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The Influence of Athletic Trainers on the Incidence and Management of Concussions in High School Athletes

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Context: In many US high schools, the athletic trainer (AT) has the responsibility to identify and manage athletes with concussions. Although the availability of ATs varies a great deal among schools, how the level of AT availability in high schools affects the reported incidence and management of sport-related concussions (SRCs) is unknown.

Objective: To determine how the presence of an AT affects the reporting and management of SRCs.

Design: Prospective cohort study.

Patients or Other Participants: A total of 2459 (female = 37.5%, age = 16.1 ± 1.2 years) athletes from 31 Wisconsin high schools were categorized as having low availability (LoAT), mid availability (MidAT), or high availability (HiAT) of ATs. Athletic trainers recorded the incidence, days lost from sport, and postconcussion management through return to sport. The incidence of SRC reporting among categories was examined using a multivariate Cox proportional hazards model. Fisher exact tests were used to determine if postconcussion management differed based on AT availability.

Results: The incidence of reported SRCs was lower for the LoAT schools (2.4%) compared with the MidAT (5.6%, hazard ratio = 2.59, $P = .043$) and HiAT (7.0%, hazard ratio = 3.33, $P = .002$) schools. The median time before the first AT interaction was longer for LoAT schools (24.0 hours) than for MidAT (0.5 hours, post hoc $P = .012$) and HiAT (0.2 hours, post hoc $P = .023$) schools. The number of post-SRC interactions was different in all groups (LoAT = 2 interactions, MidAT = 3, and HiAT = 4; all post hoc P values $< .05$). Days lost were greater for MidAT and HiAT (both 14 days lost) schools compared with LoAT schools (11.5 days lost, post hoc $P = .231$ and $P = .029$, respectively). Athletes at LoAT schools were less likely to undergo a return-to-play protocol (9/18 SRCs, 50.0%) than athletes at MidAT (44/47 SRCs, 93.6%; post hoc $P = .001$) or HiAT (64/64 SRCs, 100%; post hoc $P < .001$) schools.

Conclusions: The level of AT availability positively influenced the reported incidence of SRCs as well as postconcussion management activities in this sample of high schools.

Key Words: adolescents, health care access, sport injury, epidemiology

Key Points

- Athletes enrolled in high schools with high athletic trainer (AT) availability were more likely to be determined to have sustained a sport-related concussion (SRC) compared with athletes at schools with low AT availability.
- Fifty percent of high school athletes who sustained SRCs at schools with low AT availability underwent a return-to-play protocol versus 100% at schools with high AT availability.
- Athletes with SRCs at schools with high AT availability were kept out of sport for longer than those at schools with low AT availability.

Nationwide, an estimated 7.1 to 7.5 million athletes participate in high school sports.[1] Approximately 340 000 sport-related concussions (SRCs) occur each year in the United States,[2] with significant numbers occurring in basketball, football, ice hockey, soccer, and wrestling.[3] Sport-related concussion injuries comprise approximately 8% to 13% of all injuries that occur in high school sport settings.[4] In recent years, these injuries have caused a high level of concern for athletes, parents, school officials, and health care providers, as evident from the extensive coverage by various media outlets across the United States.[5,6]

In addition, organizations such as the 4th International Conference on Concussion in Sport,[7] the American Medical Society for Sports Medicine,[8] and the National Athletic Trainers' Association (NATA)[9] have produced consensus statements with specific evidence-based guidelines for preventing, identifying, and managing athletes with SRCs.

Of particular concern is that a substantial number of SRCs nationwide may go unreported[10–12] and that premature return to sport may increase the risk for additional SRCs[13–15] and other sport-related injuries.[16,17] Having qualified licensed medical professionals readily available to adolescent athletes who have sustained an SRC has been consistently cited[7–9] as (a) integral to the prompt identification and evaluation of the injury, (b) necessary to provide appropriate evidence-based managed care, and (c) important to ensuring that the athlete is not allowed to return to play prematurely.

The NATA[18] has consistently advocated for an increased athletic trainer (AT) presence in high schools across the United States. The American Medical Association[19] and youth sports advocacy groups[20] have also recognized the value of having high school-based ATs. However, despite this advocacy, the extent to which ATs are available to high school athletes is inconsistent at best. Although some states require ATs at the high school level, other states have reported that fewer than 50% of their schools have an AT.[21] Athletic trainer availability in a high school setting, however, may not truly measure the extent of effective medical care delivered to the athletes at an individual school. A survey[22] conducted by the NATA and the Korey Stringer Institute demonstrated that 70% of secondary schools had access to an AT in some capacity, but only 37% of secondary schools had a full-time AT.

In Wisconsin, the availability of ATs in the high school setting varies a great deal and directly mimics the nationwide phenomenon. More than 400 schools sponsor interscholastic teams in Wisconsin, yet only one-third of these schools have an AT available on a daily basis during school and sport practice and competition hours. Another third of the schools have an AT available only for 10 to 15 hours per week and limited event coverage. The remaining third of the schools have extremely limited AT (1.0 to 1.5 hours a week) or no coverage during the school year.

The limited access to AT services suggests that high school athletes may not receive consistent SRC identification and uniform management, which could have rare but catastrophic or long-term consequences.[7,8,10,18] Even though it is widely recommended that ATs be available in high school sport settings to identify and manage athletes with SRCs, to date, prospective trials that quantify the services ATs provide to high school athletes diagnosed with SRCs are lacking.

Therefore, the objective of our study was to determine how the availability of an AT affected the incidence of reported SRCs and the management of those with SRCs in secondary schools. We hypothesized that schools with low AT availability would report lower SRC incidences and would rate poorly on measures of SRC management compared with schools that had more AT availability.

METHODS

High School Allocation

This study was approved by the Health Sciences Institutional Review Board at the University of Wisconsin in February 2015. A sample of high schools in Wisconsin was contacted, and each agreed to allow data collection to take place during the 2016–2017 school year and the fall of 2017. Each school was identified based on school enrollment, number of unique athletic participants, and the hours an AT was available at the school as part of an earlier study[23] on the influence of socioeconomic factors on AT availability in Wisconsin high schools.

The level of AT availability at each school was determined based on the number of athletes the AT was expected to serve per hour he or she was on site (athletes/AT hour). Using this metric, a school categorized as having a high level of AT availability (HiAT) would have fewer total athletes to serve per hour than a school with midlevel (MidAT) or low level (LoAT) availability. For example, if an AT was working 10 hours per week at a school with 250 individual athlete participants, the athletes/AT hour = 25.0. The schools in this sample were allocated into 1 of 3 groups identified as *HiAT* (<20.0 athletes/AT hour), *MidAT* (20.0–40.0 athletes/AT hour), and *LoAT* (>40.0 athletes/AT hour). None of the schools in our sample directly employed their ATs. Instead, each school had an AT provided by a local or regional medical provider (hospital or clinic) on a contracted basis.

Solicitations to participate in the study were e-mailed to all ATs who indicated they worked in a Wisconsin high school. Once an AT indicated he or she wanted to participate, the school's athletic director was contacted. Each school's AT needed to sign and submit a letter of agreement to participate in the study and complete the required research training module through the University of Wisconsin. The school athletic director had to submit a letter of agreement allowing data collection at the school. Only schools that met these criteria were eligible to participate in the study. Thirty-four schools initially agreed to participate, but 3 schools (2 MidAT and 1 HiAT) dropped out due to changes in AT personnel or administration before data collection, leaving 31 as the final number (n = 14 LoAT, n = 8 MidAT, n = 9 HiAT).

Participants

Potential volunteers included all interscholastic athletes (ages 14–18 years, grades 9–12) who were engaged in interscholastic sports at participating schools and were fully able to take part in team activities on the first day of preseason team practices. Participants were recruited in person by the research staff during preseason player and parent meetings. After the player provided assent and a parent or guardian provided consent, the player filled out a demographic form with additional questions detailing the sport participation expected during the school year and concussion history and completed the Standardized Concussion Assessment Tool (SCAT)[24] symptom scale, Patient Health Questionnaire-9 (depression),[25] and Pediatric Quality of Life Inventory, version 4.0 (health-related quality of life).[26]

Data Collection by ATs

During the study period, ATs electronically recorded the number of athlete-exposures (AEs) for each participant in every sport via Qualtrics (Provo, UT). An *AE* was defined as any coach-directed interscholastic sport-related competition, practice, or conditioning session and reported to the study team as *yes* or *no*. Athletic trainers recorded the incidence of any suspected *SRC* using the definition provided by the NATA "Position Statement: Management of Sport Concussion"[9]: "[T]rauma-induced alteration in mental status that may or may not involve loss of consciousness." Additional information fields recorded the sport, type of AE (practice, competition, or conditioning session), injury mechanism, activity, position or event, field or court location, duration of symptoms, loss of conscious-

Table 1. School Characteristics

Characteristic	Athletic Trainer Availability			Total (N = 31)	*P* Value
	Low (n = 14)	Mid (n = 8)	High (n = 9)		
	Median (Interquartile Range)				
Enrollment	301 (183, 661)	650 (394, 966)	421 (285, 538)	404 (274, 714)	.269
Athletes/athletic trainer hour	59.0 (48.7, 93.0)	24.1 (22.1, 27.1)	11.6 (6.7, 12.7)	27.8 (15.5, 57.1)	
	No. (%)				
Setting					
Rural	10 (71)	4 (50)	2 (22)	16 (52)	
Suburban	0 (0)	4 (50)	2 (22)	6 (19)	
Urban	4 (29)	0 (0)	5 (56)	9 (29)	
Funding					
Private	0 (0)	0 (0)	7 (78)	7 (23)	
Public	14 (100)	8 (100)	2 (22)	24 (77)	

ness, and any immediate actions taken by the AT or school personnel at the time of injury onset.

Athletic trainers also recorded all post-SRC management activities, including the date and frequency of consensus-based interventions that have reportedly been used by ATs in high school settings.[27,28] Specific actions recorded included time points when the AT had communicated with the athlete's coach, parent or guardian, or primary care provider or pursued academic modification (if warranted). In addition, ATs recorded the dates and frequencies of any post-SRC assessments that may have included individual components of or the full SCAT2 or SCAT3 or other neurocognitive testing. Injured athletes were asked to complete the concussion symptom scale within 24 to 72 hours after the SRC was sustained, 7 days postinjury, and on the date of unrestricted return to activity. Athletic trainers also recorded the dates of symptom resolution, the start of gradual return-to-play activities, and clearance for full unrestricted athletic activity. Wisconsin law requires that any high school athlete suspected of sustaining an SRC must be examined by a licensed medical provider (AT or physician) and medically cleared before he or she is allowed to return to any interscholastic AE.[29,30] Although AEs were recorded via Qualtrics, all SRC incidence and post-SRC management data were reported via REDCap (Research Electronic Data Capture, Nashville, TN) to maintain the confidentiality of protected health information.

Statistical Analysis

Baseline characteristics of the schools and participants were summarized using frequencies (%), means, and medians (interquartile range: 25th, 75th) and examined to identify potential differences among the groups using analyses of variance, Kruskal-Wallis tests, and χ^2 tests.

The numbers of AEs until the first reported SRC were compared among the 3 groups while controlling for possible confounders (history of SRC, sex, cohort year, contact sport, depression status, quality of life, and concussion-symptom score) using a multivariate Cox proportional hazards model with school as a cluster factor.

Chi-square tests and Fisher exact tests were used to determine if the frequency of post-SRC management interventions differed among the 3 groups. Kruskal-Wallis tests were used to compare the number of days before the athletes in each group were allowed to return to their sports. Data from all SRCs were included in the analysis of post-SRC management interventions. A sensitivity analysis for treating all 129 SRCs independently, instead of accounting for athletes with 2 years of data as a random cluster effect, showed no difference in the results (primary comparison *P* values = .043 and .002 versus .031 and .003).

Any global test of the 3 groups with a significant *P* value was examined with post hoc 2-way comparisons using a Holm adjustment for 3 tests. All analyses were conducted using R (version 3.3; the R Project for Statistical Computing, Vienna, Austria), and all tests were evaluated at the .05 significance level.

RESULTS

Data were collected at 31 high schools (n = 14 LoAT, n = 8 MidAT, n = 9 HiAT). A description of the schools in each group is provided in Table 1. Median (interquartile range) total student enrollment was highest at the MidAT schools (650 [394–966]), followed by HiAT and then LoAT schools (421 [285–538] and 301 [183–661], respectively; Kruskal-Wallis $P = .269$). By definition of the groups, the median numbers of athletes/AT hour progressively decreased from LoAT to HiAT schools: 59.0 (48.7–93.0) in the LoAT group, 24.1 (22.1–27.1) in the MidAT group, and 11.6 (6.7–12.7) in the HiAT group ($P < .001$). In the LoAT group, most schools (78%) were located in a rural setting, whereas the HiAT group had the most schools (56%) located in urban settings. All of the schools in the LoAT and MidAT groups were publicly funded; the HiAT group had the most schools with private funding (78%).

A total of 2459 participants (females = 37.4%, age = 15.9 ± 1.1 years) enrolled in the study. Of these, 225 (9.2%) reported sustaining an SRC within the previous 12 months and 459 (18.7%) reported sustaining any previous SRC. The median baseline concussion-symptom score was 0.0 (0.0, 2.0), and the median symptom-severity score was 0.0 (0.0, 2.0) for all participants. The athletes took part in 3866 athlete-seasons and a total of 221 897 AEs (competitions = 63 327, practices = 158 570). The highest percentages of athlete-seasons were in football (30.4%), followed by boys' and girls' basketball (24.4%) and volleyball (13.7%). A summary of the overall participant demographics for each AT group is shown in Table 2.

Table 2. Participant Demographics

Demographic	Athletic Trainer Availability				*P* Value
	Low (n = 747)	Mid (n = 828)	High (n = 884)	N = 2459	
Sport seasons	n = 1263	n = 1306	n = 1297	N = 3866 (%)	
	No. (%)				
Sex					<.001
Female	257 (34.4)	271 (32.7)	392 (44.3)	920 (37.4)	
Male	490 (65.6)	557 (67.3)	492 (55.7)	1539 (62.6)	
Grade					.012
9	208 (27.8)	293 (35.6)	271 (30.7)	772 (31.4)	
10	190 (25.4)	190 (22.9)	251 (28.4)	631 (25.7)	
11	183 (24.5)	186 (22.5)	199 (22.5)	568 (23.1)	
12	166 (22.2)	159 (19.2)	163 (18.4)	488 (19.8)	
Sport-related concussion history					
Any	111 (14.9)	186 (22.5)	162 (18.3)	459 (18.7)	.001
Within past 12 mo	59 (7.9)	94 (11.4)	72 (8.1)	225 (9.2)	.026
	Median (Interquartile Range)				
Total symptoms	0.0 (0.0, 1.0)	0.0 (0.0, 1.0)	0.0 (0.0, 2.0)	0.0 (0.0, 2.0)	.001
Symptom severity	0.0 (0.0, 1.5)	0.0 (0.0, 2.0)	0.0 (0.0, 3.0)	0.0 (0.0, 2.0)	.001
Patient Health Questionnaire-9 score	0.0 (0.0, 2.0)	0.0 (0.0, 2.0)	1.0 (0.0, 3.0)	0.0 (0.0, 2.0)	<.001
Pediatric Quality of Life Inventory, total score[a]	93.2 ± 8.2	93.5 ± 8.0	92.9 ± 8.0	93.2 ± 8.0	.311
	No. (%)				
Sport					
Baseball	61 (4.8)	51 (3.9)	84 (6.5)	196 (5.1)	
Basketball	381 (30.2)	262 (20.1)	300 (23.1)	943 (24.4)	
Football	452 (35.8)	402 (30.8)	320 (24.7)	1174 (30.4)	
Ice hockey	10 (0.8)	18 (1.4)	24 (1.9)	52 (1.3)	
Soccer	48 (3.8)	166 (12.7)	121 (9.3)	335 (8.7)	
Softball	41 (3.2)	62 (4.7)	47 (3.6)	150 (3.9)	
Track	31 (2.5)	75 (5.7)	105 (8.1)	211 (5.5)	
Volleyball	172 (13.6)	152 (11.6)	206 (15.9)	530 (13.7)	
Wrestling	20 (1.6)	23 (1.8)	37 (2.9)	80 (2.1)	
Other[b]	47 (3.7)	95 (7.3)	53 (4.1)	195 (5.0)	

[a] Apart from the *P* value column, values presented in this row are mean ± SD, not median (interquartile range).
[b] Cheer, cross-country, field hockey, golf, lacrosse, swimming, tennis.

A total of 126 participants (5.1%; females = 45, males = 81) reported sustaining 129 SRCs. Roughly 50% (n = 65) of the SRCs were sustained by football players, whereas 13.2% (n = 17) were sustained by basketball players and 10.9% (n = 14) were sustained by volleyball players. The overall incidence of reported SRCs was 0.5814 per 1000 AEs. The median number of hours to the first AT interaction among all participants was 0.5 (0.0, 24). After the onset of the SRC, participants reported SRC symptoms for 7.4 ± 6.7 (median [range] = 5 [1–40]) days. Eighty-six (66.7%) of the participants were seen by their primary care provider, and 7 (5.4%) were medically disqualified from further sport participation during the school year. The median days until unrestricted return to play for the remaining participants (n = 122) were 13 (10, 18.0). A total of 117 (90.7%) of the athletes with reported SRCs underwent an AT-initiated return-to-play protocol, and the median number of post-SRC interactions with an AT was 3.0 (3.0, 4.0).

The results of the multivariate Cox proportional hazards model are presented in Table 3. Participants in the HiAT group were more likely to have reported sustaining an SRC than those in the LoAT group (hazard ratio [HR] = 3.33, 95% confidence interval = 1.55, 7.13; *P* = .002). Participants in the MidAT group were also more likely to have reported sustaining an SRC compared with those in the LoAT group (HR = 2.59, 95% confidence interval = 1.03, 6.53; *P* = .043). The incidence of reported SRCs for the LoAT group (0.2393 per 1000 AEs) was lower than for the MidAT (0.6405 per 1000 AEs) and HiAT (0.8731 per 1000 AEs) groups.

The median number of hours before the first AT interaction after the reported SRC was higher in the LoAT group (24.0 [5.4, 58.0]) than in the MidAT group (0.5 [0.0, 20.0]) and the HiAT group (0.2 [0.0, 25.0]; post hoc *P* = .012 and .023, respectively), but the time to AT interaction between the MidAT and HiAT groups (post hoc *P* = .965) did not differ. After the reported SRC, ATs having an interaction with a parent was associated with AT group (*P* = .001), tending to occur less in the LoAT group than in the MidAT and HiAT groups. However, no post hoc comparisons were statistically significant (all *P* values >.05). Athletic trainers were more likely to interact with the participant's coach in the MidAT and HiAT groups (post hoc *P* = .033 and .024, respectively). Athletes in the LoAT group had fewer post-SRC evaluations than those in the MidAT and HiAT groups (both post hoc *P* values <.001). Players in the MidAT group also had fewer post-SRC

Table 3. **Sport-Related Concussion (SRC) Rate by Athletic Trainer Availability[a]**

Athletic Trainer Availability	n	SRCs (%)	Univariable Analysis		Multivariable Analysis[b]		Univariable Analysis		Multivariable Analysis[c]	
			OR (95% CI)	*P* Value	OR (95% CI)	*P* Value	HR (95% CI)	*P* Value	HR (95% CI)	*P* Value
Low	747	18 (2.4)	Reference	—	Reference	—	Reference	—	Reference	—
Mid	828	46 (5.6)	2.38 (1.04, 5.48)	.041	2.39 (0.98, 5.82)	.055	2.63 (1.06, 6.52)	.037	2.59 (1.03, 6.53)	.043
High	884	62 (7.0)	3.05 (1.48, 6.31)	.003	3.15 (1.51, 6.60)	.002	3.37 (1.58, 7.21)	.002	3.33 (1.55, 7.13)	.002

Abbreviations: CI, confidence interval; HR, hazard ratio; OR, odds ratio.

[a] Reported as n (%), ratio estimate (95% CI). Odds ratio estimated from generalized estimating equation model accounting for cluster effect of school. Hazard ratio estimated from Cox-Proportional Hazards model accounting for cluster effect of school.

[b] Controlling for sex, year, grade, and any previous SRC.

[c] Controlling for all sex, year, grade, any previous SRC, and session (practice versus competition) and contact sport (basketball, football, ice hockey, soccer, and wrestling: *yes*/*no*).

evaluations than those in the HiAT group (post hoc $P < .001$). Participants in the LoAT group were less likely to take part in a supervised return-to-play protocol than those in the MidAT (post hoc $P < .001$) and HiAT (post hoc $P < .001$) groups. Finally, the athletes in the HiAT group were kept out of their sport longer than those in the LoAT group (post hoc $P = .029$). A summary of the post-SRC management activities for each group is found in Table 4.

DISCUSSION

The level of AT availability in secondary schools was associated with various rates of reported SRCs and postconcussion management activities. Further, the incidence of reported SRCs in the LoAT group was lower than expected when compared with previously published research. The reported SRC rate in the LoAT group was approximately 30% lower than that reported by O'Connor et al (0.389 per 1000 AE)[31] and 50% lower than that reported by Rosenthal et al (0.51 per 1000 AE).[3] This difference may be accounted for by the pooled AT availability data from the O'Connor et al and Rosenthal et al papers compared with the parsed data herein. Regardless, this finding is troubling because experts have voiced concerns that the prevalence of unrecognized SRCs may approach 50%.[10,12] In addition, the implications of unreported or underreported SRCs in secondary school athletes have been discussed extensively,[7–9] given the potential for repeat SRC[32] and the increased risk for musculoskeletal injury.[17,33,34]

Our findings agree with those of previous investigators who examined the effects of AT staffing on concussion identification. Kroshus et al[35] observed that football and boys' soccer teams at high schools with ATs had more diagnosed concussions than schools without an AT present. Although that study was limited to high school football and boys' and girls' soccer teams, we found a similar effect of AT availability on SRC incidence and management across a broader sample of high school sports. A number of factors have been demonstrated to influence the incidence rates of SRCs, but we believe that the most likely explanation for the lower-than-expected incidence of SRCs in our study was AT availability.

When we examined other potential influencing factors in the context of our study, they had little, if any, effect on our findings. For example, one often cited rationale for a lower-than-expected incidence of SRC is a lack of athlete awareness or education (or both) regarding the identification of symptoms and long-term consequences of SRCs.[12] This is not likely to be the reason, as Wisconsin state law requires that each high school athlete and his or her parent or guardian must view the same educational video detailing SRC symptoms before each school year. Therefore, we would not expect differences in awareness or education among the different groups in our study.

A second factor thought to affect SRC reporting is a lack of awareness and recognition of SRC symptoms by team coaching staffs.[36] Although we did not measure the knowledge and behaviors of the coaches at each school, we are confident that the enrollment characteristics, sports offered, and school settings (rural, suburban, urban) were similar among our groups, making it unlikely that the school coaching staffs were significantly different with regard to SRC symptom awareness. In addition, since 2014,

Table 4. **Postconcussion Management[a]**

Variable	Athletic Trainer Availability: Low (n = 18 SRCs)	Mid (n = 46 SRCs)	High (n = 67 SRCs)	*P* Value
Hours until seen by AT	24.0 [5.4, 58.0]	0.5 [0.0, 20.0][b]	0.2 [0.0, 25.0][b]	.015
AT contacted parent	15 (83.3)	47 (100.0)	63 (98.4)	.001
AT contacted coach	14 (82.4)	47 (100.0)[b]	64 (100.0)[b]	<.001
AT contacted physician[c]	9 (56.2)	21 (44.7)	40 (62.5)	.175
Number of post-SRC assessments	2.0 [1.0, 2.8]	3.0 [3.0, 3.0]	4.0 [3.0, 5.0]	<.001
Used return-to-play protocol	9 (50.0)	44 (93.6)[b]	64 (100.0)[b]	<.001
Days out from sport	11.5 [9.2, 14.0]	14.0 [10.0, 18.0]	14.0 [11.0, 23.0][b]	.023

Abbreviations: AT, athletic trainer; SRC, sport-related concussion.

[a] Reported as either mean [interquartile range] or n (%). All pairwise comparisons were significant for the number of post-SRC assessments.

[b] Pairwise significant differences compared with the low AT availability group.

[c] Based on the percentage of athletes seen by a physician for this concussion.

making high school coaches and athletic officials aware of SRC symptoms has been an area of extensive emphasis. Also, specific regulations allow coaches and athletic officials to disqualify from athletic competition any player they think has sustained an SRC.[30]

A third factor may be related to the distribution of male versus female athletes. In a recent study, Wallace et al[37] reported that males were much less likely to report an SRC than females. The percentage of males was indeed higher in the LoAT group than in the HiAT group, but the percentage of males was similar between the LoAT and MidAT schools. Therefore, the observed differences in SRC incidence between both the LoAT and MidAT schools and the LoAT and HiAT schools indicates that the lower incidence of SRCs in the LoAT schools was unlikely to be related simply to the distribution of males versus females in our sample.

In addition to the differences in SRC diagnosis, post-SRC management practices diverged based on AT availability at the school. The management of SRCs falls within several domains of practice identified by the NATA Board of Certification.[38] The 2014 NATA position statement on concussion[9] specifically noted that the role of the AT in SRC injuries includes promptly removing the athlete from the sport, assessing the injured athlete using appropriate post-SRC evaluation tools, communicating the status of the athlete with an SRC to his or her parent or guardian and primary care provider, monitoring the athlete's course of recovery, and supervising a gradual return to physical activities. A nationwide survey[28,39] showed that the majority of ATs employed in secondary school settings did perform these evaluation and management roles at their schools.

In our study, the elapsed time between the onset of the SRC and initial evaluation was much longer in the LoAT group compared with the MidAT and HiAT groups. This is not surprising because the ATs in the MidAT and HiAT groups were more likely to be on site for practice sessions and competitions. The LoAT group was characterized as having access to an AT for just a few hours per week, making it much more likely the AT would not be available to interact with the injured participant for several days.

Furthermore, ATs in the MidAT and HiAT groups engaged in coach and parental interactions for every SRC that was sustained, whereas the percentage for coach and parental contact was much lower in the LoAT group. This is important: appropriate post-SRC management emphasizes limiting early return to sport and monitoring school performance and physical exercise. Contact among the AT, coach, and parent improves the likelihood that these management recommendations are being followed. Moreover, athletes in the LoAT group who sustained an SRC underwent fewer post-SRC evaluations with an AT and returned to sport sooner than athletes in the MidAT or HiAT groups. Perhaps most concerning, only about half (52.9%) of athletes who sustained SRCs in the LoAT group underwent a supervised return-to-sport protocol compared with nearly all of the athletes with SRCs in the MidAT and HiAT groups.

At a typical school in the LoAT group, an AT would come to the school for 1 hour a week during the school day throughout the school year and be present on the sideline during home varsity football games. A MidAT school usually had an AT at the school 20 to 40 hours per week, including availability during and after school practice sessions and some home varsity events. A school in the HiAT group normally had an AT 35 to 45 hours per week throughout the year and at every home varsity and subvarsity (junior varsity and freshman) competition. In addition to the ATs being available for more hours at the HiAT schools, fewer athletes participated at those schools compared with the MidAT and LoAT schools, reducing the athlete-to-AT ratio.

Our study findings are in contrast to the work of Pryor et al,[22] who reported that schools with lower enrollments had less access to an AT. This could be due in part to the fact that they looked at the schools with any reported AT availability, whereas we analyzed the school data further to determine the number of hours as well as the number of unique athletes who attended the school.

Unfortunately, our results indicate that the lack of uniform AT availability in the secondary school sports settings likely increases the number of unrecognized SRCs. This creates the potential for a variety of negative outcomes after an SRC. First and foremost, the increased potential for undiagnosed SRCs and the delayed and limited post-SRC management observed in the LoAT group may lead to athletes returning to sport prematurely or not receiving proper medical care in a timely manner. Additionally, growing evidence indicates that neuromuscular control may be impaired after an SRC, thereby increasing the musculoskeletal injury risk.[17,33,34] Thus, limited AT availability may create a cascading effect that ultimately limits the player's ability to participate in athletic events.

Our findings also imply that concussed athletes in LoAT schools were less likely to be treated according to evidence-based guidelines. Position statements from the International Conference on Concussion in Sport,[7] American Medical Society for Sports Medicine,[8] and NATA[9] all call for prompt onsite assessment by a physician or AT, comprehensive concussion management including neuropsychological assessment, and a gradual and progressive return-to-sport protocol. Athletic trainer availability at the secondary school level is a primary factor in meeting these standards, and schools with low AT availability appear to be falling far short of providing proper care. Athletes at LoAT schools first interacted with an AT at an average of 24 hours after their SRC and received fewer post-SRC neuropsychological evaluations; roughly half did not undergo any SRC return-to-play protocol.

This study illustrates that a higher level of AT availability was associated with increased reporting of SRCs and with how these SRCs were managed. Athletic trainers and their professional organizations at the state and national levels should use these findings to bolster the argument that ATs are integral members of the health care delivery system in the United States. Advocating for all high school and club-sport athletes to have access to ATs at a sufficient level of availability to ensure the proper recognition and management of their SRCs as well as all of their sport-related injuries is vital. However, we must also recognize that the financial resources of any individual school district will undoubtedly influence the level of AT availability at the schools. For example, the HiAT schools in our study were far more likely to be privately funded than the MidAT and LoAT schools, which all had public funding. As such, it could be assumed that the financial resources of these private schools made HiAT availability more likely for their athletes. Recognizing the financial constraints schools may face if they strive to increase the level of AT availability for their athletes is integral to addressing this concern.

Future researchers should determine if the findings from a single state can be replicated in a larger nationwide sample. In addition, we must consider how to increase the availability of ATs in schools with limited economic resources.

Several limitations to this study should be considered when interpreting the results. First, the differences in reported SRC incidence rates that we observed may have resulted from factors other than AT availability, such as the true incidence, lack of athlete or coach education, or male and female reporting tendencies. However, as detailed earlier, we believe that these factors were unlikely to have played major roles in our results due to their relatively uniform distribution among schools and participants. Second, the school ATs may have tended to overreport their post-SRC (SRC management) interactions to conform and meet the accepted standards. In an attempt to control for this potential bias before and during data collection, we repeatedly stressed to the ATs the importance of recording only the services they actually provided. Third, selection bias may have existed in the school ATs who agreed to participate. As noted, we attempted to control for this by enrolling a wide variety of schools from different settings (rural, suburban, urban), including a number of schools that had never participated in our previous research efforts, so we would not be aware of the level of care they would be expected to provide at their school. Finally, the data for this study were collected in a single state and, as such, may not represent high schools in other states across the United States or schools with various AT employment models.

CONCLUSIONS

The level of AT availability influenced the reported incidence of SRCs and post-SRC management activities. Given the significant public health burden that adolescent SRCs impose, AT availability is crucial to rapidly identifying, assessing, and managing patients with not only this injury but all injuries and medical conditions that may occur during sporting events. Continued legislative efforts at the state and national levels are needed to provide uniform standards of medical access and care to high school athletes at risk for or diagnosed with an SRC.

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