COMPARISON OF KNOWLEDGE, PERCEPTION, AND ATTITUDES OF CONCUSSION IN CONCUSSED VERSUS NON-CONCUSSED YOUTH SOCCER PLAYERS

By

CAITLYN NICOLE MYRDAL

_____

A Thesis Submitted to The Honors College

In Partial Fulfillment of the Bachelors degree
With Honors in

Neuroscience and Cognitive Science

THE UNIVERSITY OF ARIZONA

M A Y 2016

Approved by:

_____

Dr. Anna Waterbrook
Emergency Medicine, Sports Medicine

Comparison of knowledge, perception and attitudes of concussion in previously concussed versus non-concussed youth soccer players

Caitlyn N. Myrdal; Anna Waterbrook, MD.

ABSTRACT

BACKGROUND: Concussions in youth sports are growing in prevalence. This “invisible injury” can cause permanent brain damage and even death. An increased understanding of how youth athletes view the injury is imperative in improving education and developing more effective return-to-play protocols.

OBJECTIVE: To examine if history of concussion is associated with a difference in knowledge, attitudes, and perception of concussive injuries in youth soccer players.

METHODS: We conducted a survey of youth soccer players aged 14 to 18 years. Players were recruited from Tucson Soccer Academy in Tucson, Arizona.

RESULTS: Surveys were obtained from 90 athletes, with 32 (36%) previously sustaining at least one concussion. On average, participants responded “correctly” to 77% of attitude questions and 81% of knowledge questions. There was not a significant difference in knowledge of or attitude towards concussion between previously concussed and non-concussed athletes; however, females scored significantly higher on knowledge questions than males.

CONCLUSIONS: This study shows a high level of awareness of concussion in youth soccer players, while still highlighting a need for education. Limited distinctions were made among subgroups of players, suggesting directions of future research in investigating the role, if any, outside factors have on knowledge and perception of concussion.

INTRODUCTION

It is estimated that approximately 7.8 million high-school aged individuals participate in competitive sports in the United States each year [1]. Second to motor vehicle crashes, sports are the leading cause of traumatic brain injury in individuals aged 15 to 24 years, contributing to an estimated 300,000 sport-related TBIs annually [2]. Traumatic brain injuries occur at the highest rates in the

sports of football and soccer for males, and soccer for females [2]. As the number of youth athletes who participate in sports increases annually, the number of reported head injuries rises as well. Traumatic brain injury proves to be a significant risk for anyone who plays competitive sports, especially football or soccer. A majority of the traumatic brain injuries seen each year are concussions or other mild forms of TBI. A concussion is a type of brain injury caused by a bump, blow, or jolt to the head, causing the brain to move quickly back and forth in the skull [3]. Concussive injuries have a range of symptoms, including but not limited to: headache, amnesia, confusion, difficulty concentrating, temporary loss of consciousness, irritability, and various psychological adjustment problems. Symptoms generally last for days, weeks, or months depending on the severity of the injury. Although most symptoms resolve in a few weeks, long-term problems can be seen in athletes who suffer multiple concussive injuries. Concussive injuries can be thought of as 'additive', and thus, individuals with multiple consecutive brain injuries may present with lasting and progressive impairment in brain function. Second impact syndrome (SIS), rare but usually fatal, occurs when an individual experiences a second blow to the head before the signs and symptoms of a first concussion have resolved. A second injury may result in rapid and fatal brain swelling [4]. Some studies suggest that youth athletes are more susceptible to concussion than adults, partially because their brains are not fully developed and are more vulnerable to injury. Consequently, young adults take longer to recover from a concussion and thus are at higher risk for a second concussive injury to occur before the first resolves [5, 6, 7].

Past research has suggested the need for increased education on the dangers of traumatic brain injury, as it was found that many players and parents don't completely understand the definition of a concussion, the symptoms, or the return to play protocols [8, 9, 10, 11]. In a survey of youth athletes, four out of five players reported that they have heard about concussions, however, only one-fourth of them reported a basic understanding of the injury [8]. Additionally, it has been reported that there are often misconceptions about traumatic brain injuries in the general public [12, 13]. This misconception has also been consistently reported in youth athletics. Whether it is indirect pressure from the coach or parents to continue playing, pressure from teammates, or personal perception of the severity of the injury, many studies suggest that youth athletes find reporting a concussion as

unimportant, or even cowardly. These misconceptions, paired with the lack of knowledge of concussive injuries, may influence the self-reporting rates of athletes with a concussion [14, 15, 16, 17]. The literature has highlighted a need for increased education and strict return to play protocols in hopes to decrease the morbidity of concussion in youth sports.

As discussed, there is an abundance of literature focusing on knowledge of concussion in youth athletes, their parents, trainers, and even coaches. Additionally, there has been an emphasis on investigating self-reporting attitudes and accompanying perception of concussion in youth athletes. However, little has been focused on examining the differences in attitude, knowledge, and self-reporting attitudes of athletes who have received a concussive injury in the past as compared to athletes who have not.

The purpose of this study is to examine the differences in knowledge, attitudes, and perceptions between previously concussed youth soccer players and players who have never received a concussion. Additionally, we will examine if previously concussed athletes will be more likely to self-report a possible concussive injury. Examining whether or not these attitudes towards concussions differ between athletes based upon their personal history of prior concussion will provide a better understanding of self-reporting behavior and give insight into the effect of previous concussions on an athlete's perception and knowledge of the injury. The better we are at understanding athletes' knowledge, perceptions, and attitudes about concussion and minor head injuries, the better we will be able to develop methods to increase concussion education and awareness amongst athletes and help to reduce the pressures to minimize, or even ignore, this important injury. We hypothesize that athletes who have sustained prior concussive injuries will be more knowledgeable about concussions, have less misperceptions about concussions, and will be more likely to self-report their injury.

METHODS

Design

This was an in-season survey of youth soccer players who participate in the Tucson Soccer Academy (TSA) club organization. The survey was designed to assess the athletes' knowledge, perception, and attitudes of concussion while additionally asking athletes to recall previous concussion-like events and subsequent treatment. Institutional Review Board approval was obtained before administration of the survey and TSA board approval was obtained prior to recruitment of the athletes.

Participants

Youth athletes were recruited from TSA in Tucson, Arizona. Recruitment occurred during the soccer season. All of the athletes, both males and females, were high school aged and ranged from 14 to 18 years old. Of the 257 registered club soccer players, 92 completed the survey after written, informed consent was obtained from both the players and their legal guardians.

Instrument

A survey using various modified questions from prior studies was developed to examine the athletes' knowledge and perception of concussion, self-reporting attitudes, and history of concussion. Please see Figure 1 for survey tool. The survey was broken up into three sub-sections: demographics, knowledge, and attitudes/perceptions. The first section requested basic demographic information of the participant and asked about history of concussions and subsequent treatment. The knowledge section asked participants to select symptoms of concussion from a list of possible choices. It also asked them to select the degree to which they agree/disagree with certain statements about the symptoms, complications and typical recovery course from concussion. Lastly, the attitudes/perception section assessed the participant's willingness to self-report a concussion, whether the player perceives reporting a concussion as cowardly or embarrassing, and whether there is a stigma amongst the team in self-reporting. To ensure clarity and effectiveness, members of the study team reviewed the questions prior to finalization of the survey.

Survey Administration

Participant recruitment spanned September through October of 2015. Assent and consent forms were given to players post-training along with a letter discussing the nature of the study. In order to recruit a larger number of participants, legal guardians of the players were personally addressed at practices and/or tournaments. Parental consent forms were collected and totaled for each team prior to survey administration, while minor assent forms were collected at the time of the survey administration. Survey administration occurred after practice at the Rillito training complex in Tucson, Arizona. The coaches of each team were contacted and notified of the nature of the study. On their preferred date, the survey was administered to the players. Participants who had a completed parent consent form were asked to stay after practice, while the others were allowed to leave. The participants were again given a verbal summary of the study. Prior to completing the survey, participants completed and handed in the minor assent form. Each participant received a printed copy of the survey and completed it in pen before returning it to one of the research investigators. All surveys were anonymous and the coaches were not permitted to see the individual responses. The results were recorded in an Excel spreadsheet and were separated by team, age, and gender.

Statistical Analyses

Primary analysis

Questions K2 – K7 and A1 – A7 form the "knowledge" and "attitudes/perceptions" questions, respectively. See appendix for complete survey tool. All items in question K2 were coded as 2 if chosen as a symptom of concussion, and 1 if otherwise, except for "nosebleed" and "fever" where the scale was reversed. All items within questions K3 to A7 were based on a 1 – 4 Likert scale, where 1 indicates "strongly disagree" and 4 indicates "strongly agree", except for questions K3, K5 and K7 where the scale was reversed. Questions A8 to A12 were based on a 1 – 5 Likert scale, where 1 indicates incorrect attitude and 5 indicates correct attitude, except for questions A2, A6 and A7 where the scale was reversed. Cronbach's alpha was calculated to measure the internal consistency of the "knowledge" and "attitude/perception" questions separately. Total scores for the "knowledge" and "attitudes/perceptions" questions were computed as primary outcomes, respectively. Total

scores for question K2 were also computed separately as an additional primary outcome. When using questions based on different scales to calculate the total score, individual responses were first standardized to have mean 0 and standard deviation 1.

Participants were categorized as “previously concussed” if they responded “yes” to the question “have you ever had a concussion”, and “non-concussed” if they responded “no” or “I’m not sure”. Simple linear regression models and multiple linear regression models adjusting for age and years of playing soccer were used to compare the unadjusted and adjusted difference in outcomes between previously concussed and non-concussed participants, respectively. To account for correlation among individuals within the same team, robust sandwich estimators were used to calculate standard errors using team as the clustering unit. Missing covariates were imputed using the sample mean from the non-missing values. For participants who answered at least half of the questions, missing responses were imputed using the mean response from the non-missing values in the sample.

Secondary analysis

To explore whether knowledge about and attitudes/perceptions towards concussion is different among participants who were uncertain about previous concussive injuries compared to those who were certain about their past injuries, participants who answered “I’m not sure” to the question “have you ever had a concussion” was categorized as a separate group in addition to those who answered definitively. The above linear regression analyses were repeated for the three-group comparison. Impact of previous education on concussion was investigated by comparing the primary outcome measures among participants who answered “no”, “yes”, or “somewhat” to the question “have you ever received education regarding the symptoms/risks/recovery of concussions”. To explore possible trends in individual questions, scores based on the original scales were compared between non-concussed and previously concussed participants for each question adjusting for age and years of playing soccer. Similarly, gender differences in the primary outcomes were also explored using linear regression adjusting for age and years of playing soccer. All statistical analyses were carried out using STATA (version 13).

RESULTS

Out of a total of 257 eligible participants, 92 (36%) parental consent forms were obtained. 90/92 (98%) eligible participants with completed parental consent forms completed the survey.

Demographics

Demographic characteristics of the 90 participants are summarized in Table 1. The median age was 16 years, and 51 (57%) were male. In the study population, 65 (74%) participants indicated that they have had previous education about concussions, while 32 (36%) responded "yes" to the question of whether or not they have sustained a concussion. Distributions of all demographic variables did not differ significantly between non-concussed and previously concussed participants.

Knowledge Questions

Of the maximum possible score of 22 points for K2, the average score was 19.1 and 19.4 for non-concussed and previously concussed players, respectively. Of the maximum score of 20 for K3-K7, the average score was 14.5 and 15.2 for non-concussed and previously concussed participants, respectively (Table 2). Cronbach's alpha, a measure of internal consistency, is 0.36 for questions K2 – K7, 0.40 for items in K2.

Attitude Questions

For both non-concussed and previously concussed players, 93% indicated that they would agree or strongly agree that concussions are a serious medical problem. 95% reported that they would agree or strongly agree with the statement "I would tell my coach/trainer if I believed that I might have sustained a concussion". Of the participants, 19% (17) reported that they would agree or strongly agree with the statement "I am fearful that my teammates/friends would think less of me for sitting out because of a concussion". Out of a maximum possible score of 28 for A1-A7, the mean score of non-concussed athletes was 21.3 while the mean score of previously concussed athletes was 20.9.

For a maximum possible score of 25 on A8-A12, the mean score of non-concussed athletes was 20.1 and for previously concussed athletes was 19.5. Cronbach's alpha is 0.81 for questions A1 – A12.

Comparison between non-concussed and previously concussed participants:

Raw scores were calculated by combining questions from the same category ("knowledge" or "attitude") that had the same original scale, as summarized in Table 2. Raw total scores were comparable between the two groups. Using the primary outcome measures, no significant differences were found between previously concussed and non-concussed participants in terms of their overall knowledge about concussion, symptoms of concussion, or attitudes toward and perception of concussion after adjusting for age and years of playing soccer (Table 3). As shown in Table 4, overall knowledge about concussion, symptoms of concussion, or attitudes toward and perception of concussion did not differ among groups with different levels of education on concussion after adjusting for age and year of playing soccer. Participants who received prior education on concussion demonstrated significantly better knowledge on concussion (questions K2 – K7) compared to those who circled "somewhat" in regard to previous education on concussion. However, no significant differences were found between other pair wise comparisons among the three groups, nor in any other primary outcomes (Table 5). Significant differences were detected in questions K7 and A8 between non-concussed and previously concussed participants (Table 6. See supplemental figures.). On average, previously concussed participants had a better recognition that an athlete should stop playing sports again if they have sustained 3 or more concussions, but considered sitting out of practices/games when experiencing signs and symptoms of a concussion less important. There was a significant difference in questions K2-K7 between male and female participants, with females scoring higher on those knowledge-based questions. There was no significant difference between females and males in questions A1-A12, or K2 (Table 7).

DISCUSSION

To our knowledge, this is the first investigation to specifically look at whether history of concussion has an impact on an athlete's knowledge, attitude, and perception of concussive injuries. The results of this study provide new information about the differences in knowledge and perception of concussion between previously concussed versus non-concussed athletes. We found that overall there was a high level of awareness and knowledge about concussive injuries amongst the participating athletes. Most of the players indicated that they have received some sort of education regarding concussions and there was an overall positive score on the knowledge-based questions (on average, 74.25% of knowledge questions K3-K7 were responded to correctly, and 87.5% of symptoms were correctly identified from a list). Participants who indicated that they had received previous education on concussions scored significantly better on knowledge questions K3-K7 than participants who indicated they had only received "somewhat" of a concussion education. This high level of awareness indicates that recent efforts to raise awareness and education of concussive injuries in youth athletics are making an impact.

In this study, it was also found that there were significant differences between previously concussed and non-concussed athletes on two specific survey questions. Questions K7 and A8 yielded a significant difference between the groups. Knowledge question 7 (K7) asked the athlete whether or not they agreed with the statement "an athlete is never allowed to play sports again if they have sustained 3 or more concussions". Athletes who had previously sustained a concussion responded correctly to this question more often than athletes who had never been concussed. Attitude question 8 (A8) asked the player to rank how important they think it is to sit out of practices/games when experiencing signs and symptoms of a concussion. Interestingly, athletes who had previously sustained a concussion more frequently got this question "incorrect", and indicated less of an importance in sitting out of games/practices than athletes who had not previously sustained a concussion. Additionally, we found a significant difference between male and female athletes on knowledge questions K2-K8, with females scoring better than males on average.

Consistent with previous findings [11], our results indicated that female athletes had an increased knowledge of concussive injuries as compared to males. Additionally, similar to recent articles, our results also suggest that there is a high level of awareness regarding concussions in youth sports [8]. However, even with a high level of awareness, some athletes weren't able to accurately identify symptoms of a concussion. This finding suggests the need for continued refinement of concussion education in youth sports. As similar articles point out [8, 10, 11], educational methods need to be personalized for age, gender, and even sport in order to be more efficient and effective. Moreover, educational tools aimed to increase awareness and knowledge of concussive injuries should also attempt to improve perceptions and attitudes towards the injury in hopes of improving stereotypes associated with concussion [11].

An abundance of literature has been focused on second impact injuries, their symptoms, long-term manifestations, and preventative measures [15, 18-21]. Obtaining a second concussive injury before completely healing from the first can have large consequences. Players who have sustained a concussion and don't report it greatly increase their risk of recurrent symptoms, permanent-brain damage, and second-impact syndrome if they receive a second hit. Second-impact syndrome results in rapid swelling of the brain, causing sustained and worsened symptoms and in the worst case, even death [3, 4, 5]. Results from our study indicate that 37% of participants wouldn't tell their coach if they had symptoms of concussions if it were the day before a championship game. This is alarming as 93% of participants agreed that they considered concussions as a critical medical issue. This finding is consistent with those of previous articles, which also highlighted existing negative self-reporting attitudes in youth sports [9, 11, 14, 15]. Negative self-reporting attitudes add to the athlete's risk of obtaining a second hit to the head before adequate healing of the first injury. Furthermore, recognizing the symptoms of a concussion is essential in knowing when to report one. If an athlete is not familiar with the symptoms of the injury, they will not know to report it. Our results indicate that the study population didn't consistently identify the symptoms of a concussion from a list. It could be possible that in addition to a reluctance in self-reporting the injury, an athlete may not realize that they have sustained a concussion, thus causing them to not report it. Once again, this emphasizes the

need for increased education, allowing youth athletes to more correctly identify the symptoms and signs of a concussion.

Although past literature has examined whether or not factors such as age, gender, and sport influence athletes' knowledge, self-reporting attitudes, or perception of concussion, ours is the first study to our knowledge to look directly at whether or not previous injury has an impact on these variables. Two survey questions yielded significant differences between the groups, however, our findings suggest that there was no significant difference in knowledge, attitudes or perceptions of concussion between the two groups overall. It is possible that this could be a result of small sample size or validity of the survey questions. Although we examined differences between genders, our study did not look at differences between age groups due to small sample size and insufficient numbers for statistical analysis.

Due to the exploratory nature of the study, future research is necessary in developing a more reliable method of investigation to confirm this lack of association. For instance, the validity of survey questions needs to be confirmed prior to administration. In future studies, it would be of central importance to include a larger sample size of youth athletes. It would also be interesting to examine associations between non-concussed and previously concussed athletes of different ages and of different sports. It has been previously described that soccer participation is associated with improved self-reporting attitudes [11]. It is a possibility that differential cultures created within various sports could affect self-reporting attitudes and perceptions of concussion. Evaluating the reasons behind this discrepancy could be beneficial in creating more personalized educational programs for athletes. Finally it would also be interesting to look further into the reasoning behind the discrepancy in concussion knowledge between females and males as to better develop educational tools for male athletes.

LIMITATIONS

There are several limitations to our study. The overall sample size is small due to difficulty in obtaining parental consent. Many parents are not present at practices and thus tracking them down to return consent forms was difficult. This small sample size limits conclusions and generalizability that may be made about youth soccer players. The survey was given to members of a single soccer club, and thus the population studied may be homogeneous. It is a possibility that the members of the club have received similar education regarding concussions or follow the same return-to-play protocol. Additionally, due to participation of only one local club of one sport, the study does not account for regional, state, or national comparisons in youth athletes' knowledge, attitude, or perception of concussion. It also does not account for differences between sports or age groups. This study relied upon players' self-reporting attitudes and overall perception of concussion; however, the reliability of direct reporting rates was not quantified. Lastly, the low Cronbach's alpha value for knowledge questions indicates that the knowledge-based questions may have not accurately assessed the extent of a player's knowledge about concussions. This may be due to small sample size.

CONCLUSIONS

Our study found a high level of awareness of concussion among youth soccer players. The study shows that athletes overall scored well on knowledge questions regarding concussive injuries, however, there is still room for improvement and further education. Additionally, this study highlights the need for educational measures that also focus on improving attitudes towards concussion and self-reporting behavior. While the results of this study suggest that there may not be a significant relationship between history of concussion and an athlete's knowledge, attitudes, and perception of concussion, the sample size is small and thus limits definite conclusions. Future research is needed to further assess whether or not history of concussion affects knowledge and attitudes of concussions in athletes.

REFERENCES

[1] "High School Participation Increases for 25th Consecutive Year." *National Federation of State High School Associations*. NFHS.org, 30 Oct. 2015. Web.
[2] Gessel LM, Fields, SK, Collings CL, Dick RW, Comstock RD. Concussions among United States high school and collegiate athletes. J Athl Train. 2007; 42(4): 495-503.
[3] "Facts About Concussion and Brain Injury". *Centers for Disease Control and Prevention.* U.S. Department of Health and Human Services. Web.
[4] "Diseases and Conditions: Concussions". Mayo Clinic. 2 April, 2014. Web.
[5] "Kids and Concuccsions". *Concussion and Brain Injury Clinic.* Weill Cornell Medical College: Cornell University.
[6] McCrory P, Collie A, Anderson V, et al. Can we manage sport related concussion in children the same as in adults? Br J Sports Med 2004; 38: 516-9.
[7] Bauer R,Fritz H. Pathophysiology of traumatic injury in the developing brain: An introduction and short update. Exp Toxicol Pathol 2004; 56:65-73.
[8] Bloodgood Bonny, Inokuchi Derek, Shawver Willis, et al. Exploration of awareness, knowledge, and perceptions' of traumatic brian injury among American youth athletes and their parents. J Adolescent Health 2013; 53: 34-39.
[9] Sullivan L, Thomas AA, Molcho M. An evaluation of Gaelic Athletic Association (GAA) athletes' self-reported practice of playing while concussed, knowledge about and attitudes towards sports-related concussion. Int J Adolesc Med Health 2016; 28.
[10] King D, Brughelli M, Hume P, Gissane G. Assessment, management and knowledge of sport-related concussion: systematic review. Sports Med. 2014; 44:449–471.
[11] Kurowski BG, Pomerantz WJ, Shaiper C, Ho M, Gittelman MA. Impact of preseason concussion education on knowledge, attitudes, and behaviors of high school athletes. J Trauma Acute Care Surg 2015.
[12] Swift TL, Wilson SL. Misconceptions about brain injury among the general public and non-expert health professionals: an exploratory study. Brain injury. 2001; 15(2): 149–65.
[13] Springer JA, Farmer JE, Bouman DE. Common misconceptions about traumatic brain injury among family members of rehabilitation patients. J Head Trauma Rehabil 1997; 12:41-50.
[14] Williamson IJS, Goodman D. Converging evidence for the under-reporting of concussions in youth ice hockey. Br J Sports Med 2006; 40:128-32.
[15] McCrea M, Hammeke T, Olsen G, et al. Unreported concussion in high school football players: Implications for prevention. Clin J Sport Med 2004; 14:13-7.
[16] Meehan William P, Mannix Rebekah, O'Brien Michael, Collins Michael. The prevalence of undiagnosed concussions in athletes. Clin J Sport Med. 2013; 23(5): 339-342.
[17] Kaut KP, DePompei R, Kerr J, et al. Reports of head injury and symptom knowledge among college athletes: implications for assessment and educational intervention. Clin J Sport Med. 2003 Jul; 13: 213–221.
[18] McCrory PR, Berkovic SF. Second impact syndrome. Neurology. 1998; 50(3):677–683.
[19] McCrory P, Davis G, Makdissi M. Second impact syndrome or cerebral swelling after sporting head injury. Curr Sports Med Rep. 2012; 11(1):21–23.

[20] Giza CC, Kutcher JS, Ashwal S, et al. Summary of evidence-based guideline update: evaluation and management of concussion in sports: report of the Guideline Development Subcommittee of the American Academy of Neurology. Neurology. Jun 11; 2013 80(24):2250–2257.
[21] Guskiewicz KM, Brogolio SP. Acute sports-related traumatic brain injury and repetitive concussion. Handb Clin Neurol. 2015; 127:157-72.

Figure 1. Survey questions aimed to assess athletes' knowledge, perception, and attitudes of concussion

Demographics	Circle one: Male/Female How many years have you been playing soccer? _____ Have you ever had a concussion? Yes / No / I'm not sure If yes, how many? _____ My concussion was diagnosed by: coach / trainer / doctor / other (please indicate): _____ Did you see a medical provider for the concussion? Y / N Did you miss practice/games because of the injury? Y / N
Knowledge	K1: Have you ever received education regarding the symptoms/risks/recovery of concussions? yes / no / somewhat K2: Place an "x" next to what you would consider to be a sign/symptom of a concussion: * options: confusion, slurred speech, blurred vision, confusion, sharp burning pain in neck, headache, dizziness, nosebleed, loss of consciousness, numbness/tingling of arms, fever *Select the degree to which you agree with the following statements:* K3: A concussion can <u>only</u> be caused by a direct blow to the head: strongly agree / agree / disagree / strongly disagree K4: After sustaining a concussion, athletes must gradually return to play: strongly agree / agree / disagree / strongly disagree K5: Loss of consciousness is necessary to be diagnosed with a concussion: strongly agree / agree / disagree / strongly disagree K6: If a second concussion occurs before the first is fully healed, there is a higher risk of death/permanent brain damage: strongly agree / agree / disagree / strongly disagree K7: An athlete is never allowed to play sports again if they have sustained 3 or more concussions: strongly agree / agree / disagree / strongly disagree
	Select the degree to which you agree with the following statements

Attitudes/ Perceptions	A1: I view concussions as a serious medical problem: strongly agree / agree / disagree / strongly disagree A2: I believe that concussions are <u>less</u> important than other medical problems: strongly agree / agree / disagree / strongly disagree A3: I believe it is necessary to miss practice/games/school if necessary to recover from a concussion: strongly agree / agree / disagree / strongly disagree A4: I would tell my coach/trainer if I believed that I might have sustained a concussion: strongly agree / agree / disagree / strongly disagree A5: If it were the day before a championship game, I would tell my coach/trainer if I believed that I might have sustained a concussion: strongly agree / agree / disagree / strongly disagree A6: I am fearful that my teammates/friends would think less of me for sitting out because of a concussion. strongly agree / agree / disagree / strongly disagree A7: I would play through symptoms after a hit to the head in order for my team to win. strongly agree / agree / disagree / strongly disagree A8: How important do you think it is sit out of practices/games when experiencing signs and symptoms of a concussion? Not important 1 2 3 4 5 Very Important A9: For me, reporting probable signs and symptoms of a concussion to a coach/trainer/medical professional is: Cowardly 1 2 3 4 5 Bold Extremely Difficult 1 2 3 4 5 Extremely Easy Not important 1 2 3 4 5 Very Important Embarrassing 1 2 3 4 5 Respectable

Table 1. Demographics

	Non-concussed (n=58)	Previously concussed (n=32)	Total (n=90)
Age, yrs	15.9±1.1	16.1±1.2	16.0±1.1
Years of playing	10.0±2.4	10.7±2.1	10.3±2.3
N missing	1	1	2
Female	26 (45)	13 (41)	39 (43)
# previous concussions		1.8±1.1	
Previous education on concussion			
No	7 (13)	1 (3)	8 (9)
Yes	40 (71)	25 (78)	65 (74)
Somewhat	9 (16)	6 (19)	15 (17)
N missing	2	0	2
Who diagnosed concussion			
Coach		2	
Trainer		12	
Doctor		23	
Other (Parent)		2	

Data presented as mean±SD (continuous variables) or n (%) (categorical variables), except for "who diagnosed concussion" where data were presented as counts.

Table 2. Mean raw total scores in non-concussed and previously concussed participants.

Raw total score	Non-concussed	Previously concussed	maximum possible score
K2	19.1±1.5	19.4±1.3	22
K3 - K7	14.5±2.1	15.2±1.8	20
A1 - A7	21.3±2.7	20.9±3.9	28
A8 - A12	20.1±2.5	19.5±3.6	25

Mean scores were presented as mean±SD.

Table 3. Difference in total scores between previously concussed and non-concussed participants, presented as difference (95% confidence interval).

Total score	Unadjusted	Adjusted
Questions K2 - K7 (n=88)*	1.56 (-1.52, 4.65)	1.47 (-1.76, 4.71)
Question K2 (n=88)*	0.28 (-0.44, 1.00)	0.25 (-0.50, 1.00)
Questions A1 – A12 (n=90)	-1.23 (-4.64, 2.19)	-1.23 (-4.66, 2.21)

*Difference was calculated as (previously concussed) – (non-concussed). Adjusted: multiple linear regression adjusting for age and years of playing football. *: There are two participants who did not circle any items in question K2, and thus their responses could not be imputed.*

Table 4. Differences in total scores between previously concussed, non-concussed participants and those who were uncertain if they had a concussion before, presented as difference (95% confidence interval).

Total score	Difference	Unadjusted	Adjusted
Questions K2 - K7 (n=88)	(Previously concussed) - (non-concussed)	1.46 (-2.07, 4.99)	1.34 (-2.37, 5.04)
	(Not sure) - (non-concussed)	-0.49 (-6.32, 4.17)	-0.61 (-5.12, 3.89)
	(Not sure) - (previously concussed)	-1.94 (-5.86, 1.97)	-1.95 (-5.80, 1.90)
Question K2 (n=88)	(Previously concussed) - (non-concussed)	0.27 (-0.60, 1.14)	0.22 (-0.69, 1.14)
	(Not sure) - (non-concussed)	-0.05 (-1.57, 1.46)	-0.11 (-1.60, 1.37)
	(Not sure) - (previously concussed)	-0.32 (-1.53, 0.89)	-0.34 (-1.49, 0.82)
Questions A1 – A12 (n=90)	(Previously concussed) - (non-concussed)	-1.72 (-5.40, 1.95)	-1.72 (-5.48, 2.05)
	(Not sure) - (non-concussed)	-2.40 (-7.48, 2.67)	-2.27 (-7.49, 2.94)
	(Not sure) - (previously concussed)	-0.68 (-5.44, 4.08)	-0.56 (-5.28, 4.17)

Not sure: participants who answered "I'm not sure" to the question "Have you ever had a concussion".

Table 5. Differences in total scores between participants who answered "yes", "no" and "somewhat" to the question "have you ever received education regarding the symptoms/risks/recovery of concussions", presented as difference (95% confidence interval).

Total score	Difference	Unadjusted	Adjusted
Questions K2 - K7 (n=87)	(Yes) - (No)	6.21 (-1.77, 14.20)	6.13 (-2.22, 14.49)
	(Somewhat) - (No)	3.91 (-3.83, 11.65)	3.88 (-3.92, 11.67)
	(Somewhat) - (Yes)	-2.31 (-4.21, -0.40)*	-2.26 (-4.45, -0.06)*
Question K2 (n=87)	(Yes) - (No)	1.52 (-0.73, 3.78)	1.48 (-0.87, 3.83)
	(Somewhat) - (No)	0.87 (-1.42, 3.15)	0.86 (-1.45, 3.16)
	(Somewhat) - (Yes)	-0.66 (-1.47, 0.16)	-0.62 (-1.49, 0.24)
Questions A1 – A12 (n=90)	(Yes) - (No)	3.90 (-3.58, 11.38)	4.14 (-3.82, 12.11)
	(Somewhat) - (No)	2.74 (-4.37, 9.85)	2.80 (-4.07, 9.67)
	(Somewhat) - (Yes)	-1.17 (-4.18, 1.84)	-1.35 (-4.46, 1.77)

**: 0.001 < p-value < 0.05.*

Table 6. Mean differences for questions K3 – A12 between previously concussed and non-concussed participants (N=90).

Question	Raw score: non-concussed	Raw score: previously concussed	Unadjusted mean difference	Adjusted mean difference
K3	2.8±2.8	2.9±0.8	0.06 (-0.49, 0.62)	0.07 (-0.47, 0.61)
K4	2.6±2.6	2.9±0.9	0.24 (-0.38, 0.85)	0.24 (-0.35, 0.84)
K5	2.8±2.8	2.9±0.9	0.10 (-0.38, 0.57)	0.10 (-0.39, 0.59)
K6	3.5±3.5	3.2±0.7	-0.27 (-0.62, 0.08)	-0.27 (-0.62, 0.08)
K7	2.7±2.7	3.2±0.7	0.53 (0.16, 0.89)*	0.53 (0.09, 0.97)*
A1	3.3±3.3	3.2±0.6	-0.12 (-0.43, 0.19)	-0.13 (-0.45, 0.19)
A2	2.9±2.9	3.0±0.8	0.17 (-0.24, 0.58)	-0.19 (-0.56, 0.17)
A3	3.3±3.3	3.5±0.6	0.19 (-0.17, 0.55)	0.16 (-0.24, 0.56)
A4	3.4±3.4	3.3±0.6	-0.07 (-0.33, 0.19)	-0.07 (-0.35, 0.21)
A5	2.9±2.9	2.5±1	-0.35 (-0.95, 0.25)	-0.32 (-0.88, 0.24)
A6	3.1±3.1	3.0±0.8	-0.05 (-0.38, 0.27)	0.07 (-0.25, 0.39)

A7	2.5±2.5	2.3±1	-0.22 (-0.59, 0.16)	0.22 (-0.16, 0.61)
A8	4.4±4.4	3.9±0.9	-0.46 (-0.89, -0.03)*	-0.48 (-0.91, -0.04)*
A9	3.9±3.9	3.8±1	-0.10 (-0.49, 0.29)	-0.08 (-0.43, 0.27)
A10	3.3±3.3	3.5±1.2	0.16 (-0.44, 0.75)	0.18 (-0.38, 0.75)
A11	4.4±4.4	4.4±0.7	-0.07 (-0.46, 0.32)	-0.07 (-0.48, 0.33)
A12	4.0±4.0	3.8±1.1	-0.16 (-0.80, 0.49)	-0.14 (0.78, 0.50)

*Differences are calculated as (previously-concussed) – (non-concussed), and presented with 95% confidence interval in parentheses. Adjusted: multiple linear regression adjusting for age and years of playing football. Maximum possible score is 4 for questions K3 – A7, and 5 for questions A8 – A12, respectively. *: 0.001 < p-value < 0.05.*

Table 7. Difference in total scores between male and female participants, presented as difference (95% confidence interval).

Total score	Unadjusted	Adjusted
Questions K2 - K7 (n=88)*	-2.39 (-4.04, -0.75)*	-2.53 (-4.43, -0.63)*
Question K2 (n=88)*	-0.56 (-1.22, 0.10)	-0.53 (-1.14, 0.08)
Questions A1 – A12 (n=90)	-1.94 (-4.86, 0.99)	-2.70 (-5.82, 0.42)

*Difference was calculated as (male) – (female). Adjusted: multiple linear regression adjusting for age and years of playing football. *: There are two participants who did not circle any items in question K2, and thus their responses could not be imputed. *: 0.001 < p-value < 0.05.*