

Manuscript version: Author's Accepted Manuscript

The version presented in WRAP is the author's accepted manuscript and may differ from the published version or Version of Record.

Persistent WRAP URL:

<http://wrap.warwick.ac.uk/155468>

How to cite:

Please refer to published version for the most recent bibliographic citation information. If a published version is known of, the repository item page linked to above, will contain details on accessing it.

Copyright and reuse:

The Warwick Research Archive Portal (WRAP) makes this work by researchers of the University of Warwick available open access under the following conditions.

Copyright © and all moral rights to the version of the paper presented here belong to the individual author(s) and/or other copyright owners. To the extent reasonable and practicable the material made available in WRAP has been checked for eligibility before being made available.

Copies of full items can be used for personal research or study, educational, or not-for-profit purposes without prior permission or charge. Provided that the authors, title and full bibliographic details are credited, a hyperlink and/or URL is given for the original metadata page and the content is not changed in any way.

Publisher's statement:

Please refer to the repository item page, publisher's statement section, for further information.

For more information, please contact the WRAP Team at: wrap@warwick.ac.uk.

The times are they a-changing? Evolving attitudes in Australian exercise science students' attitudes towards sports concussion.

Janet A. Young¹, Charlotte Ganderton², Adam J White³, John Batten⁴, Nathan Howarth^{3,5}, Calum Downie¹, Alan J. Pearce^{6*}

¹ First Year College, Victoria University, Melbourne, Australia

² Faculty of Health, Arts and Design, Department of Health Professions, Swinburne University, Melbourne, Australia

³ Faculty of Health and Life Sciences, Oxford Brookes University, Oxford, UK

⁴ School of Sport, Health and Community, The University of Winchester, Winchester, UK

⁵ Department of Mental Health and Wellbeing, Warwick Medical School, University of Warwick, Coventry, UK

⁶ College of Science, Health and Engineering, Department of Dietetics, Human Nutrition and Sport, La Trobe University, Melbourne, Australia

ARTICLE INFO

Received: not required

Accepted: not required

Online: not required

Keywords:

Mild brain injury

Student attitudes

Sports science

Behaviour

ABSTRACT

The issue of concussion in sport continues to be discussed widely in the community as current and retired players reveal personal experiences, and concerns, about the long-term sequelae of their concussive injuries. This is the first study to examine evolving attitudes and beliefs towards concussion in sport by comparing data in an Australian exercise science student cohort between 2015 and 2020. Using a repeated cross-sectional design 1,013 participants (2020 cohort: n = 751; 21.6 ± 7.1 years; 2015 cohort: n = 312; 22.0 ± 5.2 years) responded to statements about concussion: personal attitudes; the media's portrayal; elite athletes who continue to play concussed; if participants would continue to play on concussed; and on completing rehabilitation for concussion. Comparisons revealed statistically significant differences between cohorts across the majority of statements. Specifically, more progressive attitudes were found regarding the media presentation (glorification) of concussed athletes (decreased agreement of 14.7%, p < 0.001), admiration of concussed athletes who continued to play (decreased agreement of 10.5%, p < 0.001), and rehabilitation (increased agreement of 13%, p < 0.001). However, participants still presented attitudes of wishing to continue to train or play if they had a concussion for fear of letting team-mates down, or if the injury was not noticeable. While positive attitudes are evolving, more work is required, particularly as attitudes towards concussion still appear to be situation dependent.

1. Introduction

While the incidence of concussions continues to rise, awareness regarding the signs, symptoms and risks of concussion concurrently grows. Here, the increase in reported concussions might be a result of the increased media attention (White et al., 2020) featuring the premature retirement of elite athletes, as well as the long-term sequelae of older retired athletes. Following growing concerns about the pathophysiological and neuropathological changes in the brains of American Football players (Mez et al., 2017), Association Football (Grinberg et al., 2016), Rugby (Buckland et al., 2019), and Australian Football

players (Pearce et al., 2020), some national sporting organisations have also driven initiatives around education and concussion management. However, education alone has limited effectiveness on attitudinal changes. For example, a recent systematic review reported that knowledge improvements, and associated attitudinal responses, tend to return to baseline as time progresses following educational sessions (Conaghan, Daly, Pearce, King, & Ryan, 2020).

Conversely, public discussion, particularly through media framing of concussion, has the potential to influence public perceptions and attitudes over time (White et al., 2020). While

previous studies have suggested that ongoing media coverage may trivialize the injury (Kennard, McLellan, & McKinlay, 2018) supporting negative attitudes towards concussion this is not always the case. Recently the media have published articles about retired athletes' mental health relating to their head injuries. The media have also reported scientists calling out media presentation around the language of concussion (i.e., glorification and/or humour to diminish its seriousness), and changes in management of concussion rules to ensure athletes have improved recovery outcomes (see examples by Cherny, 2016; Belson, 2019; and Twomey, 2021). How this shapes attitudes and beliefs over time has yet to be examined.

The aim of this study was to explore changing attitudes towards concussion over time. Studies investigating attitudes towards concussion in 'student-athletes' at high schools, colleges and club athletes at elite and non-elite levels (Kraak, Coetzee, Kruger, Stewart, & van Vuuren, 2019; Register-Mihalik, Guskiewicz, et al., 2013) have traditionally only surveyed participants at a single timepoint. Therefore, it is difficult to know if changes in attitude towards concussion are evolving, particularly in light of the ongoing media discussion. In our previous study, with data collected in 2015 (Pearce, Young, Parrington, & Aimers, 2017) we assessed an exercise science cohort on their beliefs and attitudes towards concussion. Investigating an exercise science student cohort provided us with a sample who are learning and preparing to work with athletes, of all levels, as well as in allied health settings where students will be exposed to individuals who have been concussed. Moreover, exercise science students are generally active in regular competitive sport, so we would anticipate some to have the 'lived experience' of being concussed, which may also shape their attitudes. Finally, having subsequent university cohorts undertaking the same course content, allows us to reprise our questions to determine if any changes in attitudes have occurred towards concussion five years apart. With continuing mainstream media and wider discussion, for example in social media, regarding concussion in sport, we hypothesised that attitudes between the groups would differ; with data collected in a 2020 cohort having more positive progressive attitudes regarding concussion when compared to the 2015 cohort.

2. Methods

The combined sample consisted of 1,013 undergraduate students (2020 cohort: male, n = 495; female n = 256; mean age 21.6 ± 7.1 years; 2015 cohort: male, n = 217; female, n = 95; mean age 22.0 ± 5.2 years). All students were enrolled at the same two Australian Universities offering courses under the umbrella of exercise science. Students were invited to participate in the anonymous survey. No incentive was provided to participants. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and was approved by the University Human Research Ethics committees (HRE-16-237).

Replicating previous research (Pearce et al., 2017), the survey consisted of 17 closed questions (see Table 1). Demographic data between both groups are shown in Table 2.

Table 1. Survey questions Attitudes and beliefs towards concussion (Pearce et al., 2017).

Please circle the number that best represents what you believe, even if you have never sustained a concussion previously.

	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

Perceptions of support when/if concussed: Even if you have not received a concussion, circle the number that best represents what you think your coach/ administrators/ teammates would provide if you had sustained a concussion.

	Always	Often	Sometimes	Rarely	Never
My coach supports me to stop playing or training when I am concussed	1	2	3	4	5
The administration of my club supports me to stop playing or training when I am concussed	1	2	3	4	5
My teammates support me to stop playing or training when I am concussed	1	2	3	4	5
My family (parents, siblings, spouse, children) supports me to stop playing or training when I am concussed	1	2	3	4	5

Perceptions of first aid, medical follow up, rehabilitation following concussion: Even if you have not received a concussion, circle the number that you think best represents your club would provide if you had sustained a concussion.

	Always	Often	Sometimes	Rarely	Never
My club provides me with first aid support (e.g. sports trainers) when I am concussed	1	2	3	4	5
My club provides me with follow up medical support (e.g. doctor to examine me after the game and the following week) when I am concussed	1	2	3	4	5
The club assists me with my rehabilitation when I am concussed	1	2	3	4	5

Comparisons of attitudes were made between all participants over time (2020 vs. 2015 cohort). Further analyses were made between comparisons between those previously concussed and those not reporting concussions, over time.

Data was entered an Excel spreadsheet and analysed with SPSS v.26.0.0 (SPSS Inc., USA). A Shapiro-Wilk test for normal

distribution was conducted (2015: 0.547-0.913, $p < 0.001$; 2020: 0.426-0.914, $p < 0.001$). Transformation of the data showed that the data was still not normally distributed (2015: 0.605-0.877, $p < 0.001$; 2020: 0.465-0.874, $p < 0.001$). Therefore Mann-Whitney

U tests were conducted to evaluate differences between cohorts, except for proportion of participants experiencing a concussion which was assessed using Chi-square. Significance was set at $p < 0.05$.

Table 2. Demographic data for 2020 and 2015 cohorts.

Characteristic (# reporting)	Frequency (%) ^a	
	2020 (<i>n</i> = 751)	2015 ^b (<i>n</i> = 312)
Gender		
Male	495 (66.0)	217 (69.6)
Female	256 (34.0)	95 (30.4)
Primary sport played		
Team sport – contact	200 (26.6)	164 (52.6)
Team sport – non-contact	246 (32.8)	81 (26.0)
Individual sport – contact	28 (3.7)	8 (2.6)
Individual sport – non contact	161 (21.4)	41 (13.1)
No competitive sport (e.g. weights, recreational running/cycling/swimming)	116 (15.5)	18 (5.8)
Participation type of sport played		
Competitive (all levels)	635 (84.6)	136 (43.6)
Recreational non-competitive ^b /No competitive sport/physical activity	116 (15.4)	176 (56.4)
Self-reporting concussion		
Yes	318 (42.3)	105 (33.7)
No	432 (57.7)	207 (66.3)
Mean (±SD)/median number of reported concussions	2.4 (± 2.3)/2.0	2.5 (± 1.9)/2.0

Table 3. Percentages of agreement towards attitudinal and perception statements between 2020 (*n* = 751) and 2015 (*n* = 312) cohorts.

Attitude statement	Agreement with item		<i>U</i>	<i>p</i>	<i>M</i> _{rank}	
	2020	2015			2020	2015
I believe that it is safe to play or train with a concussion	0.7%	13.1%	100296.0	<0.001	550.4	477.9
I would risk playing or training with a concussion if I thought my chances of being selected to compete would be affected	17.1%	21.8%	96375.0	<0.001	552.6	465.9
Players who continue to play or train with a concussion are likely to suffer problems later in life	62.4%	45.8%	94204.5	<0.001	498.8	591.6
I believe that players should be fully rehabilitated before returning to play or train again after they have suffered a concussion	88.6%	75.6%	89320.0	<0.001	492.2	613.2
I admire elite athletes who continue to play or train when they are concussed	10.3%	20.8%	82881.0	<0.001	572.5	460.4
The media glorify elite athletes when they continue to play with a concussion	28.9%	43.6%	94673.5	<0.001	550.2	460.4
<i>I am willing to play or train with a concussion if:</i>						
I didn't feel any symptoms	47.5%	53.5%	100799.5	0.008	536.9	484.1
I felt symptoms but know within myself I'm okay	24.2%	27.5%	100847.5	0.008	536.5	483.6
I felt symptoms but can't let my team mates down	20.5%	26.9%	97242.5	0.001	540.7	471.8
I was knocked out but came to before the end of the game	8.3%	12.5%	90161.0	<0.001	549.0	449.6
<i>My coach</i> supports me to stop playing or training when I am concussed	88.7%	82.7%	101883.0	0.002	504.8	557.4

The <i>administration</i> of my club supports me to stop playing or training when I am concussed	89.8%	86.2%	107276.5	0.11	511.9	539.1
My <i>teammates</i> support me to stop playing or training when I am concussed	81.7%	73.1%	96799.0	<0.001	498.1	576.3
My <i>family</i> (parents, siblings, spouse/partner, children) supports me to stop playing or training when I am concussed	94.0%	88.8%	104338.0	0.001	508.7	553.1
My club/association provides me with <i>first aid</i> support (e.g. sports trainers) when I am concussed	88.3%	89.4%	111833.5	0.731	521.6	516.3
My club/association provides me with <i>follow up medical</i> support (e.g. doctor to examine me after the game and the following week) when I am concussed	66.9%	60.2%	107688.5	0.223	512.4	536.1
My club/association assists me with my <i>rehabilitation</i> when I am concussed	65.2%	60.3%	108674.0	0.347	513.5	531.9

Table 4. Percentages of agreement towards attitudinal and perception statements in participants reporting a concussion between 2020 (n=318) and 2015 (n=105)

Attitude statement	Agreement with item		U	p	M _{rank}	
	2020	2015			2020	2015
I believe that it is safe to play or train with a concussion	11.0%	18.1%	13828.5	0.002	221.0	184.7
I would risk playing or training with a concussion if I thought my chances of being selected to compete would be affected	21.7%	25.7%	14978.0	0.114	216.7	195.6
Players who continue to play or train with a concussion are likely to suffer problems later in life	59.4%	52.5%	15231.5	0.250	207.4	222.1
I believe that players should be fully rehabilitated before returning to play or train again after they have suffered a concussion	86.1%	68.6%	12938.0	<0.001	199.7	246.8
I admire elite athletes who continue to play or train when they are concussed	11.4%	21.8%	11711.5	<0.001	227.1	164.5
The media glorify elite athletes when they continue to play with a concussion	28.3%	45.7%	13193.0	0.002	281.1	187.8
<i>I am willing to play or train with a concussion if:</i>						
I didn't feel any symptoms	53.0%	61.7%	14127.0	0.023	218.1	187.8
I felt symptoms but know within myself I'm okay	30.6%	35.2%	14582.5	0.037	216.4	189.9
I felt symptoms but can't let my team mates down	25.7%	32.4%	13864.5	0.016	217.1	185.0
I was knocked out but came to before the end of the game	9.9%	17.3%	13695.0	0.006	217.9	184.2
My <i>coach</i> supports me to stop playing or training when I am concussed	86.7%	89.5%	16131.5	0.919	207.8	206.6
The <i>administration</i> of my club supports me to stop playing or training when I am concussed	89.3%	93.4%	15281.0	0.284	210.5	198.5
My <i>teammates</i> support me to stop playing or training when I am concussed	75.9%	67.7%	14463.5	0.058	202.5	226.2
My <i>family</i> (parents, siblings, spouse/partner, children) supports me to stop playing or training when I am concussed	93.6%	91.4%	15585.0	0.319	205.8	214.6
My club/association provides me with <i>first aid</i> support (e.g. sports trainers) when I am concussed	87.0%	91.4%	15804.5	0.623	208.8	203.5

My club/association provides me with <i>follow up medical</i> support (e.g. doctor to examine me after the game and the following week) when I am concussed	62.4%	54.3%	14930.0	0.200	203.3	219.8
My club/association assists me with my <i>rehabilitation</i> when I am concussed	59.9%	54.3%	15738.5	0.635	205.9	212.1

Table 5. Percentages of agreement towards attitudinal and perception statements in participants not reporting a concussion between 2020 (n=426) and 2015 (n=207).

Attitude statement	Agreement with item		U	p	M _{rank}	
	2020	2015			2020	2015
I believe that it is safe to play or train with a concussion	3.3%	10.6%	38358.5	<0.001	331.2	289.3
I would risk playing or training with a concussion if I thought my chances of being selected to compete would be affected	13.1%	19.9%	33653.0	<0.001	339.8	266.9
Players who continue to play or train with a concussion are likely to suffer problems later in life	64.5%	43.4%	33124.0	<0.001	290.9	366.4
I believe that players should be fully rehabilitated before returning to play or train again after they have suffered a concussion	90.4%	79.2%	33038.5	<0.001	291.1	370.4
I admire elite athletes who continue to play or train when they are concussed	9.7%	19.8%	31649.0	<0.001	346.2	256.9
The media glorify elite athletes when they continue to play with a concussion	29.5%	42.7%	36809.5	<0.001	331.7	282.2
<i>I am willing to play or train with a concussion if:</i>						
I didn't feel any symptoms	43.5%	51.3%	38210.5	0.026	320.7	282.0
I felt symptoms but know within myself I'm okay	18.3%	24.5%	37461.5	0.017	323.4	287.8
I felt symptoms but can't let my team mates down	16.8%	25.0%	36502.0	0.004	325.7	283.0
I was knocked out but came to before the end of the game	7.1%	10.5%	32968.5	<0.001	332.4	265.7
My <i>coach</i> supports me to stop playing or training when I am concussed	90.0%	79.6%	36281.5	<0.001	296.9	347.4
The <i>administration</i> of my club supports me to stop playing or training when I am concussed	90.2%	83.0%	38308.0	0.006	301.4	336.5
My <i>teammates</i> support me to stop playing or training when I am concussed	85.9%	75.8%	35505.0	<0.001	294.7	351.5
My <i>family</i> (parents, siblings, spouse/partner, children) supports me to stop playing or training when I am concussed	94.3%	87.4%	38949.5	0.002	303.5	336.5
My club/association provides me with <i>first aid</i> support (e.g. sports trainers) when I am concussed	89.2%	89.2%	42871.0	0.911	312.8	313.9
My club/association provides me with <i>follow up medical</i> support (e.g. doctor to examine me after the game and the following week) when I am concussed	70.2%	63.9%	42871.0	0.433	308.7	320.2
My club/association assists me with my <i>rehabilitation</i> when I am concussed	69.1%	64.4%	40492.5	0.241	306.4	323.5

3. Results

A greater proportion of participants in the 2020 cohort (see Table 2) reported experiencing a concussion when compared to

the 2015 cohort (42.3% versus 33.7% respectively, $\chi^2 = 7.16, p = 0.007$). However, the median number of concussions reported between groups were not different (2.0 and 2.0 concussions respectively).

3.1. Overall comparisons between cohorts

The percentage of participants that responded with agreement (by responding with 'always' or 'often') to the statements are presented in Table 3. The 2020 cohort was found to be less risk adverse with a 12.4% reduction in agreement to the statement regarding it is *safe to play or train with a concussion* ($U = 100296.0, p < 0.001$), alongside a 4.7% reduction in agreement to personally *risk playing or training with a concussion if I thought my chances of being selected to compete would be affected* than the 2015 cohort ($U = 96375.0, p < 0.001$). Similarly, the 2020 cohort reported increased (16.6%) concerns regarding players who continue to play with a concussion and possible (negative) long-term outcomes ($U = 94204.5, p < 0.001$), as well as 13% increase in reporting that players should be fully rehabilitated prior to returning to training and competition ($U = 89320.0, p < 0.001$). Conversely, the 2020 cohort showed significantly less (10.5%, $U = 82881.0, p < 0.001$) admiration for athletes who continued to play or train when concussed and less cynicism (14.7%, $U = 94673.5, p < 0.001$) about the media 'glorifying' athletes who play through a concussion.

Similarly, differences were found in the statements relating to playing with a concussion under different circumstances. For example, compared to the 2015 cohort the 2020 cohort were significantly less in agreement to play or train with a concussion if they didn't feel any symptoms (47.5% vs. 53.5% respectively, $U = 100799.5, p = 0.008$), felt symptoms but thought they were okay (24.2% vs. 27.5% respectively, $U = 100847.5, p = 0.008$), didn't want to let teammates down (20.5% vs. 26.9% respectively, $U = 97242.5, p = 0.001$), or were knocked out but came to (8.3% vs. 12.5% respectively, $U = 90161.0, p < 0.001$).

A higher percentage (88.7 vs. 82.7%) of participants felt that their coach would be more supportive when comparing the 2020 with the 2015 participants and this was significant ($U = 101883.0, p = 0.002$) (see Table 3). Similarly, the 2020 cohort believed their teammates ($U = 96799.0, p < 0.001$) and family would be more supportive when compared with the 2015 cohort (94.0% vs. 88.8% respectively, $U = 104338.0, p < 0.001$). However, differences were not identified between cohorts with regards to club/association administration, including first aid (88.3% vs. 89.4% respectively, $U = 111833.5, p = 0.731$), medical follow-up (66.9% vs. 60.2% respectively, $U = 107688.5, p = 0.223$), or rehabilitation support (65.2% vs. 60.3% respectively, $U = 108674.0, p = 0.347$).

3.2. Previously concussed

Attitudes of participants who indicated that they had previously experienced a concussion are presented in Table 4. There were significant improvements were found across a number of statements. For example, there was an 8.9% decrease in the 2020 compared to the 2015 groups in terms of their agreement with the statement that *it is safe to play or train with a concussion* (11.0% vs. 18.1% respectively, $U = 13828.5, p = 0.002$) and an increase of 17.5% in the 2020 group who agreed that players should be *fully rehabilitated before returning to play or training* (86.1% vs. 68.6% respectively, $U = 12938.0, p < 0.001$). Changes were also observed in positive attitudes towards admiration of elite athletes continuing on after a concussion (reduction in

agreement of 10.4%, 11.4% vs. 21.8% respectively, $U = 11711.5, p < 0.001$), as well as media glorification of concussion (reduction in agreement of 17.4%, 28.3% vs. 45.7% respectively, $U = 13193.0, p < 0.002$).

When asked if participants were willing to play on or train with a concussion, there were significant changes in attitudes between 2020 and 2015 cohorts as indicated by decreases in agreement for playing/training on if *I didn't feel any symptoms* (8.7%, 53.0% vs. 61.7% respectively, $U = 14127.0, p = 0.023$), *I felt symptoms but know within myself I'm okay* (4.6%, 30.6% vs. 35.2% respectively, $U = 14582.5, p = 0.037$), *I felt symptoms but can't let my teammates down* (6.7%, 25.7% vs. 32.4% respectively, $U = 13864.5, p = 0.016$), as well as *I was knocked out but came to before the end of the game* (7.4%, 9.9% vs. 17.3% respectively, $U = 13695.0, p = 0.006$). No other significant changes were found.

3.3. No previous concussion

Those who denoted they had not experienced a concussion were compared between cohorts (see Table 5). In all but three statements (club/association first aid support, club/association follow-up medical support, club/association rehabilitation support), significant differences were found in attitudes between 2020 and 2015 groups. Here, the largest positive changes in attitudes were found in agreement with players who continue to play or train with concussion are likely to suffer problems later in life (21.1%, 64.5% vs 43.4% respectively, $U = 33124.0, p < 0.001$), and players should be fully rehabilitated before returning to playing or training (11.2%, 90.4% vs 79.2% respectively, $U = 33038.5, p < 0.001$). Similarly, positive changes in attitudes, as shown by significant reduction in agreement with statements were observed with it being safe to play or train with a concussion (7.3%, 3.3% vs 10.6% respectively, $U = 38358.5, p < 0.001$), admiration for elite athletes who continue to play or train with a concussion (10.1%, 9.7% vs 19.8% respectively, $U = 31649.0, p < 0.001$), as well as the media glorifying elite athletes when they continue to play with a concussion (13.2%, 29.5% vs 42.7% respectively, $U = 36809.5, p < 0.001$).

4. Discussion

This is the first study to compare cohorts of undergraduate students studying exercise science and related courses, across two time points, separated by five years. Data between the two cohorts shows a meaningful and positive shift in attitudes, accompanied by a reduction in risk-adverse attitudes towards playing with a concussion. At the same time, there was an increased acknowledgement of the possible long-term consequences of concussions, reflecting a continued positive evolution of attitudes towards sports concussion. While this study did not explicitly investigate why attitudes changed, we speculate that the continuing publicity from regular media articles discussing older athletes revealing their on-going concerns as well as younger players retiring early, may have had an effect (White et al., 2020). Indeed, with increasing evidence of long-term impairments and neurodegenerative disease associated with repeated brain trauma in contact sports the opinion of many sports medicine practitioners is that concussion is now considered the number one

problem in international sport (Brukner, 2020). However, this existential concern is not only due to clinical outcomes of athletes suffering from multiple concussions (Alosco et al., 2020) but due to wider sociological concerns regarding the effects of concussions on athlete welfare (Liston, McDowell, Malcolm, Scott-Bell, & Waddington, 2018; White et al., 2020).

In recent years there have been increased exploration of the presentation of concussion in the media regarding concussion in sport (Ahmed & Hall, 2017; Cassilo & Sanderson, 2018). In Australia, this has been illustrated by major news articles reporting post-mortem analyses of neurodegenerative disease in deceased football players, as well as increasing number of media articles that have highlighted older retired athletes speaking out on their multiple concussions and concerns about their long-term brain and mental health. There has also been increasing attention on recently retired younger athletes discussing their decisions to retire prematurely due to too many concussions, alongside the effects it has on their quality-of-life post career. These examples support the assertion that media attention of athlete health and safety in sport is growing (Cassilo & Sanderson, 2018). Specifically, the media is likely to have influenced this study's participant responses about no longer glorifying or trivialising concussion, participants expressing less admiration for elite athletes who play on with a concussion, as well as agreeing that players who continue to play on with a concussion are at-risk of experiencing neurological concerns later in life (see Table 3).

While we are encouraged by the positive shift in attitudes between the cohorts, it is still nevertheless disquieting to observe that five years on, while less than 1% of the 2020 cohort agreed with the statement that it was *safe to play or train with a concussion*, nearly a quarter (24.2%) agreed that they would play on with concussive symptoms; with a fifth saying that they would play on to not let teammates down (20.5%). Although this is lower than 2015 data (27.5% and 26.9% respectively) such findings are still concerning. This should not be surprising, however. Indeed, studies over a similar time period to ours have reported that despite a doctor's assessment athletes themselves believe they should make the final decision on continuing to play (Lee, Resch, Han, Miles, & Ferrara, 2016; Salmon et al., 2020), highlighting a general lack of awareness that concussion is a brain injury. Moreover, this disparity may indicate an engrained culture of either playing with pain and symptoms, including concussion and mild head injury (Chrisman, Quitiquit, & Rivara, 2013; Conway et al., 2020; Kaut, DePompei, Kerr, & Congeni, 2003), concerns about a loss of athletic standing in a team, or interpersonal pressure to not let team mates down (Conway et al., 2020; Longworth, McDonald, Cunningham, Khan, & Fitzpatrick, 2021; Register-Mihalik, Linnan, et al., 2013), as well as a high internal motivation to continue playing in the belief that they are making a contribution to their team (Longworth et al., 2021; Salmon et al., 2020).

While overall positive improvements across the years were seen in participants with a history of concussion or no injury (see table 4), greater positive attitudinal changes were seen in the non-concussed participants (see table 5). This is illustrated specifically in the lack of statistical significance in differences across years in the concussed group for their beliefs with regards to *playing or training with a concussion if I thought my chances of being selected would be affected*, and that *players who continue to play or train with a concussion are likely to suffer problems later in*

life. Here, it is well known that previous experiences can influence current attitudes (known as planned behaviour) first argued by Ajzen (1991) and more recently by Kroshus, Baugh, Daneshvar, and Viswanath (2014). As such, we suggest that those who have previously been concussed may view the injury as 'less serious' than those who have never experienced a concussion. Accordingly, the attitudes in those with a previous experience of concussion(s) have not changed over time irrespective of the wider public discussion. Similarly, the lack of change in attitudes across both cohorts from those previously concussed towards support from coaches, administrators and clubs (table 4) reflects the lived experience that when concussed there was no assistance. Thus, the 'subjective norms' within this sporting culture may downplay the severity of concussion and/or athletes who have a suspected concussion may feel little 'perceived behavioural control' with regards to reporting concussive symptoms. This highlights the need for not only content specific education regarding concussion for club administrators and coaching staff, but also the development of awareness and sociocultural change towards the injury from a holistic perspective. An example of this would be to develop a cultural change that coaching and administration staff will take seriously athletes who speak up that they are concussed, or team-mates who notice a concussion to notify club trainers and coaching staff.

Although a novel aspect of our study was to quantify changing attitudes, a limitation of our study was that it was not possible to explore the motivations, from a qualitative perspective, for changes that were observed across the cohorts. Other limitations included not asking the students about their knowledge regarding concussion injury to ascertain if changes in attitudes were due to improved general or specific knowledge about concussion.

Given the continuing discussion and resulting increasing awareness regarding concussion in sport, future research should continue in tracking changes in attitudes and beliefs towards this injury. Moreover, in contextualizing changes in attitudes, not only a mixed-methods approach should be employed, but further research could expand questions with regards to participants' understanding of how various factors, such as leadership behaviour and psychological safety, may play a role in influencing and shaping attitudes towards concussion and concussion reporting intentions and behaviours (Light Shields, Gardner, Light Bredemeier, & Bostro, 1997).

In conclusion, this is the first study to directly examine attitudes towards concussion across comparable student cohorts, five years apart. The positive shift in attitudes found in this study may reflect an evolving cultural narrative influenced by altered media framing, such as highlighting long-term sequelae in former players. Nevertheless, there remained a contradiction in the 2020 cohort regarding attitudes towards concussion safety, such as playing on with a concussion. These findings suggest that, while attitudes towards concussion are changing, shifts in sociocultural attitudes are slow. Similar to other health-related change behaviours, concussion awareness may require a multi-faceted strategy to address this important public health issue; including published guidelines by national sporting organizations; ongoing media attention of individuals that have had adverse concussion experiences (e.g., persistent post-concussion symptoms), as well as a united approach by the sporting community (administrators, coaches, education institutions, medical and allied health professionals, and politicians).

Conflict of Interest

No specific funding was provided for this manuscript. AJP currently receives partial research salary funding from Sports Health Check charity and the Erasmus+ strategic partnerships program (2019-1-IE01-KA202-051555). AJP has previously received partial research funding from the Australian Football League, Impact Technologies Inc., and Samsung Corporation. AJW and NH currently receive partial research funding from the Erasmus+ strategic partnerships program (2019-1-IE01-KA202-051555). The remaining authors declare no conflicts of interests.

Acknowledgment

No funding was provided for this research.

References

- Ahmed, O. H., & Hall, E. E. (2017). "It was only a mild concussion": Exploring the description of sports concussion in online news articles. *Phys Ther Sport*, 23, 7-13. doi:<https://doi.org/10.1016/j.ptsp.2016.07.003>
- Ajzen, I. (1991). The theory of planned behavior. *Organ Behav Hum Decis Process*, 50(2), 179-211. doi:<https://doi.org/10.1016/0749-5978/91>
- Alosco, M. L., Tripodis, Y., Baucom, Z. H., Mez, J., Stein, T. D., Martin, B., . . . Stern, R. A. (2020). The Late Contributions of Repetitive Head Impacts and TBI to Depression Symptoms and Cognition. *Neurology*, 95(7), e793-e804. doi:10.1212/wnl.0000000000010040
- Belson, K. (2019). The concussion crisis in Australian rules football. *New York Times*. Retrieved from <https://www.nytimes.com/2019/09/26/sports/afl-football-concussions.html>
- Brukner, P. (2020, 21 December 2020). The No.1 problem for sports around the world. *The Age*. Retrieved from <https://www.smh.com.au/sport/cricket/the-no-1-problem-for-sports-around-the-world-20201217-p56oiv.html>
- Buckland, M. E., Sy, J., Szentmariay, I., Kullen, A., Lee, M., Harding, A., . . . Suter, C. M. (2019). Chronic traumatic encephalopathy in two former Australian National Rugby League players. *Acta Neuropathol Commun*, 7(1), 16. doi:<https://doi.org/10.1186/s40478-020-0895-z>
- Cassilo, D., & Sanderson, J. (2018). "I don't think it's worth the risk." Media framing of the Chris Borland retirement in digital and print media. *Commun Sport*, 6(1), 86-110. doi:<https://doi.org/10.1177/2167479516654513>
- Chrisman, S. P., Quitiquit, C., & Rivara, F. P. (2013). Qualitative study of barriers to concussive symptom reporting in high school athletics. *J Adolesc Health*, 52(3), 330-335. doi:10.1016/j.jadohealth.2012.10.271.
- Conaghan, C., Daly, E., Pearce, A. J., King, D. A., & Ryan, L. (2020). A systematic review of the effects of educational interventions on knowledge and attitudes towards concussion for people involved in sport – Optimising concussion education based on current literature. *J Sports Sci*, 1-16. doi:<https://doi.org/10.1080/02640414.2020.1835223>
- Conway, F. N., Domingues, M., Monaco, R., Lesnewich, L. M., Ray, A. E., Alderman, B. L., . . . Buckman, J. F. (2020). Concussion symptom underreporting among incoming national collegiate athletic association division I college athletes. *Clin J Sport Med*, 30(3), 203-209. doi:<https://doi.org/10.1097/JSM.0000000000000557>
- Grinberg, L. T., Anghinah, R., Nascimento, C. F., Amaro Jr, E., Leite, R. P., Martin, M. d. G. M., . . . Nitrini, R. (2016). Chronic traumatic encephalopathy presenting as Alzheimer's disease in a retired soccer player. *J Alzheimer's Dis*, 54(1), 169-174. doi:<https://doi.org/10.3233/JAD-160312>
- Kaut, K. P., DePompei, R., Kerr, J., & Congeni, J. (2003). Reports of head injury and symptom knowledge among college athletes: implications for assessment and educational intervention. *Clin J Sport Med*, 13(4), 213-221. doi:<https://doi.org/10.1097/00042752-200307000-00004>
- Kennard, M., McLellan, T., & McKinlay, A. (2018). Sports media representations of concussions in the National Rugby League. *Aust Psychol*, 53(1), 97-102. doi:<https://doi.org/10.1111/ap.12272>
- Kraak, W., Coetzee, L., Kruger, A., Stewart, R., & van Vuuren, H. (2019). Knowledge and attitudes towards concussion in western province rugby union senior club rugby players. *Int J Sports Med*, 40(13), 825-830. doi:<https://doi.org/10.1055/a-0959-2113>
- Kroshus, E., Baugh, C. M., Daneshvar, D. H., & Viswanath, K. (2014). Understanding concussion reporting using a model based on the theory of planned behavior. *J Adolesc Health*, 54(3), 269-274. doi:<https://doi.org/10.1016/j.jadohealth.2013.11.011>
- Lee, H. R., Resch, J. E., Han, T. K., Miles, J. D., & Ferrara, M. S. (2016). Sport-related concussion knowledge and occurrence: a survey of high school and college athletes in South Korea. *Int J Athl Ther Train* 21(2), 53-60. doi:<https://doi.org/10.1123/ijatt.2014-0087>
- Light Shields, D. L., Gardner, D. E., Light Bredemeier, B. J., & Bostro, A. (1997). The relationship between leadership behaviors and group cohesion in team sports. *J Psychol*, 131(2), 196-210. doi:<https://doi.org/10.1080/00223989709601964>
- Liston, K., McDowell, M., Malcolm, D., Scott-Bell, A., & Waddington, I. (2018). On being 'head strong': The pain zone and concussion in non-elite rugby union. *Int Rev Sport Sociol*, 53(6), 668-684. doi:<https://doi.org/10.1177/1012690216679966>
- Longworth, T., McDonald, A., Cunningham, C., Khan, H., & Fitzpatrick, J. (2021). Do rugby league players under-report concussion symptoms? A cross-sectional study of elite teams based in Australia. *BMJ Open Sport Exerc Med*, 7(1), e000860. doi:<https://doi.org/10.1136/bmjsem-2020-000860>
- Mez, J., Daneshvar, D. H., Kiernan, P. T., Abdolmohammadi, B., Alvarez, V. E., Huber, B. R., . . . McKee, A. C. (2017). Clinicopathological evaluation of chronic traumatic encephalopathy in players of american football. *Jama*, 318(4), 360-370. doi:10.1001/jama.2017.8334

- Pearce, A. J., Sy, J., Lee, M., Harding, A., Mobbs, R., Batchelor, J., . . . Buckland, M. E. (2020). Chronic traumatic encephalopathy in a former Australian rules football player diagnosed with Alzheimer's disease. *Acta Neuropathol Commun*, 8, 23. doi:<https://doi.org/10.1186/s40478-020-0895-z>
- Pearce, A. J., Young, J. A., Parrington, L., & Aimers, N. (2017). Do as I say: Contradicting beliefs and attitudes towards sports concussion in Australia. *J Sports Sci*, 35(19), 1911-1919. doi:<https://doi.org/10.1080/02640414.2016.1241420>
- Register-Mihalik, J. K., Guskiewicz, K. M., McLeod, T., Linnan, L. A., Mueller, F. O., & Marshall, S. W. (2013). Knowledge, attitude, and concussion-reporting behaviors among high school athletes: a preliminary study. *J Athl Train*, 48(5), 645-653. doi:<https://doi.org/10.4085/1062-6050-48.3.20>
- Register-Mihalik, J. K., Linnan, L. A., Marshall, S. W., McLeod, T. C. V., Mueller, F. O., & Guskiewicz, K. M. (2013). 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. doi:<https://doi.org/10.3109/02699052.2013.775508>
- Salmon, D. M., McGowan, J., Sullivan, S. J., Murphy, I., Walters, S., Whatman, C., . . . Romanchuk, J. (2020). What they know and who they are telling: Concussion knowledge and disclosure behaviour in New Zealand adolescent rugby union players. *J Sports Sci*, 1-10. doi:<https://doi.org/10.1080/02640414.2020.1749409>
- Twomey, C. (2021). AFL doubles mandatory break under strict new concussion protocols. Retrieved from <https://www.afl.com.au/news/543220/afl-introduces-mandatory-12-day-breaks-under-strict-new-concussion-protocols>
- White, A. J., Parry, K. D., Humphries, C., Phelan, S., Batten, J., & Magrath, R. (2020). Duty of Karius: Media framing of concussion following the 2018 UEFA champions league final. *Commun Sport*, 1-20. doi:<https://doi.org/10.1177/2167479520948048>