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Delays in Immediate Athletic Training Evaluation Following Concussion Among High School Football Players: A Report From the Athletic Training Practice-Based Research Network

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Context: Football is the most popular sport among high school boys in the United States. Concussion risk is elevated in the sport due to the high degree of physical contact. Health care providers are more likely to be present at the time of concussion during games and for varsity-level athletes, but how time to an immediate athletic trainer evaluation varies between sport levels and injury settings has yet to be investigated.

Objective: To investigate associations between athlete sport level, injury setting, and same-day athletic trainer evaluation among high school football players following a concussion.

Design: Cross-sectional study.

Setting: Retrospective analysis of deidentified patient records created within the Athletic Training Practice-Based Research Network.

Patients or Other Participants: Patients evaluated and diagnosed with a concussion during in-season high school football participation from 2010 to 2023.

Main Outcome Measure(s): Sport level (freshman, junior varsity [JV], and varsity), injury setting (game, practice), and same-day evaluation following concussion (yes, no).

Results: In total, 1260 patient cases were included in the analysis. A significant association was found between sport level and same-day evaluation ($P = .02$) and between injury setting and same-day evaluation ($P < .001$). A higher percentage of patients playing at the varsity level were evaluated the same day as their injury than those playing at the JV and freshman levels. Additionally, a higher percentage of football athletes were evaluated the same day if they sustained an injury during an in-season practice than if they sustained an injury during a game. These associations remained significant after stratifying by sport level for freshman ($P = .01$) and JV ($P < .001$) athletes but not for varsity athletes ($P = .61$).

Conclusions: Freshman and JV football athletes, as well as those injured during games, are less likely to receive a same-day evaluation by an athletic trainer after concussion. Timely care improves recovery following concussion, emphasizing the need for equitable access to immediate care across sport levels and settings.

Key Words: concussion, evaluation, athletic training, football

Key Points

- Prompt identification, diagnosis, and management is essential for better recovery following concussion, and almost half of all football players were evaluated by their high school athletic trainer the same day they sustained a concussion during in-season football participation.
- A higher percentage of patients playing at the varsity level were evaluated the same day as their injury than those playing at the junior varsity and freshman levels.
- Injury setting was not associated with delays in athletic trainer evaluation for varsity athletes, but a significantly higher percentage of freshman and junior varsity athletes received a same-day evaluation if they sustained a concussion during practice than if they sustained a concussion during a game.

Over 1 million student-athletes participated in football during the 2022–2023 school year, making it the most popular sport among high school boys in the United States.[1] Due to the high degree of physical contact, high school football continues to have one of the highest concussion rates compared with other sports in this setting.[2,3] This raises concern for the health and well-being of the athlete, as concussions interrupt participation in physical activity, school, and social activities and can lead to reduced health-related quality of life.[4,5] Additionally, high school football participants who sustain a concussion report an increased number of symptoms and time to return to play compared with youth and collegiate football athletes.[6] The most consistent predictor of a slower recovery

following concussion is the severity of an athlete's acute and subacute symptoms, with some evidence showing that high school–aged athletes may be the most vulnerable to developing persistent symptoms following concussion.[7,8] However, emerging evidence shows that continued sport participation and delayed access to health care providers after concussion may also prolong recovery.[9,10] Thus, health care professionals qualified in concussion identification, diagnosis, and management, such as certified athletic trainers (ATs), should be accessible to athletes at all levels of play during football participation.

Football is more likely to have on-site medical coverage during games and practices than other boys' and girls' high school sports, which is warranted due to the high risk of injury and catastrophic events compared with other sports at this level.[11–13] Further research in the high school setting has shown that health care providers are more likely to be present at the time of concussion during games than during practices and for varsity-level athletes than for those participating at lower competition levels.[14] However, it is unknown how injury setting and sport level may impact time from concussion to an AT evaluation among high school football participants. The National Athletic Trainers' Association recommends that an AT should be physically present for all football practices and competitions and that athletes suspected of sustaining a concussion should be immediately removed from play and undergo a clinical examination.[15–17] Because continued sport participation and limited access to health care providers properly trained in concussion diagnosis and management are risk factors for delayed or difficult recovery following concussion, it is important to identify factors that may be associated with delays in AT evaluation to work toward increasing health care accessibility, reducing the number of athletes that participate while concussed, and improving outcomes for those who sustain a concussion.

The purpose of this study was to determine the association between athlete sport level (freshman, junior varsity [JV], and varsity) and same-day AT evaluation among high school football players following concussion. A secondary purpose was to evaluate the association between injury setting (game or practice) and same-day evaluation, stratified by sport level, among the same population. We hypothesized that a higher percentage of varsity athletes would be evaluated for their concussion the same day as their injury than JV and freshman-level athletes. We also hypothesized that a higher percentage of athletes would be evaluated the same day if they sustained their injury during a game than if they sustained their injury during practice.

METHODS

Design and Setting

We conducted a retrospective analysis of deidentified patient records from the Athletic Training Practice-Based Research Network. Patient records were created by ATs providing routine care at 182 high schools across 31 states that represent the South ($n = 9$), Midwest ($n = 8$), Northeast ($n = 6$), and West ($n = 8$) regions of the United States as classified by the US Census Bureau.[18]

Patients

Only patients who were evaluated and diagnosed with a concussion during in-season high school football participation (game or practice) were included in the analysis. All patients received care from an AT within the Athletic Training Practice-Based Research Network between 2010 and 2023. This study was determined to be exempt from review by the institutional review board at the University of Wisconsin-Madison due to it being a retrospective analysis of deidentified patient records.

Procedures

Data were created and recorded within the Athletic Training Practice-Based Research Network's electronic medical record (EMR) by ATs who successfully completed a training session. Data extraction procedures used in the current study were similar to those used in previously published investigations.[19,20] Specifically, one research team member (K.C.L.) oversaw the daily management of the EMR and completed the data extraction for quality assurance procedures.[21] Individual patient records were first identified by the number of days between injury and diagnosis. Using this unique identifier, we were then able to identify and extract the remaining study variables from the EMR database for analysis. Data analyzed in this study were a subset of a larger, previously published dataset.[22]

Patients were identified as receiving a concussion diagnosis using the International Classification of Disease diagnostic code on their record. This study only included records of patients who were evaluated and diagnosed with a concussion less than or equal to 7 days following their injury, leading to 73 patient records being excluded from analysis. This timeframe would allow athletes to seek an evaluation from their high school AT within 1 week of sustaining a concussion during in-season play, with a goal of improving validity of any significant results by minimizing possible outliers.

Instrumentation

The CORE-AT (www.core-at.com) is a web-based, Health Insurance Portability and Accountability Act–compliant documentation system that includes standard documentation forms, an injury-surveillance feature, and access to patient-reported outcome forms. In-depth descriptions of the CORE-AT EMR, including its features and functionality, have been previously reported.[23,24] Patient characteristic variables, extracted from the demographics form, included sport level (freshman, JV, or varsity), injury setting (practice or competition), diagnosis (International Classification of Disease-10 code), and time between injury and AT evaluation. Our main outcome variable (time to AT evaluation) was measured as the number of days between when the injury was sustained, as reported by the patient, and evaluation, as reported by the AT. Patients evaluated 0 days after injury were categorized as having received a same-day evaluation, and patients diagnosed 1 to 7 days following their injury were categorized as not having been evaluated the same day that they sustained a concussion during in-season play.

Statistical Analysis

Frequencies and percentages were used to describe categorical variables of interest, whereas age, the only continuous

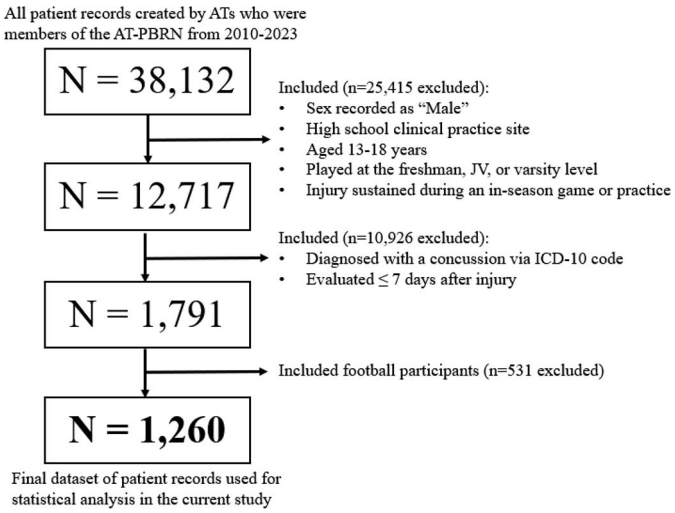

Figure 1. Flow diagram for selection of patient cases. Abbreviations: AT, athletic trainer; AT-PBRN, Athletic Training Practice-Based Research Network; ICD, International Classification of Disease; JV, junior varsity.

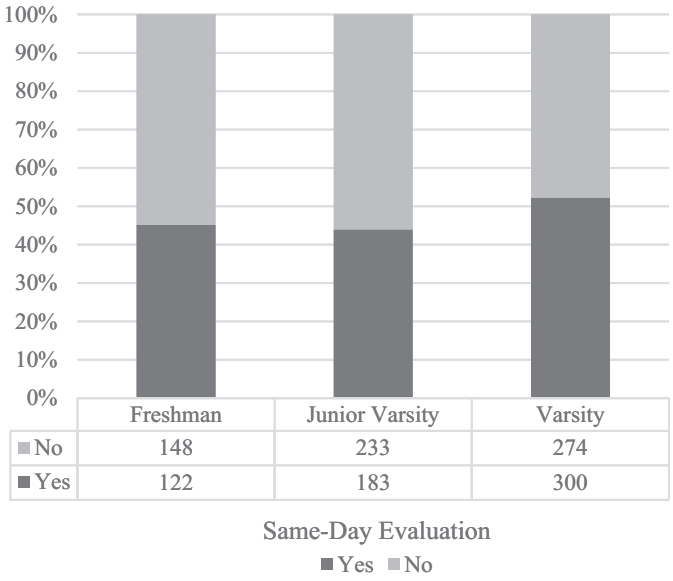

Figure 2. Association between sport level and same-day evaluation. There was a significant ($P = .02$) association between sport level and same-day evaluation. A higher percentage of varsity athletes were evaluated the same day that they sustained a concussion than athletes competing at the freshman and junior varsity level.

variable of interest, was described using mean and SD. Chi-square analyses were used to evaluate possible associations between athlete sport level (freshman, JV, or varsity) and same-day evaluation (yes or no) and between injury setting (in-season practice or in-season game) and same-day evaluation stratified by sport level. All analyses were completed using SPSS 28.0 (SPSS, Inc), and statistical significance was set a priori at $P < .05$.

RESULTS

A total of 1260 patient cases were included in the final analysis (Figure 1). Concussions sustained during an in-season game accounted for 56% ($n = 706$) of the cases, whereas 44% ($n = 554$) of concussions were sustained during an in-season practice. Of all injury cases included, 45.6% ($n = 574$) of patients played at the varsity level, 33% ($n = 416$) played at the JV level, and 21.4% ($n = 270$) played at the freshman level. Football sport positions represented in this study included offensive line (25.3% of patient cases), defensive line (16.9%), wide receiver (16.1%), running back (13.9%), linebacker (12.5%), safety (8.9%), quarterback (5.8%), and kicker (0.6%). Additional athlete demographics can be viewed in Table 1.

Table 1. Athlete Demographics[a]

	Freshman	Junior Varsity	Varsity
n (%)	270 (21.4)	416 (33)	574 (45.6)
Age, y (±SD)	13.95 ± 0.7	14.77 ± 0.89	15.91 ± 1.08
Injury setting			
Game, *n* (%)	128 (47.4)	226 (54.3)	352 (61.3)
Practice, *n* (%)	142 (52.6)	190 (45.7)	222 (38.7)
Position			
Offensive line	63 (23.3)	107 (25.7)	149 (26)
Defensive line	43 (15.9)	74 (17.8)	96 (16.7)
Running back	40 (14.8)	56 (13.5)	79 (13.8)
Quarterback	12 (4.4)	22 (5.3)	39 (6.8)
Wide receiver	54 (20)	68 (16.3)	81 (14.1)
Linebacker	36 (13.3)	53 (12.7)	69 (12)
Safety	20 (7.4)	36 (8.7)	56 (9.8)
Kicker	2 (0.7)	0 (0)	5 (0.9)

[a] Values represent frequency and percentage or mean and SD.

Almost half (48%, $n = 605$) of all patients were evaluated and diagnosed with a concussion the same day that they sustained their injury during in-season football participation. A significant association was found between sport level and same-day evaluation following concussion, and a higher percentage of patients playing at the varsity level were evaluated the same day as their injury than those playing at the JV and freshman levels ($\chi^2_2 = 7.72$, $P = .021$). A total of 52.3% ($n = 300$) of varsity athletes were evaluated the same day that they sustained a concussion compared with 44% ($n = 183$) of JV athletes and 45.2% ($n = 122$) of freshman-level athletes (Figure 2).

Additionally, there was a significant association between injury setting and same-day evaluation ($\chi^2_1 = 13.21$, $P < .001$). A higher percentage of football athletes were evaluated the same day if they sustained an injury during an in-season practice than if they sustained an injury during a game (same-day evaluation: practice = 53.8%, game = 43.5%; evaluation greater than 24 hours after injury: practice = 46.2%, game = 56.5%). This finding can be observed in Figure 3. These associations remained significant after stratifying by sport level for freshman and JV athletes but not for varsity athletes. A higher percentage of freshman and JV athletes were evaluated the same day if they were injured during an in-season practice than if they were injured during an in-season game. There was no significant association between injury setting and same-day evaluation for athletes playing at the varsity level (Table 2).

DISCUSSION

The primary finding of this study is that athletes participating at lower sport levels (ie, freshman and JV) were less likely

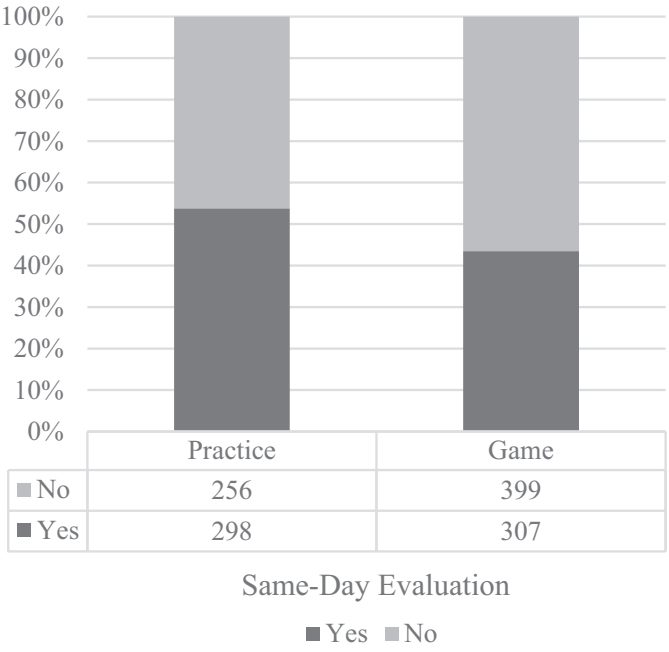

Figure 3. Association between injury setting and same-day evaluation. There was a significant ($P < .001$) association between injury setting and same-day evaluation. A higher percentage of football athletes were evaluated the same day if they sustained a concussion during an in-season practice than those sustained during in-season games.

to be evaluated the same day that they sustained a concussion, supporting our first hypothesis. A secondary finding is that athletes who sustained a concussion during an in-season game were less likely to be evaluated the same day as their injury, which disagrees with our secondary hypothesis. However, further analyses revealed that this association was only significant for lower sport-level athletes. These findings are important as this is the first study to describe the percentage of high school football players who are evaluated by an AT the same day they sustain a concussion during in-season play. Additionally, we identified key factors associated with delays in immediate evaluations, highlighting disparities in timely access to care among athletes of different sport levels within this population.

Our results suggest that time to an immediate AT evaluation following concussion differs based on sport level in the high school setting. One possible explanation for this finding is decreased availability of medical professionals for athletes at lower sport levels, which is supported by previous research. Using injury reports from a national sample of high schools across the United States, Haarbauer-Krupa et al reported that health care professionals are less likely to be present at the time of concussion for high school athletes participating at lower competition levels.[14] Although we did not quantify whether or not a health care provider was on-site at the time of injury, our findings suggest that ATs may be less available to immediately evaluate freshman- and JV-level football participants following concussion. These results differ from Renner et al, who reported that freshman athletes experienced a shorter time from injury to AT evaluation than JV and varsity athletes in the high school setting.[22] However, Renner et al included all sports and acute injuries in their analysis.[22] It is possible that time from concussion to

Table 2. Associations Between Injury Setting and Same-Day Evaluation Following Concussion Stratified by Sport Level

		Same-Day Evaluation		
Sport Level	Injury Setting	Yes (%)	No (%)	*P* Value
Freshman	Practice	75 (27.8)	67 (24.8)	.01[a]
	Game	47 (17.4)	81 (30)	
Junior varsity	Practice	110 (26.4)	80 (19.2)	<.001[a]
	Game	73 (17.5)	153 (36.8)	
Varsity	Practice	113 (19.7)	109 (19)	.61
	Game	187 (32.6)	165 (28.7)	

[a] Denotes statistical significance ($P < .05$).

AT evaluation for football players specifically may follow different patterns than grouped data across multiple sports and injury types.

Further results from our study show that a significantly higher percentage of athletes were evaluated the same day if they sustained a concussion during an in-season practice than if they sustained an injury during an in-season game. However, when stratified by sport level, these significant associations between injury setting and same-day evaluation remained only for freshman and JV athletes but not for varsity athletes. These results align with findings from Renner et al, who found that acute injuries sustained during games were associated with longer times to an AT evaluation.[22] A possible explanation for this finding is that ATs may be less likely to travel to away games for athletes not participating at the varsity level, limiting their availability to evaluate freshman or JV athletes immediately after a concussion sustained during a game. Interestingly, Haarbauer-Krupa et al reported contradictory findings, stating that health care providers were less likely to be on-site at the time of concussion during practices than during games.[14] Given that high school football players are more likely to sustain a concussion during a game than during a practice, it is critically important to ensure that qualified medical personnel, such as ATs, are available to evaluate student-athletes immediately following a head injury during athletic events for all levels of play.[2]

It is important to note that athletes who have access to an AT may choose not to disclose suspected head injuries, which may further contribute to delays in evaluation and diagnosis. A previous investigation found that more than 50% of high school varsity football participants did not disclose a suspected concussion to anyone.[25] The most common reasons that players did not report a concussion were because they did not think their injury warranted medical attention and they did not want to be withheld from competing.[25] The desire to continue competing at the time of injury may explain why a lower percentage of athletes in our study were evaluated the same day if they competed at the JV or freshman levels or if they sustained a concussion during an in-season game. Athletes participating at lower sport levels may continue playing after a head injury in hopes of moving up to higher sport levels. Additionally, athletes may not recognize symptoms of a concussion until the adrenaline from competing wears off. It is important to note that concussion symptoms can evolve over the first 24 hours following injury, and a small percentage of athletes may not experience any, or very mild, symptoms immediately after their injury, which may lead to delays in seeking treatment.[26] Future research should investigate

how a lack of an AT, or limited AT availability, may indirectly lead to concussion underreporting, or delayed reporting, among high school football athletes.

Concussions are prevalent among high school football players, highlighting the need for equitable access to qualified medical professionals at all levels of play. Such access is critical to rule out potentially catastrophic cervical spine injuries, remove athletes from play, and promptly evaluate for concussion.[16,17] Research has shown that delayed recovery from concussion is associated with continued sport participation after injury, delayed reporting by patients, and lack of immediate access to health care providers.[9,10] Certified ATs are highly trained in concussion diagnosis and management, and future studies should examine how delays to an AT evaluation specifically may impact clinical outcomes during concussion recovery.

Although our findings were significant, there are several limitations to the current study that must be acknowledged. Mainly, we were unable to account for unreported concussions among this population, which may bias results. Additionally, our main outcome measure was patient reported, making the accuracy of the time from injury to evaluation dependent on patients providing truthful information to their AT. Further, we did not control for the level of AT availability, defined as the number of athletes per hour the AT provides services at the school. Previous research has shown that the level of AT availability is associated with time from concussion to AT evaluation in the high school setting.[27] Lastly, all patient records analyzed in this study were from athletes with access to an AT during sport participation. It remains unknown how time from concussion to evaluation may differ for athletes attending schools without an AT.

High school ATs provide youth athletes with unparalleled access to qualified health care during sport participation and are often the only provider to manage concussions from initial injury identification and diagnosis to full recovery and beyond.[28] Timely care provided by ATs may reduce undiagnosed concussions, shorten recovery periods, and mitigate the financial burden of injuries by providing in-house treatment. Findings from our study revealed that nearly half of football players were evaluated the same day that they sustained a concussion. However, athletes participating at lower sport levels and those injured during in-season games were less likely to be evaluated the same day than varsity athletes and those injured during practices. These results highlight disparities in timely access to care, which may disproportionately increase the risk of adverse health outcomes for these athletes. Increasing AT availability across all levels of play, particularly for lower sport-level athletes, is critical to improving safety and ensuring equitable access to qualified medical care during sport participation.

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