



Attitudes Towards Sports Concussion in Australian Exercise Science Students. Does the Type and Level of Participation in Sport Matter?

BILLYMO RIST^{†1}, JANET A. YOUNG^{‡2}, and ALAN J. PEARCE^{‡1}

¹Department of Rehabilitation, Nutrition and Sport, La Trobe University, Melbourne, VIC AUSTRALIA; ²Institute for Sport, Exercise and Active Living, Victoria University, Melbourne, VIC, AUSTRALIA.

[†]Denotes graduate student author, [‡]Denotes professional author

ABSTRACT

International Journal of Exercise Science 11(5): 739-753, 2018. Concussion in sport is a growing public health issue. However, research suggests that under-reporting of concussion by student-athlete cohorts reflects conflicting attitudes compared to the wider community. Interestingly, previous studies have focused on the attitudes and beliefs irrespective of the type or level of sport played at. This study explored concussion beliefs and attitudes in a cohort of Australian exercise science students, analyzing responses based upon the type and the level of sport participated. Two-hundred and ninety-four students (m = 208; f = 86; age 22 ± 5.2 years) responded to a series of statements regarding their personal attitudes and beliefs towards concussion, risk playing with a concussion, and their views on elite/professional athletes who continue to play after a concussion. Data was compared between the type of sport played (team and individual, contact and non-contact) and the level of sport played at (elite, regional and recreational). Significant differences were reported in those experiencing a concussion, and the number of concussions sustained between different types of sports. Specifically, significant differences in attitudes between team-contact versus individual non-contact sports were found. Similarly, significant differences in attitudes were observed between team contact and individual non-contact sports. Conversely, similar attitudes were found between team contact, team non-contact and individual contact. Irrespective of the level of competition, no differences were found in previous concussion history and the number of concussions, reflecting similar attitudes. The data from this study suggests that concussion awareness programs should be delivered across all sports and to all levels.

KEY WORDS: Traumatic brain injury, perspectives, Likert scale, university students

INTRODUCTION

The emerging evidence of the increased risk of injury (28) and the long-term consequences for contact sport athletes sustaining multiple concussions during their careers (25, 30) has led to increased media attention about concussion (22) resulting in overall greater public awareness of the issue (33). However, there is growing concern that attitudes towards the issue of sport concussion by athletes, at all levels of participation, do not reflect the wider community's concerns (15, 31).

Studies to date have focused on the individual's attitudes towards concussion. For example, McCrea, Hammeke, Olsen, Leo and Guskiewicz (21) and Register-Mihalik, Guskiewicz, McLeod, Linnan, Mueller and Marshall (34) reported that US high school-aged student-athletes did not report concussion because they thought the injury was not serious enough to report, but also feared being removed from the match. In US college-aged student-athletes, Kaut, DePompei, Kerr and Congeni (14) exploring under-reporting of concussions found nearly one in five surveyed failed to report concussions with the authors positing that not reporting a concussion was likely due to fear of being removed from the game, as well cultural issues of continuing to play through pain (14). A follow up study in a similar US population (39) found that 43% of student-athletes surveyed had knowingly concealed concussion symptoms to allow them to continue playing. Interestingly, despite being formally educated about concussion signs, symptoms and risks, 22% of those surveyed indicated they would be "unlikely" or "very unlikely" to report a concussion to their coach or athletic trainer for similar reasons of removal from the match or team non-selection (39).

Studies have also been undertaken in community-based sports clubs (main sports system in the United Kingdom, Ireland and Australia) to approach the question from a personal perspective but also where the individual is not subject to a scholarship to participate in their sport (3, 15, 20). For example, in club-based English junior rugby union, Kearney and See (15) found the majority of participants (aged 11-17 years) reported positive attitudes (i.e. reporting their suspected concussion to a coach, a concussion can occur without loss of consciousness) towards concussion. However, the authors report that a substantial minority (up to 30%) reported incongruous attitudes in response to specific questions such as playing on after a concussion, having a responsibility to play while experiencing concussion symptoms, and expectation of teammates to carry on playing after sustaining a concussion. Similarly, in a cohort of Irish U-20 club rugby union players, despite acknowledging the seriousness of concussion, 25% of those surveyed reported playing at some point of their career with a concussion (3). Similar findings have also been observed in North America with Canadian senior community level rugby union players. Martin, Hrubeniuk, Witiw, MacDonald and Leiter (20) found in the sample surveyed nearly 94% of participants acknowledged the danger of playing with concussion symptoms. However, nearly 30% admitted they would continue playing with a concussion and nearly 40% revealed they would let others down if they did not play following a concussion injury.

Further to club sport based attitudinal research, Pearce, Young, Parrington and Aimers (31) investigated a mixed cohort of Australian university students undertaking exercise science and related courses. Whilst North American studies presented findings from scholarship-based college students, the aim of the study by Pearce and colleagues was to address the attitudes in students not dependent upon university scholarships to support their sport (31). Australian students may represent their universities at the state or national varsity games, they do so voluntarily and are not dependent upon scholarships to support their academic tuition fees whilst representing their universities in the college sports system. Whilst the main finding of the study was that students overall believed it was 'not safe to play with a concussion', and 'repeated concussions would lead to neurological problems later in life', students also revealed

they would 'risk playing with a concussion' and 'admired elite athletes who continued to play on after a concussion'. In comparison to female students, males were more likely to have an attitude of continuing to play or train after a concussion, and to report to be less concerned about long-term consequences of repetitive concussions (31). Similar differences were identified in the attitudes of students with past experience of concussion, compared to those with no prior experience of concussion.

This initial data suggests that while the general discussion regarding the issue of concussion appears to focus on high performance (professional or elite college) team contact sport athletes (33), previous experiences (1, 35) and gender (31), a wider understanding of the issue is required. Given the need for more research addressing attitudes of athletes at all levels, this study extended previous research with Australian exercise science students (31). The new study specifically investigated in a mixed sport university cohort, beliefs and attitudes towards concussion, specifically focusing on the type and the level of sport played at. The objective was to establish whether differences between types and competitive levels of sport might warrant targeted concussion education and awareness programs. With public health awareness and discussion surrounding concussion in predominantly contact sports and elite athletes, we hypothesized that students who played contact sports (irrespective of team or individual) would be more likely to agree with statements regarding taking risks with concussion, compared to those participating in non-contact team or individual sports. We also hypothesized that riskier attitudes would be seen in those who played at a higher level (i.e. elite) compared to those at non-elite levels (i.e. recreational).

METHODS

Participants

The sample consisted of 294 students (male, $n = 208$; female, $n = 86$; mean age 22 ± 5.2 years) enrolled in university courses under the broad spectrum of exercise science and sport studies (including physical and health education, exercise physiology, exercise rehabilitation, sports science, sports coaching and sports administration). Students were invited to participate in the anonymous survey following general announcements across student workshops and seminars, lectures, and tutorial classes. No incentive was provided to participants. All study protocols and the survey instrument were approved by the University Human Research Ethics committees and conducted in accordance with the ethical principles of the Declaration of Helsinki.

Protocol

Developed by the investigators from previous research (10), the survey consisted of 10 closed questions using a Likert-scale (Table 1). Employing previous methods (31, 34) test-retest agreement of the survey was assessed with 65 university students who were undertaking a variety of unrelated courses. These participants completed the survey instrument twice, with questions in randomized order, at least 60 minutes apart. The agreement across all attitude items used on the questionnaires ranged from 0.73 to 0.91. Mean difference between Likert-scale attitude questions was less than 0.22 (maximum score for each question = 5). Cronbach α

was calculated for attitude constructs ($\alpha = 0.77$) and perception constructs ($\alpha = 0.81$) on the survey instrument.

Prior to the main survey, participants were asked to complete general demographic questions that did not identify themselves, such as gender and age, as well as listing the sport the participant played *the most*, and indicating the *highest* level of competition they played at. The students then responded to a series of statements about their personal attitudes and beliefs towards concussion using a 5-point Likert-scale for their agreement towards various statements, ranging from 1 (“*always*”) to 5 (“*never*”). The statements explored their attitudes towards playing with a concussion and expectation of rehabilitation before returning to play, level of admiration for elite athletes who play on after a head knock and the media presentation of such events.

Table 1. Statements and scale of agreement/disagreement by students sampled.

	Always	Often	Sometimes	Rarely	Never
I believe that it is safe to play or train with concussion	1	2	3	4	5
I would risk playing or training with a concussion if I thought my chances of being selected to compete would be affected	1	2	3	4	5
Players who continue to play or train with a concussion are likely to suffer problems later in life	1	2	3	4	5
I believe that players should be fully rehabilitated before returning to play or train again after they have suffered a concussion	1	2	3	4	5
I admire elite athletes who continue to play or train when they are concussed	1	2	3	4	5
The media (television, newspapers, radio) glorify elite athletes when they continue to play with a concussion	1	2	3	4	5
<i>I would be willing to play or train with a concussion if:</i>					
I didn't feel any symptoms (i.e. dizzy etc.)	1	2	3	4	5
I felt dizzy but know within myself I'm okay	1	2	3	4	5
I felt dazed but can't let my team mates down	1	2	3	4	5
I was knocked out but came to before the end of the game	1	2	3	4	5

Statistical Analysis

The primary sport played by the individual was categorized into one of four main groupings: team contact sports (e.g. football codes), team non-contact sports (e.g. volleyball or rowing), individual contact sports (e.g. boxing or martial arts), or individual non-contact sports (e.g.

racquet sports). The level of participation at which the participant reported they played at was categorized into one of three main groupings: elite (e.g. international/national competitions), regional (e.g. state league, but did not play at national levels), recreational (e.g. intracub or social club league but did not represent at state levels), or no competitive sports participation (e.g. non-competitive weight lifting).

Data from returned surveys was entered into, and analyzed, using SPSS V24 (SPSS Inc, USA). Comparison of the number of self-reported concussions by primary sport played and the level of sport participated at were conducted using one-way ANOVA with Bonferonni post-hoc tests. Shapiro-Wilk tests were conducted to screen for normal distribution of the dependent variables. The data was not normally distributed ($SW = 0.547$ to 0.913 ; $p < 0.001$). Transformation of the data showed a non-normal distribution ($SW = 0.418$ to 0.532 ; $p < 0.05$), Kruskal-Wallis tests, with Bonferonni post hoc comparisons, were conducted to evaluate differences between students' beliefs and attitudes towards concussions with the type, and the level, of sport participated. Spearman's rank correlations were used to determine relationships between the primary sport played, the level of sport participated at, and the number of self-reported concussions experienced on beliefs and attitudes. Alpha was set at $p < 0.05$.

RESULTS

Descriptive data and correlations between variables: From 400 initial surveys, two hundred and ninety four anonymous responses were returned to the investigators (response rate of 73.5%). Students participated across a range of sports (four categories, figure 1a) and various levels of competition (three categories, figure 1b). The primary sport for the majority of students ($n = 159$; 54.1%) was 'team contact', whilst individual contact sports were the least reported ($n = 8$; 2.7%). The majority of students participated at a recreational level ($n = 156$), whereas 6.5% ($n = 19$) did not participate in organized sports. Those who responded that they did not participate in organized sports were not included in the statistical analyses.

A majority of participants did not report experiencing a concussion ($n = 182$; 66.3%) whilst 33.7% ($n = 93$) of the cohort reported sustaining one or more concussions playing sport (mean 2.5 ± 1.9 concussions). Team contact sports had the highest percentage (42.8%) of participants reporting a previous concussion ($n = 118$, figure 2a) with an average of $2.7 (\pm 1.9)$ concussions (figure 2b). With the level of sport participated at (figure 3a), elite athletes had the highest reported concussion history ($n = 94$; 34.1%), reporting an average of $2.3 (\pm 1.9)$ previous concussions. State/regional athletes reported a history of concussion (33.1%; $n = 91$) of with an average of $2.2 (\pm 1.6)$ previous concussions. Recreational sport participants (32.8%; $n = 90$) reported an average of $2.8 (\pm 2.1)$ previous concussions (figure 3 b). The number of self-reported concussions across the type of sport was significant ($F_{3,293} = 8.40$, $p < 0.001$) with students in team contact sports self-reporting a significantly greater number of concussions than team non-contact sports ($p < 0.001$). No other significant differences were observed. Conversely there were no significant differences in the number of self-reported concussions across the level of sport participated ($F_{3,293} = 1.86$, $p = 0.117$).

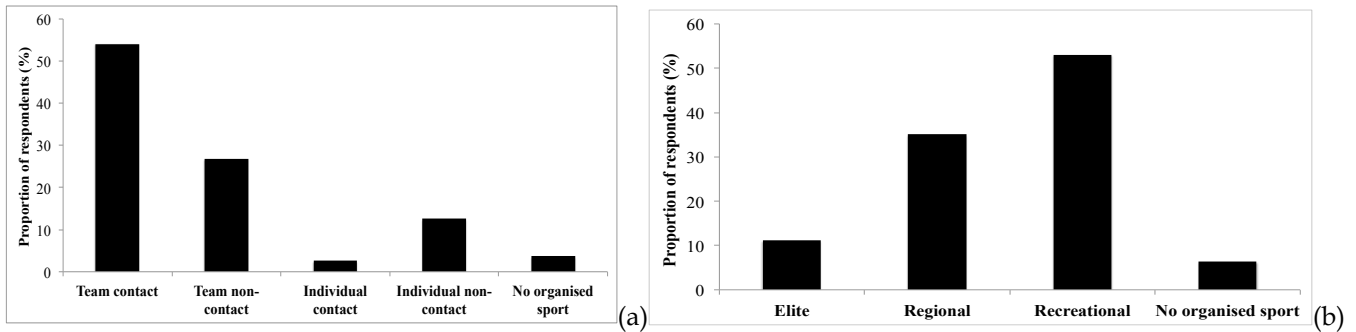


Figure 1a and b. Type of sport (a) and level of sport (b) played, as reported by students.

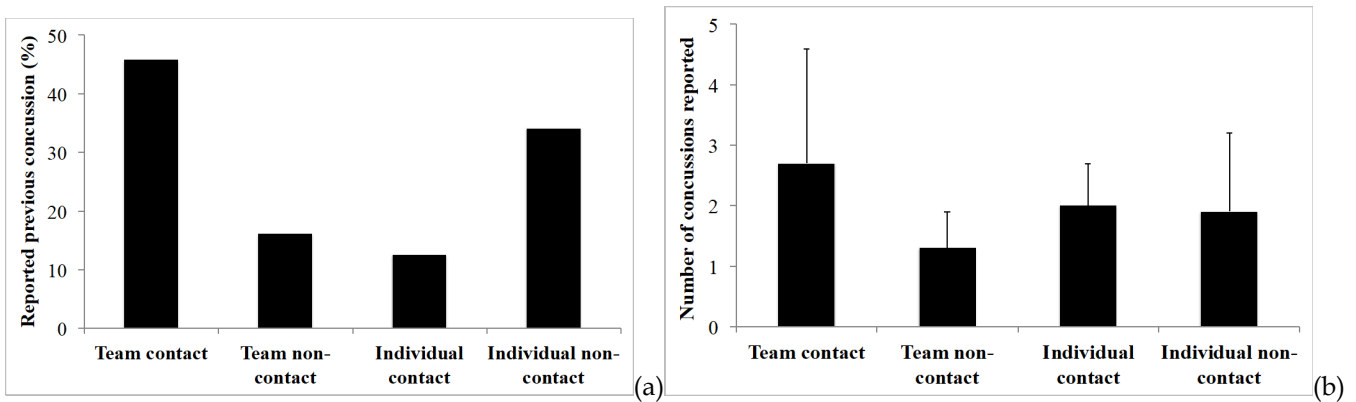


Figure 2 a and b. Percentage reporting concussion by type of sport (a) and the mean (\pm SD) number of concussions by type of sport (b), as reported by students who had reported a previous concussion.

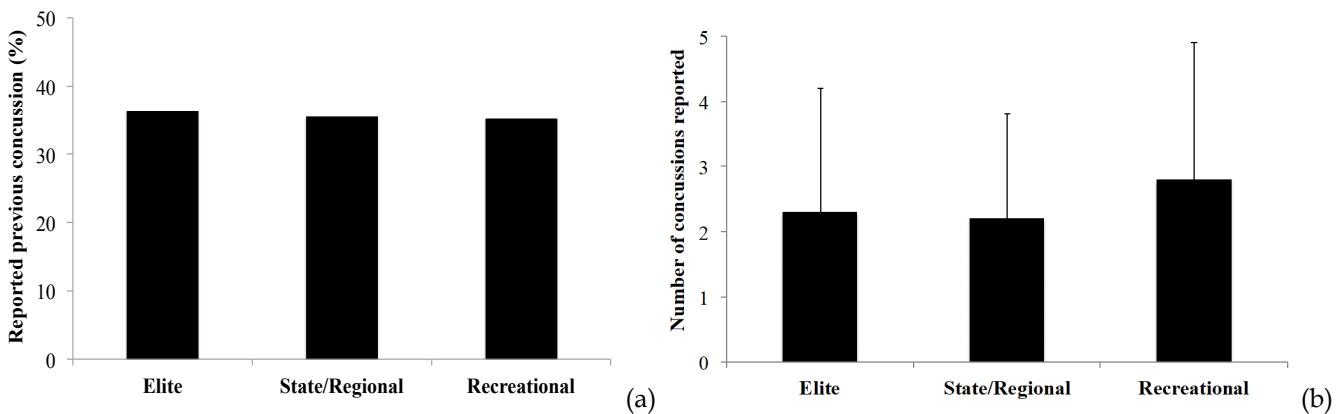


Figure 3 a and b. Percentage reporting concussion by level of sport played at (a) and the mean (\pm SD) number of concussions by level of sport (b), as reported by students.

Type of sport and attitudes towards concussion: There were significant differences in groups who had reported a previous concussion ($\chi^2 (3) = 21.89, p < 0.001$, fig 2a). Post hoc comparisons revealed a greater reporting of concussions were observed in team contact versus team non-contact ($U = 4670.5, p < 0.001, r = 0.33$) and individual contact ($U = 571.5, p = 0.042, r = 0.18$). Significant differences were also found with the number of reported concussions between types of sports ($\chi^2 (3) = 10.03, p = 0.018$; fig 2b). However, comparisons revealed that the only significant difference observed was between team contact and team non-contact sports ($U = 247.5, p = 0.004, r = 0.28$).

Table 2 illustrates the percentage of students who *agreed* or *strongly agreed* with statements presented to them in the survey. Significant differences were found between the type of sport played and beliefs towards playing or training whilst still suffering signs and symptoms of concussion ($\chi^2(3) = 13.26, p = 0.009$). Comparison between the groups showed that those who participated in team contact sports reported a stronger agreement with the statement that it was 'safe to play with a concussion' compared to students who participated in individual non-contact sports ($U = 2478.50, p = 0.003, r = 0.21$). Significant differences were also found when students were asked about risking playing with a concussion if their chances of being selected to compete would be affected ($\chi^2(3) = 11.05, p = 0.02$). Group comparisons revealed that participants in team contact and non-contact ($U = 2351.00, p = 0.003, r = 0.21$; $U = 1534.60, p < 0.001, r = 0.32$ respectively), and individual contact sports ($U = 103.50, p < 0.001, r = 0.49$) reported taking a greater risk than students who participated in individual non-contact sports.

Table 2. Percentage agreement with statements by students across types of sports.

Item	Type of sport played – agreement with statement (%)			
	Team contact (n = 164)	Team non-contact (n = 81)	Individual contact (n= 8)	Individual non-contact (n= 41)
It is safe to play or train with concussion	2.4	0.0	0.0	2.4
I would risk playing or training with a concussion for selection	26.8	34.6	37.5	7.3
Those who play on with a concussion likely to suffer problems later in life	45.7	39.5	50	58.5
Believe in rehabilitated before returning to play or train again	71.3	72.8	62.5	95.1
Admiration of elite athletes with concussion	29.3	13.6	50.0	1.2
Media glorify concussion	42.1	45.7	75.0	21.0
<i>I would be willing to play or train with a concussion if:</i>				
No symptoms	64.6	49.4	37.5	12.3
Felt dizzy but okay	36.6	21.0	25.0	3.7
Felt dazed but didn't want to let teammates down	33.5	22.2	37.5	4.9
Knocked out but came to	16.5	8.6	25.0	1.2

Whilst there were no significant differences between the groups for attitudes towards multiple concussions contributing to 'problems later in life' ($\chi^2(3) = 1.281, p = 0.865$), significant group differences were observed for 'admiration of elite athletes who continued to play following a concussion' ($\chi^2(3) = 29.18, p < 0.001$). Students who participated in team contact sports reported greater admiration than students who participated in team non-contact sports ($U = 4901.50, p < 0.001, r = 0.22$), as well as individual non-contact sports ($U = 2058.00, p < 0.001, r = 0.28$). In addition, students who participated in individual contact sports reported more admiration than students who participated in individual non-contact sports ($U = 61.50, p = 0.004, r = 0.41$).

In students who had reported a concussion, there were significant correlations in the primary sport played and responses to a majority of the questions. Significant correlations were observed between contact sport athletes and a willingness to continue to play with a concussion ($\rho = 0.21$; $p < 0.001$), would risk playing or training for selection ($\rho = 0.16$; $p = 0.006$), admiring athletes with concussion ($\rho = 0.26$; $p < 0.001$), and willing to play on if no symptoms, dizzy but okay, not letting team mates down and if knocked out ($\rho = 0.27$; $p < 0.001$; $\rho = 0.29$; $p < 0.001$; $\rho = 0.31$; $p < 0.001$; $\rho = 0.25$; $p < 0.001$ respectively). Conversely, correlations were found with non-contact sport athletes and athletes being fully rehabilitated before returning to play ($\rho = 0.23$; $p < 0.001$).

Significant differences were found when students were asked about continuing to play or train if they 'didn't feel any symptoms' ($\chi^2(3) = 23.44$, $p < 0.001$), with students who participated in team contact sports more willing to play than students who participated in individual non-contact sports ($U = 1772.50$, $p < 0.001$, $r = 0.31$). Continuing to play or train if they were 'dizzy but thought that they were ok' also showed significant differences ($\chi^2(3) = 29.38$, $p < 0.001$), with students who participated in team contact sports more willing to play than students who participated in team non-contact sports ($U = 4750.50$, $p = 0.001$, $r = 0.22$), and also those from individual non-contact sports ($U = 1676.50$, $p < 0.001$, $r = 0.33$). Further, significant differences were found when asked 'if they would be willing to play or train when they felt dazed but were afraid to let their team mates down' ($\chi^2(3) = 35.31$, $p < 0.001$). Students who participated in team contact sports were more willing to play than students who participated in team non-contact sports ($U = 4747.00$, $p = 0.001$, $r = 0.22$), and also students who participated in individual non-contact sports ($U = 1567.00$, $p < 0.001$, $r = 0.36$). When asked if they were willing to continue to play if they were 'knocked out but came to' before the end of the game showed significant differences ($\chi^2(3) = 25.17$, $p = 0.01$) with students who participated in team contact sports more in agreement with the statement, than students who participated in team non-contact sports ($U = 4848.00$, $p = 0.002$, $r = 0.20$), and also students who participated in individual non-contact sports ($U = 1974.00$, $p < 0.001$, $r = 0.27$).

Significant differences were found when students were asked if individuals should be fully rehabilitated before returning to play or training after they have suffered a concussion ($\chi^2(3) = 25.16$, $p < 0.001$). Students who participated in individual non-contact sports reported greater agreement of completing full rehabilitation before returning to training or playing than students who participated in team contact sports ($U = 1975.50$, $p < 0.001$, $r = 0.31$) and team non-contact sports ($U = 1044.50$, $p < 0.001$, $r = 0.33$).

Participation level and attitudes towards concussion: Across level of participation (table 3), no significant differences were observed in the reporting of concussions between levels of participation ($\chi^2(2) = 0.014$, $p = 0.990$). Comparisons between levels revealed no significant differences in the number of concussions reported between groups ($\chi^2(2) = 1.87$, $p = 0.392$).

A significant correlation was found in students who had sustained a concussion and level of play were regional level athletes and agreeing that those with multiple concussions would be

more likely to suffer later in life ($\rho = 0.15$; $p = 0.008$). No other significant correlations were observed.

Table 3. Percentage agreement with statements by students across level of sports competition.

Item	Type of sport played – agreement with statement (%)		
	Elite (n = 35)	State/regional (n = 103)	Recreational (n= 156)
It is safe to play or train with concussion	1.0	0.9	1.3
I would risk playing or training with a concussion for selection	27.3	20.4	21.8
Those who play on with a concussion likely to suffer problems later in life	38.4	38.8	34.6
Believe in rehabilitated before returning to play or train again	84.8	75.7	72.4
Admiration of elite athletes with concussion	18.2	14.6	26.3
Media glorify concussion	48.5	42.7	42.3
<i>I would be willing to play or train with a concussion if:</i>			
No symptoms	51.5	54.4	55.1
Felt dizzy but okay	27.3	22.3	32.1
Felt dazed but didn't want to let teammates down	36.4	24.3	27.6
Knocked out but came to	9.1	12.6	12.8

DISCUSSION

Extending the study by Pearce, Young, Parrington and Aimers (31) which showed differences between female and male exercise science students, and previous experiences of concussion on current beliefs and attitudes, this study explored whether the type of sport played and the level of sport participated at influenced differences in beliefs and attitudes towards sports concussion. Team contact sport athletes reported having the most experience of concussion injuries and the number of concussions, compared to team non-contact athletes; however, the reporting of concussions and the number of concussions did not differ across the level of participation. Our first hypothesis only found that students who played team contact sports differed to students who played individual non-contact sports in their beliefs and attitudes. Despite this, in those who self-reported having a previous concussion(s), correlations were observed between the type of sport played and agreement to statements implying risk of playing. However, the level of competitive participation (hypothesis two) did not influence attitudes across the range of questions relating to sports concussion. Similarly, in those who had a previous concussion injury there were no correlations to the level of participation, other than recreational athletes agreeing on potential long-term outcomes of multiple concussions. this study explored in exercise science students, whether the type of sport played, and the level of sport participated at influenced differences in beliefs and attitudes towards sports concussion. Contrary to our first hypotheses we found that, other than students who played team contact sports compared to students who played individual non-contact sports, beliefs and attitudes were overall similar towards sports related concussion. Likewise, the level of competitive participation (hypothesis two) did not influence attitudes across the range of questions relating to sports concussion.

Our finding of similar attitudes towards sports concussion between the types of sport, other than team contact sports versus non-contact sports played, was surprising. We hypothesized that those who played team contact sports would differ across all questions compared to team non-contact sports, as well as individual sports, based upon planned behavior theory (1). As argued originally by Ajzen (1), and more recently by Kroshus, Baugh, Daneshvar and Viswanath (16) and Register-Mihalik, Linnan, Marshall, McLeod, Mueller and Guskiewicz (35), planned behavior theory predicts that previous occurrences, in this case injuries from tackling, bumping and other contact experienced in contact team sports as opposed to minimal contact in non-contact team sports, would influence current attitudes towards concussion. However, while we found that concussion injuries were significantly higher in team contact sports to other types of sports (table 2), other than differences in attitudes towards playing with a concussion based on the severity of the injury (table 3) no differences, other than between team contact and individual non-contact sports, were observed in attitudes. We are unsure why similarities in attitudes were found in the majority of the questions, other than between attitudes to continue playing based on perceived severity of injury. Indeed, it may be the experience of more severe injury driving differences in attitudes, as anecdotally, it is accepted that non-contact sports are not completely injury free and accidental contact, resulting in injury, may occur (9). Further, as we only enquired in students about their primary sports experiences, it could be considered that students who play more than one sport (with their other sports being a contact sport) may be drawing their current attitudes from previous experiences of other sports participation, rather than their primary sport.

We can only speculate on similarities in attitudes, and suggest that in team sports the issue of taking additional risks, especially in light of team selection, or losing playing time, may be an issue driving attitudes irrespective of whether the sport played is considered 'contact' or 'non-contact' (14, 34, 35, 39) Stemming from the physicality associated with sports generally, and to prove their worth and to deserve selection to play (27) the mentality within team sports, but also with wider societal expectations, is one of being physically 'committed' (i.e. to always show they are ready to compete, or to not back away from a physical contest), or to have a 'warrior mentality'. This also manifests as a willingness of athletes to knowingly, or sometimes unknowingly, play with an injury risking greater pain, and more serious injury, that possibly results in long-term incapacity (8, 27). Limited studies have previously shown that the type of sport (contact versus non-contact, team versus individual) did not influence differences in attitudes to injuries (27), and recent studies have continued to support this finding. For example, Chrisman, Quitiquit and Rivara (7) found that college/varsity athletes, irrespective of sport, will hesitate reporting their injury, particularly if there was no significant pain or observable disability. It has been suggested that this attitude may be not only driven by a fear of losing a scholarship at their institution, or to be seen as letting their team-mates down, but also as a sign of 'commitment' to the team and/or sport (19, 34). Therefore, we felt it was important to address this question in light of the population sampled being university students, well versed in the issue of sports concussion but were not scholarship-supported students representing their university. Whilst we did not need to find out about considerations of scholarship in this study (19), our findings of differences between the type of sport on beliefs and attitudes towards concussion supports previous data, particularly with issues of

letting team-mates down (34). Given the limitations of using a questionnaire approach in this study, further studies, using more in-depth interview approach are required to determine the current attitudes in student populations towards concussion injuries irrespective of the type of sport played as well as the growing public awareness of the issue not reflected in this cohort.

Similarly, we were surprised to not observe differences when exploring the level of competition played at. Generally speaking, elite athletes are held to 'higher standards' across a variety of aspects of their competitive, and personal, lives (13). These 'higher standards' may also be applied towards concussion at the elite level due to disparities in medical staffing and resources between elite, sub-elite and non-elite (recreational or community) sport levels (32), rationalizing our hypothesis towards differences in attitudes with regards to levels of participation in our cohort surveyed. However, in explaining the similarities in attitudes across levels of sport participated at, it has been suggested that regardless of the level of sport they play, athletes will generally express 'toughness' or 'commitment' as evidence towards team/sport dedication, and will play, or be pressured to play, through pain and some injuries (27). The traditional perspective has suggested that elite athletes differ in 'toughness', and therefore underpins their sporting success, separating them from sub-elite athletes or non-elite players (17, 18). There have been limited studies comparing the 'competitive mindset' that may distinguish differences between elite and sub-elite athletes (11, 40). However, the data has not supported this traditional view, with equivocal findings (6, 26, 40). For example, a number of studies have presented key elements of 'toughness' studied only in elite athlete cohorts include attitudes towards injury (5, 10, 12, 38). However, in mixed elite/non-elite cohort studies Chartrand, Jowdy and Danish (6) was not able to distinguish differences in psychological mindsets of toughness between elite and non-elite collegiate athletes from a range of sports. Further, Meyers, Bourgeois, LeUnes and Murray (26) found that apart from two subsets, there were no differences in the competitive mindsets between elite and sub-elite equestrian riders. As with the findings from this study, similar attitudes across the three levels of participation towards concussion may represent the robust 'toughness' mindset of our cohort of exercise science students who compete at all levels, irrespective of the requirements for training and competition. Although caution is required in directly comparing elite versus sub-elite rates of concussion (4) and also self-reporting of concussion experiences (30) due to sampling method limitations, similarities appear to exist in concussion rates irrespective of level played. Therefore, previous experiences of those who have previously experienced concussions, irrespective of level played, may also shape their attitudes as demonstrated in this study (1, 16, 35).

In light of the specific questions explored there are some limitations in this investigation. Although our response rate was high (73.5% of the student cohort), fulfilling criteria set out in recommendations by Babbie (2) and Singleton and Straights (37), this may be due to the cohort surveyed being particularly interested in the topic given the focus of their studies. Whilst this may in itself demonstrate bias, the question posed was specific to an exercise science cohort rather than a reflection of the wider non-sporting community. Therefore, caution is required in generalizing these findings to the wider population.

Our study, extending on previous work which identified differences in attitudes between females and males, as well as previous experiences driving current attitudes (31), aimed to compare attitudes in exercise science students who play different types of sport, and at various competitive levels. We expected the rate of concussions reported in those who identified as individual non-contact sport players to be similar to those who played team non-contact sports. However, we did not examine if concussions were experienced during their primary sport or from either a second (or third) sport played, or from non-sporting activity. Despite this, significant differences were found in attitudes between these two types of sports were not consistent with predictions from the theory of planned behavior (in other words, the concussions experienced in individual non-contact sports did not drive the same attitudes). As concussion rates in individual non-contact sports is very low (29), future research should expand on those who identify as individual sport participants, to ensure that their concussion experience was specifically from their primary sport. Therefore, the descriptive data presented on concussion in individual non-contact sports in this study should be viewed with caution.

It is important to note that despite surveying exercise science students who are becoming more aware of sports concussion injury, we did not provide the definition of concussion based upon the 2012 consensus statement (24), as at time of data collection the 2016 statement was not released (23); nor did we ascertain students' knowledge about concussion. Quantifying respondents' concussion knowledge using a modified survey previously developed by Rosenbaum and Arnett (36) for a university level cohort would be appropriate to associate with beliefs and attitudes in future studies. Whilst we did not find differences in attitudes between different levels of participation, it would be important to investigate whether students who participate at higher levels of sport know the definition of concussion, and/or have a greater general understanding of concussion, given that elite athletes usually have trained healthcare providers present during training and competition (32). Similarly, with regards to questions pertaining to "willing to play" attitudes (table 1), as concussion is heterogeneous in nature and individuals can experience a range of symptoms, this may influence their motivation to continue to play or train. Because different symptoms and different motivations are used, it makes attitudes towards willing to continue difficult to compare and the data, therefore, should be viewed with caution. Future studies may need to explore this question from a qualitative perspective. Finally, further research not addressed in this study also points to the need to the need for exploration of support structures associated with concussion management for athletes playing at various levels, as well as knowledge and attitudes of elite and club coaches, and support staff, at all levels.

In conclusion this study in exercise science students specifically explored questions regarding the influence of the type of sport played, and the level of sport competed at, on attitudes and beliefs towards concussion. Contrary to our hypotheses we found, other than team-contact and individual non-contact sports, there were no differences in student beliefs and attitudes between the type of sport played, and the level of sport played at. Whilst our hypotheses were not confirmed, the findings do provide important on understanding the attitudes of concussion in those who not just play contact sports but also non-contact sports, at all levels of

competition. This understanding is useful in tailoring concussion education and awareness programs that can be relatable to all stakeholders in sport.

ACKNOWLEDGMENTS

No funding was provided for this study. The authors would like to thank Dr N Aimers and Dr L Parrington for their assistance with statistical analyses. AJP is supported by funding from Impact Technologies Inc. (Australia) and Smart Head Play charity (Australia). He has previously received funding support from Samsung Corporation and the Australian Football League.

REFERENCES

1. Ajzen I. The theory of planned behavior. *Organ Behav Hum Decis Process* 50(2):179-211, 1991.
2. Babbie ER. *The practice of social research*. Wadsworth Publishing Company; 1989.
3. Baker J, Devitt B, Green J, McCarthy C. Concussion among under 20 rugby union players in Ireland: incidence, attitudes and knowledge. *Irish J Med Sci* 182(1):121-125, 2013.
4. Braham R, Finch CF, McCrory P. The incidence of head/neck/orofacial injuries in non-elite Australian football. *J Sci Med Sport* 7(4):451-453, 2004.
5. Bull SJ, Shambrook CJ, James W, Brooks JE. Towards an understanding of mental toughness in elite English cricketers. *J Appl Sport Psychol* 17(3):209-227, 2005.
6. Chartrand JM, Jowdy DP, Danish SJ. The psychological skills inventory for sports: Psychometric characteristics and applied implications. *J Sport Exerc Psychol* 14:405-413, 1992.
7. Chrisman SP, Quitiquit C, Rivara FP. Qualitative study of barriers to concussive symptom reporting in high school athletics. *J Adolesc Health* 52(3):330-335, 2013.
8. Curry TJ, Strauss RH. *A Little Pain Never Hurt Anybody: A Photo-Essay on the Normalization of Sport Injuries*. *Sociol Sport J* 11(2)1994.
9. Echlin PS, Upshur RE, Peck D, Skopelja E. Craniomaxillofacial injury in sport: a review of prevention research. *Br J Sports Med* 39(5):254-263, 2005.
10. Gucciardi DF, Gordon S, Dimmock JA. Towards an understanding of mental toughness in Australian football. *J Appl Sport Psychol* 20(3):261-281, 2008.
11. Gucciardi DF, Gordon S, Dimmock JA. Advancing mental toughness research and theory using personal construct psychology. *Int Rev Sport Exerc Psychol* 2(1):54-72, 2009.
12. Jones G, Hanton S, Connaughton D. What is this thing called mental toughness? An investigation of elite sport performers. *J Appl Sport Psychol* 14(3):205-218, 2002.
13. Jonson P. Why are athletes alone held to higher standards? In. ABC News 2015.
14. Kaut KP, DePompei R, Kerr J, Congeni J. Reports of head injury and symptom knowledge among college athletes: implications for assessment and educational intervention. *Clin J Sport Med* 13(4):213-221, 2003.

15. Kearney PE, See J. Misunderstandings of concussion within a youth rugby population. *J Sci Med Sport* 20(11): 981-985, 2017.
16. Kroshus E, Baugh CM, Daneshvar DH, Viswanath K. Understanding concussion reporting using a model based on the theory of planned behavior. *J Adolesc Health* 54(3):269-274, 2014.
17. Loehr JE. Athletic excellence. In *Proceedings of the Mental toughness training for sport*. 1982: USA.
18. Loehr JE. *Mental toughness training for sports: Achieving athletic excellence*. Penguin Books; 1986.
19. Malinauskas R. College athletes' perceptions of social support provided by their coach before injury and after it. *J Sports Med Phys Fitness* 48(1):107-112, 2008.
20. Martin RK, Hrubeniuk TJ, Witiw CD, MacDonald P, Leiter J. Concussions in community-level rugby: Risk, knowledge, and attitudes. *Sports Health* 1941738117695777, 2017.
21. McCrea M, Hammeke T, Olsen G, Leo P, Guskiewicz K. Unreported concussion in high school football players: implications for prevention. *Clin J Sport Med* 14(1):13-17, 2004.
22. McCrory P. Future advances and areas of future focus in the treatment of sport-related concussion. *Clin J Sport Med* 30(1):201-208, 2011.
23. McCrory P, Meeuwisse W, Dvorak J, Aubry M, Bailes J, Broglio S, Cantu RC, Cassidy D, Echemendia RJ, Castellani RJ, Davis GA, Ellenbogen R, Emery C, Engebretsen L, Feddermann-Demont N, Giza CC, Guskiewicz KM, Herring S, Iverson GL, Johnston KM, Kissick J, Kutcher J, Leddy JJ, Maddocks D, Makdissi M, Manley G, McCrea M, Meehan WP, Nagahiro S, Patricios J, Putukian M, Schneider KJ, Sills A, Tator CH, Turner M, Vos PE. Consensus statement on concussion in sport – the 5th international conference on concussion in sport held in Berlin, October 2016. *Br J Sports Med* 51:838-847, 2017.
24. McCrory P, Meeuwisse WH, Aubry M, Cantu B, Dvořák J, Echemendia RJ, Engebretsen L, Johnston K, Kutcher JS, Raftery M, Sills A, Benson BW, Davis GA, Ellenbogen RG, Guskiewicz K, Herring SA, Iverson GL, Jordan BD, Kissick J, McCrea M, McIntosh AS, Maddocks D, Makdissi M, Purcell L, Putukian M, Schneider K, Tator CH, Turner M. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012. *Br J Sports Med* 47(5):250-258, 2013.
25. McKee AC, Daneshvar DH, Alvarez VE, Stein TD. The neuropathology of sport. *Acta Neuropathologica* 127(1):29-51, 2014.
26. Meyers M, Bourgeois A, LeUnes A, Murray N. Mood and psychological skills of elite and sub-elite equestrian athletes. *J Sport Behav* 22(3):399, 1999.
27. Nixon HL. Explaining pain and injury attitudes and experiences in sport in terms of gender, race, and sports status factors. *J Sport Soc Iss* 20(1):33-44, 1996.
28. Nordström A, Nordström P, Ekstrand J. Sports-related concussion increases the risk of subsequent injury by about 50% in elite male football players. *Br J Sports Med* 48(19):1447-1450, 2014.
29. Pearce A, Young J. Hard knocks: Concussion injuries in tennis. *ITF Coach Sports Sci Rev* 70:5-7, 2016.
30. Pearce AJ, Hoy K, Rogers MA, Corp DT, Maller JJ, Drury HG, Fitzgerald PB. The long-term effects of sports concussion on retired Australian football players: A study using transcranial magnetic stimulation. *J Neurotrauma* 31(3):1139-1145, 2014.

31. Pearce AJ, Young JA, Parrington L, Aimers N. Do as I say: Contradicting beliefs and attitudes towards sports concussion in Australia. . *J Sports Sci* 35(19):1911-1919, 2017.
32. Putukian M, Aubry M, McCrory P. Return to play after sports concussion in elite and non-elite athletes? *Br J Sports Med* 43(Suppl 1):i28-i31, 2009.
33. Raftery M. Concussion and chronic traumatic encephalopathy: International Rugby Board's response. *Br J Sports Med* 48(2):79-80, 2014.
34. Register-Mihalik JK, Guskiewicz KM, McLeod T, Linnan LA, Mueller FO, Marshall SW. Knowledge, attitude, and concussion-reporting behaviors among high school athletes: a preliminary study. *J Athl Train* 48(5):645-653, 2013.
35. Register-Mihalik JK, Linnan LA, Marshall SW, McLeod TCV, Mueller FO, Guskiewicz KM. Using theory to understand high school aged athletes' intentions to report sport-related concussion: implications for concussion education initiatives. *Brain Inj* 27(7-8):878-886, 2013.
36. Rosenbaum AM, Arnett PA. The development of a survey to examine knowledge about and attitudes toward concussion in high-school students. *J Clin Exp Neuropsychol* 32(1):44-55, 2010.
37. Singleton Jr R, Straits BC, Straits MM, McAllister RJ. Approaches to social research. Oxford University Press; 1988.
38. Thelwell R, Weston N, Greenlees I. Defining and understanding mental toughness within soccer. *J Appl Sport Psychol* 17(4):326-332, 2005.
39. Torres DM, Galetta KM, Phillips HW, Dziemianowicz EMS, Wilson JA, Dorman ES, Laudano E, Galetta SL, Balcer LJ. Sports-related concussion: Anonymous survey of a collegiate cohort. *Neurol Clin Pract* 3(4):279-287, 2013.
40. Young JA, Pearce AJ. Understanding, developing and maintaining mental toughness in tennis. *Med Sci Tennis* 16(2):18-22, 2011.

