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Knowledge, Attitude, and Concussion-Reporting Behaviors Among High School Athletes: A Preliminary Study

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Context: Many athletes continue to participate in practices and games while experiencing concussion-related symptoms, potentially predisposing them to subsequent and more complicated brain injuries. Limited evidence exists about factors that may influence concussion-reporting behaviors.

Objective: To examine the influence of knowledge and attitude on concussion-reporting behaviors in a sample of high school athletes.

Design: Cross-sectional study.

Setting: Participants completed a validated survey instrument via mail.

Patients or Other Participants: A total of 167 high school athletes (97 males, 55 females, 5 sex not indicated; age = 15.7 ± 1.4 years) participating in football, soccer, lacrosse, or cheerleading.

Intervention(s): Athlete knowledge and attitude scores served as separate predictor variables.

Main Outcome Measure(s): We examined the proportion of athletes who reported continuing to participate in games and practices while symptomatic from possible concussion and the self-reported proportion of recalled concussion and bell-ringer events disclosed after possible concussive injury.

Results: Only 40% of concussion events and 13% of bell-ringer recalled events in the sample were disclosed after possible concussive injury. Increased athlete knowledge of concussion topics (increase of 1 standard deviation = 2.8 points) was associated with increased reporting prevalence of concussion and bell-ringer events occurring in practice (prevalence ratio [PR] = 2.27, 95% confidence interval [CI] = 1.60, 3.21) and the reporting prevalence of bell-ringer-only events overall (PR = 1.87, 95% CI = 1.38, 2.54). Athlete attitude scores (increase of 1 standard deviation = 11.5 points) were associated with decreases in the proportion of athletes stating they participated in games (PR = 0.74, 95% CI = 0.66, 0.82) and practices (PR = 0.67, 95% CI = 0.59, 0.77) while symptomatic from concussions.

Conclusions: Most recalled concussion events in our study were not reported to a supervising adult. Clinicians should be aware that knowledge and attitude influence concussion reporting. Clinicians and administrators should make concussion education a priority and encourage an optimal reporting environment to better manage and prevent concussive injuries in young athletes.

Key Words: education, brain injuries, care seeking

Key Points

- Athlete knowledge and attitude influenced concussion-reporting behaviors in some contexts.
- A large proportion of recalled concussion events was not reported among the sample of high school athletes.
- Increasing knowledge of concussion symptoms, improving the culture of sport, and increasing the understanding of the seriousness of concussive injuries should be targets for future interventions.
- Programs should be implemented to increase awareness, promote reporting, and create a safe reporting environment.

Cerebral concussion is a physiologic injury that is difficult to identify and manage.[1] Unidentified concussive injuries, specifically among a young population, carry a risk of additional and more complicated injuries to the brain[2–4] that may result in delayed recovery or even catastrophic consequences, such as second-impact syndrome.[5,6] Despite the perception of concussions being mild, high school athletes with mild concussions may experience neurocognitive deficits and symptoms that persist beyond the day of injury.[7] Thus, understanding the factors influencing concussion reporting in athletes is important, particularly in high-school–aged athletes in whom the brain is continuing to develop.[8]

Researchers have suggested that more than 50% of concussions are unreported.[9–11] McCrea et al[9] instructed athletes to complete a survey at the end of 1 season of high

school football, whereas Echlin et al[10] examined concussions observed by a trained monitor and concussions reported by adolescent-aged ice-hockey players or identified by an athletic trainer or athletic therapist. Delaney et al[11] instructed athletes to complete a survey after 1 full year of participation in university-level football or soccer. Many athletes often do not recognize common symptoms associated with concussion and often report not knowing that their injuries could have been concussions.[5,9,12,13]

McCrea et al[9] noted reasons commonly cited by athletes who do not report concussions included they did not think the injuries were serious enough to report, did not want to leave a game, did not know the injuries were concussions, and did not want to let teammates down. However, the reasons for not reporting concussions may differ depending on the level of play (professional versus college versus high school) as motivations, and values are different across these age groups. Among high-school–aged individuals, peer acceptance[14] and coach support/mindset[15] are 2 important motivators in sport. For collegiate athletes, considerations include scholarships, peer acceptance, coach support,[16] and a longer period in which they may place a great amount of their identities in their sports. However, few, if any, researchers have addressed these motivations concerning concussion reporting among these populations. Across all sports, the desire to continue to participate is a strong motivator, but the given factors may differ in how they influence this desire. Furthermore, internal or intrinsic factors, such as knowledge and attitude, may influence concussion-reporting motivations. Knowledge and attitude are both changeable factors that may contribute to concussion-reporting and care-seeking behaviors.[17] Furthermore, improvements in these factors have been linked to improvements in other health behaviors.[18]

Knowledge alone does not equal behavior. However, better understanding, specifically consideration by an individual that he or she actually may have a concussion, is important in the decision to report a potential concussive injury. Attitude is an important factor in many behaviors,[19] with more favorable attitudes often linked to the preferred behavior.[20] Attitude consists of 2 basic components: a belief that a particular behavior leads to a certain outcome and a person's evaluation of the outcome of that behavior.[19] Thus, individuals who have a more positive perception of the behaviors about reporting concussion and not just about concussion as an injury may be more likely to report. For example, individuals may understand and believe that concussion is a serious injury and even a medical concern; however, if they also believe that their peers or coaches will take issue with their reporting the injury or that they may lose substantial playing time, they may still choose not to report the injury. This highlights a negative (less favorable) attitude about reporting the injury, which is the behavior of interest. These concepts provide the framework for not only increasing knowledge and awareness but also addressing attitudes.

Despite the overwhelming problem of underreporting concussion, few researchers have examined the influence of concussion knowledge on reporting frequency. In addition, no one concurrently has examined overall attitudes concerning concussion and reporting of possible concussions among high school athletes. Therefore, the primary purpose of our study was to examine the influence of knowledge and attitude on concussion reporting among a sample of high school athletes. We hypothesized that better knowledge and attitude scores would be associated with increased reporting prevalence.

METHODS

Research Design

We conducted a cross-sectional survey study of high school athletes in 6 sports. We collected data from November 2008 to February 2010. The survey instrument captured data on athletes' knowledge, attitudes, and beliefs regarding concussion. It also asked athletes to recall previous concussion and concussion-like events and to indicate whether they reported the events to a coach or a medical professional.

Sample and Participants

A convenience sample of 28 high schools in 9 states agreed to participate in the study, with survey data returned from 25 schools. Fifteen of the 25 respondent schools had daily access to a certified athletic trainer (AT), and 10 had no access. A total of 167 (10%) of 1669 athletes (97 males, 55 females, 5 sex not indicated; age = 15.7 ± 1.4 years, range = 14–18 years) returned the survey. Athlete descriptive and demographic data are included in Table 1. An athlete was included if he or she was listed on the roster as an athlete for varsity football, cheerleading, boys' soccer, girls' soccer, boys' lacrosse, or girls' lacrosse. All participants and their parents provided written informed assent and consent, respectively, and the Institutional Review Board of the University of North Carolina at Chapel Hill approved the study.

Instrument

A single survey served as the instrument for the study. This instrument was pretested for face validity by 3 content experts. Test-retest agreement was assessed with 50 high school athletes completing the survey instrument at 2 test times that were 30 minutes apart and in a different order. The agreement across test times for all knowledge (yes/no) items used on the questionnaires ranged from 0.60 to 1.00. For Likert scale attitude questions, the mean difference was less than 0.4 (maximum score for each item = 7) on the survey instrument. We calculated the Cronbach α for knowledge construct (Cronbach $\alpha = 0.72$) and attitude constructs (Cronbach $\alpha = 0.80$) on the survey instrument.

Athlete knowledge was assessed with a series of 35 questions concerning symptom recognition, complications related to multiple concussions, and general knowledge of concussion. Athlete attitude was assessed with 14 7-point Likert-scale questions addressing overall attitude toward concussion, concussion education, and concussion reporting. Total knowledge score for each athlete was calculated by summing the number of correct answers out of the 35 knowledge questions (possible range = 0–35). Total attitude score was calculated by summing the responses to 14 Likert-scale (range = 1–7) attitude questions (possible range = 14–98). A higher score represented a more favorable attitude toward concussion and concussion reporting.

Table 1. Athlete Demographics (N = 167)

Characteristic (No. Reporting)	Frequency (%)[a]
Sex (n = 162)	
Male	98 (60.5)
Female	64 (39.5)
Race (n = 164)	
African American	17 (10.4)
White	138 (84.1)
Hispanic	5 (3.0)
Asian	4 (2.4)
Current sport (n = 154)	
Football	66 (42.9)
Boys' soccer	20 (13.0)
Girls' soccer	18 (11.7)
Boys' lacrosse	10 (6.5)
Girls' lacrosse	9 (5.8)
Cheerleading	31 (20.1)
Concussion education discussion? (n = 167)	
Yes	130 (77.8)
No	37 (22.2)
Certified athletic trainer access? (n = 165)[b]	
Yes	81 (49.1)
No	84 (50.9)
History of concussion? (n = 167)	
Yes	44 (26.3)
No	123 (73.7)
History of bell ringer/ding? (n = 167)	
Yes	81 (48.5)
No	86 (51.5)

[a] Indicates some percentages are rounded.
[b] Indicates 2 participants did not indicate school and their scores were not included in the total.

To assess recalled concussion events and reporting during the respondents' high school years, multiple reporting variables were used (Table 2). Athletes were asked about concussion events they recalled as experienced and reported during their high school years during games and practices. The items on the survey addressing concussion events and reporting were worded as follows: (1) "In your high school years, how many concussions do you think you have experienced?" and (2) "How many of the possible concussions you experienced in high school did you report to a medical professional (doctor, athletic trainer, etc) or a coach?" Athletes also were asked about bell-ringer events they recalled as experienced and reported during their high school years during games and practices. The items on the survey addressing bell-ringer/ding events and reporting of these events were worded as follows: (1) "In your high school years, how many times have you had your 'bell rung' or been 'dinged'?" and (2) "How many of the possible concussions you experienced in high school did you report to a medical professional (doctor, athletic trainer, etc) or a coach?" The term *bell ringer* was employed as a means of assessing when possible concussions occurred and to assess recalled events that athletes considered a bell ringer. No formal definition for the term *bell ringer* was given to participants because the study was based on personal perceptions. Athletes commonly use the term to describe brief, transient alterations in neurologic function. Whereas not all of these events may have been true concussions, they warrant examination before an individual returns to participation. In addition, athletes were asked about ever continuing to participate in practices and games while experiencing concussion signs and symptoms.

Procedures

Approval from each school was obtained before initiation of the study. After school approval, school information forms were completed by a designated school contact (athletic director, AT, or administrator) serving as a research assistant at each school. The school contacts arranged questionnaire-distribution meetings for the athletes. The primary investigator or the designated school contact conducted these meetings. The meetings were performed using a standardized script to ensure similar instructions for all possible participants. Only questions pertaining to logistics of completing the questionnaire were answered during the meeting. During these meetings, the study was explained, and each athlete was issued a study packet that included an instruction letter, assent and consent documents, the survey instrument, and a postage-paid return envelope. Athletes were instructed to take the packet home, complete the survey instrument, and return it directly to the primary investigator via mail. Upon return, survey instruments were logged and entered into the study dataset.

Statistical Analyses

General descriptive statistics were used to examine athlete knowledge scores, attitude scores, and concussion-reporting behaviors. *Reporting* was defined as recalled events indicated by the athlete as reported to a coach or a medical professional. Separate binomial regression models were used to estimate the prevalence ratio (PR) for each of the 6 reporting outcomes (Table 1). Binomial regression estimates the change in the prevalence, or PR, based on changes in the predictor variables. Predictors included athlete knowledge total scores (AKT) and athlete attitude total scores (AAT). A total of 12 binomial regression models were used (2

Table 2. Six Reporting Outcome Measures and Portion of Sample Included in Analysis

Reporting Outcome	Analysis Unit	Portion of Sample Included in Analysis
Reporting of recalled concussion or bell-ringer events in games	Recalled events	Only participants with at least 1 recalled concussion or bell-ringer event in a game
Reporting of recalled concussion or bell-ringer events in practices	Recalled events	Only participants with at least 1 recalled concussion or bell-ringer event during a practice
Reporting of recalled concussion-only events	Recalled events	Only participants with at least 1 recalled concussion event
Reporting of recalled bell-ringer–only events	Recalled events	Only participants with at least 1 recalled bell-ringer event
Participation in games with concussion signs and symptoms	People	Entire sample
Participation in practices with concussion signs and symptoms	People	Entire sample

Table 3. Athlete Knowledge Items and Descriptives

Athlete Knowledge Item[a]	Frequency Answering Correctly (%)[b]
Please indicate (by checking the box beside the question) which of the following you would consider to be a sign or symptom of concussion. Check all that apply. (n = 167)	
Abnormal sense of smell (false)	151 (90.4)
Abnormal sense of taste (false)	153 (91.6)
Amnesia (true)	94 (56.3)
Joint stiffness (false)	152 (91.0)
Blurred vision (true)	147 (88.0)
Black eye (false)	149 (89.2)
Bleeding from the ear (false)	130 (77.8)
Bleeding from the mouth (false)	152 (91.0)
Bleeding from the nose (false)	145 (86.8)
Confusion (true)	154 (92.2)
Fever (false)	157 (94.0)
Dizziness (true)	148 (88.6)
Headache (true)	148 (88.6)
Insomnia (true)	140 (83.8)
Loss of consciousness (true)	127 (76.0)
Nausea (true)	107 (64.1)
Numbness or tingling of arms (true)	113 (67.7)
Skin rash (false)	167 (100.0)
Sharp burning pain in neck (false)	113 (67.7)
Weakness in neck movements (false)	91 (54.5)
General knowledge	
A concussion only occurs if you lose consciousness (false) (n = 163)	138 (84.7)
If you are experiencing any signs and symptoms of concussion after a blow to the head or sudden movement of the body, you should not return to play (true) (n = 163)	134 (82.2)
A concussion is an injury to the _____. (brain) (n = 165)	146 (88.5)
Multiple concussions: Of the following, what are possible complications of having multiple concussions? Check all that apply. (n = 167)	
No complications exist (false)	167 (100.0)
Increased risk of further injury (true)	106 (63.5)
Brain damage (true)	152 (91.0)
Joint problems (false)	150 (89.8)
I don't know (false/not checked)	157 (94.0)
Memory problems (true)	142 (85.0)
Returning to play too soon: Of the following, what are complications of returning to sporting activity while still experiencing possible concussion symptoms? Check all that apply. (n = 167)	
No complications exist (false)	166 (99.4)
Increased risk of further injury (true)	145 (86.8)
Paralysis (false)	92 (55.1)
Brain damage (true)	145 (86.8)
Joint problems (false)	147 (88.0)
I don't know (false/not checked)	154 (92.2)

[a] Indicates the correct response for each question is indicated in parentheses.
[b] Indicates the frequencies and percentages represent the proportion of the sample responding correctly to each question.

predictors × 6 outcomes). The α level was set a priori at .05. The α level was adjusted for multiple comparisons performed for each predictor (0.05/6 [number of analyses for each predictor = 0.008]). The PRs represent the change in the prevalence of recalled concussion and bell-ringer events associated with changes in AKT and AAT. We chose this method to examine the relationship among knowledge, attitude, and reporting of concussion events from cross-sectional data. To estimate the PRs associated with knowledge and attitude, an increase of 1 standard deviation (SD) from our sample mean in athlete knowledge (1 SD = 2.8 points, possible points = 0–35) and attitude score (1 SD = 11.5 points, possible points = 14–98) was selected. Thus, the PRs presented in the "Results" section represent the change in reporting prevalence that occurs for every 1 SD increase in knowledge or attitude score.

The unbalanced sample size across analyses is explained by the following: (1) when people reporting concussions or bell ringers are the analysis unit, only individuals recalling a concussion or bell-ringer event are included; (2) when examining involvement in games or practices while symptomatic, all participants answering the question are included; and (3) to be included in the analyses, all questions forming the independent and dependent variables had to be answered.

RESULTS

Athlete Knowledge and Attitude Descriptives

Athlete knowledge total scores ranged from 20 to 34 (mean = 27.9 ± 2.8; Table 3). Higher scores indicated increased knowledge. The overall AAT toward concussion

Table 4. Athlete Attitude Items and Descriptives

Athlete Attitude Item	Mean (SD)
Rate on a scale of 1–7	
How serious you think it is when you experience a headache or dizziness after a blow to your head or body	4.5 (1.5)
How important you think it is to not participate in physical activity (game or practice) when experiencing signs and symptoms of concussion	5.5 (1.6)
How important you think it is to be informed about how concussions happen	5.9 (1.4)
How important you think it is to be informed about how concussions can be prevented	5.9 (1.5)
How important it is to be informed about what to do if you have a concussion	6.3 (1.2)
How important you think it is to report possible signs and symptoms to a medical professional (eg, doctor, athletic trainer) or coach	6.1 (1.2)
Your level of agreement with the following statement: Athletes are undereducated about concussion.	5.1 (1.5)
Check the box (1–7)[a] about how you feel about the following statement for each pair of words listed: For me to report possible signs and symptoms to a coach or a medical professional when I experience them is	
Cowardly/brave	5.1 (1.6)
Embarrassing/pleasant	4.5 (1.7)
Harmful/beneficial	6.2 (1.3)
Extremely difficult/extremely easy	5.0 (1.6)
Bad/good	6.0 (1.4)
Unimportant/important	6.1 (1.4)
Worthless/valuable	6.1 (1.3)
Athlete attitude total	78.3 (11.5)

[a] Indicates *1* was beside the word presented on the left and *7* was beside the word presented on the right.

ranged from 40 to 98 (mean = 78.3 ± 11.5). Higher scores indicated a more favorable attitude (Table 4).

Athlete Reporting Behavior Descriptives

A total of 89 athletes (53.3%) recalled having at least 1 possible concussion or bell-ringer event. Of these 89, only 15 (16.9%) indicated reporting all experienced concussive/bell-ringer events to a coach or a medical professional. Participants recalled 84 concussions, and in only 41 (48.8%) of these events, the respondent indicated that he or she had reported the event to a coach or a medical professional. In addition, participants recalled 584 bell-ringer events, and in only 72 (12.3%), the respondent indicated he or she had reported the event to a coach or a medical professional. Overall, the most common reasons for not reporting a concussion or bell-ringer event were that the athlete did not think it was serious enough to report (52/74, 70.2%), did not want to be removed from a game (27/74, 36.5%), did not want to let down teammates (20/74, 27.0%), and did not want to let down coaches (17/74, 23.0%). Not knowing the event was a concussion (11/74, 14.9%) and not wanting to be removed from practice (10/74, 13.5%) were the remaining reasons cited for not reporting the recalled event.

In games only, participants recalled a total of 320 concussion and bell-ringer events and indicated that they reported only 73 (22.8%) of these events to a coach or a medical professional. For practices only, participants recalled a total of 348 concussion and bell-ringer events and indicated reporting only 40 (11.5%) of these events to a coach or a medical professional. In addition, 37.7% (n = 63) of the athlete sample indicated they had continued participating in a practice or a game at least once while experiencing signs and symptoms of a concussion.

Influence of Athlete Knowledge and Attitude

Increased AKT was not associated with the prevalence of athletes indicating they continued to participate in a game or practice while experiencing concussion symptoms (Table 5). The AAT was associated with a decrease in athletes reporting to participate in a game while symptomatic (PR = 0.74), whereas the prevalence of athletes reporting that they continued participating in a practice while symptomatic also decreased (PR = 0.67; Table 6).

The AKT and AAT were not associated with reporting of recalled concussion or bell-ringer events during games (Tables 5 and 6). Alternatively, a 1-SD (2.8-point) increase in AKT was associated with an increased prevalence of reporting these recalled events in practices by 2.27 times. A 1-SD (11.5-point) increase in AAT also was associated with a 1.38-times increased prevalence of recalled event reporting during practices. However, when accounting for

Table 5. Athlete Knowledge Influence on Reporting Prevalence Ratios, Standard Errors, and Confidence Limits

Predictor 2.8-Point Increase	Prevalence Ratio	Standard Error	95% Confidence Limits	χ^2	*P* Value
Knowledge and reporting of concussion and bell-ringer events in games (n = 58)[a]	1.11	0.16	0.83, 1.49	0.51	.48
Knowledge and reporting of concussion and bell-ringer events in practices (n = 56)[a]	2.27[c]	0.40	1.60, 3.21	21.25	<.001
Knowledge and reporting of recalled concussion events (n = 40)[a]	0.99	0.15	0.74, 1.32	<.001	.98
Knowledge and reporting of recalled bell-ringer events (n = 69)[a]	1.87[c]	0.29	1.38, 2.54	16.24	<.001
Knowledge and reporting continuing in a game while symptomatic (n = 129)[b]	0.97	0.11	0.77, 1.24	0.04	.84
Knowledge and reporting continuing in a practice while symptomatic (n = 128)[b]	0.96	0.14	0.73, 1.27	0.02	.80

[a] Indicates recalled events were the unit of analysis.
[b] Indicates people were the unit of analysis.
[c] Indicates an association.

Table 6. Athlete Attitude Influence on Reporting Prevalence Ratios, Standard Errors, and Confidence Limits

Predictor 11.5-Point Increase	Prevalence Ratio	Standard Error	95% Confidence Limits	χ^2	*P* Value
Attitude and reporting of concussion and bell-ringer events in games (n = 61)[a]	1.19	0.13	0.95, 1.50	2.37	.12
Attitude and reporting of concussion and bell-ringer events in practices (n = 55)[a]	1.45[c]	0.24	1.04, 2.02	4.75	.03
Attitude and reporting of recalled concussion events (n = 40)[a]	1.00	0.12	0.78, 1.29	<.001	.96
Attitude and reporting of recalled bell-ringer events (n = 69)[a]	1.48[d]	0.18	1.15, 1.89	9.78	.002
Attitude and reporting continuing in a game while symptomatic (n = 129)[b]	0.74[d]	0.04	0.66, 0.82	26.99	<.001
Attitude and reporting continuing in a practice while symptomatic (n = 128)[b]	0.67[d]	0.04	0.59, 0.77	36.47	<.001

[a] Indicates recalled events were the unit of analysis.
[b] Indicates people were the unit of analysis.
[c] Indicates a trend.
[d] Indicates an association.

the adjusted α level, this increase was not different. The AKT and AAT were not associated with reporting recalled concussion-only events. Alternatively, both AKT and AAT were associated with reporting bell-ringer–only events because the reporting prevalence of these events increased by more than 1.8 times with a 1-SD (2.8-point) increase in AKT and 1.4 times with a 1-SD (11.5-point) increase in AAT. A summary of the overall influence of knowledge and attitude on reporting behaviors is presented in Table 7.

DISCUSSION

The most important findings in our study are that most recalled concussions sustained by high school athletes were not reported and that concussion knowledge and attitudes both play a role in concussion-reporting behaviors. Although this information was self-reported, it suggested that a large proportion of possible concussion events are never reported to a coach or a medical professional and that knowledge and attitude may play substantial roles in these reporting decisions. Athletes in the study sample classified most of these events as bell ringers. The difference between the proportion of athletes recalling concussions and bell ringers highlights the misunderstanding concerning the use of these terms and athletes' lack of association between the term *bell ringer* and concussive injury.

We employed the term *bell ringer* in our study to examine the number of these events that athletes would classify as occurring. However, according to Guskiewicz et al,[21] the term should not be used in clinical, athletic, or educational settings because it minimizes the serious nature of a possible concussion. All of these bell-ringer events may not have been true concussions, but these events should have been reported and evaluated by clinicians to make the determination about whether concussions did occur. If these events are not reported, athletes are more likely to continue to play in a potentially vulnerable state. In addition, our findings provide insight into the importance of increased knowledge and increased attitude on the behavior of concussion reporting among high school athletes. A summary of the influences of these factors on reporting measures included in the study is shown in Table 7.

Overall Knowledge, Attitude, and Concussion-Reporting Behaviors

The AKT indicated an average of 7 (out of 35) questions missed, illustrating that a gap still exists in what athletes should know concerning concussion concepts, such as common signs and symptoms. The most common questions missed were those concerning less frequent symptoms, such as nausea and amnesia.[22,23] These findings were similar to those reported by Valovich McLeod et al,[13] although they addressed youth coaches. Nausea is a symptom associated with many conditions, such as dehydration or overeating before an event. Young athletes and coaches[13] may have difficulty recognizing that this symptom is associated with concussion or brain injury. The findings in our sample suggest athletes are relatively knowledgeable about the general signs and symptoms of concussion (Table 3). Student-athletes' knowledge about concussions, specifically about signs and symptoms, has been reported to be lower than what we observed.[12] The increased knowledge of concussion symptoms may be due to recent educational and social initiatives to increase concussion awareness.[24] However, future efforts also should emphasize the less common symptoms, such as nausea, to help young athletes better recognize potential concussive injuries.

Attitude (overall attitude about concussion) had a wide range of scores, illustrating the disparity in perceptions of concussion across the athletic population. Many of the athletes indicated only moderate agreement (mean = 4.5/7)

Table 7. Summary of Changes in Reporting Behaviors

Reporting (Recalled) Outcome	Athlete Knowledge 10-Point Increase	Athlete Attitude 10-Point Increase
Game events[a]		Increase
Practice events[a]	Increase	Increase
Concussion only[a]		
Bell-ringer only[a]	Increase	Increase (trend)
Participation in games with symptoms[b]		Decrease (positive behavior)
Participation in practice with symptoms[b]		Decrease (positive behavior)

[a] Indicates recalled events were the analysis unit.
[b] Indicates people were the analysis unit.

with the statement on the questionnaire that concussion symptoms were serious. In addition, many believed reporting concussion may be somewhat embarrassing (mean = 4.5/7). Downplaying concussion symptoms and feelings of embarrassment about reporting them illustrate some of the attitudes toward concussion and reporting that need attention. Few researchers have addressed attitudes concerning concussion and concussion reporting among athletes despite attitude being one of the factors that may modify behavior.[17,25] A better understanding of the role of attitude about concussion-related behaviors is needed.

The issues concerning concussion in the high school athletic setting are further highlighted in our sample by gross underreporting of recalled concussion events. In addition, a large proportion of the study sample indicated continuing to participate in both games and practices while experiencing concussion signs and symptoms. McCrea et al[9] observed the prevalence of underreporting among high school football players to be as high as 50%. Delaney et al[26] also reported that many college-aged football and soccer athletes do not recognize potential concussion events. More recently, researchers have highlighted that relying on self-report and even a single medical provider may result in underrecognition of concussive injuries.[10] We used different methods to investigate and explain this phenomenon, but we observed an underreporting rate of approximately 40% for perceived concussions.

More strikingly, athletes only indicated reporting 13% of events they considered bell ringers, which likely were concussive injuries. Athletes not reporting these bell-ringer events may have continued to participate or returned to participation too early, predisposing them to further injury.[3,27] This illustrates the need for clinicians, parents, coaches, and athletes to better recognize that these mild events should be reported and addressed. Reporting to a coach is very different from reporting to a medical professional; however, not all schools or athletes in our study had access to an AT, which models the reality that many high school athletes also do not have access to an AT, especially during athletic participation. The National Athletic Trainers' Association[28] reported that only 42% of high schools have access to an AT. The purpose of reporting to an authoritative figure is to acknowledge a potential concussion and to seek additional help. McCrory et al[29] identified the role of the coach as initiating medical care in the event an athlete is injured. Coaches do not have the same training as medical professionals, but when no medical professional is present, they are often the people to whom individuals report a concussion or other injury.

The most common reason athletes cited for not reporting possible concussions was not thinking the injury was serious enough to report, followed by not wanting to be removed from a game. These reasons are similar to those that McCrea et al[9] reported. In contrast to McCrea et al,[9] letting down teammates and coaches was prioritized in our sample over lack of concussion awareness as possible reasons for not reporting. Whereas reporting behaviors in our study sample were based on recalled events, they suggest the behavior of underreporting possible concussion events is prevalent.[10] Continuing to participate in the presence of concussive injury is risky given the possible negative outcomes[3,4,27,30–33] associated with the behavior. Our study highlights the risk-taking behaviors of athletes, which have been suggested in other literature.[34]

Athlete Knowledge and Attitude Influence on Reporting of Recalled Events

In general, improved athlete knowledge positively affected reporting, as the proportion of people reporting bell-ringer events, proportion of events reported during practice, and proportion of bell-ringer events reported were greater with increased athlete knowledge. Increases in knowledge encompass recognition of signs and symptoms. This possible increase in recognition may have resulted in more knowledgeable athletes recognizing the signs and symptoms of these events as needing to be reported because the primary reason for not reporting events in our sample was not thinking the injury was serious enough to report. Improved knowledge about concussions may result in athletes recognizing these injuries are possible concussions and reporting them to someone in authority. This also may explain why findings related to concussion-only events and continued participation while symptomatic were not associated with increases in knowledge. Valovich McLeod et al[35] observed that, when asked about concussion history using the terms *concussion* and *bell ringer*, a greater proportion of the high school participants reported having sustained a bell ringer than having sustained a concussion. Our study further supports these findings, underscoring the issue that young athletes often believe that bell ringers are not concussions.

Athlete attitude also had overall positive effects on reporting behaviors, with an increased proportion of reported bell-ringer events in games and practices. Athletes with a more favorable attitude toward reporting a concussive injury may have a better understanding about the importance of reporting possible concussion events. An increase in this attitude score may help athletes believe they are more capable of accurately reporting with the increased understanding of the injury.[9,12]

Limitations

The low return (10%) among the participants is concerning and limits generalizability. Our results cannot be generalized to the general population because the study sample was one of convenience. In addition, the behavior we assessed (reporting/not reporting) was not observed directly but was self-reported, yielding results based largely on athlete perceptions. In addition, 42.9% (n = 66) of the sample were football athletes (Table 1). This may have led to bias toward findings relative to football. Our cross-sectional study can only provide insight on the 1 point in time when the survey instrument was completed. In addition, time of reporting in proximity to the concussion or bell-ringer event was not obtained. Therefore, we do not know if the athletes reported the event immediately after injury or at a later time, which will be important to know in future research. Whereas we acknowledge other factors external to the athlete may influence athlete self-reporting, we investigated the influence of factors at the athlete level. In the future, researchers should investigate how external factors, such as coach, parent, and teammate pressures, influence reporting of concussion among high school athletes. They also should include additional high-risk

sports, such as ice hockey, basketball, and wrestling. Furthermore, potential recruitment strategies, such as having a parent–athlete meeting at which parents can consent and athletes can complete the questionnaire in a single session in contrast to asking high school athletes to take forms home to have them signed, may be useful in future research to increase return. During the study period, a substantial amount of media attention was given to concussion in sport, which may have resulted in the relatively high knowledge scores in our sample.

CONCLUSIONS

Underreporting of concussion is a multifaceted problem, as evidenced by the influence of the factors addressed in our study. Knowledge and attitude both appear to influence reporting behaviors in some contexts. Our most striking finding was the large proportion of recalled concussion events that this sample of high school athletes did not report. In addition, our findings suggest that increasing knowledge of concussion symptoms, improving the culture of sport, and increasing the understanding of the serious nature of concussive injuries should be targets for future interventions. Furthermore, our findings support policies for educating both coaches and athletes. In addition, they support implementation of programs increasing awareness, promoting reporting, and creating a "safe" reporting environment. Clinicians can work to create this safe environment by educating the community, coaches, parents, and athletes about concussion; helping others to see they are not alone in their experiences; and providing platforms for individuals, especially those respected in the athletic community, to speak out about concussion and why these injuries should be reported and managed properly. These efforts can be used to increase tolerance and health literacy, both of which potentially may increase reporting and careseeking for concussive injury. Our study is also 1 of the first to encompass the constructs of knowledge, attitude, and self-report behavior into a single study aimed at understanding concussion-reporting behaviors among young athletes.

Although our study encompassed only 1 convenience sample of athletes, the major findings illustrated the importance of increased athlete knowledge, more favorable athlete attitude, and context of reporting concussion among high school athletes. We highlighted the importance of addressing multiple factors to increase reporting of possible concussive injuries. In addition, we highlighted the need for multifactorial interventions in the high school setting to address these risky behaviors. Clinicians, parents, and coaches should make concussion education and awareness a priority and address factors to provide a more optimal concussion-reporting environment. In turn, increases in reporting may lead to decreases in recurrent injuries in this young population. In the future, researchers should address the influence of increasing knowledge and attitude on reporting concussions and recurrent concussions in large prospective studies.

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