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Concussion Knowledge in High School Football Players

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Context: Participating in sports while experiencing symptoms of a concussion can be dangerous. An athlete's lack of knowledge may be one factor influencing his or her decision to report symptoms. In an effort to enhance concussion education among high school athletes, legislation in Florida has attempted to address the issue through parental consent forms.

Objective: To survey high school varsity football players to determine their level of knowledge about concussions after the initiation of new concussion-education legislation.

Design: Cross-sectional study.

Setting: Descriptive survey administered in person during a team meeting.

Patients or Other Participants: A total of 334 varsity football players from 11 high schools in Florida.

Main Outcome Measure(s): Participants completed a survey and identified the symptoms and consequences of a concussion among distractors. They also indicated whether they had received education about concussions from a parent, formal education, neither, or both.

Results: The most correctly identified symptoms were headache (97%), dizziness (93%), and confusion (90%), and the most correctly identified consequence was persistent headache (93%). Participants reported receiving education from their parents (54%) or from a formal source (60%). Twenty-five percent reported never receiving any education regarding concussions. No correlations were found between the method of education and the knowledge of symptoms or consequences of concussion.

Conclusions: The high school football players we surveyed did not have appropriate knowledge of the symptoms and consequences of concussions. Nausea or vomiting, neck pain, grogginess, difficulty concentrating, and personality or behavioral changes were often missed by participants, and only a small proportion correctly identified brain hemorrhage, coma, and death as possible consequences of inappropriate care after a concussion. Even with parents or guardians signing a consent form indicating they discussed concussion awareness with their child, 46% of athletes suggested they had not.

Key Words: head injuries, education, symptoms, consequences, adolescent

Key Points

- High school football players did not have adequate knowledge of the symptoms and consequences of concussions.
- Athletic trainers should educate high school athletes about concussions and perform a comprehensive evaluation any time they suspect a concussion because athletes may not report the injuries.

According to the Centers for Disease Control and Prevention (CDC), more than 300 000 patients present to emergency departments each year for sport-related traumatic brain injuries.[1] However, 1.6 to 3.8 million concussions occur each year during sports and recreation, and more than half can be attributed to football.[2,3] Evidence suggests that high school football players may not be reporting or recognizing the signs and symptoms of a concussion,[4] leading to improper management of the injury, which can increase the risk for postconcussion syndrome and second-impact syndrome.[5]

Unreported or unrecognized concussions are particularly concerning in adolescents, who are more susceptible to the negative consequences of concussions than adults because of differences in brain physiology.[6–8] They have an increased risk for a secondary injury, such as second-impact syndrome, which disproportionately affects adolescents because they are subject to longer and more diffuse cerebral swelling.[9,10] One possible reason the adolescent brain responds differently from that of an adult is that the former is 60 times more sensitive to glutamate and *N*-methyl-D-aspartate, 2 components of the metabolic chain reaction that occurs after a concussion.[11] This increased sensitivity leads to an ionic shift that raises the demand for glucose, which in turn increases the vulnerability to a secondary injury.[12] Although the literature remains inconclusive, factors postulated to increase adolescents' vulnerability to secondary injury include a larger head-to-body ratio, thinner cranial bones, decreased neck strength, reduced cerebral blood volume, larger subarachnoid space, immature nervous system, incomplete myelination, and elasticity of the skull vault.[13–16]

Adolescent athletes' lack of knowledge about concussions may be one of the main predictors of a premature return to play after sustaining a concussion.[4,17,18] Evidence also suggests that young athletes, parents, and coaches do not have the knowledge needed to assess and manage concussions and make return-to-play decisions.[19,20]

The lack of parent and athlete education is a major focus of recent concussion legislation. In 2012, the Florida High School Athletic Association implemented a new concussion consent form that was mandatory for all parents and

student–athletes to sign before the latter could participate in an organized interscholastic sport. This form provides information about the signs and symptoms of a concussion, as well as the associated risks. It also states that athletes need to report to a licensed athletic trainer, coach, or parent if they experience symptoms of a concussion or if they suspect a teammate is experiencing symptoms of a concussion. However, it is unclear what effect such requirements have on concussion awareness in these athletes. Despite the new consent requirements, it is unknown (1) whether these athletes have an adequate understanding of the signs, symptoms, and consequences of a concussion; (2) how many parents have actually discussed this material with their sons; and (3) if those athletes who have discussed the material with their parents have more knowledge than those who did not. A better understanding of the athletes' knowledge level and how the education method affects their awareness of concussions would help athletic trainers, athletic administrators, and lawmakers design and implement more effective concussion-management legislation and education. Therefore, the purpose of our study was to assess the knowledge level of high school varsity football players regarding the symptoms and possible consequences of concussions. In addition, we asked the athletes whether they had received education from their parents or guardians or through a formal class, and we analyzed the correlation between the education received and the knowledge level. We hypothesized that these athletes would have a poor knowledge of concussions and most would report not receiving any form of education regarding concussions.

METHODS

We contacted 13 local high schools in North Central Florida to ask permission to distribute a written questionnaire evaluating their varsity football team's level of knowledge about concussion. Eleven schools agreed to participate. Researchers attended in-season team meetings to distribute our questionnaire in the first half of the 2012 season. This study was approved by the Institutional Review Board for the Protection of Human Research Subjects by the University of Florida.

The questionnaire, which we developed by using a literature review and expert review, consisted of 3 sections. Most of the signs of concussions were taken directly from either the CDC's "Heads Up" information program for athletes[20] or the Sport Concussion Assessment Tool (version 2) form.[21] The first section contained 5 questions that asked participants to identify symptoms of a concussion within a list of 10 symptoms. Each question included 3 to 5 choices that were in no way related to concussions. In the second section, 4 questions asked participants to select from a list of 6 outcomes which ones they believed were possible consequences from an improperly managed concussion. For the first 2 sections, we informed the participants to circle all answers that might apply. In the final section, we asked participants to indicate whether they received education about concussions from their parents, another formal source, both, or neither. We assessed their educational experience by self-report only and did not provide any information regarding concussion during our study. Two content experts reviewed the questionnaire before its use. We assessed test-retest agreement with 28 high school football athletes who completed the written survey twice, 60 minutes apart. The correlation (r values) across test times for sign and symptom questions ranged from 0.64 to 1.00. We entered data from each questionnaire into Excel (version 2010; Microsoft Corporation, Redmond, WA). We used descriptive statistics to determine the frequency of identification of each symptom and the consequence of concussions, as well as the percentage of participants who had received education from their parents or another formal source. We calculated an overall score (percentage correct) for each participant and evaluated the association between the education received and the overall score with linear regression using SPSS (version 21.0; IBM Corporation, Armonk, NY). Finally, we assessed the correlation between the education received and successful identification of a few key symptoms (nausea or vomiting, being nervous or anxious, fatigue or low energy, "just not feeling right," and trouble falling asleep) and the worst consequences (brain hemorrhage, coma, and death).

RESULTS

We distributed and collected a total of 334 questionnaires. After reviewing each questionnaire, we rejected 20 questionnaires because the answers were unclear or the participant failed to follow the instructions. We also rejected 1 questionnaire because it was impossible to determine which answers the participant selected. However, we included 8 questionnaires on which some questions were left unanswered and only tabulated the questions the participants had answered.

The mean age of the participants was 16.3 $\pm$ 1.2 years, and their average experience in high school football was 2.1 $\pm$ 1.3 years (Table 1). The mean overall score was 73.2% $\pm$ 12.5%. We calculated a Cronbach α for the questions about symptoms (Cronbach $\alpha = 0.90$) and the questions about consequences of concussions (Cronbach $\alpha = 0.83$).

Symptoms

The most commonly identified symptoms related to concussions were headache (97%), dizziness (93%), and confusion (90%) (Table 2). Loss of consciousness was selected as a symptom by 81% of participants, whereas nausea or vomiting was recognized by only 53%. Few participants correctly identified symptoms such as behavior and personality change (40%), trouble falling asleep (36%), being more emotional (30%), and being nervous or anxious (27%). The most commonly identified distractors were muscle spasms in the neck and jaw pain (24% and 20%, respectively).

Consequences

Persistent headache (93%) was the most widely recognized consequence of inappropriate care of a concussion (Table 3). Only 60% to 70% of participants correctly identified brain hemorrhage, coma, and death as possible consequences. Early-onset dementia (64%), early-onset Alzheimer disease (47%), and early-onset Parkinson disease (28%) are long-term consequences of repetitive concussions or improper management that were only identified to a moderate degree. Participants improperly

Table 1. Participants' Demographic Information

Years	Mean ± SD
Age	16.3 ± 1.2
Experience in high school football	2.1 ± 1.3

identified increased risk of blindness with age (50%) and increased risk of stroke (38%) as consequences of improper care of a concussion.

Education

Fifty-four percent of participants stated they had discussed concussion with their parents, whereas almost 60% said they had had formal education about concussion either in class or online. Twenty-five percent indicated they had never received any form of education about concussions.

Influence of Education on Knowledge Regarding Concussion

We used a linear regression to quantify the correlation between the method of education and the overall score. The R^2 value was 0.032 ($1 - \beta = .82$), indicating a poor correlation.

We used a binary logistic regression to evaluate if the method of education was significantly correlated with the identification of specific symptoms and consequences. Analysis revealed a Cox-Snell R^2 for the following symptoms: being nervous or anxious (0.007), nausea or vomiting (<0.001), fatigue or low energy (0.001), being more emotional (0.010), "just not feeling right" (0.006), and trouble falling asleep (0.023). No relationship was evident between the method of education regarding concussion and the identification of any symptoms. We performed the same analysis to assess the correlation between the method of education regarding concussion and the recognition of these possible consequences: brain hemorrhage (0.001), coma (<0.001), and death (0.003). Again, no association was observed between the method of education and the ability to identify these possible consequences.

DISCUSSION

Concussions are common in the young athletic population.[22] Continued participation despite experiencing symptoms of a concussion can be detrimental and result in a range of sequelae from prolonged symptoms (postconcussion syndrome) to second-impact syndrome and death.[5,6] Of concern are the facts that fewer than half of athletes are likely to report a concussion[4] and almost 25% of football players participated in their sport while experiencing symptoms of a concussion.[17] One of the main factors responsible for athletes not reporting their injury to an appropriate health care professional is a lack of knowledge about the signs, symptoms, and consequences of concussions.[4,17,18] Our findings confirm that athletes have very poor recognition of nausea or vomiting, neck pain, grogginess, difficulty concentrating, and personality or behavioral changes as symptoms of a concussion. A small proportion of the participants did identify brain hemorrhage, coma, and death as possible consequences of inappropriate care after a concussion.

Table 2. Frequency of Concussion Symptom Identification by High School Varsity Football Players

Symptom	No. (%)
Headache	305/314 (97)
Dizziness	292/314 (93)
Confusion	282/314 (90)
Balance problems	276/314 (88)
Double or blurred vision	264/314 (84)
Pressure in the head	257/314 (82)
Anterograde amnesia	258/314 (82)
Loss of consciousness	256/314 (82)
Forgetting plays	251/314 (80)
Sensitivity to light	249/314 (79)
Retrograde amnesia	243/310 (78)
"Just not feeling right"	230/310 (74)
Feeling slowed down	221/314 (71)
Difficulty concentrating	215/314 (68)
Feeling like in a fog	203/310 (65)
Drowsiness	182/314 (58)
Sensitivity to noise	177/310 (57)
Fatigue or low energy	169/310 (55)
Nausea or vomiting	167/314 (53)
Neck pain	162/314 (52)
Feeling groggy	162/314 (52)
Behavior or personality change	124/314 (39)
Trouble falling asleep	113/311 (36)
Being more emotional	94/310 (30)
Nervous or anxious	84/310 (27)
Irritability	58/314 (18)
Distractors:	
Muscle spasm in the neck	74/310 (24)
Jaw pain	61/314 (19)

We believe that the lack of knowledge about concussions was the result of a lack of a quality education on this topic. Our results suggest that 25% of participants never received education about concussions and only 54% had discussed it with their parent(s) or guardian(s). When we assessed the relationship between education and knowledge, we found no correlation. This suggests that the education provided to our student–athletes did not promote a better knowledge about the symptoms and consequences of a concussion. Our results seem to indicate that student–athletes are now more knowledgeable regarding concussions than was reported by previous authors, who found that 25% of the adults and 25% to 50% of the players were either not able to name any symptom of a concussion or could only name 1.[18] The participants in our study were able to correctly identify major symptoms of concussions, such as headache, dizziness, and loss of consciousness. However, few of the varsity high school football players correctly identified behavioral symptoms (27%–40%) or nausea and vomiting (53%). Apart from lack of knowledge, other factors impede an athlete's ability to recognize the symptoms of a concussion. Symptoms may be subtle, resemble other conditions such as dehydration and heat exhaustion, or resolve in less than 15 minutes or appear a few days later.[23–25] We also observed that consequences such as brain hemorrhage, coma, and death were not identified by more than 30% of participants, suggesting that more education should be directed toward those consequences and risks associated with concussions. Although we did not

Table 3. Frequency of Consequences of Inappropriate Care of Concussion Identification by High School Varsity Football Players

Consequence	No. (%)
Persistent headache	288/309 (93)
Persistent dizziness	266/309 (86)
Persistent balance problems	264/307 (86)
Persistent difficulty concentrating	252/309 (82)
Persistent sensitivity to light	232/308 (75)
Brain hemorrhage	211/308 (69)
Persistent fatigue or low energy	198/307 (65)
Early-onset dementia	197/306 (64)
Death	196/308 (64)
Coma	193/308 (63)
Persistent sensitivity to noise	177/307 (58)
Early-onset Alzheimer disease	145/306 (47)
Persistent irritability	121/309 (39)
Early-onset Parkinson disease	85/306 (28)
Distractors:	
Increased risk of blindness	152/306 (50)
Increased risk of stroke	117/306 (38)

assess them in our study, other factors that may influence knowledge about concussion are age and level of competition.[10] Older athletes and those in more competitive leagues show greater knowledge about concussion.[10]

As with every research project, our study had some limitations. We recruited local high schools, each of which had access to a licensed athletic trainer. It would be helpful to see similar studies done in high schools without access to an athletic trainer. In addition, we distributed the questionnaire to large groups of young athletes at the same time; even though the researchers and coaches monitored data collection, some participants may have assisted each other in identifying answers.

CONCLUSIONS

High school football players did not have appropriate knowledge regarding the signs, symptoms, and consequences of concussions. Symptoms such as headache, dizziness, confusion, and balance problems were adequately identified by the participants. However, other major symptoms, such as nausea, neck pain, grogginess, difficulty concentrating, and personality changes, were missed by almost half of the respondents. Severe consequences such as brain hemorrhage, coma, and death were identified by a low percentage. Many experts advocate education about concussion as one of the main components of prevention and management.[4,15,17] We believe that having more knowledge about concussion would help athletes detect symptoms associated with concussions and having a better understanding of the consequences would encourage athletes to report their injuries to a health professional. Action should be taken to better educate athletes and to ensure the proper recognition and management of concussions. Because high school football players most frequently report their concussions to a certified athletic trainer when given the opportunity,[4] one step toward preventing unwanted consequences of concussions and promoting education about concussions would be to place athletic trainers in every high school. Many other approaches can be used to provide quality information and education about concussions to young athletes, parents, and coaches. Preparticipation meetings, instructional videos, and Web-based programs are only a few examples that have already been suggested.[4] Such approaches should be evaluated in the future to ensure their efficacy. Athletic trainers working in a high school setting should be aware of their athletes' level of knowledge about concussions and take steps to help educate them as needed. Athletic trainers should always perform a comprehensive evaluation on any athlete suspected of having a concussion, and they should never assume the athlete will self-report symptoms. Furthermore, athletic trainers should not take for granted that concussion-education programs available to the parents, coaches, and athletes will result in well-educated athletes.

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