

1 Concussion in university level sport: knowledge and 2 awareness of athletes and coaches

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17 **Abstract:** The objective of this study was to evaluate concussion knowledge among university level
18 athletes and coaches. n=20 rugby union players, n=20 Gaelic football players and n=8 experienced
19 team coaches were assessed using a validated cross-sectional survey. Levels of knowledge of
20 concussion was high across all participants. Coaches had higher knowledge scores for almost all
21 areas, but there was evidence of important gaps, even in this group. Knowledge was not sufficient
22 in identifying concussion, and when it is safe to return to play following a concussion. Impaired
23 knowledge of how to recognise concussion, and misunderstanding the need for rest and
24 rehabilitation before return to play presents a hazard to health from second impact and more
25 catastrophic brain injury. We discuss reasons for misconceptions of guidelines, and suggest that
26 attitude issues on the significance of concussion may underlie willingness to want to play with a
27 concussion. This suggests current education on sport-related concussion needs to be expanded for
28 appropriate management of University level contact sport.

29 **Keywords:** Sport-related concussion; signs; symptoms; return to play guidelines; traumatic brain
30 injury

31

32 **Introduction:**

33 Concussion, a type of traumatic brain injury (TBI), can occur following a forceful impact to the
34 head, face, neck or body that induces sudden impulsive trauma to the brain. The American Medical
35 Society for Sports Medicine defines concussion as a “transient disturbance of brain function” [1]; in
36 the UK the online National Health Service similarly asserts that concussion is usually a temporary
37 injury [2]. There is, however, evidence that the physiological changes that follow concussion provide
38 potential for chronic, as well as acute, physical, cognitive and emotional impairments [3,4]. It follows
39 from this that concussion is an underappreciated public health issue [5] that presents a serious
40 situation with possible long-term challenges to health.

41 Concussion should be suspected whenever there are changes in mental status following impact
42 on a sports field [6]. This requires an immediate decision on whether an occasion where there has
43 been forceful impact was sufficient to cause concussion. Early observable features of concussion
44 include headache, disorientation, vomiting, nausea, dizziness, slurred speech, and delayed responses

45 [6,7]. There may be temporary loss of consciousness, but this is not necessary to suspect concussion
46 [7].

47 Players of contact sports are at risk of concussion [5,8]. This raises the question of sufficiency of
48 knowledge of concussion in this population, particularly in amateur university-level team sports,
49 where medical support is generally not on site. The question is becoming more critical, in view of
50 accumulating evidence of symptoms of concussive brain injury such as persistent headaches,
51 confusion, irritability, sleep disturbance, amnesia and fatigue continuing for several months, pointing
52 to more long-term negative health effects of concussion. Additionally, brain function studies in
53 former athletes and post-mortem have provided evidence that even when asymptomatic in youth,
54 cognitive and motor impairments can become apparent in later life [9-11]. Most recently, a
55 retrospective population study reports an elevated risk of early-onset dementia in those with a
56 history of moderate to severe TBI [12].

57 It is known that the incidence of concussion in youth sports is not negligible [5,7]. For example,
58 5.1% of the sample of 17,659 collegiate and high school football players in US sustained at least one
59 concussion during play in a single season, and that 14.7% of this number suffered a second concussion
60 during the same season [7], potentiating severity [13]. Although based on a much lower sample size,
61 findings from an incidence study [14] of under-20s Rugby Union players in Ireland were that 64
62 of the 133 reported they had experienced at least one concussion in their playing history. 61 of these
63 players reported their symptoms to their coach, but just 36 (56%) sought medical attention, in line
64 with previous findings of underreporting concussions, and low adherence to return to play
65 guidelines [15-20]. Primary reasons cited by athletes for failing to report their concussion are: not
66 thinking the injury was serious enough (63%), not wanting to leave the field of play (41%), and being
67 unaware they had suffered a concussion (36%) [14].

68 Medical under-reporting of concussions by athletes is a major concern due to the potentially
69 serious consequences of the injury. It also raises questions regarding knowledge of concussion in high
70 risk populations. Most research in this area has been undertaken in the United States of America
71 (USA), and in response in 2003 the Centres for Disease Control and Prevention (CDC) launched the
72 *Heads Up* campaign [21] to provide information for high-school and youth sports team coaches. The
73 intervention materials were widely distributed in the USA, but it has been suggested that although
74 initial gains in knowledge led to increased efforts to minimize risks associated with concussion, the
75 intervention has not stood the test of time [22]. There has been no obvious promulgation of the *Heads*
76 *Up* information materials across the Atlantic Ocean, raising the question of whether there is a need
77 to improve knowledge of short-time and long-term sequelae of concussions in amateur sport in the
78 United Kingdom (UK). A primary starting point is to ascertain what is already known.

79 Investigating knowledge of concussion is justified as many thousands of young people
80 participate in impact sports – particularly at University level. In U, Rugby Union and Gaelic Football
81 are popular contact sports in Universities, yet there is no literature on levels of knowledge of
82 concussion in players, or their coaches. This research was undertaken to address that fact, in the first
83 instance, towards supporting a risk assessment of concussion in this setting. Coaches were included
84 as well as players, as coaches are often the first individual to recognize that an athlete could have
85 concussion, and importantly, in amateur University-level sports coaches typically have little to no
86 education on concussion [23]. In line with participation in the contact sports used in this study,
87 rugby union and Gaelic football, participants were all male. On the basis of the literature it was
88 anticipated that misconceptions in concussion knowledge would be evident in coaches and athletes
89 in both sports.

90 **Materials and Methods**

91 *Subjects*

92 Following institutional ethical approval (ID: 1007305), n=20 rugby union players (age: 22 ± 2
93 years, playing experience: 8 ± 1 years), n=20 Gaelic football players (age: 21 ± 1 years; playing

94 experience: 5 ± 1 years) and $n=8$ coaches (age: 28 ± 2 years; coaching experience: 6 ± 1 years) were
 95 recruited from university contact sports teams. Coaches were recruited from Gaelic football, rugby
 96 union, soccer, hockey, netball and basketball to increase limited sample of contact sports coaches.
 97 All participants were male gender, and competing in amateur university leagues.

98 Procedure

99 Recruitment was carried out via email circulated to university sports personnel to enquire if
 100 coaches and respective players would like to take part in a survey concerning an “aspect of health”.
 101 All participants who expressed an interest provided written informed consent and then completed
 102 the same survey prior to a team training session individually in a private room with only the
 103 researcher present. This prevented the possibility of participants viewing each other’s responses
 104 and/or conferring with one another.

105 Survey

106 The previously validated pre-test questionnaire from the CDC Concussion in Youth Sports
 107 campaign was utilized [21]. This questionnaire comprises 11-items that assess knowledge of
 108 concussion, including items related to mechanisms, signs and symptoms of concussion, and return
 109 to play guidelines. Each item has three alternatives, and participant chooses what they believe to be
 110 correct response. Correct answers were scored a value of 1, and all incorrect responses 0. This
 111 provided a final score for each participant between 0 and 11; knowledge across items was also
 112 assessed; the sum of correct responses according to type of participant was expressed as a percentage
 113 for analysis.

114 Statistical analysis

115 SPSS Statistics 22, IBM, Chicago, IL, USA was used to analyse the data. The alpha level for
 116 statistical significance was set at $p<0.05$. All variables were tested for normality (Shapiro-Wilk test)
 117 and homogeneity of variance (Levene’s test). A one-way analysis of variance was used to establish
 118 differences between groups. Significant main effects were followed up using Tukey’s post-hoc
 119 analysis.

120 Results

121 **Table 1.** Percentage of correct group responses to the CDC Concussion in Youth Sport Questionnaire
 122 (abridged here).

Question	Correct responses of participants based on group (%)		
	Rugby Union (n=20)	Gaelic Football (n=20)	Coaches (n=8)
1. A concussion is a...	80	80	100
2. When can concussions occur?	85	80	95
3. How do you identify a concussion?	85	60	75
4. Which are signs of a concussion ?	95	75	100
5. Which are symptoms of a concussion?	95	85	100
6. Consequences of a previous concussion?	90	90	95
7. First thing to do when player has sustained a blow to the head and isn't acting right?	80	80	100

8. Which are signs of a severe concussion and requiring emergency treatment?	85	80	95
9. When can an athlete return to play after a concussion?	65	45	75
10. When should athlete's parents know about the possible concussion?	85	80	100
11. How can you help prevent concussions?	70	75	95
Mean score (SD)	83.18 (9.29)	75.45 (12.54)	93.64 (9.51)

123

124 As can be seen in Table 1, knowledge of concussion levels in university level players and coaches
 125 in Scotland was quite high overall, nevertheless, there were some important misconceptions –
 126 particularly surrounding return to play after a concussion, and identifying concussion. To test
 127 whether the observed difference in means between groups (Rugby union, Gaelic-football, Coaches)
 128 was statistically significant, we performed a one-way analysis of variance. There was a significant
 129 main effect for group ($F=8.22$, $p<0.01$); post-hoc analyses demonstrated a significantly higher
 130 proportion of correct responses from coaches in comparison to Gaelic-football players ($p<0.01$).
 131 Whilst approaching significance ($p=.068$) there was no significant difference in knowledge between
 132 coaches and rugby-union players, and there was no difference in concussion knowledge between
 133 Gaelic football and rugby union players.

134 With respect to coaches, we found all could identify the signs of a concussion, and most (95%)
 135 were correct in identifying when concussion can occur. All coaches were aware of the procedures to
 136 follow in the event of a concussion and that they should tell parents immediately. In contrast to
 137 guidelines, however, 25% of coaches believed that an athlete could return to play immediately after
 138 being evaluated by a health care professional.

139 With respect to players, 40% of Gaelic footballers were unaware that a concussion was identified
 140 by watching for a change in the athlete's behavior, thinking, or physical functioning. Similarly, 25%
 141 of Gaelic footballers were not aware that "if the athlete appears stunned, is unsure of the game, score,
 142 or opponent, is confused about their assignment or position, and is answering questions slowly" they
 143 may be suffering from a concussion. 20% both rugby union players and Gaelic footballers had
 144 incorrect beliefs of what a concussion is and the same proportion considered that organizers should
 145 "allow an athlete to finish the game and then seek medical attention". 35% rugby union players and
 146 55% Gaelic footballers did not know that organizers should not allow an athlete to return to play as
 147 soon as they are feeling better.

148 Discussion

149 Knowledge of concussion in our sample of University level sportsmen was insufficient in
 150 various areas. Coaches scored better than players on almost all aspects of concussion, and their
 151 knowledge was significantly superior to Gaelic football players. There were, nevertheless, important
 152 gaps in knowledge of concussion even in coaches, even when asked using a forced-choice response
 153 format, which is less demanding than generating answers from memory. Our results corroborate
 154 previous findings [18,24] that athletes and coaches across various sports hold misconceptions
 155 surrounding concussion. Misunderstandings were particularly pertinent in the two questions asking
 156 about identifying a concussion, and returning to play after a concussion. This presents a hazard to
 157 health for the large numbers known to engage in contact sports at University, and indicates
 158 intervention towards improving knowledge.

159 Regarding identifying a concussion, it is important for players and coaches to know that the
 160 hallmarks of concussion are confusion and amnesia [6] and that these can be recognized on the field,

161 and in the community. Nearly one-quarter of coaches in this study considered that *looking at scans of*
162 *an athlete's brain* was the way to diagnose a concussion. But they are not alone in their mistake: a
163 similar study found 50% Italian soccer coaches identified brain scans as the primary method to detect
164 concussions [17].

165 The majority of players and all coaches knew that after a blow to the head or body an athlete
166 must be immediately removed from play to look for symptoms of concussion; the athlete must not
167 be allowed to play on before taking a medical examination. This is reassuring, in that even though
168 one fifth of players, a similar figure to previous studies [15,19,24] believed it was acceptable to
169 continue playing while experiencing concussion symptoms, a knowledgeable coach would remove
170 them from play. Linked to this, more than 90% of the sample understood that a history of concussion
171 increases the likelihood of a recurring injury.

172 From our data, we found most errors in knowing when it is safe for an athlete to return to play.
173 All athletes who have experienced concussion should have a medical examination [25], and it is this
174 that should determine the extent of need for rest and rehabilitation according to severity. Return to
175 play is determined by a six-step procedure and a player must be asymptomatic before being allowed
176 to return to play [25,26]. In our study, not all coaches were on board with these guidelines, and
177 similarly just under half of players were aware of the mandatory return-to-play guidelines [26]. It has
178 previously been reported that 40% of high school athletes return to play prematurely after a reported
179 concussion [16], indicating there may be a fundamental attitude problem underlying this misconception.

180 Return to play guidelines are an important part of tackling the negative impact of sport-related
181 concussion. Warnings of the susceptibility for a second impact changing a relatively minor
182 concussion into a catastrophic brain injury, have been in the literature since at least 1984 [13],
183 accompanied by authoritative guidelines on management of concussion [6] and return to play [25].
184 Nevertheless, our findings demonstrate that a substantial number of athletes perceive it to be safe to
185 return to play as soon as they feel better.

186 Failing to follow return to play guidelines can be explained in two ways: by lack of knowledge
187 of the guidelines, and by an imprudent attitude towards the consequences of concussion. With
188 respect to knowledge, there have been various campaigns [21,22,27] to improve concussion
189 education. Nevertheless high rates of concussion in contact sports continue to be reported. It has been
190 noted that there has been limited research supporting the effectiveness of these programmes [23,28],
191 and in particular a prospective study of concussion education in university level ice hockey players
192 in US found no significant improvements in knowledge, and called into question the education
193 process [28]. It is plausible that athletes who have been educated on concussion have not assimilated
194 the information, because it is at odds with their attitudes to concussion and sporting behaviour. That
195 is, premature return to play is due to attitudes that encompass a desire to succeed, and not wanting
196 to let the team down, and other similar pressures [24,27,29]. Such possibilities can be satisfactorily
197 explained with reference to cognitive dissonance theory [30]. To illustrate: consider that those
198 voluntarily involved in university level contact sports feel that playing football / rugby, etc. is
199 enjoyable, and they believe that participation is an important support for their health and wellbeing.
200 Thus, their behaviour on the field is that they fully engage with all aspects of the game. If then, as a
201 player or as a coach, they are presented with an injury on the field, the belief that they should stop
202 play is a threat to their more heavily reinforced belief that playing is good. That is, the person has
203 two opposing cognitions: playing is good and stopping play now is good. Since these two cognitions
204 cannot be reconciled, one has to change. Studies on attitude have found that once formed they are
205 resistant to change, which can explain why the cognition *playing is good* may prevail unless the
206 magnitude of dissonance is sufficiently raised by an affective appreciation of stopping play now
207 would be more beneficial to them regardless of negative impact on game and team.

208 It follows from this that modes of education around concussion require more than presenting
209 bald facts and directions, but also a consideration of existing attitudes and that they are ultimately
210 based upon the social norms of their team sport. Social norms are learned, socially based rules that
211 prescribe behavior in a given situation, and on the sports field it is that one fully engages in the team

212 game. Stopping play also presents a challenge to behaving in line with given social norms, as well as
 213 one's own attitude, and unrealistic optimism about their own comparative level of risk.

214 Conclusions

215 In conclusion, whilst appreciating the limitations of this study in terms of sample type and
 216 size, the findings reported here illustrate there are misconceptions in knowledge of concussion
 217 among university level athletes and coaches, and we provide a robust, theory-based explanation,
 218 for the persistently high levels of inappropriate reaction to sport-related concussion [20]. The
 219 recommendations that flow from the explanation is for improved educational tools that take into
 220 account existing attitudes to benefits and risks in playing contact sports; this can be generalized to
 221 other groups playing contact sports. Perhaps we can learn from previous social norms media
 222 marketing strategies successful at changing health behaviors with respect to tobacco usage [31],
 223 drink driving [32] and sugar consumption [33]. In turn, this may reduce the prevalence of TBI.

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