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Knowledge and attitudes towards concussion in UK based male ice hockey players: a need for attitude change?

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Complete List of Authors:	Hutchinson, Sarah; Edge Hill University, Psychology Ellison, Paul; Edge Hill University, Sport & PA Levy, Andy; Edge Hill University, Psychology Marchant, David; Edge Hill University, Sport & PA
Keywords:	Concussion misconceptions, Concussion reporting, Ice-Hockey, Mild traumatic brain injury, concussion
Abstract:	<p>Objective: Concussion is a common injury in ice hockey and previous research suggests some misconceptions and unsafe attitudes amongst players. The purpose of this study was to assess sport concussion knowledge, attitudes and the effect of sport concussion history in UK based male ice hockey players across three levels of competition: professional, semi-professional, and amateur. Methods: Sixty-one participants across a number of UK ice hockey teams completed the Rosenbaum Concussion Knowledge and Attitudes Survey (RoCKAS) and reviewed a series of statements to assess knowledge (CKI), attitudes (CAI) and misconceptions of concussion. Results: Level of competition and concussion history had no significant effect on CKI or CAI. A positive significant relationship exists between playing experience and CKI and CAI. Statements identified common misconceptions and areas of accurate knowledge regarding concussion symptoms suggesting that male ice hockey players have a higher-level knowledge compared to a sample of the UK general public. Playing experience was associated with increased knowledge and increasingly safe attitudes towards concussion. Conclusion: Despite knowledge relating to loss of consciousness and correct management of symptoms being generally accurate, there are worryingly unsafe attitudes regarding aspects of concussion. Such attitudes may well pose significant threats to player safety and long-term health.</p>

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Manuscripts

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3 **Running Head: ICE HOCKEY CONCUSSION KNOWLEDGE AND**
4 **ATTITUDE**
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9 **Knowledge and attitudes towards concussion in UK based male ice hockey**
10 **players: a need for attitude change?**
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14 **Sarah Hutchinson, Paul Ellison, Andrew Levy, David Marchant**
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16 **Edge Hill University, Ormskirk, UK**
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For Peer Review

Abstract and keywords

Objective: Concussion is a common injury in ice hockey and previous research suggests some misconceptions and unsafe attitudes amongst players. The purpose of this study was to assess sport concussion knowledge, attitudes and the effect of sport concussion history in UK based male ice hockey players across three levels of competition: professional, semi-professional, and amateur. *Methods:* Sixty-one participants across a number of UK ice hockey teams completed the Rosenbaum Concussion Knowledge and Attitudes Survey (RoCKAS) and reviewed a series of statements to assess knowledge (CKI), attitudes (CAI) and misconceptions of concussion. *Results:* Level of competition and concussion history had no significant effect on CKI or CAI. A positive significant relationship exists between playing experience and CKI and CAI. Statements identified common misconceptions and areas of accurate knowledge regarding concussion symptoms suggesting that male ice hockey players have a higher-level knowledge compared to a sample of the UK general public. Playing experience was associated with increased knowledge and increasingly safe attitudes towards concussion. *Conclusion:* Despite knowledge relating to loss of consciousness and correct management of symptoms being generally accurate, there are worryingly unsafe attitudes regarding aspects of concussion. Such attitudes may well pose significant threats to player safety and long-term health.

Ice Hockey Concussion Knowledge and Attitude

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9 21 *Keywords:* Concussion misconceptions, Concussion reporting, Ice-Hockey, Mild
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11 22 traumatic brain injury
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15 24 Knowledge of and attitudes towards concussion in UK based male ice hockey players:
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17 25 A need for attitude change?
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Introduction

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23 27 The Consensus Statement on Concussion in Sport indicates that concussion is a
24
25 28 complex pathophysiological process affecting the brain as a result of traumatic
26
27 29 biomechanical forces. Symptoms such as loss of consciousness to nausea, headaches,
28
29 30 dizziness and general disorientation usually appearing rapidly, though in some cases
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31 31 symptoms are delayed by several minutes to hours ¹. However, it is only recently that
32
33 32 concussion has been acknowledged as a traumatic brain injury and more care given to
34
35 33 those with concussion ². Knowledge of the indicators of concussion and how to manage
36
37 34 concussion is essential for key personnel (i.e. athletes, coaches, and family) to help
38
39 35 prevent injury and aid recovery. The latter may involve encouraging the return-to-play
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41 42 protocols, which are often dismissed by athletes once they feel ‘back to normal’ ³. Such
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43 43 beliefs highlight the importance of accurate knowledge and safe attitudes towards
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45 46 concussion held by the athlete themselves.
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51 39 There is a lack of epidemiological data, however at the highest level of ice
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53 40 hockey (the National Hockey League) the concussion rate in the 2011-2012 season was
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9 41 10.24 per 100 games (Actual Concussion 6.83, Suspected Concussion 3.41). 64.2% of
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11 42 the concussions were caused by body-checking, whilst only 28.4% of the concussions
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13 43 (and 36.8% suspected) were caused by illegal incidents ⁴. In a description of concussion
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15 44 in international ice hockey between 2006-15 Tuominen et al., identified that 66% of the
16
17 45 concussions were caused by illegal contact ⁵. The most common situation leading to
18
19 46 concussion was contact with another player (89%) with checking to the head (CTH)
20
21 47 (42%) and body checking (23%) accounting for the majority of these. These statistics
22
23 48 highlight that concussion is currently an inevitable part of the game and consequently,
24
25 49 there is a need for effective knowledge amongst those involved. Previous research into
26
27 50 athletes' understanding of concussion has typically shown poor knowledge regarding
28
29 51 injury mechanisms and symptoms, post injury vulnerabilities and recovery time ⁶. For
30
31 52 example, Sye et al.,⁷ found that high school rugby athletes typically consider loss of
32
33 53 consciousness necessary for a concussion injury. Research by Hänninen et al., however
34
35 54 shows that loss of consciousness is only one of a number of diverse clinical
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37 55 presentations ⁸. As an example, high school American football coaches' concussion
38
39 56 knowledge of symptom recognition is reasonable and they possess good awareness of
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41 57 their athletes' reluctance to report concussions ⁹. Jorgensen et al.,¹⁰ suggested that
42
43 58 increased knowledge of concussion reporting and behaviours did not necessarily
44
45 59 correlate to better attitudes in seventy-two varsity soccer, hockey and basketball
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47 60 athletes. However, in agreement with the findings by Sye et al.,⁸ a significant number of
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9 61 youth sport coaches considered loss of consciousness as necessary for a concussion
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11 62 injury ¹¹. Studies have also shown significant misconceptions relating to recovery from
12
13 63 and symptoms of concussion in the general population ¹².

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16 64 A recent study by Weber and Edwards (2012) ³ assessed concussion knowledge
17
18 65 of 227 members of the UK general public (aged 18 – 76), with participants rating the
19
20 66 truthfulness of a series of statements relating to concussion with a choice of four
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22 67 responses (true, probably true, probably false, and false), to determine the difference
23
24 68 between a lack of knowledge and clear misconceptions. The results identified
25
26 69 widespread lack of knowledge and misconceptions around the most frequent indicators
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28 70 of concussion within the general public. Participants expressed definite “incorrect”
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30 71 responses to a subset of statements e.g. trouble remembering events from before the
31
32 72 concussion, but not having trouble learning new things, which is in fact false, and the
33
34 73 increased vulnerability to concussion after a previous concussion which is true. The
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36 74 non-definite results for these statements showed that the majority (more than 50%) of
37
38 75 participants were unsure of their responses. The seriousness of concussion is clearly
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40 76 underestimated, for example, most participants rejected the idea of increased
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42 77 vulnerability to and likelihood of re-injury following concussion. The general public
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44 78 also showed a lack of knowledge of injury mechanisms and recovery assessment.
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46 79 Participants’ history of concussion had no influence on their knowledge. However,
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48 80 Weber and Edwards ³ suggested previous experience may have created a false sense of
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9 81 understanding evidenced through increased certainty of, but not accuracy in their
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11 82 knowledge.
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13 83 More recently Williams et al.,¹³ examined English professional soccer players'
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15 84 concussion knowledge and attitude by implementing the Rosenbaum Concussion
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17 85 Knowledge and Attitudes Survey (RoCKAS) and semi-structured interviews. The
18
19 86 RoCKAS provides a comprehensive measure of concussion knowledge and attitude, and
20
21 87 has proved to be valid and reliable⁶. The results evidenced some accurate knowledge:
22
23 88 the majority (88.5%) knew that loss of consciousness was not required for a concussion
24
25 89 and recognised that concussions will affect sport performance (88.5%). However, some
26
27 90 concerning misconceptions included only 3.8% knowing that there is an increased
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29 91 likelihood of repeat concussions after a player has sustained one and only 46.2% aware
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31 92 of long term risks to health from multiple concussions. Participants expressed safe
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33 93 attitudes towards concussion including: athletes who lose consciousness should be taken
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35 94 to hospital (80.8%); managers should not let players with concussion play (80.8%); and
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37 95 it is the physiotherapists who make the return to play decision (69.3%). But 64% of
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39 96 players stated they would continue to play even if they believed they had suffered a
40
41 97 concussion, with 96% indicating that the importance of the match would influence their
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43 98 reporting and action towards the injury. To the best of our knowledge, there is no
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45 99 current literature relating to knowledge and attitudes within ice hockey players, which is
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47 100 concerning given the prevalence presented above.
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Ice Hockey Concussion Knowledge and Attitude

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9 101 Education about concussion within ice hockey is relatively new, with
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11 102 educational programmes focusing particularly on symptom recognition and reporting
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13 103 procedures ^{14,15,16} as an injury prevention intervention. For example, Cook et al.,¹⁴ had
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15 104 11-12 year old male hockey players in Canada viewing a concussion and spinal cord
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17 105 injury prevention video. The video included medical information and personal
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19 106 experiences of recognised professional players, team doctors, coaches and trainers.
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21 107 Knowledge significantly improved and did not decay over a three-month period. Rule
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23 108 infringements of crosschecking and checking from behind both showed a decline in
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25 109 number of calls against the players who had viewed the video. Smart Hockey, Heads
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27 110 Up, and Heads Up Hockey (USA Hockey) are the main programmes in North America,
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29 111 however none of these programmes have been systematically evaluated, meaning
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31 112 conclusions on their effectiveness cannot definitely be made. Hockey Canada has also
32
33 113 developed a concussion awareness app that is available to provide detailed information
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35 114 on concussion as an injury, how to manage symptoms and recovery, and returning to
36
37 115 play. In the UK there is currently only one educational programme: Headcheck,
38
39 116 launched in 2015 to raise awareness of concussion. The initiative includes information
40
41 117 about the symptoms of concussion, the potential consequences of the injury and advice
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43 118 on how to manage the injury, and information about the return to play protocol. Posters
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45 119 and leaflets are available to download from the website for all individuals involved i.e.
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47 120 managers, coaches, medical staff, players, and parents.
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9 121 Despite an increase in research and professional interest in sport concussion, the
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11 122 application of the known facts (causes, symptoms, recovery) does not appear to be
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13 123 transferring to those most involved i.e. players, coaches, and parents. As highlighted by
14
15 124 the widespread lack of knowledge within the general public ³ and the concerning
16
17 125 attitudes of footballers who would continue to play even if they suspected a concussion
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19 126 ¹³. Current educational approaches such as Smart Hockey (Canada), Heads Up Hockey
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21 127 (USA), and Headcheck (UK) are attempting to address the concerns of insufficient
22
23 128 knowledge of concussion. Given the increased incidence of concussion in ice hockey,
24
25 129 the present study aims to replicate the work of Williams et al., ¹³ and Weber and
26
27 130 Edwards ³ to examine the current knowledge about and attitudes towards concussion in
28
29 131 a group of adult male UK based ice hockey players. To-date, there is no known
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31 132 research addressing UK based ice hockey players. It is anticipated that (a) based on
32
33 133 previous research in the UK, there will be misconceptions and a lack of knowledge and
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35 134 unsafe attitudes within the male ice hockey player population; and (b) attitude and
36
37 135 previous experience of concussion may influence athletes' knowledge and behaviour
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39 136 regarding concussion.

Method***Participants***

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48 138 Sixty-one male ice hockey players within the UK volunteered to participate in
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50 139 the study, ages ranged from 19-48yrs. (M=27.25). All players were competing at one of
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9 141 three leagues (low to high): Laidler Conference, Moralee Conference, or the English
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11 142 Premier League (EPL). Players represented Professional (N=19), Semi-Professional
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13 143 (N=28) and Amateur (N = 24) playing standards. The study was approved by the
14
15 144 University Institutional Review Board, and full compliance of the Helsinki Convention,
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17 145 1964 and Declaration of Tokyo, 1975, as revised 1983 was adhered to at all times. All
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19 146 participants provided informed consent and were debriefed upon completion of the task.
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147 Measures

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25 148 *Knowledge of and Attitude towards Concussion:* Concussion knowledge and
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27 149 attitudes were assessed using the previously validated 55-item Rosenbaum Concussion
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29 150 Knowledge and Attitudes Survey (RoCKAS; Rosenbaum & Arnett ⁶, Chapman et al.,¹⁷)
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31 151 which generates 2 scores: a concussion knowledge index (CKI) and concussion attitude
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33 152 index (CAI). The CKI contains 14 basic and 3 applied true and false questions graded 1
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35 153 (correct) or 0 (incorrect), and recognition of 8 common concussions symptoms (with 8
36
37 154 distractor symptoms) for a total possible score 25. The CAI contains 15 Likert scale (1:
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39 155 strongly disagree – 5: strongly agree) questions. Safer answer receive 5 points and the
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41 156 least safe answer receive 1 point resulting in a score range of 15–75. High scores on
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43 157 CKI (e.g., 25) and CAI (e.g., 75) indicate better knowledge of and attitudes towards
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45 158 concussions.

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50 159 *Concussion Knowledge Misconceptions:* The second measure consisted of 24
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52 160 true or false statements adapted from Weber and Edwards ³ to explore sport concussion
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9 161 knowledge. For example, “*An SC can cause brain damage even if the sports person is*
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11 162 *not knocked out*” (True). Two original statements were removed from the original 26
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13 163 statements due to their lack of relevance to the study and sample population: “*in sport,*
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15 164 *sport concussion never happens*” and “*a sports concussion affects men’s and women’s*
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17 165 *brains differently*”. The remaining 24 statements required responses of true, probably
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19 166 true, probably false, and false; with the original researchers,³ suggesting indefinite
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21 167 answers highlight uncertainty. Misconception percentages were calculated as
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23 168 misconceptions in collapsed responses (true/probably true; false/probably false), and
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25 169 percentage of participants making definite and non-definite responses. The measure was
26
27 170 appropriate for this setting as it has been used with UK general population ³ and a UK
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29 171 athletic sample (English Professional Football ¹³) to elucidate misconceptions.

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34 172 *Player Characteristics:* Basic demographics of each participant were also
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36 173 collected, including their playing experience (the length of time individuals have played
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38 174 competitively), current level of competition (Professional, Semi-Professional, Amateur)
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40 175 and concussion history (how many known concussions individuals have suffered).

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43 176 ***Procedure***

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46 177 UK based ice hockey teams were initially contacted regarding access to their
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48 178 players and participation in the study, as well as individual players through direct
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50 179 contact. To conduct the study, the lead author travelled to participating team training
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52 180 sessions during the 2015-2016 season. Participating players provided written informed
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181 consent, and were debriefed upon completion. After receiving written informed consent
182 from the participants, the instruments were completed individually and privately.

183 Statistical Analysis

184 SPSS V22 (IBM, Chicago, USA) was used for final data analysis (significance p
185 $< .05$). One-way ANOVAs were used to examine any difference in CKI, CAI, and
186 Concussion Knowledge Misconceptions across the three competition levels
187 (Professional, Semi-Professional, Amateur). An independent t-test examined differences
188 in concussion knowledge or attitude based on previous concussion history. The
189 normality and homogeneity of variances within the data were confirmed with the
190 Kolmogorov-Smirnov test and Levene tests, respectively. No missing values were
191 identified. Finally, Pearson's correlations assessed relationships between years of
192 playing experience, concussion knowledge and attitude.

193 Results**194 RoCKAS**

195 It was anticipated that playing level, concussion history, and playing experience would
196 impact on RoCKAS scores. A one-way ANOVA revealed no significant effect of
197 playing level on CKI, ($F_{(2,58)} = .206, p = .814$) or CAI ($F_{(2,58)} = 1.325, p = .274$) (See
198 Table 1). An independent t-test indicates that CKI was not different for those with a
199 history of concussion ($N = 30, M = 18.42, SE = 1.91$) compared to those who had never
200 had a concussion ($N = 31, 17.73 \pm 2.85$) ($t = 1.10, df = 50.47, p = .27$). Similarly, CAI

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9 201 was not different for those with a concussion history (55.03 ± 2.07) compared to those
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11 202 without a concussion history (59.47 ± 6.24) ($t = 1.86$, $df = 59$, $p = .07$) (See Table 2).
12
13 203 There were significant positive relationships between years of playing experience and
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15 204 CKI ($r = .408$, $p = .008$) and the CAI ($r = .285$, $p = .008$). These correlations highlight a
16
17 205 positive relationship: greater playing experience is associated with increased concussion
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19 206 knowledge and increasingly safe attitudes towards concussion. There was no significant
20
21 207 difference in playing experience between those who reported they would continue to
22
23 208 play when concussed ($N = 40$) and those who would not ($N = 21$) ($t = 1.03$, $df = 59$, $p =$
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25 209 0.31).

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30 210 ****Table 1 near here****

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33 211 ****Table 2 near here****

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36 212 ***Symptom Recognition***

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39 213 The mean correct symptom recognition score, out of 16 symptoms (8 legitimate
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41 214 symptoms and 8 distractor symptoms) was 7.93, with a range of 3 to 12 symptoms
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43 215 selected (See Table 3). Of the 60 participants that completed the symptom section, 50%
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45 216 selected all 8 symptoms correctly (but ticked 8 or more symptoms), but only 6.66%
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47 217 selected just the 8 correct symptoms. The most commonly correctly identified
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49 218 symptoms were headache (98.33%), dizziness (95%), and difficulty concentrating
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51 219 (93.33%). The most commonly missed correct symptoms were feeling in a fog
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220 (71.67%) and difficulty remembering (80%). Amongst the distractor symptoms,
221 participants most often identified difficulty speaking (66.67%) as a symptom of
222 concussion.

223 ****Table 3 near here****

224 ***Concussion Knowledge Misconceptions***

225 Percentages of each possible response (true/probably true, false/probably false) were
226 given to show the difference between collapsed (true and probably true or false and
227 probably false) and definite responses (See Table 4). The statement with the most
228 certainty was (statement one) “*a concussion is harmless and never results in long-term*
229 *problems or brain damage*”: 98.36 % thought this was false, 81.97% of that knew it was
230 definitely false. The statement with the most common misconception was (statement
231 twelve) “*it is good advice to rest and remain inactive during recovery*”, 55.74% thought
232 this was definitely false and 22.95% thought it was probably false.

233 ****Table 4 near here****

234 **Discussion**

235 Knowledge of and attitudes towards concussion within UK based male ice
236 hockey players was examined for the first time. Whilst the results of the study found no
237 significant difference between knowledge of and attitude towards concussion across the
238 three levels of competition (professional, semi-professional, and amateur), the overall

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9 239 scores across the levels show clear limitations in both knowledge and attitude. Attitude
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11 240 was safest in the amateur level (mean CAI = 59.46) which could be due to a number of
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13 241 factors such as that players at this level generally participate as a hobby and have
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15 242 careers outside of the sport. Although professional and some semi-professional athletes
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17 243 may have the support of team doctors/medics to assess their condition and advise on
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19 244 correct procedures to follow, they may feel a pressure to continue playing, encouraging
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21 245 an unsafe attitude towards concussion.
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26 246 A players' concussion history had no significant impact on concussion
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28 247 knowledge or attitudes, suggesting exposure to the injury itself does not necessarily
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30 248 change perceptions of concussion. This supported Weber and Edwards³ who found that
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32 249 personal experience of sport concussion did not impact the accuracy of concussion
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34 250 knowledge. Furthermore, this relationship partially supports the observations of
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36 251 Register-Mihalik et al.¹⁸ who found no relationship between concussion history and
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38 252 knowledge, but a negative effect on attitudes. This relationship may be driven by
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40 253 multiple variables. For example, recognition of and concerns about concussion
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42 254 disclosure may have limited accurate self-report of concussion history in this study. As
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44 255 noted by Register-Mihalik et al., continued participation post-concussion with no
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46 256 experienced disabilities may negatively impact on perceived severity and importance of
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48 257 concussion itself. Indeed, Weber and Edwards concluded that personal experience of
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50 258 sport concussion might result in a false sense of security. A further note is that
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9 259 concussion history is only operationalised from a personal perspective, and does not
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11 260 consider the potential role of teammates' concussion occurrences on knowledge and
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13 261 attitudes. The positive relationship between playing experience, CKI and CAI appears
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15 262 to indicate that players early in their career exhibit concerning knowledge and unsafe
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17 263 attitudes towards concussion compared with players with greater experience. Increasing
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19 264 exposure to the sport corrects these shortcomings, and thus highlights early career as a
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21 265 key intervention stage. That concussion history does not influence CKI and CAI
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23 266 suggests that increasing experience of the sport has a separate influence from personal
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25 267 exposure to concussion injury itself, potentially through social, cultural and normative
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27 268 processes^{18,19}. However, longitudinal data is required to ascertain the processes
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29 269 through which experience plays its role on these variables.
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34 270 Specific statements from the RoCKAS survey were analysed and showed some
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36 271 accurate knowledge amongst the participants; for example, the majority (93.4%) knew
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38 272 that loss of consciousness was not required for a concussion, which was slightly higher
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40 273 than the knowledge of the football sample (88.5%) in the Williams et al.,¹³ study.
41
42 274 Positively, 72.1% of the participants in this study knew that there is an increased
43
44 275 likelihood of repeat concussions after a player has sustained one, as opposed to only
45
46 276 3.8% of the participants in the Williams et al., study. This knowledge is supported by
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48 277 the statement from Weber and Edwards³ regarding athletes' abilities to withstand a
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50 278 second blow to the head after previously sustaining concussion as 67.21% said this was
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9 279 true/probably true. Although, only 14.75% responded definitely true, suggesting the
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11 280 certainty of knowledge is limited.

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13 281 Following this trend in increased knowledge within the ice hockey sample,
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15 282 68.8% were aware that there are long-term risks to health from multiple concussions,
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17 283 compared to the 46.2% in the football sample. Participants in the study indicated safe
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19 284 attitudes towards concussion regarding athletes who lose consciousness in that they
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21 285 should be taken to hospital (85.2%) which is similar to the football sample (80.8%).
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23 286 However, a significantly concerning attitude is that 65.6% of players would continue to
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25 287 play even if they believed they had suffered a concussion (similar to 64% of footballers
26
27 288 in Williams et al.,¹³). That knowledge and attitudes do not appear to mitigate against
28
29 289 continuing to play when concussed demonstrates their limitations in explaining
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31 290 behaviour where strong social and normative values also play a critical role^{18,19}. After
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33 291 more detailed analysis of some of the statements included in the RoCKAS the results
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35 292 further support the suggestion that the athletes have some accurate knowledge regarding
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37 293 concussion, but this seemingly does not promote a safer attitude towards playing when
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39 294 concussed. This further substantiates Register-Mihalik et al.'s¹⁸ findings that accurate
40
41 295 knowledge is not necessarily associated with positive attitudes in athletes. The most
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43 296 common symptoms selected from the list provided were headache, dizziness, and
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45 297 difficulty concentrating. However, a low recognition rate was observed for "Feeling in a
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47 298 fog". Some distractor items identified as potential symptoms, although at a low rate,
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9 299 included *panic attacks*, and *reduced breathing rate*. Together, these results highlight
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11 300 the need for not only education, but the development of interventions to encourage safer
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13 301 attitudes towards concussion.
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16 302 The statements by Weber and Edwards³ enabled a more in-depth analysis of the
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18 303 knowledge of concussion within the sample and facilitated the identification of correct
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20 304 knowledge, uncertainty, and clear misconceptions. The results indicated a trend that
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22 305 collapsed correct responses were noticeably higher than definite correct responses,
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24 306 suggesting a lack of confidence in the respondents' knowledge, as suggested by Weber
25
26 307 and Edwards³. The areas that players showed correct definite knowledge were:
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28 308 *concussion is harmless and never results in long-term problems or brain damage*,
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30 309 81.97% knew this was false, which is higher than the Weber and Edwards' general
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32 310 public sample's definite knowledge of this (74.4%). Another area where players
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34 311 expressed confident knowledge was that concussion *can cause brain damage even if the*
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36 312 *sports person is not knocked out*, 62.3% knew this was true, which is again better than
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38 313 the knowledge of Weber and Edwards' general public sample (50.2%). This result
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40 314 coincides with the findings relating to the knowledge in the RoCKAS that loss of
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42 315 consciousness is not the only way a concussion can occur and that brain damage can
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44 316 occur without losing consciousness. However, clearly a significant proportion of these
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46 317 players did not confidently identify this statement as correct.
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9 318 The highest level of misconception for these players concerned remaining
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11 319 inactive during recovery from concussion, with 55.74% stating this a definitely true
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13 320 (22.95% non-definite). However, it is worth noting that although Weber and Edwards
14
15 321 (2012) mark this statement false, the efficacy of this approach has not been conclusively
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17 322 demonstrated regarding the relationship between cognitive rest and duration of
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19 323 concussive symptoms (e.g., Gibson et al., ²⁰). It may well be inappropriate to conclude
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21 324 fully on the level of knowledge in this area within this sample, but there is still a clear
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23 325 difference in perspective on this statement.
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27 326 Another misconception was that a concussed athlete may have trouble
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29 327 remembering events from before the concussion, but usually does not have trouble
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31 328 learning new things. This is in fact false, as a long term effect of concussion is difficulty
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33 329 in learning ². In our ice hockey sample, 60.66% misconceived this statement overall
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35 330 (with 21.31% definite misconception) compared to 66% in the ³ general public sample.
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37 331 Suggesting that ice hockey players' knowledge of concussion is only marginally better
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39 332 than the general public. Whilst 67.2% of the sample thought that once recovered from a
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41 333 concussion an athlete is less able to withstand a second blow to the head, only 14.75%
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43 334 knew it was definitely true. The uncertainty here is a concern given the danger repeated
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45 335 blows to the head (or repeated concussion) hold and the potential for long term damage,
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47 336 such as chronic traumatic encephalopathy (CTE), ²¹. Regarding assessment of
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49 337 concussion, 62.3% of the sample thought that asking athletes who were concussed about
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9 338 their recovery is the most accurate and informative way to assess progression.
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11 339 Contrasting this, 93.44% of players agreed (47.54% definite; 45.90% non-definite) that
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13 340 athletes with a concussion are not fully aware of its effect on their behaviour and
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15 341 performance. Interestingly, only 36.1% of the general public thought this was true,
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17 342 emphasising the generally greater knowledge within this athletic sample.
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20 343 A key limitation of the present study concerned accessing teams for
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22 344 participation, with only a limited number of teams available to the researcher resulting
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24 345 in a small sample size. In future, the opportunity to complete the form online could
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26 346 improve uptake. Similarly, the cross sectional design limited conclusions made on the
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28 347 influence of player experience and concussion history. Longitudinal research is
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30 348 encouraged to assess changes in knowledge and attitudes across playing seasons and
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32 349 careers. Finally, whilst the CKI has been shown to have good reliability and validity,
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34 350 concerns have been raised regarding the CAI's potential utility. From their data on
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36 351 collegiate athletes Chapman et al.,¹⁷ suggest adding further attitudes items focusing
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38 352 sporting, social and normative factors, reflecting the concerns raised above.
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353 Conclusion

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45 354 To conclude, whilst there are some areas of accurate knowledge and evidence of
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47 355 safe attitudes regarding concussion there are some clear misconceptions within this
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49 356 male ice hockey player sample. Knowledge regarding loss of consciousness and the
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51 357 effects of this on concussion was better than expected. It can also be concluded that
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9 358 playing experience was positively associated with knowledge of and attitudes towards
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11 359 concussion. These ice hockey players generally had better knowledge of concussion
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13 360 than a general public sample ³ and a sample of professional English soccer players ¹³.
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15 361 Attitudes, however, were similar across studies, suggesting that attitude towards
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17 362 concussion may not be specific to individual sports. However, in a worrying contrast to
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19 363 this, 65.6% of the players indicating they would continue to play even if they believed
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21 364 they had sustained a concussion. Such an attitude may undermine any other positive
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23 365 attitude and knowledge regarding concussion, particularly when game status may
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25 366 influence such decision-making in players. For educational programmes to be truly
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27 367 effective, these findings support Provvidenza et al.,²² study and highlight specific areas
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29 368 for behaviour and attitude change. Encouraging adherence to return to play procedures
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31 369 by educating athletes and coaches on their importance and the potential consequences of
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33 370 non-adherence. Despite positive findings here, such an approach is critical given the
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35 371 existing attitudes towards playing when concussed. This specific attitude poses a
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37 372 significant risk to player safety and long-term health.
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374 **Disclosure of interest**

375 The authors report no conflicts of interest.

376 **References**

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Table 1: Mean and Standard Deviations for Concussion Knowledge Index (CKI) and Concussion Attitude Index (CAI) scores

CKI		
Level	Mean	SD
Pro	18.21	2.42
Semi-Pro	18.28	2.05
Amateur	17.83	2.75

CAI		
Level	Mean	SD
Pro	56.74	7.82
Semi-Pro	54.72	13.10
Amateur	59.46	7.13

Note: CKI scores range from 0–25 and CAI scores range from 15–75, with higher scores represented greater knowledge safer attitudes about concussion respectively.

1 **Table 2:** Mean and Standard Deviation for Concussion History

CKI		
Concussion History	Mean	SD
No (n= 30)	17.73	2.85
Yes (n=31)	18.42	1.91

CAI		
No (n= 30)	59.47	6.24
Yes (n=31)	55.03	11.54

2 Note: CKI scores range from 0–25 and CAI scores range from 15–75, with higher scores
3 represented greater knowledge safer attitudes about concussion respectively.

1 **Table 3:** The 16-item symptom recognition list. The percentage (%) of respondents who
 2 correctly identified the correct symptom are bolded.

Symptom	Symptom Response (%) (<i>n</i> = 60)
Hives	0.00
Headache	98.33
Difficulty speaking	66.67
Arthritis	0.00
Sensitivity to light	83.33
Difficulty remembering	80.00
Panic attacks	11.67
Drowsiness	88.33
Feeling in a fog	71.67
Weight gain	3.33
Feeling slowed down	88.33
Reduced breathing rate	21.67
Excessive studying	3.33
Difficulty concentrating	93.33
Dizziness	95.00
Hair loss	0.00

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1 **Table 4:** Knowledge statement responses. Adapted from Weber and Edwards (2012).

Statement	Correct (%)		Misconception (%)	
	Collapsed Responses	Definite Responses	Definite	Non-Definite
1 A concussion is harmless and never results in long-term problems or brain damage (<i>F</i>)	98.36	81.97	0.00	0.00
2 A little brain damage does not matter, as people use a small portion of their brains anyway (<i>F</i>)	96.72	78.69	0.00	1.64
3 A concussion can cause brain damage even if the sports person is not knocked out (<i>T</i>)	86.89	62.30	3.28	6.56
4 Most sports persons with a concussion are not fully aware of its effect on their behaviour and performance (<i>T</i>)	93.44	47.54	1.64	3.28
5 Sometimes a second blow to the head can help a sports person remember things that were forgotten (<i>F</i>)	85.25	42.62	0.00	13.11
6 Once a recovering sports person feels “back to normal” the recovery process is complete (<i>F</i>)	75.41	32.79	1.64	21.31
7 Complete recovery from a concussion is not possible, no matter how badly the person wants to recover (<i>F</i>)	75.41	36.07	8.20	14.75
8 Drinking alcohol may affect a sports person differently after a concussion (<i>T</i>)	88.52	42.62	3.28	6.56
9 How quickly a sports person recovers from a concussion depends mainly on how hard they work on recovery (<i>F</i>)	72.13	45.90	13.11	13.11
10 It is easy to tell if a sports person has brain damage from a concussion by the way the person looks or acts (<i>F</i>)	68.85	44.26	4.92	24.59
11 Whiplash injuries to the neck can cause brain damage even if there is no direct blow to the head (<i>T</i>)	75.41	44.26	4.92	18.03
12 It is good advice to rest and remain inactive during recovery (<i>F</i>)	14.75	4.92	55.74	22.95
13 In sports, a concussion can have positive and negative effects on the sports person (<i>F</i>)	65.57	39.34	8.20	22.95
14 Concussed sports persons usually show good understanding of their problems because they experience them every day (<i>F</i>)	50.82	29.51	8.20	32.79
15 A concussion may cause one to feel depressed, hopeless and sad (<i>T</i>)	81.97	37.70	1.64	13.11
16 Emotional problems after a concussion are usually not related to brain damage (<i>F</i>)	70.49	21.31	1.64	24.59
17 Recovery from a concussion is usually complete in about a week (<i>F</i>)	78.69	50.82	4.92	11.48
18 The only sure way to tell if someone has suffered brain damage from a concussion is by an X-ray of the brain (<i>F</i>)	47.54	22.95	16.39	31.15

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19	A sports person who has recovered from a concussion is less able to withstand a second blow to the head (<i>T</i>)	67.21	14.75	8.20	19.67
20	Asking sports persons who were concussed about their recovery is the most accurate and informative way to find out how they have progressed (<i>F</i>)	31.15	9.84	31.15	31.15
21	When a sports person is knocked unconscious, most wake up quickly with no lasting effects (<i>F</i>)	55.74	24.59	4.92	34.43
22	Sports persons usually have more trouble remembering things that happen after a concussion than remembering things from before (<i>T</i>)	57.38	11.48	9.84	27.87
23	A concussed sports person may have trouble remembering events from before the concussion, but usually does not have trouble learning new things (<i>F</i>)	34.43	6.56	21.31	39.34
24	Sports people who have had one concussion are more likely to have another (<i>T</i>)	72.13	36.07	9.84	11.48

2 *Notes:* The correct answer is indicated at the end of each statement (T = true; F = false). Correct responses and
 3 collapsed response (true/probably true; false/probably false) dependent on answer, and misconception
 4 (definite/non-definite) are shown as a percentage of the sample. Bold statements indicate clear knowledge or
 5 misconception.
 6