups for all players. The effect of playing experience was examined independently by gender (Table 6). For CKI, males with greater than 10 years of playing experience scored significantly higher than males with 6–10 years of playing experience ($M = 18.8$ vs. 18.0, t_{263}=2.43, $p = 0.016$), and also scored significantly higher than males with 0–5 years of playing experience ($M = 18.8$ vs. 17.7, t_{203}=3.04, $p = 0.003$). Males' CAI improved with playing experience, and significant differences were observed between males with 0–2 years and >10 years' experience ($M = 57.2$ vs. 60.1, $t_{150} = 2.94$, $p = 0.004$). While similar trends were observed in females with increased playing experience improving CKI and CAI, these differences were not significant. When playing experience was combined for males and females CRI was better in those players that had more than 10 years experience compared to those with 0-2 years ($M = 2.4$ vs. 2.8, $t(277) = 2.8$, $p = 0.005$). Previous concussion history did not show any significant differences between groups for CKI, CAI, or CRI.

Coaches. There were no significant differences observed for CKI or CAI in coaches when examined by gender, ethnicity, age, coaching experience, or grade coached

Table 5. Players concussion knowledge, concussion attitude, and concussion reporting intention scores evaluated by gender, ethnicity, age, concussion history and school decile.

	Players											
	CKI				CAI				CRI			
	Valid N	*Mean*	*SD*	*95% CI*	*Valid N*	*Mean*	*SD*	*95% CI*	*Valid N*	*Mean*	*SD*	*95% CI*
Gender												
Male	317	18.4	2.6	[18.1 18.6]	319	58.8[a]	7.0	[58.0 59.5]	319	2.4[a]	1.2	[2.3 2.6]
Female	195	18.9	2.1	[18.6 19.2]	199	60.2[a]	6.5	[59.3 61.1]	199	2.7[a]	1.2	[2.6 2.9]
Ethnicity												
NZ European	258	19.1[b]	2.1	[18.9 19.4]	262	60.1[b]	6.7	[59.3 60.9]	262	2.5	1.1	[2.4 2.7]
Māori	139	18.6[c]	2.4	[18.2 19.0]	141	58.9	7.0	[57.8 60.1]	141	2.5	1.3	[2.3 2.7]
Pasifika	101	17.2[bc]	2.7	[16.7 17.8]	102	57.7[b]	6.6	[56.5 59.0]	102	2.6	1.2	[2.4 2.9]
Other	14	17.8	2.3	[16.6 19.0]	13	59.1	7.3	[55.1 63.0]	13	2.4	1.0	[1.8 3.0]
Age												
≤14 years	74	18.5	2.5	[17.9 19.0]	76	59.1	7.3	[57.5 60.7]	76	2.5	1.2	[2.3 2.8]
15–16 yrs	188	18.6	2.3	[18.2 18.9]	188	58.6	6.9	[57.6 59.6]	188	2.5	1.2	[2.3 2.7]
≥17 years	250	18.6	2.5	[18.3 18.9]	254	59.9	6.6	[59.1 60.7]	254	2.6	1.2	[2.4 2.7]
Previous Concussion History												
Yes	170	18.5	2.6	[18.1 18.9]	170	59.3	7.0	[58.3 60.4]	170	2.5	1.2	[2.3 2.7]
No	328	18.6	2.4	[18.4 18.9]	335	59.2	6.7	[58.5 59.9]	335	2.6	1.1	[2.5 2.7]
School Decile												
Low	128	18.0[d]	2.7	[17.6 18.5]	129	57.8[d]	7.0	[56.6 59.0]	129	2.6	1.3	[2.4 2.8]
Mid	175	18.4	2.5	[18.1 18.8]	175	59.4	6.4	[58.5 60.4]	175	2.5	1.1	[2.4 2.7]
High	209	19.0[d]	2.2	[18.7 19.3]	214	60.1[d]	6.9	[59.2 61.0]	214	2.6	1.1	[2.4 2.7]

As indicated, significant differences were found between the following groups:
[a] Males and Females;
[b] NZ European and Pasifika;
[c] Māori and Pasifika;
[d] Low and High decile schools.

Table 6. Players concussion knowledge, concussion attitude, and concussion reporting intention scores evaluated by playing experience.

	Players											
	CKI				CAI				CRI			
Players experience	*Valid N*	*Mean*	*SD*	*95% CI*	*Valid N*	*Mean*	*SD*	*95% CI*	*Valid N*	*Mean*	*SD*	*95% CI*
Male Playing Experience												
0–5 years	73	17.7[a]	3.0	[17.0 18.4]	73	57.2[a]	6.6	[55.7 58.7]	73	2.6	1.1	[2.3 2.8]
6–10 years	106	18.0[b]	3.0	[17.4 18.5]	106	58.2	7.1	[56.9 59.6]	106	2.5	1.2	[2.3 2.8]
>10 years	132	18.8[ab]	2.3	[18.4 19.2]	132	60.1[a]	6.7	[58.9 61.2]	132	2.3	1.1	[2.1 2.5]
Female Playing Experience												
0–1 years	91	18.6	2.4	[18.1 19.1]	90	59.9	5.7	[58.7 61.1]	90	2.8	1.1	[2.6 3.1]
≥2 years	93	18.8	2.6	[18.3 19.4]	93	60.2	7.1	[58.7 61.6]	93	2.6	1.2	[2.4 3.9]
Playing Experience (Combined)												
0–2 years	141	18.6	2.4	[18.2 19.1]	140	59.3	6.1	[58.2 60.3]	140	2.8[c]	1.1	[2.6 2.9]
3–5 years	89	17.9	2.9	[17.3 18.5]	88	59.0	7.0	[57.5 60.4]	89	2.6	1.2	[2.3 2.8]
6–10 years	124	18.1	2.8	[17.6 18.6]	123	58.7	7.1	[57.4 59.9]	124	2.5	1.2	[2.3 2.7]
>10 years	141	18.8	2.2	[18.6 19.3]	141	59.9	6.9	[58.8 61.0]	141	2.4[c]	1.2	[2.2 2.6]

As indicated, significant differences were found between the following groups:
[a] Males 0–5 and >10 years experience;
[b] Males 6–10 and >10 years experience;
[c] All Players 0–2 and >10 years experience.

Table 7. Coaches concussion knowledge, concussion attitude, and concussion reporting intention scores evaluated by gender, ethnicity, age, coaching experience, and grade coached.

	Coaches											
	CKI				CAI				CRI			
Demographic details	*Valid N*	*Mean*	*SD*	*95% CI*	*Valid N*	*Mean*	*SD*	*95% CI*	*Valid N*	*Mean*	*SD*	*95% CI*
Gender												
Male	682	20.0	1.8	[19.9 20.2]	682	65.2	5.4	[64.8 65.6]	682	1.5	.8	[1.4 1.5]
Female	51	19.9	1.8	[19.4 20.4]	51	66.4	5.5	[64.9 67.9]	51	1.4	.7	[1.2 1.6]
Ethnicity												
NZ European	588	20.1	1.8	[19.9 20.2]	588	65.3	5.4	[64.9 65.8]	588	1.4	.7	[1.4 1.5]
Māori	66	20.1	2.0	[19.6 20.5]	66	64.5	5.4	[63.2 65.8]	66	1.6	.9	[1.4 1.8]
Pasifika	40	19.5	2.2	[18.8 20.2]	40	65.7	6.1	[63.8 67.6]	40	1.4	.9	[1.1 1.7]
Other	39	19.9	2.4	[19.1 20.6]	39	65.4	5.9	[63.5 67.3]	39	1.5	.9	[1.3 1.8]
Age												
≤30 years	74	19.7	2.3	[19.1 20.2]	74	64.4	5.9	[63.0 65.7]	74	1.8[ab]	1.0	[1.5 2.0]
31–40 years	190	20.2	1.8	[19.9 20.5]	190	65.1	5.1	[64.4 65.9]	190	1.5[c]	.8	[1.4 1.7]
41–50 years	352	20.1	1.6	[19.9 20.3]	352	65.4	5.4	[64.8 65.9]	352	1.4[a]	.8	[1.3 1.5]
>50 years	117	19.9	2.1	[19.5 20.2]	117	65.8	5.8	[64.7 66.8]	117	1.3[cb]	.5	[1.2 1.4]
Coaching experience												
≤2 years	309	20.0	1.9	[19.8 20.2]	309	64.7	5.8	[64.0 65.3]	309	1.6[de]	.9	[1.5 1.7]
3–5 years	214	20.1	1.8	[19.8 20.3]	214	65.7	5.0	[65.0 66.4]	214	1.3[e]	.7	[1.2 1.4]
>5 years	210	20.1	1.7	[19.9 20.3]	210	65.7	5.3	[65.0 66.4]	210	1.4[d]	.7	[1.3 1.5]
Grade coached												
U9 years	244	20.0	1.9	[19.8 20.2]	244	65.1	5.5	[64.4 65.7]	244	1.5	.8	[1.4 1.6]
9–13 years	190	19.9	1.9	[19.7 20.2]	190	65.1	5.6	[64.3 65.9]	190	1.4	.8	[1.3 1.5]
High School	164	20.1	1.7	[19.9 20.4]	164	65.3	5.4	[64.5 66.2]	164	1.5	.8	[1.4 1.6]
Senior Rugby	135	20.1	1.8	[19.8 20.4]	135	65.9	5.2	[65.0 66.7]	135	1.4	.7	[1.3 1.5]

As indicated, significant differences were found between the following groups:
[a] ≤30 and 41–50 years;
[b] ≤30 and >50 years;
[c] 31–40 and 41–50 years,
[d] ≤2 and >5 years experience;
[e] ≤2 and 3–5 years experience.

(Table 7). However, coaches with more experience (>2 years) scored higher on CAI and reported safer CRI. Coaches with 3–5 years' experience scored significantly safer than coaches with <2 years' experience ($M = 1.3$ vs. 1.6, $t_{521} = 3.68$, $p < 0.001$) and coaches with >5 years' experience scored significantly safer than coaches with <2 years' experience ($M = 1.4$ vs. 1.6, $t_{517} = 2.78$, $p = 0.006$). The scores for all groups are summarised in Table 7. Significant differences were also observed for CRI in coaches by age, however, no significant differences were observed for gender nor ethnicity. The older cohorts of coaches reported safer CRI behaviours than younger coaches. Significant differences were observed in CRI between ≤30 coaches and 41–50-year-old coaches ($M = 1.8$ vs. 1.4, $t_{424} = 3.29$, $p = 0.001$), between ≤30 coaches and >50-year-old coaches ($M = 1.8$ vs. 1.3, $t_{189} = 4.32$, $p < 0.001$) and between 31–40–year–old coaches and > 50–year–old coaches ($M = 1.5$ vs. 1.3, $t_{305} = 2.96$, $p = 0.003$).

Discussion

The purpose of this study was to examine concussion knowledge, attitude, and reporting behaviours in high school players and community rugby coaches in NZ and to explore the impact gender, age, ethnicity, decile, playing experience and concussion history had on these outcome measures. Coaches scored significantly higher than players across all three outcome measures. This finding is unsurprising as coaches in NZ are required to attend an annual RugbySmart course which includes a concussion education component, while players receive no direct concussion education. However, there are still opportunities for improvement for coaches' CK, the low referral rate of players to immediate care following a loss of consciousness needs to be addressed in future educational initiatives. Compared to previous research with NZ high school players,[25] CK levels were overall higher

in the current sample as illustrated by the high level of symptom identification reported by both players and coaches. Similar to previous findings,[24,51] poorer attitudes towards symptoms disclosure were reported towards the 'business' end of the season (i.e., semi-final and final games), with this difference being more pronounced in players. Ethnicity influenced CK and CA with the lowest levels reported in the Māori and Pasifika cohort, which highlights the need for culturally responsive concussion strategies that better address the needs and challenges faced by this demographic. A similar pattern was seen for high school players from lower decile schools. Interestingly the intention to report concussions was poor across all player groups regardless of socio-economic status or ethnicity which would suggest a common factor or belief that resonates with all players that influences concussion non-disclosure.

Concussion knowledge

Overall, coaches scored higher than players for CKI and CAI and reported safer CRI. Using the RoCKAS survey, Tsao et al.[51] and van Vuuren et al.[46] reported similar differences between players and coaches in US collegiate soccer teams and SA senior club rugby, respectively. However, US collegiate athletes scored slightly higher on CK than the NZ high school players ($M = 19.9$ vs. 18.6) which could be attributed to the fact that college athletes in the US must attend a mandatory pre-season concussion education session. In NZ, players are not directly educated about concussion; rather this information is disseminated by their coach, or passively through online RugbySmart content.[35]

Player survey data has identified rugby coaches in NZ as a key conduit of concussion information with 71% of high school players reporting that they received concussion information from their coach.[35] However, research examining the dissemination of concussion information from coaches to players has shown that a coach's attitudes and beliefs are a stronger predictor of communication than their knowledge.[69] This finding suggests that a coach with a poor CA and low CRI would likely model these attitudes to their players, thereby impacting the dissemination of concussion information. The current dissemination of concussion information to players places reliance on the coaches to engage with the players, which may or may not happen based on the coaches' personal attitudes and beliefs regarding concussion and/or injury reporting. This highlights the importance of the coach education strategies targeting positive CA and CRI in these individuals and a multi-modal strategy that engages with players directly. Additionally, improvement in CKI and CAI scores in high school football athletes following an education intervention[63] highlights the need to implement an educational strategy targeted specifically at players. Recommendations for the delivery of future concussion education programs would be to include coach education that targets improving CA and CRI in this population and the inclusion of an education strategy which directly engages players.

The identification of concussion signs and symptoms was quite high among NZ community coaches and high school players, with coaches and players correctly identifying 92.9% and 86.2% of symptoms, respectively. Viljoen et al.[44] also used the RoCKAS survey to evaluate South African (SA) high school rugby players. NZ high school players were able to correctly identify more symptoms than SA high school rugby players (86% vs. 66%); however, SA players reported they received concussion information primarily from health care providers (HCP) and from their school[44] whereas NZ players have reported their coach as the primary source of concussion information.[35] Given the limited access of HCP in community rugby,[36] the higher level of knowledge in NZ players would suggest that coaches may be better positioned to provide concussion-related information. For symptom identification, "headaches" and "dizziness" were the most common symptoms identified, which is similar to the findings from high school rugby players in Ireland.[47] The least commonly identified symptoms were "feeling slowed down", "feeling in a fog", and "drowsiness" which is supported in other studies.[55,56] These consistent findings would suggest an international trend in the concussion symptom knowledge of players and highlight specific symptoms which are universally not well recognised following a concussive event.

Sye et al.[25] assessed NZ high school rugby players' CK, but employed a different assessment tool; however, there was overlap with a few questions from the RoCKAS. In the previous study, 25% of players indicated "being knocked out cold" as the best descriptor of a concussion, contrasted against 8.4% in the current study indicating an improved awareness that being knocked-out is not a necessary precursor for a concussion. The previous study also found that 27% of players reported that they would return-to-play (RTP) in an important game such as a final[25] compared to 16% in the current study. Although there are limitations in comparing data from two different instruments at two different time points, it is possible that over time, players' CK and CA have improved. Continued education efforts coupled with longitudinal assessments will be able to better improve and track such outcomes.

Concussion attitude

Coaches' overall attitudes (87.5% positive) towards concussion were safer than players (73.3% positive). When compared with SA high school players (65.7%), NZ players' and coaches' attitudes scored safer. Somewhat concerning was that only 56.3% of coaches believed that an athlete who is knocked unconscious should be taken to the emergency room compared to 85.3% of players. Coaches' in NZ who reported the safest response (27%, strongly agree) were also much lower than American university coaches (40%).[51] As per the Concussion Recognition Tool (CRT5),[70] and the Sport Concussion Assessment Tool (SCAT5),[71] the loss of consciousness is a "red flag" that requires the player to be referred to immediate care.[10] Future coach education initiatives should attempt to address this lack of knowledge regarding "red flag" identification and the need for immediate care referral. Similar to other findings, players' reporting behaviour declined in a hypothetical scenario comparing the first game of the season to playoffs,[24,51] with players' from the current study personal (*"I..."*) and perceived (*"Most athletes..."*) attitudes decreasing 7.4% and 8.7%, respectively. Coaches' personal and perceived attitude towards concussion also decreased by 0.4% and 4.0%, respectively. A potential explanation for this drop may be the perceived risk of peer- and coach-pressures for players which may be heightened during playoffs.[35] This change in reported attitude towards risk-taking behaviour adopted by both players and coaches during playoffs highlights the need to reinforce symptom disclosure strategies towards the end of the season. These strategies may want to emphasize not only the health risks but also the performance impacts playing through a concussion may have such as decreased reaction time,[72] and increased risk for lower limb injury.[73,74]

Concussion reporting intention

Reporting intention has been strongly associated with in-season concussion reporting behaviour.[38] Only 55% of players in the present study reported they would remove themselves from play if they suspected they had a concussion, compared to 92% of coaches. Player reporting intention has been previously examined in English community rugby, where 36% of youth players aged 11–17 years (n = 255) stated that they would continue playing despite a concussion,[48] and in Ireland where 72% of community rugby players aged 12–18 years (n = 304) reported they would continue to play on in an important match despite a suspected concussion.[47] These results underscore the issue of symptom disclosure among youth rugby players worldwide. In rugby, there is a strong sub-culture of brother/sisterhood and camaraderie;[75,76] while this is a positive aspect of the game, the hardy group of athletes and "cavalier attitude"[75] has also been identified as one of the reasons players will not report their concussion symptoms.[20,77] When examining the roles of players in the concussion management system, it was observed that players are often not willing to report their own concussion (for fear of letting the team down), but were comfortable identifying concussion symptoms in their teammates.[36] This sub-culture of 'mateship' could provide an alternative education strategy where the focus is shifted from individual symptom disclosure to empowering players to look after one another by recognizing concussion symptoms in their teammates. The use of popular opinion leaders, those who are trusted and respected by others, to deliver concussion education shows promise to shift the sports-cultural norms to adopt concussion prevention practices.[78]

While the coaches had a high intention to self-report their own concussions and feel that it is important for players to be fully recovered before they RTP, management of the concussion falls often to the team medic or health care provider (HCP) within the team.[36] In NZ community rugby, there is often not a HCP associated with the team. This highlights the need for coaches to be comfortable with the immediate management and recovery information that players may need post-injury following a confirmed or suspected concussion. The potential for coaches to address this gap through the provision of information post-injury and during the recovery process would warrant its inclusion in coaches' concussion education.

Ethnicity

Variations in CKI and CAI were observed between ethnicities. Players of NZ European descent scored significantly higher on CKI and CAI than Pasifika players, and Māori players scored significantly higher than Pasifika players on CKI only. No significant differences were observed for CRI between ethnicities, suggesting that the lack of symptom disclosure is consistent across ethnicities and is a systemic issue to address with future concussion initiatives across all players. No significant differences in CKI/CAI/CRI were observed between coach ethnicity; however, the coach population in the current study cohort was predominantly NZ European (80%). Previous research has identified that knowledge transfer improves with culturally responsive education strategies.[79] Indigenous research methods within the NZ context have recognized the cultural belief that the head is the most sacred part of the body and inclusion of the extended family (whanau) is a fundamental component of overall well-being.[80] This highlights the

need for further development of culturally responsive education strategies that encompass both the people delivering the education and the method in which it is delivered by respected individuals, or opinion leaders, in the community.[78] Future research should focus on the use of interviews and focus groups with coaches and players to better understand the barriers and challenges within the concussion management pathway and potential language and cultural barriers that may exist. This information can also be used to inform the development of strategies or interventions that specifically address the challenges faced by Māori and Pasifika stakeholders.

School decile

In alignment with what other studies have found, higher CKI and CAI scores were associated with socio-economic status,[81] however, what appears to be consistent across all deciles are the low levels of symptom disclosure. Previous research has identified that the implementation of concussion education and prevention strategies are patterned by community-level socioeconomic characteristics and that limited infrastructure or resources to support interventions can influence the uptake of such strategies.[52] This highlights the need to consider that while common societal issues exist, tailored outreach and support may be required to enhance the implementation of concussion prevention strategies and address identified knowledge gaps to best support all socioeconomic communities.

Gender and experience

Females reported significantly more positive attitudes towards concussions than males, however, males reported safer behaviours on CRI. While females' CK was not significantly higher than the males' in the current study, the data presents a trend that would support previous studies where females have been observed to have higher CK than males.[82,83] In contrast to related research,[82–84] we found that males had a safer CRI than females; however, CRI appears to be more strongly linked to playing experience rather than gender. In the present study, male players had a significantly higher playing average experience than females (8.7 years vs 2.6 years). When playing experience was evaluated together for all players, CRI improved with more experience, with a significant difference reported between 0–2 and >10 years' experience. These results would indicate that playing experience may improve CRI. However, when playing experience was independently evaluated by gender, significant differences were observed for male players with increased playing experience improving CKI and CAI. Female players saw a similar trend, although the difference was non-significant. When CRI was evaluated independently by gender, CRI improved with experience, however, the difference was not significant. A larger sample size of females with an even distribution through playing experience is needed to evaluate this further. These overall findings would highlight the need to educate the players who are new to rugby as they may have less practical knowledge of concussions due to fewer personal exposures.

Coaching experience and grade coached

A similar result was observed in the coaches with more experienced coaches reporting higher CAI and safer CRI scores over the initial first 5 years, however, there was minimal change observed for CKI with increased coaching experience. These findings may suggest that the continued annual exposure to the RugbySmart concussion content results in improved CAI and CRI suggesting a positive attitude and behaviour shift towards supporting player welfare around concussions. When the grade coached (the level and age of athletes) was explored, no significant differences in CKI, CAI or CRI were observed. This is a relatively positive finding as it would suggest that all coaches, regardless of the grade they coach or level of support they receive, are reporting similar CKI, CAI and CRI levels.

Previous concussion history

Previous concussion history in players was not a significant factor for CKI, CAI or CRI. Players who had a previous concussion history scored slightly lower on CKI, and slightly higher on CAI and CRI; however, these differences were not significant. In contrast to previous research which found that concussion attitude decreased with a previous concussion history,[18] these findings highlight the need for concussion initiatives to support athletes with and without previous history of concussion, and to target any concussion-related attitudes they may have previously conceived.

Practical considerations

Overall, these results can help to inform future concussion education initiatives with community rugby players and coaches. A culturally responsive education delivered by popular opinion leaders in the rugby community may improve concussion attitudes and behaviours among players.[78] The need to provide concussion education to new, or first-year players, to the game is an issue that was highlighted and could be supplemented by online content. A low CRI was identified as a systemic issue that was common across all

ethnicities and decile; shifting the responsibility of reporting from self-identification of concussion symptoms to empowering peer-recognition of concussion signs and symptoms is recommended. For coaches, recommendations include continued annual coach education and emphasis on the pivotal role coaches play in concussion management through their dissemination of concussion information, and the recognition, removal, and referral of symptomatic players particularly when a loss of consciousness occurs. The significant change in reporting behaviours of players as the season progresses would advise the need to reinforce symptom disclosure strategies with both players and coaches towards the end of the season.

Strengths and limitations

The strengths of this study include a large sample size for both male and female high school players and community coaches in NZ; the sample population is largely reflective of both the current player and coach demographic; the use of a validated tool that enables direct comparison against other research that has employed this tool; and the inclusion of both ethnicity and decile details enables the exploration of how these variables influence CK, CA, and CRI in NZ.

Study limitations were that due to logistical constraints of the pre-season data collection we were only able to capture coaches using an online survey methodology. This methodology is susceptible to non-response bias in which the coaches who did not voluntarily complete the survey were left out. The majority of surveyed coaches were male; while representative of coaching demographics in NZ, future work should be directed to explore CK, CA and reporting behaviours in females specifically. In addition, due to the nature of survey data, the results may be subject to acquiescence or demand characteristics bias.[85] Lastly, the RoCKAS is a validated instrument that has been utilised across a multitude of sports and countries. However, a recent analysis of the RoCKAS survey demonstrates the ceiling effects of the RoCKAS survey,[56] particularly in the analysis of concussion attitudes.

Conclusion

In the current study, the higher CK, CA and CRI observed in coaches is likely a testament to the concussion content delivered in the annual RugbySmart training. The poorer scores observed in the player population likely reflect the fact that players in NZ do not typically receive any formal concussion education. This would potentially support exploring the impact of a concussion specific education strategy and the impact directly engaging with players has on the outcome measures, rather than through passive means such as coach dissemination or online content. In line with other research, players who identified as Māori or Pasifika and those from schools in low socio-economic areas displayed poorer attitudes and knowledge towards concussions. These findings highlight the need for concussion strategies that are culturally responsive and that have the capacity to address the specific needs of each school/club to remove financial barriers. For both players and coaches, experience played a critical role in improving CA and is a factor that should be considered when welcoming new participants to either role. Concussion non-disclosure is an issue that appears to transcend both gender, ethnicity, and socio-economic status and appears to worsen as the season progresses. This issue requires specific focus for future concussion education strategies.

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Supplemental Material

Supplemental material for this article is available online.

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