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Concussion knowledge and attitudes amongst competitive cyclists

Jack Hardwicke[1], Howard Hurst[2]

[1] University of Winchester

[2] University of Central Lancashire

* Correspondence: Jack Hardwicke. J.Hardwicke.15@unimail.winchester.ac.uk

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Abstract: The purpose of this study was to examine the concussion knowledge and attitudes of UK competitive road cyclists to identify gaps in knowledge and assess attitudes. This was a cross-sectional study using 118 UK competitive cyclists, spanning a range of ages and abilities. An adapted Rosenbaum Concussion Knowledge and Attitudes Survey (RoCKAS) was administered to the participants. The RoCKAS contained separate knowledge and attitude sections (possible scores ranged from 0-33 and 15-75, respectively). A cohort analysis was conducted to examine for differences in attitudes amongst the participants. The mean score for concussion knowledge was 26.4 ± 4.12 and 63.1 ± 6.4 for concussion attitude. Statistically significant differences were found in attitudes between the 49-58 age group and the 19-28 age group ($p=0.013$). Significant differences were also found between competitive cyclists and recreational cyclists who trained but did not race. The results of this study suggest that UK competitive cyclists have moderate concussion knowledge and good concussion symptom recognition. A cohort analysis shows that youth are less concerned about concussion than older participants and higher ability groups were associated with more dangerous attitudes. These findings can help inform targeted educational interventions in cycling to improve concussion awareness, reporting behaviors, and concussion management behaviors.

Keywords: Concussion; survey; cycling; attitudes; concussion reporting

1. Introduction

There is debate amongst fields on the medical classification of a concussion (Meehan, 2017). This is because it exists as a term which captures some of the symptoms of traumatic brain injury and is classifiable by the event which causes it. Yet, traumatic brain injury can also exist without symptomology, complicating the classification of the injury (McCrory et al. 2013).

Terminology here is important, with research demonstrating the impact the different terms, concussion and traumatic brain injury, can have on athlete perception on severity of injury (See; McKinlay et al. 2011; Weber & Edwards, 2010; Kelly & Erdal, 2016; Sussman et al. 2018).

Recognising the influence of terminology, concussion is the chosen term in this paper to remain consistent with the terminology used in data collection, but it is acknowledged that the term is representative of one element of traumatic brain injury.

The 2017 Concussion in Sport Group defined concussion as a traumatic brain injury caused by brain trauma from a biomechanical load that leads to micro-level structural damage, inhibiting the brains ability to function normally (McCrory et al. 2017). A concussive injury can be seen through a range of short-term symptoms such as somatic (e.g., headache), cognitive (e.g. feeling like in a fog, slowed reaction times) and/or emotional symptoms (e.g. lability, irritability) (McCrory et al. 2017) but again, there may also be no symptoms at all. This makes determining what is a concussive and what is a sub-concussive impact or jarring of the brain, difficult to determine.

Despite this diagnostic and definitional difficulty, research shows that both concussive and sub-concussive injuries pose long-term effects for brain health (See; Esterov & Greenwald B, 2017; Farrell et al. 2019; Wilson et al. 2017; Moore et al. 2017).

While one concussion can leave an individual with debilitating brain injuries that remain symptomatic for life, the vast majority of consequences of repetitive brain trauma occurs later in life (McKee et al. 2011).

Researchers have found a range of neurodegenerative diseases that are over-representative among contact-sport athletes: including, Chronic Traumatic Encephalopathy (CTE) (Kiernan et al. 2015), Dementia (Kulkarn et al. 2019), Alzheimer's (Taghdiri et al. 2019), Parkinson's (Jafari et al. 2013) and Multiple Sclerosis (Montgomery et al. 2017). The growing concern over long-term chances of acquiring these neurodegenerative diseases from multiple types of behaviors that occur in many sports, alongside the cultural esteem that competitive sport has in culture (Anderson & White 2018) makes this a significant, contemporary, culture concern.

Within the USA, research indicates that 1.6-3.8 million diagnosed concussions occur in sport activities annually (Daneshvar et al. 2011); however, comparable data from the UK is not currently available. This estimated figure becomes more significant in that research also estimates as much as fifty per cent of concussions go unreported (Harmon et al. 2013).

Possible reasons for this underreporting and non-reporting are multifaceted. Lower levels of concussion knowledge and awareness can lead many athletes to be unaware their injury is symptomatic of concussion (Williams et al. 2016). The belief that concussion does not present a serious injury can also lead to underreporting (Baron et al. 2013). Further factors, such as athletic identity (Wayment et al. 2019), sex (Weber et al. 2019; Merritt et al. 2019) and subscribing to team sporting cultures (Baron et al. 2013), are receiving more research interest for explaining concussion management behaviors and underreporting.

With the concerns around the brain health of contact sport athletes occupying most of researchers' attention, various forms of cycling have been under-examined. However, in 2019, British Cycling had 150,000 active members representing a three-fold increase since 2012, and the largest recorded membership base since its establishment (British Cycling, 2019). While the participant figures are not as much as mainstream sports; the various forms of cycling still occupy a large percentage of athletic endeavors by people in the United Kingdom. It is therefore important that cycling sports be included in research focused on brain trauma. To date, there is very little research in this area (See; Elliott et al. 2019)

Exemplifying the importance of studying cycling and brain trauma, in Mountain Biking and BMX, Hurst and colleagues (Hurst et al. 2018a, 2018b) reported that these athletes may be at risk of sub-concussive brain trauma that is measured through reduced executive functioning. They theorise this to be due to the external loads experienced from the demands of the terrain and excessive head movements. Road cycling is also recognised as having high rates of traumatic injury (De Bernardo et al. 2012; Barrios et al. 2014) and we are seeing increasing concern with concussion in this discipline also (Heron et al. 2019)

The field of concussion in competitive cycling is in its infancy; as such, there is limited data on the incidence rates of concussion. Work from Rice and colleagues (2020) found from a sample of 780 recreational and competitive cyclists in the USA, 408 suffered a crash over a two-year period and 77 of these sustained a concussion described through experiencing 17 of the 22 symptoms on the Sport Concussion Assessment Tool 3 symptom checklist. Hurst and colleagues (2018) found in a sample of 1990 competitive cyclists and cycling stakeholders, 526 (26.6 per cent) reported having a cycling-related concussion formally diagnosed and 629 (31.7 per cent) reported having a suspected cycling-related concussion without formal diagnosis. Earlier work from Decock and colleagues (2016) in road cycling, suggests that between 5-13 percent of all cycling injuries involved a diagnosis of concussion.

With limited central management of these injuries in competitive cycling, studies, at current, rely on self-reporting methods to ascertain incidence rates of concussion. This is coupled with the limited concussion policy in place in the sport (Heron et al. 2019), regardless of ability or discipline (Hurst et al. 2019). Therefore, this study adds to this limited field through an investigation of concussion knowledge and attitudes in UK competitive road cyclists to greater understand the problem, and concussion reporting intentions.

2. Materials and Methods

2.1 Participants

The study consisted of a cross-sectional cohort of 118 athletes from the UK involved in competitive road cycling, with a range of ages and abilities (See Appendix A). Participants for the study were achieved through the distribution of a survey via social media outlets, such as Twitter and Facebook, where it was advertised on cycling pages and groups.

2.2 Procedures

An amended version of the RoCKAS instrument (Rosenbaum & Arnett 2010) was recreated on JISC's Online Surveys (Jisc 2020) and administered to assess knowledge and attitudes towards concussion in road cycling. The version used for this study removed questions referring to field sports, instead replacing them with road cycling specific questions.

Because social desirability has the potential to influence the attitudes section of this survey, Rosenbaum and Arnett (2010) validated the questionnaire against the Marlowe-Crowne Social Desirability Scale. No significant relationship was found between the two measures ($p > 0.05$, $r = 0.09$), indicating the instrument was a valid indicator of attitudes towards concussion without influence of social desirability. Furthermore, the instrument has high test-retest reliability and has undergone extensive psychometric testing and is therefore is a valid and reliable instrument (Williams et al. 2016).

The survey comprised of five sections. Section one obtained demographic data and concussion incidence and training (See Appendix A and B). Section two, three and five assessed concussion knowledge through 33 true/false statements to produce a concussion knowledge index score (CKI). Section two used 15 basic items (e.g. "After 10 days, symptoms of a concussion are usually gone") and section three used three applied items based on a sport scenario that had been adapted for road cycling.

Section five contained a checklist of eight commonly reported post concussive symptoms (e.g. headache) and eight distractor symptoms (e.g. hives). The legitimate post concussive symptoms are among the most reported symptoms by concussed athletes (Guskiewicz et al. 2000; McCrea et al. 2003). Correctly answered items received one point, and incorrectly answered items received no points. The Concussion Knowledge Index (CKI) was derived by summing the scores across sections two, three and five. Possible scores range from 0-33, with higher scores indicating higher levels of knowledge.

Section four of the survey assessed attitudes through 15 items, each with a five-point Likert scale ranging from "strongly disagree" to "strongly agree". This was broken into two sections, the first section assessed personal opinions through 5 basic items (e.g., "I feel that coaches need to be extremely cautious when determining whether an athlete should return to play"). The second section used 10 applied opinion items based on sport scenarios; again, these had been adapted to be specific to road cycling. Like the applied knowledge questions, participants were provided a road cycling specific scenario and then a range of statements they could respond to on the five-point Likert scale to signify the extent they either agreed or disagreed with the statement. Participants received 1 to 5 points for each item, depending on the safety of their response (1 point for a very unsafe response and 5 points

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for a very safe response). The scores from section four comprised the Concussion Attitudes Index (CAI). Possible scores of the CAI ranged from 15-75, with higher scores representing safer attitudes (Rosenbaum & Arnett 2010).
Acknowledging the validity issues with self-report surveys (Li et al. 2020), the instrument used for the current study included seven items to assess inconsistent responses and/or lack of engagement in responding to questions, which produced the validity scale. Correct responses warranted 1 point, and incorrect responses 0 points for the true/false items and higher scores on 1-5 Likert scale items indicated the correct answer (Rosenbaum & Arnett 2010). The validity index was derived from summing the total score from the seven items and dividing this figure by 7. Validity index scores of two or above are considered valid. Nine subjects had scores below this threshold and were taken out the data before analysis, leaving a sample of 118.

2.3 Data analysis

All data were exported from JISC's online surveys (Jisc 2020) to Microsoft Excel 2016 (Microsoft corp 2016). Data were then analysed using IBM SPSS Statistics 26 (2020). Descriptive statistics were generated to assess participant knowledge and attitudes. Mean ± standard deviation is presented for CKI (0-33) and CAI (15-75) scores, along with the frequency and percentage of respondents who answered correctly to concussion knowledge items (See Appendix C).
The study also examined for cohort differences in attitude scores. Two independent variables, age and ability, were run as separate tests against the dependent variable (CAI scores) to ascertain any significant differences. The sample data (n=118) was deemed not normally distributed, calculated using a Kolmogrorov-Smirnov test (p=0.04). As such, nonparametric Mann-Whitney U tests were run to establish any statistically significant differences in concussion attitudes between groups. The Alpha level was set at $p \leq 0.05$.

2.4 Ethics

Ethical approval for the study was granted following Faculty level review from the Faculty of Health and Wellbeing at the University of Winchester, UK (reference number: HWB_REC_20_04). Online resources for more information on sports-related concussion, and appropriate recovery protocols following a concussive injury, were signposted at the end of the survey for participants that may have been affected by concussion. A participation information sheet was provided as a pre-amble to the survey and given its on-line procedure, the ability to withdrawal was salient. Participants were not required to give written permission to be part of this study.

3. Results

3.1 Concussion knowledge and attitudes
The sample of 118 was male dominated (89%), with the highest concentration of responses being in the 19-28 age group (40%). All respondents were UK based, and had been involved in competitive road cycling in some capacity. Appendix B presents the incidence rates and level of formal training on cycling related concussion.
The mean score for the CKI was 26.4 ± 4.12. Looking at concussion knowledge, the most correctly identified general knowledge items were 'Symptoms of a concussion can last for several weeks' (True; 98.3%), 'If you receive one concussion and you have never had a concussion before, you will become less intelligent.' (False; 99.1%) and 'Concussions can sometimes lead to emotional disruptions.' (True; 97.5%). The most correctly identified symptoms of concussion were 'headache' (True; 96.9%), 'dizziness' (True; 95.3%) and 'difficulty concentrating' (True; 94.3%).
Of the incorrect responses, the most common misperceptions in general knowledge were An athlete who gets knocked out after getting a concussion is experiencing a coma.' (True; 13.6%), 'After a concussion, people can forget who they are and not recognise others but be perfect in every other way.' (False; 26.3 %) and 'After a concussion occurs, brain imaging (e.g., CAT Scan, MRI, X-Ray, etc.)

typically shows visible physical damage (e.g., bruise, blood clot) to the brain.' (False; 32.2%). The most incorrectly identified symptoms of concussion were 'Difficulty Speaking' (82%), 'Panic Attacks' (26.5%) and 'Reduced Breathing Rate' (18.7%).
Mean score for the CAI was 63.1 ± 6.4. With regard to attitudes towards concussion, the safest and most desirable responses were related to being cautious when determining whether an athlete should return to play following a concussion (Agree; 96.6%), that concussions are less important than other injuries (Disagree; 94.1%) and that athletes should report symptoms to coaches or medical personnel (Agree; 94.9%). The least desirable and dangerous attitudes were participants stating they would continue to compete following a concussion (Agree; 23.4 %; Neutral; 11.1 %).

3.2 Cohort analysis of attitudinal differences

3.2.1 Age differences

A Mann-Whitney U test showed a statistically significant difference (U=130.5, p=0.013) between two age groups, with the CAI scores being greater for the 49-58 age group (n=11) than the 19-28 age group (n=46). The mean CAI score for 19-28 was 61.4 ± 6.7, compared to 67.2 ± 5.5 for the 49-58 group. All other age groups were tested, with no significant statistical differences.

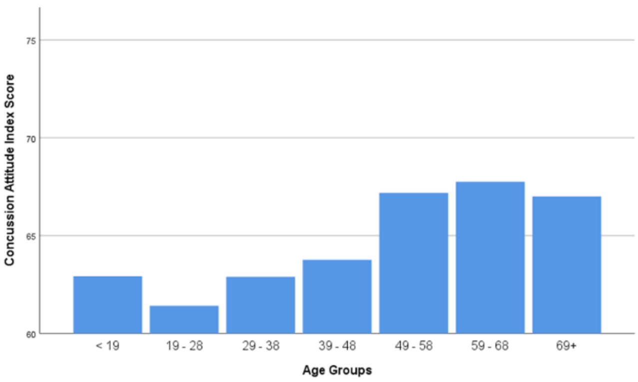

Figure 1: Mean concussion attitude index (CAI) scores by age groups

3.2.2 Ability differences

Mann-Whitney U tests showed statistically significant differences between ability groups. Tests showed that there was a statistically significant difference (U=33.5, p=0.045) between first category riders (n=11) and recreational riders (n=12) for CAI scores (mean CAI score were 62.4 ± 6 and 68.3 ± 5.8 for first category and recreational riders, respectively).

There was also a statistically significant difference (U=91.5, p=0.009) between second category riders (n= 31) and recreational riders (n=12) in CAI scores. The mean CAI score for second category riders was 62.1 ± 6.2, compared to 68.3 ± 5.8 for recreational riders.

Further, the difference was also seen (U=64, p=0.042) between third category riders (n= 19) and recreational riders (n=12) in CAI scores. The mean CAI score for third category riders was 63.2 ± 7.3, compared to 68.3 ± 5.8 for recreational riders.

There was a statistically significant difference (U=67.5, p=0.019) between those that race outside the British Cycling system (n= 22) and recreational riders (n=12) in CAI scores. The mean CAI score for those racing outside the British Cycling system was 63.4 ± 5.8, compared to 68.3 ± 5.8 for recreational riders.

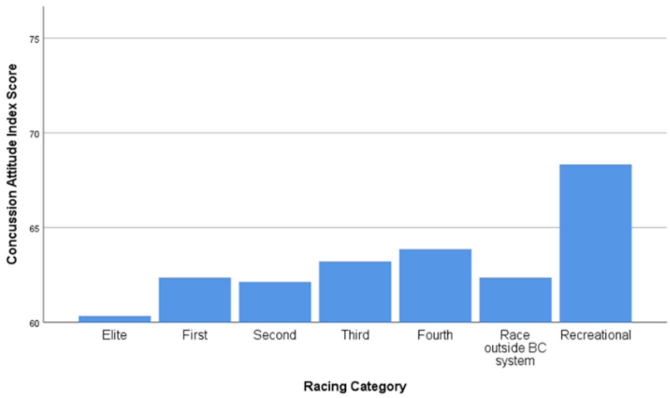

Figure 2: Mean concussion attitude index (CAI) scores by racing category

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4. Discussion

This study aimed to assess the extent of concussion knowledge and attitudes held by competitive cyclists in the UK along with any cohort differences in attitudes towards concussion. Over half of the respondents (54.2%) had experienced a concussion, or a suspected concussion, because of a crash; and much of the cohort had not received any training on concussion (71.9%). Using inferential statistical analysis, statistically significant differences were found in attitudes between age and ability groups.

The concussion knowledge index data suggests this cohort of UK competitive cyclists had moderate levels of knowledge compared to those seen in other sports, and the general population (Weber & Edwards 2012; Register-Mihalik et al. 2013; Krohus et al. 2013). Indeed, the current study presents some higher scores than seen in other studies, with a mean CKI of 78.8%. The study by Hurst and colleagues (2018) found an almost identical score in an international sample of cyclists and cycling personnel (78.5%). Compared to other sports, the current study's score was higher than those reported in English professional football players (65.6%) (Williams et al. 2016), Irish amateur and semi-professional football players (74.8%) (Gallagher & Falvey 2017), amateur South African rugby players (65.9%) (Viljoen et al. 2017) and amateur American motocross riders (63.8%) (Miller et al. 2016)

When comparing to other sports, the modifications to the RoCKAS to make it cycling-specific should be considered. However, UK competitive cyclists appear to demonstrate sound concussion knowledge. In terms of correct symptom recognition, this study suggests UK competitive cyclists have a good grasp of concussion signs and symptoms, with a mean reporting of 7.2/8 of the correct symptoms, these present higher scores than previous studies in other sports (Valovich et al. 2007; Fraas et al. 2014)

A notable misperception in concussion general knowledge included 59.3% not believing that a person is more likely to suffer another concussion following a first incidence, despite research demonstrating this (Zemper 2003; Guskiewicz et al. 2003). This is significant as it could have implications on athletes deciding to continue riding following a crash and suspected concussion, both in training and in competition.

The cohort analysis sought to greater understand any demographic variables in concussion attitudes within the sample. Significant differences were found in responses according to age groups, with safer attitudes being associated with older age groups.

These results fit with research seen in the literature that risky behaviours are more associated with younger age groups (Turner & McClure 2003). Rhodes and Pivik (2010) conducted a phone survey of 504 teen (age 16–20) and 409 adult (age 25–45) drivers in the USA. They found riskier behaviours were more frequently expressed within the teen cohort. Much of the literature is situated in research of risky behaviours in age groups motor-vehicle use, with little specific work on age differences in sports-related concussion. One study by Mrazik and colleagues (2015) found in a sample of Hockey players that younger athletes were more likely to ignore best practice and hold fewer desirable attitudes towards concussion.

An alternative interpretation is that those in the older cohort may have experienced more crashes and concussions, resulting in a more cautious approach. Further, this cautious approach may be compounded by more responsibilities associated with the older cohort, such as jobs and family commitments. Regardless of the reasons, further research is required in sports-related concussion to greater understand the processes behind these age differences, and if it is universal across sport. In competitive road cycling, it seems greater emphasise must also be placed on the education of younger riders to address this apparent gap in attitudes.

The ability of the participants was also analysed for any attitudinal differences. This was obtained through participants indicating their level of ability based on the British Cycling race categorisation system, which provides an insight to the experience and ability of the athletes. The option of racing outside of this system or being a recreational cyclist was also provided. Recreational cyclists here represent those that are engaged with the competitive cycling community, but do not race.

There is limited literature on the impact of ability level on concussion attitudes held by athletes. Hurst and colleagues (2018) found participants involved in competitive cycling favoured performance over health in attitudes towards concussion, whilst Wijlhuizen and colleagues (2016) found competitive attitudes typically held by cyclists had an influence on the frequency of crashes. In a study of university students on a sports course, in Australia, students believed that elite athletes that continued to play following a concussion were to be admired and viewed as living up to the expectations of elite-level sport (Pearce et al. 2016). They also indicated they would also adopt these behaviours. Thompson and Carlson (2014) found self-perceived proficiency was associated with increased patterns of risky behaviours in skiers and snowboarders.

This study shows that those involved in competitive cycling were associated with less desirable and unsafe attitudes towards concussion compared to cyclists that did not race. This finding concurs with the literature on competitive sport propagating performance over bodily health, and normalising pain and injury (Curry 1993; Loland et al. 2012; Sabo 2009)

Additionally, within competitive cycling, this study found that the higher abilities in the sport were more associated with the dangerous attitudes towards concussion. The reasons for this may be multifaceted and require further research. One possible explanation is the increased self-perceived proficiency of higher-level athletes, which has been shown to be associated with high propensity to engage in risky behaviours (Thomson & Carlson 2014)

5. Practical Applications.

This study provides insight to the state of concussion knowledge and attitudes, specifically amongst UK competitive road cyclists. Knowledge was moderate in the cohort, but dangerous attitudes were present regarding continuing in competition following a concussion. Youth participants displayed less concern for concussion than older participants. Further, being involved in racing was associated with more dangerous attitudes towards concussion, which increased with the higher ability participants.

The findings align with wider research that knowledge of concussion symptoms in sport may not be of major concern (Chrisman et al. 2013; Register-Mihalik et al. 2013; Frass et al. 2014) Rather, the translation of knowledge and safe attitudes into action may be of greater concern. This study therefore supports the need for interventions to target behavioural outcomes of competitive cyclists, with more emphasis on attitudinal changes than solely knowledge-based resources.

6. Limitations

Further research is needed with larger sample sizes to establish the reasons for the differences found in this study. The data used was gained from a self-reporting survey, which has potential to suffer from social desirability bias.

The lead researcher acknowledges the limitations of the RoCKAS as an instrument to measure concussion knowledge and attitudes (Chapman et al., 2018; Williams et al., 2016). Despite these limitations, it is the only validated instrument currently available. For this reason, the study used this instrument but acknowledges its limitation in measurement. For this preliminary study into the UK competitive cycling context, it provided a validated instrument which can be used in comparison to other sports, and as an extension to the work of Hurst and colleagues (2018).

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Appendices

Appendix A: Participant demographics

Characteristic (Total number of participants)	n= Frequency (%)
Sex (n=118)	
Male	105 (89)
Female	13 (11)
Other	0 (0)
Prefer not to say	0 (0)
Age (n= 115)	
< 19	12 (10.4)
19-28	46 (40)
29-38	19 (16.5)
39-48	21 (18.3)
49-58	11 (9.6)
59+	6 (5.2)
British Cycling race category (for the 2019 season) (n=115)	
Elite	6 (5.2)
First cat	11 (9.6)
Second cat	31 (26.9)
Third cat	19 (16.5)
Fourth cat	14 (12.2)
Recreational cyclist (Not raced before)	12 (10.4)
I race outside of the British Cycling System	22 (19.1)

Appendix B: Incidence and training of cycling related concussions

Concussion item (Total number of respondents)	n=Frequency (%)
Have you ever had a concussion or suspected that you had a concussion as a result of a crash? (n= 118)	
Yes	64 (54.2)
No	54 (45.8)
Have you ever undertaken any training on concussion? (n= 118)	
Yes	28 (23.7)
No	84 (71.9)
Not sure	6 (5.1)

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Appendix C: Frequency of correct responses to knowledge items

Please read the following statements and tick TRUE or FALSE for each question.	n=Frequency (%)
There is a possible risk of death if a second concussion occurs before the first one has healed. [True] (n=118)	101 (85.6%)
People who have had one concussion are more likely to have another concussion. [True] (n=118)	48 (40.7 %)
In order to be diagnosed with a concussion, you must be knocked out. [False] (n=118)	110 (93.2%)
A concussion can only occur if there is a direct hit to the head. [False] (n=118)	89 (75.4%)
Being knocked unconscious always causes permanent damage to the brain. [False] (n=118)	102 (86.4%)
Symptoms of a concussion can last for several weeks. [True] (n=118)	116 (98.3%)
Sometimes a second concussion can help a person remember things that were forgotten after the first concussion. [False] (n=118)	94 (79.7%)
After a concussion occurs, brain imaging (e.g., CAT Scan, MRI, X-Ray, etc.) typically shows visible physical damage (e.g., bruise, blood clot) to the brain. [False] (n=118)	38 (32.2%)
If you receive one concussion and you have never had a concussion before, you will become less intelligent. [False] (n=118)	117 (99.1%)
After 10 days, symptoms of a concussion are usually completely gone. [True] (n=118)	64 (54.2%)
After a concussion, people can forget who they are and not recognize others but be perfect in every other way. [False] (n=118)	31 (26.3%)
Concussions can sometimes lead to emotional disruptions. [True] (n=118)	115 (97.5%)
An athlete who gets knocked out after getting a concussion is experiencing a coma. [True] (n=118)	16 (13.6%)
There is rarely a risk to long-term health and well-being from multiple concussions. [False] (n=118)	98 (83.1%)