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What they know and who they are telling: Concussion knowledge and disclosure behaviour in New Zealand adolescent rugby union players

Danielle M. Salmon^a, Jody McGowan^a, S. John Sullivan^b, Ian Murphy^a, Simon Walters^c, Chris Whatman^c, Sierra Keung^c, Amanda Clacy^d and Janelle Romanchuk^a

^aHealth Safety and Welfare, New Zealand Rugby, Wellington, New Zealand; ^bCentre for Health, Activity and Rehabilitation Research, School of Physiotherapy, University of Otago, Dunedin, New Zealand; ^cSports Performance Research Institute New Zealand, School of Sport and Recreation, Auckland University of Technology, Auckland, New Zealand; ^dSunshine Coast Mind and Neuroscience – Thompson Institute, University of the Sunshine Coast, Birtinya, Australia

ABSTRACT

The purpose of this study was to survey high school rugby players from a range of ethnic, geographic and socioeconomic backgrounds in New Zealand (NZ) to gain an understanding of concussion knowledge, awareness of NZ Rugby's (NZR) guidelines and attitudes towards reporting behaviours. Male and female high school rugby players ($n=416$) from across NZ were surveyed. The findings indicated that 69% of players had sustained a suspected concussion, and 31% had received a medical diagnosis of concussion. 63% of players indicated they were aware of NZR's guidelines. Māori and Pasifika players were less likely to be aware of the guidelines compared to NZ European, Adjusted OR 0.5, $p=0.03$. Guideline awareness was significantly higher for those from high decile schools when compared to low (Unadjusted OR 1.63, $p=0.04$); however, when ethnicity and school locations were controlled for this became non-significant (Adjusted OR= 1.3, $p=0.37$). The coach was the key individual for the provision of concussion information and disclosure of symptoms for players. The findings of this study will inform the development and delivery of NZR's community concussion initiative and how these examined factors influence a high school player's concussion knowledge and reporting behaviour.

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KEYWORDS

Ethnicity; high school; concussion; rugby union; socioeconomic status; reporting behaviours

Introduction

Rugby Union, hereafter referred to as rugby, is a popular full-contact team sport played in New Zealand (NZ) and administered by New Zealand Rugby (NZR). In NZ rugby is played by some 40,010 male and female high school athletes aged 13–18 years (NZR National Rugby Database, 2019). Similar to other contact sports, participation in rugby carries a risk of sustaining a concussion with self-reported lifetime prevalence rates in players ranging between 23% and 62% (Delahunty et al., 2015; Kearney & See, 2017; Sye et al., 2006).

The Accident Compensation Corporation (ACC) is a nationwide, tax-payer funded, no-fault personal injury insurance scheme providing cover for all accidents sustained in NZ, including those related to sports participation (www.acc.co.nz). ACC statistics report the highest rates of sports-related concussions in NZ are sustained in the 13–18-year-old demographic (Malpas & McEwen, 2016). Of the concussions sustained while playing a school sport, 25% occurred while playing rugby (Malpas & McEwen, 2016). The number of rugby-related concussions recorded by ACC for players in high school has steadily increased from 2011 to over 630 in 2016 (ACC data only include concussion diagnosed by a medical doctor) (Malpas & McEwen, 2016; Sye et al., 2006). The exception to this is in schools in low socioeconomic areas, where reported concussion rates have remained relatively stable (Malpas & McEwen, 2016). Despite these statistics, there is a significant body of evidence to

suggest that concussions are underreported and often poorly managed in this age demographic in both NZ (Sye et al., 2006) and internationally (Cournoyer & Tripp, 2014; Kearney & See, 2017; Register-Mihalik, Guskiewicz et al., 2013; Register-Mihalik, Linnan et al., 2013). As one of the most common injury types in youth sport (Emery et al., 2006; Emery & Tyreman, 2009), concussion in adolescents often takes longer to recover from and are more symptomatic when compared to adults (Davis et al., 2017; Harmon et al., 2019; Purcell et al., 2016). This may lead to emotional, physical, academic, cognitive and social dysfunction which can contribute to a decrease in the player's quality of life and create significant burden not only for the immediate family but the health-care system generally (Alexander et al., 2015; Kroshus et al., 2017; Register-Mihalik et al., 2017).

In NZ schools are ranked by deciles which is a measure of the relative wealth of the area the school serves. Schools with a decile ranking of 1 represent the poorest 10% and schools with a decile ranking of 10 represent the wealthiest 10% of the population (www.education.govt.nz). Most NZ high schools field a rugby team regardless of the socioeconomic status of the area (NZR National Rugby Database, 2019). However, the resources and support available for each team are unlikely to be equitably distributed, due to the fact many upper decile schools are private schools and often have access to additional funding. For example, teams from high decile schools will often employ a physiotherapist, strength and conditioning coach and occasionally have access to a school doctor, in contrast low

decile schools (decile 1–4 schools) medical support is often limited to a school nurse, which potentially limits players access to medical support. Rugby in NZ also encompasses players with diverse cultural backgrounds. At the high school level in 2017, 26% of male and 36% of female rugby players identified as being Māori (NZ's indigenous people) and 22% of male and 27% of female identified as being Pasifika (NZR National Rugby Database, 2019). Pasifika is a broad and diverse term that encompasses individuals from various Island nations and communities in the South Pacific (Zealand HRCoN, 2014). An examination of child poverty levels in NZ has reported that children from both Māori and Pasifika families are more likely to live below the poverty line when compared to those from NZ European backgrounds (Zealand HRCoN, 2014). Given the large representation of Māori and Pasifika playing rugby in high school, inferences from the child poverty data can be made that potentially a large majority of these players are from socioeconomically deprived backgrounds and are reporting fewer concussions when compared to players studying in higher decile schools (Malpas & McEwen, 2016). This situation in NZ is echoed in studies conducted in both Canada (Hunt et al., 2018) and the United States (US) (Kroshus et al., 2017; Wallace et al., 2017) and provides a compelling argument to examine concussion awareness, education, and management in the context of youth engagement in rugby in greater detail.

In 2001, NZ Rugby (NZR) partnered with the ACC to develop an injury prevention programme known as RugbySmart; a compulsory annual coach and referee education program whose genesis was in the prevention of catastrophic spinal injuries (Gianotti et al., 2009). Between 2003 and 2005, the programme added a concussion recognition and post-injury management component (Gianotti & Hume, 2007), which as continued until present. While this program has successfully reduced the number of catastrophic injuries (Quarrie et al., 2007), it is difficult to quantify the degree of knowledge transfer that has occurred from coaches to players, and what effect this has had on concussion awareness, reporting, and effective management of concussions in adolescents. A national (NZ) survey of male high school rugby players' concussion knowledge determined that only 50% of the group were aware of concussion guidelines, 60% could identify the mandatory 3-week stand-down following a diagnosed concussion, and only 22% of the players who sustained a concussion sought medical clearance to return to play (Sye et al., 2006). For injury prevention programmes to be effective, it is important to continually evaluate changes in knowledge, behaviour, and compliance of the targeted population and utilise such information as the basis for modifications for future delivery (Fraas & Burchiel, 2016). Recent data from the US and Canada have suggested that concussion knowledge and reporting behaviours of high school athletes varied depending on ethnic background (Hunt et al., 2018; Kroshus et al., 2017; Wallace et al., 2017) and geographical location of a school (Wallace et al., 2017). It has also been suggested that athletes who are "underserved" in terms of access to appropriate training and medical resources, had less knowledge of the signs and symptoms of concussion (Viljoen et al., 2017).

This study was conducted as part of the RugbySmart Concussion Initiative. While previous research informed the

content of the concussion education program (Clacy et al., 2017; Delahunty et al., 2015; Kerr et al., 2016; Register-Mihalik et al., 2017; Sye et al., 2006), NZR acknowledged the value in garnering an understanding of concussion knowledge and reporting behaviours in the current local context. The purpose of this study was to survey high school rugby players from a range of ethnic, geographic and socioeconomic backgrounds to gain an understanding of (i) awareness of NZR's concussion guidelines and (ii) knowledge of, and attitudes towards concussion reporting.

Methods

Study design

This cross-sectional study used a paper-based survey to collect data from adolescent male and female rugby players. Purposive sampling was used to target a select group of NZ high schools representing a range of ethnic, socioeconomic and geographic backgrounds. As part of NZR's RugbySmart Concussion Initiative, participants were invited to attend a concussion education session. Prior to the commencement of the education session, players were asked to complete the survey which examined knowledge of concussion signs and symptoms, NZR concussion management guidelines and attitudes towards reporting concussions. Ethical approval was obtained from the Auckland University of Technology Ethics Review Board.

Study setting

Six provincial rugby unions (PUs) in NZ were selected covering a range of geographical locations, player ethnicities, and socioeconomic backgrounds. Specific schools were targeted based on the ethnic diversity of the student population and/or the decile ranking of the school. The survey was administered in conjunction with the NZR concussion education sessions which were conducted during the 2017 high school pre-season/start of season which ran from February to May. The survey was administered at a convenient and quiet location in each school during the lunch break or prior to a scheduled rugby training session.

School recruitment

Schools were recruited through the PU networks in the Northland, Auckland, Manawatu, Horowhenua-Kapiti, Wellington, and Otago regions. Each school was contacted by a PU representative who outlined the goals and requirements of the study. A meeting was then organized between NZR and the school administration to outline the goals and aims of the study. Once confirmed, each school was sent information reiterating the purpose of the study and involvement required.

Participant recruitment

Each school that agreed to participate nominated the teams that would be involved in the study. The majority of schools elected to only involve the male 1st XV team (the highest level of high school rugby played in NZ); however, three schools included both

their male and female teams. All players who attended the NZR concussion education session were eligible to participate in the study, regardless of age, gender or socioeconomic background. All participants were informed of the goals and purpose of the study and written informed consent was then obtained from all participants prior to completing the survey. For players who were 15 years or younger, consent was obtained from parents/caregivers before they engaged in the study. Participation in the survey was voluntary and all data were provided anonymously. Participants were informed that they may withdraw from the study at any stage without explanation or consequence.

Survey

The questions used in the survey were modelled on a survey previously developed specifically for the adolescent population of NZ high school rugby players (Sye et al., 2006) and was modified to reflect the current terminology and understanding of concussion. The survey consisted of 22 questions covering the following topics: (1) player demographics (age, gender, self-reported ethnicity and school location), (2) rugby playing experience, (3) concussion history, (4) concussion guidelines, (5) concussion signs and symptoms, (6) attitude towards symptom disclosure, (7) steps in concussion recovery, and (8) knowledge of the key elements of the GRTP protocol. The content of the survey was reviewed for face validity by a panel of researchers, medical personnel, rugby coaches and educators. Questions were a mixture of dichotomous, multiple-choice and open-ended lists. Some questions were designed to incorporate a scenario so as to increase the realism of the information sought. Certain questions also permitted multiple responses. Prior to the start of the study, the survey was piloted with players from two high school rugby teams ($n = 50$) to ensure terminology and language were age appropriate and understood, and the survey was modified where necessary. These data are not included in the current study. The survey was designed to be completed in approximately 10 min.

Data processing

All data from completed questionnaires were entered into an Excel spreadsheet and verified and made available for analysis. The completed questionnaires contained the name of the participants' school, and this was used by NZR staff to identify decile rating and school location for each participant. This information was obtained from the Ministry of Education website (www.education.govt.nz). The urban classification was given to schools located in large city areas, with a minimum population of 30,000. The suburban classification was given to schools located in the outskirts of cities (population between 10,000 and 29,999) or smaller towns (population 1000–9999) (<https://www.educationcounts.govt.nz/data-services/glossary>). Data were categorised where appropriate. All qualitative data from the survey were recorded verbatim.

Data analysis

Data were analysed using the Statistical Programme for Social Sciences (SPSS) (IBM SPSS, Chicago), version 25. Descriptive

statistics (e.g., means, percentages) were created to give an overview of the data. Associations between responses to various dichotomous concussion awareness, knowledge and reporting questions and specific demographic subgroups (ethnicity, decile level, school location, and age) were investigated using univariate logistic regression analysis. Unadjusted and Adjusted odds ratios were then calculated for each response by conducting multiple logistic regression analyses controlling for all of the various demographic descriptors. Chi-square (Pearsons χ^2) analysis was completed to determine if there were any between-group differences for ethnicity, decile and school location for each of the multiple-choice questions. For all inferential analyses, the threshold for statistical significance was set at $p < 0.05$. Open-ended question answers were coded and grouped into common themes by two members of the research team (SB & JM) and verified by the primary investigator (DS). These themes encompassed the common signs and symptoms of a concussion (e.g., dizziness, headaches), things you should avoid doing following a concussion (e.g., "continue to play", "play contact sports"), the steps in the GRTP (e.g., rest, light exercise, non-contact exercise) and what would you do if you had completed the steps in the GRTP protocol but still had a headache (e.g., "see a doctor", "tell a parent", or "return to play anyway").

Results

Participant demographics

A total of 416 players (94% male; mean age 16.3 ± 0.9 years) participated in the study from 21 schools. A participant's survey was included in the analysis if they completed at least 95% of the responses. The demographic characteristics of the participants are outlined in Table 1. Players reported playing rugby for an average of 7.4 years. Of the 366 players who answered the concussion history questions, 69% ($n = 252$) stated they thought they may have been concussed at least once and 31% ($n = 113$) stated they had received a confirmed medical diagnosis of concussion. A robust representation of schools from different socioeconomic areas was obtained as indicated by the decile breakdown in Table 1. Over 72% of the players identified as having non-European heritage. Of this group, 23% identified as Māori, and 47% identified as Pasifika, with the majority of Pasifika identifying specifically as Samoan (25%) or Tongan (15%). As presented in Table 2 there was an over-representation of Māori and Pasifika players in the low decile schools.

Awareness of concussion guidelines

More than half of the participants 63% ($n = 262$) indicated they were aware of NZR's concussion guidelines. However, Māori and Pasifika players were less likely to be aware of the guidelines compared to NZ European players (Adjusted OR 0.5, 95% CI: 0.2–1.0, $p = 0.03$ and OR 0.4, 95% CI: 0.2–0.8, $p \leq 0.01$, respectively; see Table 3). A similar pattern was observed for players from low decile schools, where guideline awareness was significantly higher for those players from higher decile schools (Unadjusted OR 1.63, 95% CI: 1.0–2.6, $p = 0.04$). However,

Table 1. Demographic and playing characteristics.

	N (%)
Gender (N = 416)	
Male	393 (94)
Female	23 (6)
Age (years) (N = 369)	
13.0	2 (1)
14.0	9 (2)
15.0	59 (16)
16.0	118 (32)
17.0	158 (43)
18.0	23 (6)
Organized Rugby Playing Experience (years) (N = 411)	
0 – 2	40 (10)
3 – 4	51 (12)
5 – 6	69 (17)
7 – 8	85 (21)
9 – 10	84 (20)
11 – 12	68 (17)
13 – 14	14 (3)
Ethnicity (N = 372)	
NZ European	73 (18)
Māori	94 (23)
Pasifika:	173(47)
Samoan	92 (25)
Tongan	55(15)
Fijian	8(2)
Cook Island	7(2)
Tokelauan	6(2)
Nuiean	5(1)
Other:	32 (8)
Asian	4(1)
South American	27(7)
Unspecified	1(0)
Decile Ranking (N = 416)	
Low 1 – 3	137 (33)
Medium 4 – 6	90 (21)
High 7–9	189 (46)
School location (N = 416)	
Urban	264 (64)
Suburban	152 (36)

Table 2. Comparison of player ethnicity by decile school ranking.

Player Ethnicity	N	School Decile Ranking		
		Low (1–3)	Medium (4–6)	High (7–9)
NZ European	73	7	22	44
Māori	94	35	18	40
Pasifika	173	69	44	61
Other	32	8	5	19

when ethnicity and school locations were controlled for the odds ratio between high and low decile schools became non-significant (Adjusted OR = 1.3, 95% CI: 0.7–2.3, $p = 0.37$). To further explore the relationship between ethnicity and decile, we compare only those players from high decile schools and found no significant differences between the different ethnicities. This would suggest that school decile had the most significant impact on awareness of concussion guidelines. When awareness of guidelines was compared to suspected and confirmed concussion history, the results indicated that a player was significantly more likely to be aware of the guidelines if they had sustained a suspected OR 2.4, 95% CI: 1.5–3.8, $p \leq 0.01$, or confirmed concussion OR 0.3, 95% CI: 0.2–0.5, $p \leq 0.01$. Of those who were aware of the guidelines, 71% ($n = 188$) reported receiving guideline information from their coach, 57% ($n = 147$) reported getting information from medical personnel and 38%

($n = 101$) attributed their awareness to their parents. Māori, Pasifika and NZ European players all had similar responses in terms of who they attributed their awareness of NZR concussion guidelines to, even when adjusted for age, decile, and school location. These findings indicate that there was a difference in concussion knowledge across the ethnicities; however, the individuals the various ethnicities attributed to providing this concussion information were the same.

Concussion knowledge

The 87% ($n = 363$) of participants were able to correctly identify at least one sign or symptom of a concussion, 79% ($n = 330$) identified two, 57% ($n = 238$) were able to identify three and 34% ($n = 140$) could recall four. The most commonly recalled signs and symptoms were dizziness (23%, $n = 241$), headaches (21%, $n = 223$), memory loss (14%, $n = 153$), vomiting (8%, $n = 87$) and loss of consciousness (6%, $n = 64$). In a free text format, players were asked to identify the six steps in the GRTP guidelines. One player correctly identified all six steps in the GRTP and only 39% of players ($n = 166$) were able to identify a single correct step in the GRTP. Only 15% ($n = 56$) of players were able to correctly identify the current minimum 23-day stand-down period in NZ for players under the age of 19 yrs. When players were asked in a free text format what things to avoid following a concussion, the most commonly identified theme was contact activities ($n = 260$) followed by physical activity ($n = 151$), use of screens ($n = 56$) and sleeping ($n = 52$). A total of 87% ($n = 360$) of players were able to list one thing to avoid, 57% ($n = 238$) two, 26% ($n = 107$) three and 8% ($n = 33$) listed four activities to avoid. Most players (97%, $n = 391$) thought it was necessary to see a doctor to be cleared to return to rugby if they had sustained a concussion.

Concussion attitudes

Most participants (88%, $n = 338$) considered a concussion to be serious and 99% ($n = 402$) indicated that sustaining a second concussion before recovery from the first would result in a more serious injury. When asked what should happen next when a player looks like they may have a suspected concussion, 72% ($n = 287$) stated they should leave the field and get checked out. While 26% ($n = 101$) indicated that they should stop playing and have the team medick assess them on the field; however, they felt that the player should make the final decision as to whether or not they wish to continue playing, which make reflect a lack of awareness of the impact a concussion can have on cognitive function and performance or indicates a high level of internal motivation to continue playing and thus contribute to their team. Thus, indicating the decision to return to play should be made by the injured player not a health professional/team medick. Interestingly, whether a player was aware of the NZR guidelines had no significant relationship to selecting the correct response following the on-field suspected concussion $\chi^2(1) = 0.03$, $p = 0.87$. A similar pattern was observed for those with a history of a suspected concussion $\chi^2(1) = 0.03$, $p = 0.86$, and a confirmed concussion $\chi^2(1) = 0.41$, $p = 0.52$. This indicated that neither

Table 3. Subgroup association with awareness of guidelines.

Subgroup	Awareness of concussion guidelines N (%)		Unadjusted Odds [∞]	Adjusted Odds [^]
	Yes	No	OR (95% CI, <i>p</i> value)	OR (95% CI, <i>p</i> value)
Ethnicity:			Reference	Reference
NZ Eur	39 (59%)	27 (41%)	0.5 (0.2–1.0, <i>p</i> = 0.03)*	0.5 (0.2–1.0, <i>p</i> = 0.04)*
Māori	98 (57%)	75 (43%)	0.4 (0.2–0.8, <i>p</i> ≤ 0.01)*	0.4 (0.2–0.8, <i>p</i> ≤ 0.01)*
Pasifika	24 (80%)	6 (20%)	1.3 (0.5–3.6, <i>p</i> = 0.58)	1.3 (0.5–3.7, <i>p</i> = 0.59)
Other				
Decile:			Reference	Reference
Low	56 (64%)	31 (36%)	1.2 (0.7–2.1, <i>p</i> = 0.47)	1.1 (0.6–2.1, <i>p</i> = 0.67)
Medium	131 (70%)	55 (30%)	1.6 (1.0–2.6, <i>p</i> = 0.04)*	1.3 (0.7–2.3, <i>p</i> = 0.37)
High				
School location:			Reference	Reference
Urban	170 (65%)	91 (35%)	1.1 (0.7–1.6, <i>p</i> = 0.78)	0.9 (0.5–1.6, <i>p</i> = 0.71)
Suburban	99 (66%)	50 (34%)		

OR = Odds ratio. CI = Confidence interval. [∞] Univariate logistic regression analysis. [^] Multivariate logistic regression analysis of all three variables.

* Denotes a statistically significant difference between the identified subgroup and the reference subgroup (*p* < 0.05).

history of concussion nor awareness of the concussion guidelines was associated with the player indicating that they should leave the field following a suspected concussion.

When asked if they should return to play after the mandatory stand-down period despite having ongoing headaches, 96% (*n* = 378) of respondents indicated “No”. When asked in free text what they would do in this situation, 75% of the respondents said they would see a doctor, nurse or physiotherapist; 15% said they would continue to rest; 4% would tell their coach; 3% would avoid contact; 1% would take Panadol; and 2% would keep playing regardless. There were no statistically significant associations in any of the subgroups (ethnicity, decile or urban location) with regards to responses to questions regarding obtaining medical clearance prior to RTP, sustaining a second concussion prior to fully recovering, or returning to play while still being symptomatic.

Reporting behaviours

Players indicated a spectrum of individuals who they would report a suspected concussion to with their coach being the most frequently identified (Figure 1(a,b)).

The adjusted odds ratios are presented in Table 4. Rugby players from high decile schools were significantly more likely to report a concussion to a doctor than players from low decile schools (Adjusted OR = 2.4, *p* = 0.04). To explore the relationship between reporting to a doctor, school decile and ethnicity further we examined only those players from high decile schools and found no statistically significant differences. A history of suspected concussions also increased the likelihood that a player would report a concussion to the doctor ($\chi^2(1) = 6.98, p \leq 0.01$). Pasifika players were less likely to report a concussion to their team-mates compared to NZ European players (Adjusted OR = 0.4, 95% CI: *p* ≤ 0.01), this pattern remained when only players from high deciles were examined (OR = 0.38, 95%CI: *p* = 0.02). Pasifika players were also more likely to report a concussion to a school nurse than NZ European players (Adjusted OR 2.2, 95% CI: *p* = 0.02), this

trend remained when only players from high decile schools were compared (OR = 3.65, 95%CI: *p* ≤ 0.01). Whereas players attending schools in suburban areas were less likely to report to the school nurse than players attending schools in an urban area (Adjusted OR 0.4, 95% CI: *p* ≤ 0.01).

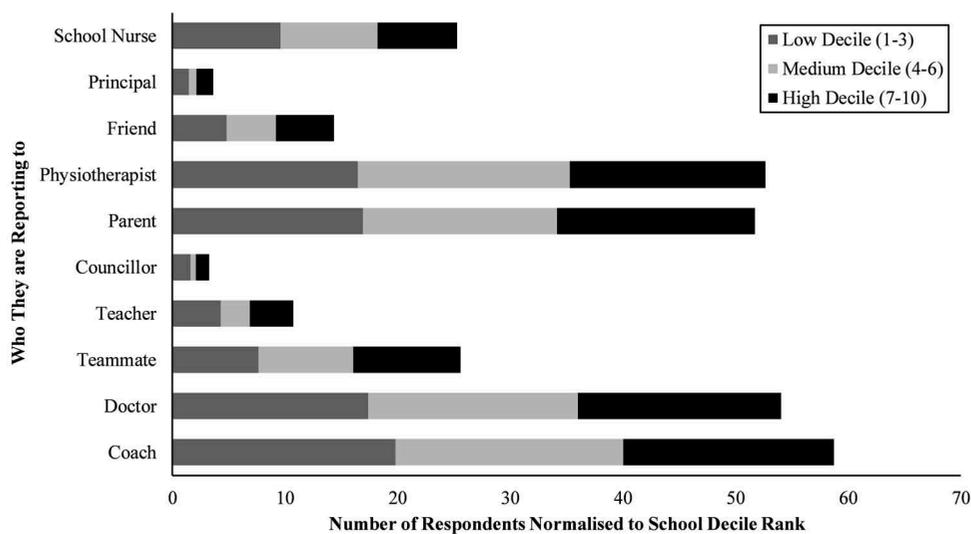
The most common reason given for not reporting a concussion was “not wanting to leave the game or miss future games” (31%, *n* = 124), followed by “not knowing they were potentially concussed” (27%, *n* = 105). There were no significant between-group differences for the reasons given for not reporting a concussion in any of the subgroup analyses, including by ethnicity ($\chi^2 = 10.1, p = 0.61$), decile group ($\chi^2 = 14.3, p = 0.08$) or school location ($\chi^2 = 1.4, p = 0.85$).

Discussion

The purpose of this study was to gain an understanding of high school rugby players’ awareness of NZR concussion guidelines and to explore the impact of ethnicity, geographic location and socioeconomic has on awareness and reporting behaviour. The findings from this survey clearly indicate that the coach is the key conduit to relay concussion information to players and is the person players feel most comfortable reporting their concussion too. Of the total sample population surveyed 69% reported they had sustained a suspected concussion; however, only 31% indicated they had sought medical treatment for their concussion, illustrating that 38% of players failed to obtain medical attention following the injury, which is a concern given the risk associated with additional impacts (ref). Players of non-European descent and from low decile schools (lower socioeconomic) were less likely to be aware of the NZR concussion guidelines. In concordance with previous research (Register-Mihalik, Guskiewicz et al., 2013; Register-Mihalik, Linnan et al., 2013; Register-Mihalik et al., 2017; Wallace et al., 2017) history of concussions and awareness of NZR guidelines had no influence on whether a player indicated they should leave the field following a concussion. Decision to return to play and socioeconomic status also demonstrated a similar

a

The person who players indicated they would report their suspected concussion to by decile (multiple responses permitted).



b

The person who players indicated they would report their suspected concussion to by ethnicity (multiple responses permitted).

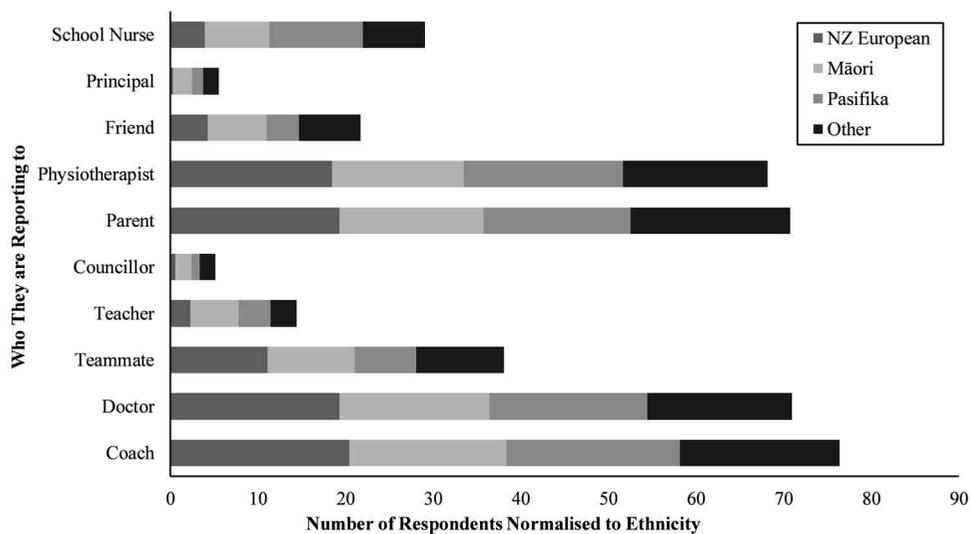


Figure 1. (a) The individual players indicated that they would report their suspected concussion to by decile (multiple responses permitted). (b) The individual players indicated that they would report their suspected concussion to by ethnicity (multiple responses permitted).

pattern to previous research (Kroshus et al., 2017) with players from low decile schools less likely to seek treatment from a doctor after sustaining a suspected concussion.

Awareness of guidelines

These results indicate that NZ high school rugby players' awareness of NZR concussion guidelines has improved from 50% in 2000 (Sye et al., 2006) to 63% in the current study. Our results are similar to those reported in an Irish study of high school rugby players where 60% indicated that they had received information about concussion (Delahunty et al., 2015). These values are substantially higher than those reported by South African rugby players of a similar age (41%) (Kraak et al., 2018), which may reflect the variation in educational strategies

employed in different countries. Despite these results, a third of the players who participated in this study indicated they were unaware of concussion guidelines. Subgroup analysis revealed that Māori and Pasifika players were significantly less likely to be aware of concussion guidelines when compared to NZ Europeans, highlighting the need for further and different educational strategies to better target players in this high school demographic. The demographics of the current group indicate an over-representation of Māori and Pasifika players enrolled in low decile schools. Previous research has identified that adoption of concussion education/prevention programs is patterned by community social and demographic characteristics, where communities with ethnically diverse populations, higher levels of poverty and lower levels of education faced greater obstacles implementing these programs (Hunt et al.,

Table 4. Subgroup association regarding who a player would report their concussion to.

Subgroups	To whom a player would self-report a concussion to Adjusted OR (95% CI)*					
	Coach	Doctor	School nurse	Teammate	Sport medick	Parents
Ethnicity	Reference	Reference	Reference	Reference	Reference	Reference
NZ Eur	0.5 (0.9–3.0, <i>p</i> = 0.45)	1.2 (0.4–3.7, <i>p</i> = 0.77)	2.0 (1.0–4.1, <i>p</i> = 0.47)	1.4 (0.7–2.6, <i>p</i> = 0.35)	0.5 (0.2–1.2, <i>p</i> = 0.12)	0.7 (0.2–1.9, <i>p</i> = 0.45)
Māori	0.6 (0.1–3.8, <i>p</i> = 0.63)	0.8 (0.3–2.1, <i>p</i> = 0.60)	2.2 (1.1–4.2, <i>p</i> = 0.02)*	0.4 (0.2–0.8, <i>p</i> ≤ 0.01)*	0.9 (0.4–2.1, <i>p</i> = 0.76)	0.5 (0.8–1.2, <i>p</i> = 0.12)
Pasifika	0.9 (0.8–10.6, <i>p</i> = 0.93)	0.7 (0.2–2.6, <i>p</i> = 0.60)	1.7 (0.7–4.1, <i>p</i> = 0.24)	1.0 (0.4–2.3, <i>p</i> = 0.97)	1.0 (0.3–3.3, <i>p</i> = 0.95)	3.0 (0.3–25.2, <i>p</i> = 0.32)
Other	Reference	Reference	Reference	Reference	Reference	Reference
Decile	Reference	Reference	Reference	Reference	Reference	Reference
Low	4.1 (0.8–20.4, <i>p</i> = 0.08)	1.9 (0.8–4.6, <i>p</i> = 0.16)	0.82 (0.4–1.5, <i>p</i> = 0.53)	1.0 (0.5–1.8, <i>p</i> = 0.97)	2.2 (0.9–5.5, <i>p</i> = 0.08)	1.2 (0.5–2.5, <i>p</i> = 0.72)
Medium	3.2 (0.9–11.3, <i>p</i> = 0.07)	2.4 (1.0–5.6, <i>p</i> = 0.04)*	0.58 (0.3–1.0, <i>p</i> = 0.06)	1.2 (0.7–2.1, <i>p</i> = 0.54)	1.5 (0.7–3.0, <i>p</i> = 0.32)	2.2 (1.0–4.7, <i>p</i> = 0.06)
High	Reference	Reference	Reference	Reference	Reference	Reference
School location	1.9 (0.5–7.0, <i>p</i> = 0.36)	1.2 (0.5–2.9, <i>p</i> = 0.62)	0.4 (0.2–0.8, <i>p</i> ≤ 0.01)*	0.6 (0.4–1.1, <i>p</i> = 0.08)	0.8 (0.4–1.8, <i>p</i> = 0.65)	1.3 (0.6–3.0, <i>p</i> = 0.50)
Urban						
Suburban						

OR = Odds ratio. CI = confidence interval. * Denotes a statistically significant difference between the identified subgroup and the reference subgroup ($p < 0.05$).

2018; Kroshus et al., 2017; Wallace et al., 2017). These findings suggest that differences in community socioeconomic status can influence the delivery and uptake of effective interventions, thereby exacerbating health inequalities (Kroshus et al., 2017). The lack of guideline awareness reported by our Māori, Pasifika, and players from low decile schools support this line of inquiry, highlighting the need for culturally responsive education strategies that can be adapted to the local context (Hunt et al., 2018).

A history of suspected and medically confirmed concussion increased the likelihood that a player reported knowledge of NZR concussion guidelines, which is consistent with previous research (Hunt et al., 2018). Despite increased awareness, a history of concussions has been linked to a decrease in the probability of concussion disclosure (Delahunty et al., 2015; Register-Mihalik et al., 2017). Our findings tell a similar story where awareness of guidelines and previous history of concussions was not associated with a player self-reporting that they would leave the field of play following a suspected concussion. Research has identified that concussion-related attitudes (rather than concussion knowledge) have the biggest impact on concussion disclosure. This highlights the need for initiatives to target concussion-related attitudes in players and key factors that influence these attitudes such as concussion history, individual beliefs, team, coach and parental relationship (Register-Mihalik et al., 2017, 2018).

The coach was most frequently cited by players as the person who provided them with concussion specific information, highlighting the influential role a coach can have in educating players about concussions. From an NZR perspective, this reinforces the emphasis placed on concussion education in the mandatory RugbySmart course all coaches must attend (Gianotti & Hume, 2007; Gianotti et al., 2009). These findings are in contrast to previous studies in South Africa and Italy where health-care providers were identified as playing the largest role in concussion information provision (Boffano et al., 2011; Viljoen et al., 2017). Many high school rugby programs in NZ often do not have on-site access to health-care providers, so it is not surprising that coaches play a larger role in the provision of concussion information.

Concussion knowledge and attitudes

Overall, players' responses regarding the recall of signs, symptoms, and what to do immediately following a concussion suggest the group surveyed had a basic knowledge of concussion. The majority of players in this study could list at least two correct symptoms of a concussion. Similar to high school players in Ireland (Delahunty et al., 2015) the two most commonly cited symptoms in the current study were dizziness and headaches. When asked what activities to avoid following a concussion the majority of players (37%) indicated rugby/contact sports; however, knowledge of the GRTP protocol and the stand-down period mandated by NZR was generally poor. Only one player was able to correctly state the six stages of the GRTP. This suggests that while players do have some understanding of the symptoms of concussion and what to do following injury the recommended recovery process may not be well understood. This trend has been reported elsewhere (Delahunty et al., 2015; Kearney & See, 2017) and emphasizes the difficulty in achieving effective knowledge transfer through education alone (Fraas & Burchiel, 2016).

Reporting behaviours

Improving player welfare outcomes in relation to concussion can only be addressed if a concussion is reported. Hence, this study also sought to understand those key persons and processes that may influence reporting behaviours. The majority of players disclosed they would report a suspected concussion to their coach. This finding again highlights the pivotal role a coach plays in the recognition of adolescent concussion and supports the current initiatives directed at coach education. Non-disclosure of suspected concussions in adolescents continues to be an issue reported by rugby unions worldwide (Fraas & Burchiel, 2016). In Ireland, a survey ($n = 304$) of community rugby players aged 12–18 years 72% stated they would play on in an important match despite a suspected concussion (Delahunty et al., 2015), and in England, 36% of a sample of 255 youth players (aged 11–17 years) would continue playing despite a suspected concussion (Kearney & See, 2017). In the

current study, the primary reason for not reporting a concussion was that they did not want to miss out on playing. This should be considered alongside the concussion history questions in this study, where 69% of respondents stated they suspected they may have been concussed yet only 31% had been diagnosed as concussed. In NZ, NZR has a mandated 21 or 23-day stand-down period if a player has been removed for a suspected concussion depending on their age. While this policy prevents players with a suspected concussion from returning which is an important safety consideration, it may also have the detrimental side effect of increasing non-disclosure in players. It is, therefore, necessary to gain a better understanding of player attitudes and how they impact concussion reporting behaviours and the likelihood that the player will seek medical attention following their injury.

When looking at whom a player reports their concussion too, there were some variations between ethnicities, socioeconomic status, and location of schools. Whilst there were no significant differences between any of the groups and reporting to the coach, differences were noted in reporting to medical professionals. Players from higher deciles were significantly more likely to report a concussion to a doctor than players from lower deciles. In NZ, visiting a doctor commonly incurs a fee and depending on geographical location, transportation to a hospital or local clinics is not always easily accessible. It may require a parent/caregiver to provide transport and possibly take time off work. These factors potentially create both financial and geographical barriers for players from lower socioeconomic areas and may provide a plausible explanation for the observed difference in the likelihood of a player seeking a concussion assessment from a medical doctor by school decile. Evidence for this hypothesis is supported by ACC data which reports a greater number of medically diagnosed concussions from geographical locations that contain higher decile schools when compared to locations that contain lower decile schools (Malpas & McEwen, 2016).

When stratifying concussion injury risk by age, adolescents and children is at a greater risk (Carson et al., 2014; Khurana & Kaye, 2012; Kirkwood et al., 2015; Voss et al., 2015), remain symptomatic for longer periods (Carson et al., 2014; Davis et al., 2017; McCrory et al., 2017; Purcell et al., 2016), experience greater symptom severity and are more likely to have persistent symptoms (Purcell et al., 2016). Based on these poorer outcomes for children and adolescents following a concussion NZR through their RugbySmart program has developed a Community Concussion Initiative (CCI) that focuses on improving player welfare through a multi-pronged approach (Salmon, Sullivan et al., 2019). The purpose of this study was to ensure that future work with the CCI was informed by and addressed the current levels of concussion knowledge and reporting behaviours of high school players in NZ and how these factors are influenced by ethnicity, socioeconomic status and geographical location (Salmon, Sullivan et al., 2019).

Strengths and limitations

The study recruited a diverse sample of high school rugby players which represented the general playing population at the high school level across NZ with the exception of the small

number of female players preventing exploration of the difference between sexes. However, the number of females playing rugby in NZ is considerably smaller compared to males. As with many studies that aim to investigate players' attitudes and reporting behaviours towards concussion in rugby, the responses of the current sample may not include the characteristics of players who have withdrawn from rugby participation due to concussions or the risk of possible concussions. Future investigations of attitudes and reporting behaviours of players should also aim to include this population. This study is the first in NZ to specifically investigate the role of ethnicity and socioeconomic status on concussion knowledge and behaviours.

Future Directions

This study along with international research (Hunt et al., 2018; Kroshus et al., 2017; Wallace et al., 2017) has identified equity issues in the delivery mechanisms and uptake of concussion education programs in ethnically diverse and economically deprived areas. Previous research has highlighted the importance of community and family in both Māori and Pasifika cultures and that these should be key consideration in the development of education and prevention strategies (Hodge et al., 2011; Schaaf, 2006). For future education programs, this emphasises the importance of involving family and the wider community and/or including or upskilling members of the targeted community to deliver these programs. For education resources (paper-based or online modules) that are developed, they should be culturally responsive and target not only players but caregivers and the wider rugby community.

In this study, a number of players indicated that following a suspected concussion the player should stop, have a team medical assess them but that they player should make the final decision on whether they continue to play. As previously highlighted, athletes often have high levels of internal motivation to continue playing (Kroshus et al., 2015). These findings when taken in combination would suggest that concussion education should include information on the performance impacts a concussion can have on the player/team as well as the player's increased risk of subsequent and perhaps more serious injury.

To address the potential inequalities in accessing a doctor following a suspected concussion, a central element in the recommended management of these injuries is how to improve access to a medical provider. This situation needs further investigation using focus groups of players and parents/caregivers to more clearly identify the barriers. A similar approach may be used to determine how best to develop educational material and strategies so that the concussion message is relevant to all groups in this study playing the game. Also given the lack of access to health-care providers within the high school team environment, the importance of providing concussion specific recovery information to coaches, parents, players and the school through other channels is essential. This could take the form of paper-based resources or online modules that these stakeholders could freely access. NZR as part of its concussion management pathway is also piloting App-based technology that sends out an automatic notification to players, parents and other

stakeholders when a player is removed with a suspected concussion (Salmon, Romanchuk et al., 2019). This notification contains specific information for players and parents/caregiver regarding the first 48 h post-injury and graduated return to play and school/work guidelines (Salmon, Romanchuk et al., 2019)

Conclusion

As part of a national initiative to better manage concussion in NZ high school rugby players, NZR surveyed 21 high school rugby teams from across NZ. While knowledge of concussion guidelines has improved, one-third of the population indicated they were still unaware. When this was explored further this knowledge gap was more predominant in low decile schools and in players of Māori and Pasifika descent. Concussion history and knowledge of concussion guidelines were also found to have little influence on positive reporting behaviours. These findings highlight the need to re-examine our traditional education practices to adopt a more culturally responsive approach that can be tailored to the local context and implement strategies that better target positive reporting behaviours.

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