

Knowledge of Concussion and Reporting Behaviors in High School Athletes With or Without Access to an Athletic Trainer

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Context: Increased sport participation and sport-related concussion incidence has led to an emphasis on having an appropriate medical professional available to high school athletes. The medical professional best suited to provide medical care to high school athletes is a certified athletic trainer (AT). Access to an AT may influence the reporting of sport-related concussion in the high school athletic population; however, little is known about how the presence of an AT affects concussion knowledge, prevention, and recognition.

Objective: To evaluate knowledge of concussion and reporting behaviors in high school athletes who did or did not have access to an AT.

Design: Cross-sectional study.

Setting: Survey.

Patients or Other Participants: A total of 438 athletes with access to an AT and 277 without access to an AT.

Intervention(s): A validated knowledge-of-concussion survey consisting of 83 items addressing concussion history, concussion knowledge, scenario questions, signs and symptoms of a concussion, and reasons why an athlete would not

report a concussion. The independent variable was access to an AT.

Main Outcome Measure(s): We examined the proportion of athletes who correctly identified knowledge of concussion, signs and symptoms of concussion, and reasons why high school student-athletes would not disclose a potential concussive injury by access to an AT. Frequency statistics, χ^2 tests, independent t tests, and linear regression were conducted to analyze the data.

Results: The underreporting of concussion among high school athletes was 55%. Athletes with access to an AT had more knowledge of concussion than did athletes without such access ($P \leq .001$). Chi-square tests did not demonstrate a significant relationship between AT access and a higher percentage reporting concussions.

Conclusions: High school athletes with access to an AT had more concussion knowledge, but they did not report suspected concussions to an authority figure more frequently than athletes without access to an AT.

Key Words: traumatic brain injuries, secondary school, health care

Key Points

- Compared with high school athletes who had access to an athletic trainer, those without such access were less knowledgeable about concussion.
- Access to an athletic trainer was not linked to high school athletes' concussion-reporting percentages. However, such access was related to 10 reasons for not reporting a concussion.
- The most common reasons for not reporting a concussion were not wanting to lose playing time, not thinking the injury was serious enough to require medical attention, and not wanting to let the team down.

Increased sport participation and sport-related concussion (SRC) incidence has led to an emphasis on having an appropriate medical professional available to high school student-athletes. The medical professional best suited to provide medical care to high school athletes is a certified athletic trainer (AT).¹ The AT is the ideal liaison among school administrators, coaches, physicians, and parents.² Although ATs are estimated to be present in 86% of all US high schools, only 36% of high school athletes have access to a full-time AT.³ This presents a problem for student-athletes participating in sports that have limited to no medical coverage, as the presence of an AT is critical to the early recognition and care of athletic injuries. Specifically, SRC is a growing health concern and represents 4% to 9% of all high school injuries.^{4,5} The true

incidence of SRC may actually be higher, as research^{6,7} suggests that approximately 50% of high school athletes may not report a concussion to an authority figure (ie, parent, coach, AT). In addition, the lack of an AT in high schools may contribute to the number of concussions that go unidentified. Therefore, access to an AT may influence the reporting of SRC in this at-risk population. Currently, few investigators have examined how the presence of an AT affects high school athletes' concussion knowledge and prevention, recognition, and reporting behaviors.

Current literature on concussion knowledge among high school athletes demonstrates a gap between what high school athletes know and what they should know about SRC. Register-Mihalik et al⁷ found that high school athletes were relatively knowledgeable about the general signs and

symptoms of concussion (eg, headache, confusion, dizziness) as compared with those in previous studies,^{8,9} although athletes were still unable to recognize some of the less common signs and symptoms of concussion, such as nausea, amnesia, and insomnia. Increased knowledge of concussion and concussion symptoms positively affects reporting but does not always equate to a change in behavior.⁷

Concussions that are unidentified and underreported can increase the risk of subsequent injury and long-term consequences in the adolescent athlete. McCrea et al⁶ noted that common reasons why high school athletes did not report their concussions included not thinking the injury was serious enough to warrant medical attention, fear of being removed from play, and lack of awareness of a likely concussion. However, this study was conducted using a retrospective survey instrument at the end of the football season. Register-Mihalik et al⁷ used a different survey instrument to further investigate why male and female high school athletes did not report their concussions and found similar results. Athletes did not report their concussive injury for reasons such as not thinking the injury was serious enough to report, not wanting to be removed from play, and not wanting to let teammates down.^{6,7} In addition, attitudes toward concussions may also contribute to the failure to report a concussion to a health care provider. Attitude scores illustrated a disparity in perceptions of concussion across the high school athletic population, and many athletes believed that reporting a concussion may be embarrassing.⁷

As high school sports participation continues to rise in the United States, and budget constraints limit resources in public schools, administrators must find a way to provide the best possible care for student-athletes. Access to an AT may influence the knowledge and reporting of SRC among high school athletes. However, few researchers have assessed the benefit of access to an AT as it relates to high school athletes' knowledge of concussion and reporting behaviors. Therefore, the purpose of our study was to assess the concussion knowledge and reporting behaviors of high school athletes in schools with access to an AT and schools with no access to an AT.

METHODS

Participants

The study population of interest comprised high school athletes between the ages of 13 and 19 years. A total of 14 schools in 2 Michigan metropolitan areas were recruited to participate. Of the 14 schools, 7 employed a full-time AT and 7 did not employ an AT. High school athletes at the 14 schools all received the same preseason, state-mandated concussion education that included the Centers for Disease Control and Prevention's "HEADS UP" concussion-education documents (<http://www.cdc.gov/headsup/youthsports>), which were sent home to be read and signed by parents or guardians. No other concussion education took place at any of the schools.

Instrumentation

A single survey served as the primary instrumentation for the study. The instrument was developed and determined to be reliable and valid by Register-Mihalik et al.⁷ The survey

was separated into sections for athlete demographics, knowledge of concussion, self-understanding of concussion, and reporting behaviors. Five demographic questions addressed race, age, sex, grade in school, and sport. Knowledge of concussion was assessed through a series of 35 questions in which participants were asked to recognize signs and symptoms of concussion, identify complications related to multiple concussions, and answer items pertaining to general knowledge of concussion. The Cronbach α calculated for knowledge construct was .80.⁷ An additional 7 signs and symptoms of concussion (eg, fogginess) were added to the survey instrument but not included in the calculation to be consistent with the validated survey by Register-Mihalik et al.⁷ The additional signs and symptoms allowed us to further evaluate knowledge and recognition of other commonly cited signs and symptoms of concussion.

Reporting behaviors were assessed by questions that inquired why athletes would not report concussion symptoms to an AT, coach, parent, or teammate or why they chose to report concussion symptoms. Reporting-behavior questions were assessed at the end of the concussion-history section. Athletes were asked how many times they reported any *bell-ringer events* (described on the survey as *having their bell rung* or *getting dinged*⁷) or concussions to a medical professional, AT, or coach. The term *bell-ringer* was used to assess when possible concussions occurred and which events athletes perceived as bell-ringers as opposed to concussions.⁷ No formal definition for *bell-ringer* or *concussion* was given to participants because the study was based on athletes' personal perceptions.⁷ Athletes were also asked if they knew of anyone who had a concussion but did not report it. The last reporting-behavior question asked student-athletes to choose reasons why they did not report any possible concussion signs and symptoms to an AT, coach, parent, or teammate. A total of 13 reasons for not reporting a concussion were offered, including not wanting to miss playing time, not thinking the signs and symptoms were serious enough to warrant medical attention, not wanting to appear weak to teammates or coaches, not wanting to let the team down, and not knowing the signs and symptoms represented a concussion at the time of the injury. The last 2 items assessed reporting behavior by asking athletes if they ever continued to play in a game or practice even though they were experiencing signs and symptoms of concussion.

The final section of the survey contained 7 Likert-scale questions that asked each athlete to rate the importance of concussion knowledge and of reporting the signs and symptoms of concussion. For example, 1 item invited each athlete to rate on a scale of 1 to 7 (1 = *not important*, 7 = *very important*) how important he or she thought it was to be informed about the ways concussions happen. The questionnaire consisted of 83 questions. Access to an AT was assessed by asking if there was an AT at the school. This was further corroborated with the primary investigator, who also recorded which schools had ATs.

Data-Collection Procedures

Institutional review board approval was obtained from Michigan State University. Schools and districts were first contacted via e-mail and then via follow-up telephone calls. Some districts required face-to-face meetings with district

administrators, and separate contract agreements were then completed to gain access to those schools. After all school and district approvals were obtained, contact with either the athletic director or AT was made at each school before the study. In high schools that had an AT, all communication with coaches and parents was directed through the AT. The AT assisted the principal investigator in setting up meetings with coaches and the teams. At schools without an AT, all communication was set up through the athletic director and individual team coaches.

After each school approved the process, school information forms were completed by a designated contact at each school (either the athletic director or AT), who served as the research contact at the site. School information forms requested contact information for the athletic director, AT, and school. The school contacts helped to arrange dates for passing out parental consents and surveys. The principal investigator attended most parent meetings and all survey distributions at each school. Survey distribution and completion took place at each school during each competitive sport season. All meetings were conducted using a standardized script to ensure similar instructions for all participants. The athletic directors and ATs were not present during survey completion.

Parental consent forms had to be signed and returned for a student-athlete to participate. Student-athletes at each of the 14 schools who returned the parental consent (whether the parent agreed to allow the child to participate or not) received a \$5 gift card for a sandwich shop. On the day of survey distribution, child assent was obtained before the student-athlete completed the survey. To be eligible for the study, male and female high school student-athletes had to participate on 1 of the following sport teams: football, volleyball, girls' or boys' basketball, wrestling, gymnastics, girls' or boys' soccer, or cheerleading. We chose these athletic teams because they were the only sports that were offered at all recruited schools. All student-athletes at each school had the opportunity to participate. Volunteers were excluded if they were not on 1 of the cited teams but were not excluded because of pre-existing learning disability, attention-deficit disorder/attention-deficit hyperactivity disorder, or any previous history of concussion. The questionnaire was a paper-and-pencil survey administered 1 time, which took participants approximately 10 to 15 minutes to complete. They were allowed to skip questions and to withdraw at any time.

Data Analysis

General descriptive (ie, means, standard deviations, frequencies) and inferential statistics were used to summarize all demographic data, independent variables, outcome variables, and athletes' knowledge-of-concussion scores. We also used frequencies to summarize student-athletes' reporting behaviors and reasons why athletes would or would not report signs and symptoms of concussion. Knowledge-of-concussion scores were determined by summing correct responses to the 35 questions (1 point for each correct answer). Scores ranged from 0 to 35, with a higher score representing a greater amount of concussion knowledge. The knowledge construct included correct responses assessing symptoms of concussion, loss of consciousness (LOC) and concussion, asymptomatic return

to play, structural injury (eg, brain, skull, face), complications of multiple concussions, and complications of returning to play too soon. Differences in knowledge of concussion between athletes with and without access to an AT were analyzed using an independent *t* test.

To calculate reporting behaviors, only participants who indicated at least 1 recalled concussive event (ie, bell-ringer or concussion; $n = 331$) were included. The numbers of recalled bell-ringers and concussions at games and practice sessions were summed for each participant. The reporting percentage was then calculated for all participants who recalled at least 1 concussive event. We divided the summed concussive events (ie, bell-ringers and concussions) by the summed reported events and multiplied that value by 100 to determine each individual's reporting percentage. For example, if an athlete stated he had 3 concussive events but only reported 1 of them, his percentage of reported events was $1/3 \times 100$, or 33.3%. Reporting percentage values were then divided into 2 groups: high reporters and low reporters. *High reporters* were any individuals who reported 50% or more of recalled concussive events, and *low reporters* were any individuals who reported fewer than 50% of recalled concussive events. We used nonparametric statistics, specifically χ^2 , to determine if access to an AT resulted in athletes reporting potential concussive injuries to an authority figure more frequently than athletes without access to an AT. Chi-square analyses were also performed to determine if any relationships existed between AT access and 13 reasons for not reporting a concussion. Finally, linear regression was used to determine if the knowledge-of-concussion score predicted a greater likelihood of reporting potential concussions. Statistical significance was set a priori at $P < .05$ for all analyses. Data were analyzed using SPSS (version 22.0; IBM Corp, Armonk, NY).

RESULTS

A total of 715 athletes (503 males, 212 females) participated in the study: 61.3% ($n = 438$) had access to an AT (AT group) and 38.7% ($n = 277$) did not have access to an AT (NoAT group). The response rate was approximately 26%. Most of the athletes played football ($n = 357$, 49.9%), followed by volleyball ($n = 103$, 14.4%) and boys' basketball ($n = 89$, 12.4%). A summary of the breakdown by sport is in Table 1.

Knowledge of Concussion

Athletes' knowledge-of-concussion scores ranged from 11 to 35 (maximum possible score = 35, mean = 27.50 ± 4.2 ; Table 2). An independent *t* test indicated a difference in knowledge-of-concussion scores between the AT and NoAT groups ($t_{2,713} = 4.77$, $P \leq .001$). Athletes with access to an AT had higher scores (28.09 ± 4.1) than athletes without such access (26.58 ± 4.2). The range of scores for the AT group was 14 to 34 and for the NoAT group was 11 to 33.

Self-Reported Understanding of Concussion

Four Likert-scale questions asked athletes to report their understanding of the nature of concussion, return-to-play criteria, and signs and symptoms of concussion (Table 3).

Table 1. High School Athletes' Sport Participation by Access to an Athletic Trainer (N = 715), n (%)

| Sport | Access to an Athletic Trainer? | |
|-------------------|--------------------------------|------------|
| | Yes | No |
| Football | 178 (24.9) | 170 (23.8) |
| Volleyball | 77 (10.8) | 26 (3.6) |
| Girls' basketball | 54 (7.6) | 13 (1.8) |
| Boys' basketball | 61 (8.5) | 28 (3.9) |
| Wrestling | 21 (2.9) | 0 (0.0) |
| Gymnastics | 7 (1.0) | 1 (0.1) |
| Girls' soccer | 10 (1.4) | 0 (0.0) |
| Boys' soccer | 15 (2.1) | 20 (2.8) |
| Cheerleading | 2 (0.3) | 10 (1.4) |
| Other | 13 (1.8) | 0 (0.0) |

Approximately 94% (n = 412) of athletes from the AT group and 87% (n = 241) of athletes from the NoAT group agreed that they understood the dangers of concussion. Moreover, 78% (n = 342) from the AT group and 61% (n = 169) from the NoAT group reported understanding the signs and symptoms of concussion. Approximately 16% more athletes in the NoAT group thought it was permissible to continue playing if they thought they had a concussion and 12% more athletes in the NoAT group thought it was acceptable to continue playing if they were experiencing a concussion symptom.

Descriptive Information on Reporting Behaviors

Of the entire sample population, 46.3% (n = 331) recalled having at least 1 concussive event (ie, bell-ringer or concussion; Table 4). Of these participants, only 21.4% (n = 71) reported the concussive event to an authority figure. The sample recalled a total of 383 concussions in practices and games and reported only 218 (56.9%). A total of 1817 bell-ringer events were recalled, which equates to 5.49 bell-ringers per athlete; 274 (15.1%) were reported to an authority figure. In schools with an AT, 1216 concussions and bell-ringers were recalled, and only 301 (24.8%) were reported. In the NoAT schools, 984 concussions and bell-ringers were recalled, and 191 (19.4%) were reported.

During games, 1172 concussions and bell-ringers were recalled, and only 295 (25.2%) were reported to an authority figure. During practices, 1028 concussions and bell-ringers were recalled, and 197 (19.2%) were reported to an authority figure. During games in schools with an AT, 658 concussions and bell-ringers were recalled, and only 196 (29.8%) were reported. During games in NoAT schools, 984 concussions and bell-ringers were recalled and 191 (19.4%) were reported. In addition, 25.3% of the AT group and 32.1% of the NoAT group indicated that they continued to play in a game while experiencing signs and symptoms of concussion. Moreover, 21.9% in the AT group and 27.8% in the NoAT group continued to participate in a practice while experiencing signs and symptoms of a concussion.

Of the 331 athletes who recalled bell-ringers and concussions, 97 (29.3%) were high reporters and 234 (70.7%) were low reporters. A total of 55.3% of the recalling group did not report any bell-ringers or concussions to an authority figure. Schools with an AT had 60 high reporters and 126 low reporters. The NoAT schools had 37 high reporters and 108 low reporters. Results from

Table 2. High School Athletes' Knowledge-of-Concussion Scores by Access to an Athletic Trainer (N = 715), n (%)

| Knowledge-of-Concussion Questions | Correct Answer Given Access to an Athletic Trainer? | |
|--|--|------------|
| | Yes | No |
| Signs and symptoms included in the knowledge score | | |
| Abnormal sense of smell | 395 (90.2) | 258 (93.1) |
| Abnormal sense of taste | 384 (87.7) | 255 (92.1) |
| Black eye | 376 (85.8) | 259 (93.5) |
| Bleeding from ear | 342 (78.1) | 230 (83.0) |
| Bleeding from mouth | 386 (87.4) | 269 (97.1) |
| Bleeding from nose | 362 (82.6) | 245 (88.4) |
| Blurred vision | 377 (86.1) | 208 (75.1) |
| Confusion | 375 (85.6) | 198 (71.5) |
| Dizziness | 376 (85.8) | 199 (71.8) |
| Fever | 372 (84.9) | 249 (89.9) |
| Headache | 405 (92.5) | 229 (82.7) |
| Joint stiffness | 364 (83.1) | 244 (88.0) |
| Loss of consciousness | 369 (84.2) | 178 (64.2) |
| Memory loss | 362 (82.6) | 188 (67.8) |
| Nausea | 290 (66.2) | 115 (41.5) |
| Numbness or tingling of arms | 315 (71.9) | 242 (87.4) |
| Sharp burning pain in neck | 289 (66.0) | 216 (78.0) |
| Skin rash | 423 (96.6) | 271 (97.8) |
| Sleep problems | 235 (53.7) | 97 (35.0) |
| Weakness in neck movements | 252 (57.5) | 184 (66.4) |
| Signs and symptoms not included in the knowledge score | | |
| Chest pain | 401 (91.5) | 257 (92.8) |
| Difficulty breathing | 354 (80.8) | 245 (88.4) |
| Fogginess | 291 (66.4) | 103 (37.2) |
| Nosebleed | 370 (84.5) | 251 (90.6) |
| Ringing in the ears | 340 (77.6) | 166 (59.9) |
| Sensitivity to light | 364 (83.1) | 169 (61.0) |
| Stiff back | 375 (85.6) | 247 (89.2) |
| General knowledge | | |
| Body part injured | 355 (81.1) | 212 (76.5) |
| Loss of consciousness and concussion | 341 (77.9) | 129 (46.6) |
| Return to play with symptoms | 288 (65.6) | 166 (59.9) |
| Complications of multiple concussions | | |
| Brain damage | 381 (87.0) | 219 (79.1) |
| Increased risk of further injury | 285 (65.1) | 138 (49.8) |
| Joint problems | 374 (85.4) | 247 (89.2) |
| Memory problems | 360 (82.2) | 189 (68.2) |
| No complications exist | 421 (96.1) | 257 (92.8) |
| I don't know | 383 (87.4) | 222 (80.1) |
| Complications of returning to play too soon | | |
| Brain damage | 349 (79.9) | 178 (64.6) |
| Increased risk of further injury | 308 (70.3) | 154 (55.6) |
| Joint problems | 366 (83.6) | 246 (88.8) |
| No complications exist | 425 (97.0) | 256 (92.4) |
| Paralysis | 250 (57.1) | 198 (71.5) |
| I don't know | 367 (83.8) | 216 (78.0) |

the χ^2 analysis showed no relationship between a higher reporting percentage and the presence of an AT ($\chi^2 = 2.34$, $P = .13$). The top reasons high school athletes did not report a potential concussive injury were not thinking the injury was serious enough to warrant medical attention (n = 241, 33.7%), not wanting to lose playing time (n = 191, 26.7%), not wanting to let the team down (n = 142, 19.9%), and not wanting to go to the doctor (n = 105, 14.7%; Table 5). The χ^2 analyses demonstrated significant relationships between AT access and 10 reasons for not reporting a concussion.

Table 3. Frequency and Percentage of Self-Reported Understanding of Concussion by Access to an Athletic Trainer (AT) (N = 715), n (%)

| Statement ^a | 1: Disagree Completely | 2: Somewhat Disagree | 3: Neither Agree nor Disagree | 4: Somewhat Agree | 5: Agree Completely |
|--|------------------------|----------------------|-------------------------------|-------------------|---------------------|
| I understand the dangers of concussion. | | | | | |
| AT | 3 (0.69) | 6 (1.4) | 17 (3.9) | 135 (30.8) | 276 (63) |
| No AT | 6 (2.2) | 9 (3.2) | 20 (7.2) | 84 (30.3) | 158 (57) |
| I understand the signs and symptoms of concussion. | | | | | |
| AT | 16 (3.7) | 36 (8.2) | 52 (11.9) | 210 (47.9) | 122 (27.9) |
| No AT | 31 (11.2) | 28 (10.1) | 49 (17.7) | 115 (41.5) | 54 (19.5) |
| If I am hit in the head and have a headache, it is OK to continue to play, as long as I didn't lose consciousness. | | | | | |
| AT | 165 (37.7) | 96 (21.9) | 87 (19.9) | 68 (15.5) | 18 (4.1) |
| No AT | 75 (27.1) | 34 (12.3) | 66 (23.8) | 66 (23.8) | 30 (10.8) |
| If I think I may have a concussion, it is OK to continue to play your sport. | | | | | |
| AT | 257 (58.7) | 88 (20.1) | 59 (13.5) | 18 (4.1) | 12 (2.7) |
| No AT | 126 (45.5) | 48 (17.3) | 42 (15.2) | 36 (13) | 18 (6.5) |

^a Items are presented in their original form.

Specifically, athletes who attended the NoAT schools were more likely to not report a concussive event for the following reasons: (1) they did not think it was serious ($\chi^2 = 3.57, P = .05$), (2) they did not want to lose playing time ($\chi^2 = 5.65, P = .02$), (3) they did not want to let their team down ($\chi^2 = 13.35, P < .001$), (4) they did not want to go to the doctor ($\chi^2 = 12.53, P < .001$), (5) they thought their parents would get upset ($\chi^2 = 7.01, P = .01$), (6) it was the end of the season and they did not want to miss a game ($\chi^2 = 5.60, P = .02$), (7) their team was in the playoffs when it happened ($\chi^2 = 10.18, P = .01$), (8) they were trying to get a college scholarship ($\chi^2 = 7.51, P = .01$), (9) they did not realize at the time that their injury was a concussion ($\chi^2 = 4.94, P = .03$), and (10) they did not have health insurance ($\chi^2 = 3.89, P = .05$; Table 5).

Finally, the knowledge-of-concussion score did not predict the athletes' reporting percentage ($F_{1,328} = 3.502, P = .251$). Higher knowledge-of-concussions scores were not associated with higher reporting percentages.

DISCUSSION

Knowledge of Concussion and Access to an AT

Previous published research to determine high school athletes' knowledge of concussion was conducted in schools that had access to an AT; therefore, we believe we are the first to examine knowledge of concussion in high school athletes with or without access to an AT. The current findings indicate that despite uniform, state-mandated concussion-education efforts, high school athletes with access to an AT had more concussion knowledge than high school athletes without access to an AT. Correct identification of signs and symptoms of concussion was approximately 10% to 30% higher in high school athletes with access to an AT. Because they are highly educated and have had concussion-specific education and training, ATs are the health care professionals best suited to provide effective and efficient medical care to high school athletes.¹ Moreover, the National Athletic Trainers' Association position statement¹⁰ on SRC emphasized that the AT should play an active role in educating athletes, coaches, and parents about the signs and symptoms associated with concussion as well as the potential risks of playing while symptomatic.

Across the sample, athletes' knowledge scores were moderate, with a mean of approximately 27 of 35 questions answered correctly; however, the NoAT group demonstrated significantly lower scores. Therefore, a gap persists between what high school athletes know and should know about concussion, and the gap is more pronounced in the NoAT group. These findings are similar to those of previous studies^{7,11,12} that have also shown high school athletes to have moderate to inadequate knowledge of concussion. Unlike earlier researchers who investigated concussion knowledge in high school athletes, we found that fewer athletes correctly identified the most common signs and symptoms of a concussion. For example, previous authors¹¹ have shown that headache, dizziness, and confusion were correctly identified 90% to 97% of the time; however, in our study, only 83% of high school athletes without access to an AT identified headache, 72% identified dizziness, and 72% identified confusion. This result is concerning because headache is the most prominent sign and symptom, experienced by at least 94% of athletes after injury.¹³ Moreover, athletes who experienced postconcussion headache were more likely to describe a larger number of additional signs and symptoms.¹⁴ Dizziness is also a common symptom and may be the best on-field predictor of delayed recovery after injury in concussed football players.¹³ Therefore, it is alarming that approximately 30% of high school athletes in the NoAT group were unable to recognize dizziness as a symptom of concussion.

Although frequent concussion signs and symptoms such as headache, dizziness, and confusion were correctly identified by a large percentage of athletes, memory loss (68%), LOC (64%), sleep problems (35%), nausea (41%), and foginess (37%) were signs and symptoms that were poorly recognized by the sample of high school athletes without access to an AT versus those with such access. Memory loss and LOC are signs and symptoms that have been shown in the literature to be more familiar to high school athletes¹⁵; however, our results indicated that many athletes were only moderately aware of these 2 signs and symptoms. Conversely, nausea and sleep problems have notoriously been reported at very low percentages by high school athletes. Register-Mihalik et al⁷ and Cournoyer and Tripp¹¹ also reported an apparent lack of knowledge about nausea and sleep difficulties as symptoms of concussion.

Table 4. Recalled and Reported Bell-Ringers and Concussions by Access to an Athletic Trainer (AT), No.

| Event | Bell-Ringers | | Concussions | |
|----------|--------------|----------|-------------|----------|
| | Recalled | Reported | Recalled | Reported |
| Practice | | | | |
| AT | 491 | 59 | 67 | 46 |
| No AT | 395 | 55 | 75 | 37 |
| Game | | | | |
| AT | 527 | 108 | 131 | 88 |
| No AT | 404 | 52 | 110 | 47 |

Nausea is a symptom that can be associated with a multitude of medical problems, which may be why it is difficult for high school athletes to recognize that this symptom is associated with concussion or brain injury.⁷ Most of the participants were unable to identify sleep problems as a symptom of concussion. Additionally, fogginess as a symptom was unfamiliar to approximately 45% of our sample. Fogginess has been described as feeling mentally foggy or mentally “slowed down”¹⁶ and is a prominent symptom; athletes who experience fogginess often experience a number of other concussion symptoms.¹⁷ We suspect that athletes did not understand the term *fogginess*; these findings truly represent the knowledge gap between what high school athletes know and should know about concussion. This knowledge gap is further observed in the NoAT athletes.

In addition to the recognition of signs and symptoms, our results illustrated that high school athletes had moderate knowledge of the complications associated with multiple concussions and with returning to play too soon after a concussion. Some of the questions that were most frequently missed in these sections dealt with understanding the complications of multiple concussions and of returning to play prematurely. A large percentage of athletes did not know that multiple concussions could lead to an increased risk of further injury or that returning to play too soon after a concussion could lead to brain damage. These findings are similar to the results of Cournoyer and Tripp,¹¹ who found that varsity football players were only moderately able to identify the long-term consequences of concussion and often incorrectly identified the risks of improper care of concussive injuries. Future concussion-education efforts should include the complications of multiple concussions and the risks of returning to play too soon.

Reporting Behaviors of High School Athletes

Previous authors^{6,7} have cited the underreporting of concussion at 40% to 50%. However, we found that approximately 55% of high school athletes did not report their concussion to an authority figure. All of the information was self-reported, and most of the recalled concussive events were classified as bell-ringers. Unreported bell-ringer events totaled 1817, with the majority of these having occurred in games. The difference between the number of reported bell-ringer events and the number of concussion events was substantial, as only 383 practice or game concussions were recalled. The difference in the proportion of recalled concussions and bell-ringers draws attention to athletes’ misunderstanding of these terms and

their inability to associate the terms *bell-ringer* and *concussion*.⁷ This finding parallels that of Register-Mihalik et al⁷: the majority of events reported in their study were also bell-ringers. The term *bell-ringer* was used to help examine the number of “having one’s bell rung” or “getting dinged” events that occurred, but the National Athletic Trainers’ Association position statement on SRC¹⁰ recommended against using the colloquial term because it minimizes the seriousness of the injury. Not all the bell-ringer events in this study might have been concussions, yet all should have been reported and evaluated by a medical professional to determine if an injury occurred. Moreover, if an athlete shows concussionlike signs and symptoms after contact to the head, the athlete sustained a mild concussion at the very least and should be treated accordingly.¹⁸ When these events are not reported, athletes are likely to continue playing in a potentially vulnerable state that could lead to second-impact syndrome.^{19,20}

Our results showed no significant relationship between higher reporting percentages and AT access. However, further analyses demonstrated significant relationships between the presence of an AT and 10 reasons for not reporting a concussion to an authority figure. In schools without an AT, high school athletes were more than 3 times as likely to not report a concussive event to an authority figure because they did not want to go to a doctor and almost 4 times more likely to not report a concussive event due to not having health insurance. Therefore, the presence of an AT may alleviate the athlete’s stress stemming from always having to seek medical help from a physician and allow for more injuries to be recognized and treated immediately. In addition, athletes at NoAT schools were approximately 5 times more likely to not report because they did not know they had a concussion at the time of injury. In their academic curriculum, ATs are well educated about new concussion-assessment methods and tools that improve the clinical identification and acute management of concussion.²¹ Funding an AT position is often difficult for low-income school districts, yet our results indicate that the presence of an AT could decrease the number of unreported concussive events and allow athletes to quickly receive needed medical care to prevent catastrophic outcomes from playing while symptomatic. If no AT is available to high school athletes, all reporting must be directed to a coach or a parent. Reporting to a coach is much different from reporting to a medical professional, and unless a coach has basic first-aid knowledge, he or she lacks the foundation for making decisions or helping athletes obtain the medical care they need.²² Athletes rely on their coaches for guidance regarding which symptoms to report, and many athletes feel that their coaches will remove them from a starting position if they report symptoms.²³ This may be a conflict of interest for coaches because taking care of injuries is not a part of their job.

The most common reasons athletes gave for not reporting possible concussions were not thinking the injury was serious enough to seek medical attention, not wanting to lose playing time, and not wanting to let the team down; percentages for choosing not to report a concussion were higher among athletes in the NoAT group. These findings and reasons align with those of previous researchers.^{6,7} Chrisman et al²³ investigated underreporting via qualitative interviews with athletes who explained they did not want to

Table 5. Reasons for Not Reporting a Concussion by Access to an Athletic Trainer (AT)

| Reason | Frequency of Reason for Not Reporting a Concussion, n (%) ^a | | | χ^2 | P Value |
|--|--|-----------------|-----------------|----------|--------------------|
| | AT (n = 438) | No AT (n = 277) | Total (n = 715) | | |
| I did not think it was serious. | 136 (31.0) | 105 (38.0) | 241 (33.7) | 3.57 | .05 ^b |
| I did not want to lose playing time. | 100 (22.8) | 91 (32.9) | 191 (26.7) | 5.65 | .02 ^b |
| I did not want to let the team down. | 68 (15.5) | 74 (26.7) | 142 (19.9) | 13.35 | <.001 ^b |
| I did not want to have to go to the doctor. | 48 (11.0) | 57 (20.6) | 105 (14.9) | 12.53 | <.01 ^b |
| I thought my parents would be upset. | 14 (3.2) | 21 (7.6) | 35 (4.8) | 12.53 | <.01 ^b |
| It was the end of the season; I didn't want to miss a game. | 50 (11.4) | 49 (17.7) | 99 (13.8) | 5.60 | .02 ^b |
| My team was going to the playoffs when it happened. | 20 (4.7) | 30 (10.8) | 50 (7.0) | 10.18 | <.01 ^b |
| I was trying to get a scholarship to play in college. | 21 (4.8) | 28 (10.1) | 49 (6.9) | 7.51 | .01 ^b |
| I did not know at the time it was a concussion. | 65 (14.8) | 59 (21.3) | 124 (17.3) | 4.94 | .03 ^b |
| I do not have health insurance and could not go to the doctor. | 7 (1.6) | 11 (4.0) | 18 (2.5) | 3.89 | .05 ^b |
| I thought my teammates would think I'm weak. | 41 (9.4) | 37 (13.4) | 78 (11.0) | 2.79 | .10 |
| I thought my coach would get mad. | 28 (6.4) | 28 (10.1) | 56 (7.8) | 3.25 | .07 |
| I thought my coach would think I'm weak. | 43 (6.0) | 39 (14.1) | 82 (11.5) | 3.04 | .08 |

^a Indicates the frequencies and percentages that represent the proportion of the sample groups that selected each statement as a reason for not reporting a concussion.

^b $P \leq .05$.

stop playing their sport because they felt the signs and symptoms would go away and they did not want to be pulled from the game. Compared with athletes in the AT group, those in the NoAT group were more than 5 times as likely to not report because they did not want to lose playing time and more than 13 times as likely to not report because they did not want to let their team down. These reasons could be the result of having to report directly to a coach. Moreover, for the 13 reasons listed on the survey, higher percentages of athletes without access to an AT chose to not report a bell-ringer or concussion to an authority figure compared with athletes who had access to an AT. We examined underreporting across a variety of different male and female sports, unlike McCrea et al,⁶ who examined underreporting only in football players, and Register-Mihalik et al,⁷ who examined underreporting in cheerleading, football, lacrosse, and soccer. In contrast to other studies, a large number of our participants did not report their concussion because they did not want to have to go to the doctor. This percentage is likely higher due to concussion legislation and regulations that require a physician clearance note for return to play.

This study is not without limitations. Our interpretation of the findings is bound by the fact that more males than females participated. Also, many athletes played multiple sports, and the survey was distributed during the fall season; therefore, our distribution of participants in various sports may not represent the actual distribution. For example, we had a larger number of football players than athletes in other male sports, and many football players also played basketball or wrestled (or both). Additionally, this study did not investigate other concussion-reporting predictors, such as attitude. Next, all testing sites had different environments, and participants did not all take the survey at the same location. Finally, due to the nature of survey instrumentation, we assumed that participants were truthful and answered the questions honestly; however, this is not a guarantee. Future research directions should involve an educational intervention targeting schools without an AT to educate athletes about the signs, symptoms, and dangers of concussion. Investigating knowledge and reporting in youth sports would enable us

to learn what a younger population knows and understands about concussion.

This is the largest study to date to examine knowledge of concussion and reporting behaviors. Although concussion knowledge did not appear to affect reporting, concussion knowledge of athletes in schools with or without an AT differed significantly. Increased knowledge of concussion did not equal increased reporting behaviors, but concussion knowledge is critical to the appropriate immediate care of a possible concussive event. Athletes must understand the signs and symptoms of concussion and the dangers of playing while experiencing symptoms. A high school athlete who has not fully recovered from a single concussion before a second injury occurs could experience catastrophic complications.^{19,20} The presence of an AT positively affects athletes' concussion knowledge; however, the presence of an AT was not associated with a higher reporting percentage. Athletes who did not have access to an AT were more likely to not report a concussive event for numerous reasons, including fear of losing playing time, not thinking the injury was serious enough to seek medical attention, not wanting to let the team down, not wanting to go to the doctor, and not having health insurance. The reporting of a concussion appears to be a problem in all schools; therefore, schools must find the resources to employ ATs, who are more skilled than coaches in recognizing when an athlete is experiencing signs and symptoms of concussion.

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