Sex Differences in Resource Allocation and Access to Care After Sport-Related Concussion

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Context: After sport-related concussion (SRC), immediate access to a certified athletic trainer (AT) is important to ensure proper treatment. However, resource allocation and coverage may differ between male and female youth sports.

Objective: To compare resource allocation between male and female sports in the following areas: (1) rates of immediate on-field evaluation by an AT at the time of injury, (2) time to general health care presentation, and (3) time to SRC clinic presentation.

Design: Retrospective cohort study.

Setting: Regional sports concussion center.

Patients or Other Participants: Athletes aged 14 to 18 years who presented to a regional sports concussion center from November 2017 to April 2022.

Main Outcome Measure(s): The primary exposure of interest was sex (male or female). The primary outcome was immediate on-field evaluation by an AT (yes or no). Secondary outcomes included time to general health care and SRC clinic presentation. Descriptive statistics, χ^2 analyses, and linear regressions were performed. Covariates included age, history of prior concussions, and statistically significant demographics.

Results: A total of 832 patients with SRC were included (age = 16.2 ± 1.2 years, 66.5% male). Female athletes had

lower rates of attention-deficit/hyperactivity disorder (χ^2 = 10.404, P = .001) and higher rates of anxiety and depression $(\chi^2 = 12.891, P < .001)$ compared with male athletes. The average time to presentation to general health care and the SRC clinic did not differ between males and females, but AT on-field evaluation occurred more in male (40.3%) than female (32.3%) athletes ($\chi^2 = 8.677$, P = .013). Multivariable linear regression found that AT on-field evaluation was a significant predictor of time to general health care presentation (β = -.085, P = .015) but not SRC clinic presentation ($\beta = -.055$, P = .099). History of prior concussions was a significant predictor of time to initial health care contact ($\beta = .083$, P = .018). History of anxiety and depression ($\beta = .136$, P < .001) and initial evaluation by emergency department or urgent care ($\beta =$.305, P < .001) were significant predictors of delayed time to SRC clinic presentation.

Concussion

Conclusions: Among 832 concussed youth athletes, female athletes were evaluated less frequently by an AT immediately after injury. Furthermore, not being evaluated by an AT on field was significantly associated with a longer time to health care presentation. Future investigations should elucidate resource equity among male and female athletes.

Key Words: ATC, female, on-field

Key Points

- Female athletes received an on-field athletic trainer evaluation after injury less often than male athletes.
- Athletic trainer on-field evaluation was associated with a shorter time to health care evaluation.

S port-related concussion (SRC) is a common injury among youth and adolescent athletes and a growing public health concern.^{1–3} Increasing awareness of SRC in both the public and the media has directed research efforts toward understanding risk factors and outcomes of the injury to improve preventative strategies and care models.⁴ Although the SRC literature is becoming more replete with articles about race, ethnicity, socioeconomic status, and outcomes, little has been published on disparities in care between male and female sports. A growing body of research exists on investigating various risk factors, both demographic and clinical, for prolonged recovery after SRC, including sex differences. Numerous authors have demonstrated that female youth athletes are at a greater risk

of SRC compared with male youth athletes in sexcomparable sports.^{2,3,5–9} In addition, female athletes have been found to exhibit longer recovery outcomes and are more likely to have persistent symptoms for greater than 1 month.^{10–15} However, the current literature on potential disparities in access to care and resource allocation after SRC based on sex differences remains sparse.

One of the main sources of health care for athletes is through athletic trainers (ATs). Prior authors have shown improved SRC recognition and outcomes when an on-site certified AT is present at the time of injury.^{16–19} Athletic trainers receive specialized training in concussion management, provide injury-specific education, and facilitate referral for further health care needs. Immediate removal of an athlete from

sport participation is the standard of care for initial SRC management, which is acutely aided by an on-site AT at the initial time of injury.²⁰ Previous researchers have demonstrated that this standard of care is implemented at higher rates in high school male athletes than female athletes in sex-comparable sports, with rates increasing when an AT is involved in an athlete's initial concussion assessment.^{6,21,22} Because there are typically not enough ATs to be on the sidelines of all sporting events at high schools, AT coverage is commonly delegated based on sport risk, with sports such as football, soccer, and basketball receiving higher priority, given that these sports have higher concussion rates than other sports.^{2,9,23} These differences in AT availability in male and female SRC care potentially lead to health care disparities between male and female athletes in youth sports.²⁴ Despite the significant role of AT assessment after SRC, limited data exist regarding the potential disparities in AT coverage allocation as it relates to an athlete's sex.

Therefore, in a cohort of athletes treated at a regional sports concussion center, we sought to compare male and female sports in the following areas: (1) rates of immediate on-field evaluation by an AT at the time of SRC, (2) time to general health care presentation, and (3) time to SRC clinic presentation. In this study, we aimed to examine potential disparities in access to care and resource allocation after SRC based on sex, which is sparsely evaluated in current literature. We hypothesized that male youth athletes would have higher rates of on-field AT evaluations at the time of SRC and shorter times to health care presentation. ^{16,17,24}

METHODS

Study Design and Patient Selection

A retrospective cohort study was conducted using data from a regional sport concussion center registry database under institutional review board approval (IRB 192033). Screening for eligibility of patients diagnosed with a concussion and seen by specialty providers between November 2017 and April 2022 was conducted (n = 2059). A concussion diagnosis was defined using the International Classification of Diseases (ICD)-9 and ICD-10 concussion codes (850.* and S06.0X**, respectively) in addition to postconcussion syndrome (310.2 and F07.81). The registry included all athletes aged 12 to 23 years at the time of injury who presented to a sport concussion center provider within 90 days of initial injury. Sport-related concussion diagnosis was confirmed by a provider according to the most recent Concussion in Sport Group guidelines at the time of presentation.²⁰ Patients were excluded from the registry if they had positive acute intracranial findings on imaging (hemorrhage, pneumocephalus, skull fracture) at the time of injury.

For our study, given the focus on high school students, inclusion criteria consisted of high school athletes aged 14 to 18 years who had sustained an SRC. To limit confounding variables that may contribute to delayed presentation to care, patients were excluded if they presented after 14 days of initial injury to any health care provider.

Data Collection

Data were extracted from provider notes and self-report intake forms via manual chart review in an electronic medical record. Patient demographics, medical history, injury details, health care presentation, and postinjury outcomes were extracted. Medical history included prior concussion history, attention-deficit/hyperactivity disorder (ADHD), learning disability, sleep disorder, migraine, psychiatric disease (eg, anxiety, depression, and bipolar disorder), and pertinent family history. Injury details included loss of consciousness (LOC), amnesia, and Post-Concussion Symptom Scale (PCSS) score from the Sports Concussion Assessment Tool, 5th edition.²⁵ The PCSS score represents concussion symptom severity at the initial clinic visit and is the sum of 22 symptoms that are each rated on a 0–6 scale. All data were stored in a secure REDCap electronic database.²⁶ The database was then used to compile the retrospective SRC registry based on the aforementioned criteria.

Primary Outcomes

Three primary outcomes were considered: (1) on-field evaluation at the time of SRC by an AT, (2) time from injury to the first health system contact, and (3) time to the initial regional sport concussion center visit (ie, SRC clinic). On-field evaluation was defined by an explicit mention of an AT or team doctor either evaluating or not evaluating the athlete for a concussion at the time of injury. If there was no explicit mention, on-field evaluation was recorded as unknown, which was ultimately coded as not an on-field evaluation under the presumption that it is common practice to note AT evaluation in the event that care is provided. Regarding the on-field AT evaluation, there were some missing data (22%), but the proportion of missing data was similar for males and females ($\chi^2 = 1.008$, P =.310). Time to health care presentation was defined as the number of days from initial injury to the date of the earliest known health system contact, not including on-field evaluations. The first health system contact was defined as the first health care provider seen off field after the injury (eg, emergency department [ED] or urgent care, primary care, specialty clinic) for care for concussion or concussionrelated symptoms based on chart review. Time to SRC clinic was defined as the days from initial injury to the athlete's first presentation at our regional sport concussion center. The term SRC clinic included any provider (ie, sports medicine, orthopaedics, neuropsychology, neurosurgery) who saw patients at our regional sport concussion center. Time to health care and time to SRC clinic were collected via medical chart reviews and were recorded for all participants. In some cases, an athlete's first health system contact was at the SRC clinic. There are many avenues for patients to get to our concussion center, including being self-referred or being referred via an ED, by a school AT with whom we have a preexisting relationship allowing for direct care for sport-related injuries, and via other medical providers in surrounding areas when patients may appear to need multidisciplinary services.

Statistical Analysis

The data were stratified by sex (ie, female or male) based on demographics listed in the electronic medical record. For descriptive statistics, categorical variables were reported as frequencies and proportions, and continuous variables were reported as mean \pm SD. We performed χ^2 analyses to

compare categorical variables between groups, whereas mean times to health care presentation and to the SRC clinic were compared between groups using independent-samples t tests. Multivariable linear regressions were used to predict primary outcomes (ie, time to health care presentation, time to SRC clinic). Independent variables were selected based on variables of interest to this study (athlete sex, on-field evaluation), demographics with statistical significance on our univariate models (ADHD, psychiatric history), and prior literature (age, prior concussion history).^{5,7} These covariates were all included in the regression analyses pertaining to time to health care presentation and time to SRC clinic to isolate their unique contributions. The model examining time to SRC clinic also included whether or not that patient sought care at an ED or urgent care for their concussion, as this may influence time to SRC clinic based on prior literature that has demonstrated its importance in SRC outcomes.^{11,14}

Finally, given that AT allocation is classically based on sport risk stratification, football was identified as a potential driver of differences in AT coverage between the sexes as a male-dominant sport.²³ Therefore, a subgroup analysis was performed excluding all athletes who sustained their SRCs while playing football (n = 511). The above aforementioned statistical analyses including comparisons were performed in this nonfootball sample. Loss of consciousness was added as a covariate given its statistical significance on our univariate models in this subgroup. All statistical analyses were performed using SPSS (version 27; IBM Corp). Statistical significance was determined at a level of P < .05.

RESULTS

Patient Demographics

A total of 832 athletes were included in our study. The majority were male (n = 553, 66.5%), with a mean age of 16.2 ± 1.2 years. Approximately half of the athletes attended public school (n = 417, 50.1%), and a majority had private health insurance (n = 681, 81.9%). Most patients had no prior concussion history (n = 501, 60.2%); 190 (22.8%) had a history of 1 previous lifetime concussion and 135 (16.2%) had a history of 2 or more prior concussions. Regarding medical history, small portions of the sample had ADHD (n = 84, 10.1%), a learning disability (n = 28, 3.4%), a sleep disorder (n = 6, 0.7%), migraines (n = 84, 10.1%), or a psychiatric disease, including anxiety, depression, bipolar disorder, and variants (n = 79, 9.5%). Across all athletes, 205 endorsed a family history of migraine (24.6%), and 111 had a family history of psychiatric disease (13.3%). Demographics and medical histories did not differ between male and female athletes beyond females having lower rates of ADHD ($\chi^2 = 10.404$, P = .001) and higher rates of psychiatric disease ($\chi^2 = 12.891$, P < .001) compared with males. Medical history and demographics can be found in Table 1.

Acute Injury Evaluation by an AT

Athletic trainer on-field evaluation occurred more in male (40.3%) than female (32.3%) athletes ($\chi^2 = 8.677$, P = .013). Regarding other aspects of acute injury presentation, female athletes had higher initial PCSS scores with a mean

value of 34.9 ± 1.7 compared with male athletes who scored at a mean of 21.4 ± 1.0 (P < .001). Other injury characteristics, including amnesia and LOC, were not statistically different between males and females (Table 1).

Time to Health Care Presentation

A majority of patients reported to a sports medicine clinic (n = 496, 59.6%) for their initial health care contact, followed by an ED (n = 183, 22.0%), primary care office (n = 48, 5.8%), neuropsychology (n = 48, 5.8%), urgent care (n = 45, 5.4%), neurosurgery (n = 4, 0.5), and other (n = 8, 1.0%). The mean time to health care presentation (males = 3.0 ± 3.3 days; females = 3.1 ± 3.3 days) was not statistically different between males and females (t =0.467, P = .640). The overall multivariable model predicting time to present to an initial health care contact was statistically significant ($F_6 = 2.667, P = .014$) and explained 1.9% of the variance. On-field evaluation by an AT ($\beta = -.085$, P = .015) and a history of prior concussions ($\beta = .083$, P = .018) were the only significant predictors in the model, such that having an AT evaluation was associated with fewer days to health care presentation, whereas having a history of prior concussions was associated with a longer time to present. All other covariates (age, sex, ADHD history, and psychiatric history) were not statistically significant predictors of time to health care presentation (Table 2).

Time to SRC Clinic Presentation

The mean time to the SRC clinic (males = 6.3 ± 8.7 days; females = 7.0 ± 8.8 days) was not statistically different between males and females (t = 1.120, P = .263). The multivariable model predicting time to SRC clinic was statistically significant ($F_7 = 15.894$, P < .001) and explained 12.1% of the variance. A history of psychiatric disease ($\beta = .136$, P < .001) and initial evaluation by an ED or urgent care ($\beta = .305$, P < .001) were significant predictors for increased time to SRC clinic. In this model, on-field evaluation by an AT was not a significant predictor of time to SRC clinic ($\beta = -.058$, P = .081), nor were age, sex, prior concussion history, or history of ADHD (Table 3).

Subanalysis: Football Excluded

Athletes who sustained an SRC while playing football made up most of the male cohort (n = 311, 56.2%) and had the highest rate of AT evaluations, with almost half receiving immediate on-field care (n = 148, 47.6%). See Supplemental Table 1 (available online at https://dx.doi.org/10. 4085/1062-6050-0280.23.S1) for a breakdown of sports by season and athlete on-field evaluation rates. When football was excluded from the data, our remaining cohort size was 511 athletes, with a female majority (n = 277, 54.2%). Notably, there was a significant difference in age between the sexes in this cohort, with a mean female age of 16.1 \pm 1.3 years and a mean male age of 16.5 \pm 1.2 years (t = 3.082, P = .002). Other demographic and medical history findings were similar to those noted in the full cohort, including a lower portion of females with ADHD (χ^2 = 4.892, P = .027) and a higher portion of females with a history of psychiatric disease ($\chi^2 = 7.415$, P = .006).

Table 1. Demographics, Medical History, and Injury Characteristics

	Participant			
Characteristic	Female (n = 279, 33.5%)	Male (n = 553, 66.5%)	<i>P</i> Value ^a	
Demographics				
Age, mean \pm SD, y	16.1 ± 1.3	16.3 ± 1.2	.055	
School type, No.				
Private	57	115	.946	
Public	137	280		
Unknown	85	158		
Insurance type, No.			.070	
Private	241	440		
Medicaid	26	77		
Military/Tricare	1	8		
Uninsured/self-pay	4	17		
Unknown	7	11		
Medical history, No. (%)				
Prior concussions			.198	
0	172 (61.6)	329 (60.1)		
1	69 (24.7)	121 (22.1)		
2	27 (9.7)	55 (10.1)		
3+	11 (3.9)	42 (7.7)		
Missing	0 (0.0)	6 (1.1)		
ADHD	15 (5.4)	69 (12.5)	.001	
Learning disability	5 (1.8)	23 (4.2)	.073	
Sleep disorder	3 (1.1)	3 (0.5)	.398	
Migraine	31 (11.1)	53 (9.6)	.501	
Family history of migraine	71 (25.4)	134 (24.2)	.777	
Psychiatric history ^b	41 (14.7)	38 (6.9)	<.001	
Family history of psychiatric disease	41 (14.7)	70 (12.7)	.450	
Injury characteristics, No. (%)				
Amnesia	45 (16.1)	110 (20.2)	.155	
Loss of consciousness	27 (9.7)	78 (14.1)	.069	
Evaluation				
On-field evaluation	90 (32.3)	221 (40.3)	.013	
Time to health care, mean \pm SD, d	3.1 (3.3)	3.0 (3.4)	.640	
Time to SRC clinic, mean \pm SD, d	7.0 (8.8)	6.3 (8.7)	.263	
Initial PCSS, mean \pm SD	34.9 (26.5)	21.4 (21.0)	<.001	

Abbreviations: ADHD, attention-deficit/hyperactivity disorder; PCSS, Post-Concussion Symptom Scale; SRC, sport-related concussion. ^a Statistically significant differences (*P* < .05) are bolded.

^b Includes anxiety, depression, bipolar disorder, and variants.

Regarding injury pattern, 1 difference from the full cohort was that LOC occurred more often in male athletes than in female athletes ($\chi^2 = 7.305$, P = .007) in the nonfootball sample. Concerning the primary outcome, no significant difference in AT on-field evaluation between male and female athletes was seen with football athletes excluded ($\chi^2 = 0.935$, P = .627).

The multivariable model predicting time to health care presentation was statistically significant ($F_7 = 4.640$, P < .001; $R^2 = .062$). Receiving an on-field evaluation ($\beta = -.108$, P = .014) and having LOC ($\beta = -.160$, P < .001) were significant predictors of fewer days to health care presentation, whereas having a history of prior concussion ($\beta = .119$, P = .008) was predictive of more days to health care presentation (Supplemental Table 2). The model predicting time to SRC clinic was statistically significant ($F_8 = 6.926$, P < .001, $R^2 = .101$). Having a history of anxiety and depression ($\beta = .113$, P = .013) and an initial evaluation by an ED or urgent care ($\beta = .252$, P < .001) were significant predictors for a greater time to the SRC clinic (Supplemental Table 3), as observed in the full cohort. In this model, on-field evaluation by an AT was not a significant predictor of time to the SRC clinic ($\beta = .009, P = .200$), consistent with full-cohort findings.

DISCUSSION

Resource allocation in schools can significantly impact AT coverage during high school sports, and on-field evaluation by an AT can be critical in receiving a timely concussion diagnosis. Many factors may drive an athlete's access to an AT, which could potentially lead to disparities in SRC diagnosis and recovery. In the current study, we assessed the relationship between an athlete's sex and AT evaluation as well as the effect of immediate AT on-field evaluation on time to health care and SRC clinic presentation. We found that female athletes were less often evaluated by an AT immediately after sustaining an SRC. Additionally, the lack of AT on-field evaluation was significantly associated with longer times to initial health care presentation.

Table 2.	Regression Coeff	icients for Predicting	Time to Initial	Health Care Contact
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Variable	B Value	SE	95% CI				
			Lower	Upper	β Value	t Value	P Value ^a
Sex	0.110	0.250	-0.381	0.601	.016	0.440	.660
Age	0.063	0.095	-0.123	0.249	.023	0.665	.507
On-field evaluation	-0.007	0.003	-0.013	-0.001	085	-2.437	.015
ADHD history	-0.022	0.395	-0.798	0.754	002	-0.056	.955
Psychiatric history	0.611	0.414	-0.201	1.423	.054	1.476	.140
No. of prior concussions	0.277	0.117	0.047	0.507	.083	2.362	.018

Abbreviation: ADHD, attention-deficit/hyperactivity disorder.

^a Statistically significant differences (P < .05) are bolded.

Access to AT Evaluation

Our results showed that a greater proportion of male youth athletes received on-field evaluation at the time of injury by an AT compared with female youth athletes (male = 40.3%, female = 32.3%). However, when football athletes were excluded from the data, this difference between AT coverage in male and female SRC assessments was not observed (male = 31.0%, female = 32.1%). Although it appears that football is the main driver of this significant difference in AT coverage based on sex, a disparity nonetheless exists. Football, a widely followed and maledominated sport, has been shown to put athletes at a higher risk of concussion because of the degree of play that increases the potential for player contact and other injuries.^{2,9} Researchers have consistently found that concussion rates are highest in American football, followed by women's soccer.^{3,22,27,28} Although it is important to direct coverage toward the increased concussion risk of football, a balance must be reached given that female youth athletes may be at higher risk for SRC overall and have been shown to have higher symptom scores and longer recovery times.^{2,3,5–15} In addition, certain female-dominant high school sports such as cheerleading, despite lower rates of concussion compared with other traditional contact sports, have been associated with greater injury severity.^{29,30} When looking at sex-comparable sports, females have higher concussion rates than their male counterparts.^{22,31} Currently, there is no female-equivalent sport to football; this, along with the increased risk of injury, has essentially put football athletes into their own category in regard to AT coverage and access to care.

The male sports with the highest representation in the football-excluded subgroup included wrestling, basketball, soccer, and ice hockey. Athletes in these sports also have a high risk of concussion.2,3,10 Although males in the football-excluded subgroup demonstrated a higher proportion of LOC compared with females, there was no statistically significant difference between sexes when examining the proportion who received an AT evaluation. Loss of consciousness is a recognizable but relatively infrequent sign of SRC that is neither a consistent nor a strong predictor of a longer time to clinical recovery, and it does not explain the football-driven difference in AT coverage between the sexes.¹¹ Age was the only other significant difference between females and non-footballplaying males (such that males were older), which likely has an inconsequential effect on AT coverage rates. This nonfootball subanalysis suggests that AT coverage is similar between sexes, despite the fact that the male sports represent high-intensity contact sports (eg. ice hockey) for which rates of concussion are high. Efforts should be made to have equal AT coverage between male and female sports.

Athletic trainer availability is almost always limited, and appropriate allocation of ATs requires triage of injury risks by sport. Athletic trainer allocation is season dependent, making direct comparison of sports with female and male counterparts (eg, boys' versus girls' soccer) not feasible when their main seasons differ (fall and spring, respectively). The fall season holds the majority of SRC injuries for both male and female athletes in our region, with football and girls' soccer responsible for the most SRCs for males and females, respectively. Trends in our sample may indicate the need for increased AT coverage during the fall for both sexes. However, seasonal trends may differ based on region. Given that football appears to drive the difference in AT evaluation rates between males and females, additional effort needs to be directed toward female sports in the fall season that may experience disparity in AT availability due

Table 3. Regression Coefficients for Predicting Time to Sport-Related Concussion Clinic

Variable			95%	95% Cl				
	B Value	SE	Lower	Upper	β Value	t Value	<i>P</i> Value ^a	
Sex	0.266	0.588	-0.889	1.421	.015	0.452	.652	
Age	-0.027	0.224	-0.467	0.413	004	-0.120	.904	
On-field evaluation	-0.011	0.007	-0.024	0.002	055	-1.651	.099	
ADHD history	-0.940	0.930	-2.765	0.884	035	-1.012	.312	
Psychiatric history	3.844	0.974	1.933	5.755	.136	3.949	<.001	
ED/urgent care visit	5.440	0.594	4.274	6.607	.305	9.156	<.001	
No. of prior concussions	-0.167	0.276	-0.708	0.374	020	-0.607	.544	

Abbreviations: ADHD, attention-deficit/hyperactivity disorder; ED, emergency department.

^a Statistically significant differences (P < .05) are bolded.

to potentially diverted coverage to football. Considering other influential factors that lead to higher SRC rates, such as older student age and competitions (versus practices), can also facilitate proper scheduling for risk reduction.¹²

Time to Health Care and SRC Clinic

The disparity in AT coverage between the sexes becomes clinically relevant when the other primary outcomes of our study-time to health care presentation and time to SRC clinic-are considered along with the factors that influence them. On-field evaluation significantly reduced the time it took athletes to present to an initial care provider, whereas an athlete's age, sex, and past medical history outside of prior concussions (ie, psychiatric disease and ADHD) did not appear to significantly influence the time taken to seek initial care for SRC in both the full cohort and the football-excluded subgroup. Thus, we were able to show that it was predominately resource allocation, as opposed to intrinsic characteristics of an athlete, that influenced this metric of care initiation. Our finding that AT evaluation was associated with a faster time to health care presentation holds great importance regarding SRC management and recovery given that athletes with an earlier initiation of clinical care have a decreased risk of prolonged recovery compared with those who sought later initial care.¹⁹ Additionally, prior authors have demonstrated that high school athletes with access to an AT have more concussion knowledge and may be more likely to report a suspected SRC, which positively impacts diagnostics.16,17,32

When football was removed from the data, LOC was observed to occur more in males than females and was a significant predictor for time to health care, which, as previously noted in literature, indicates potential increased recognition of SRC in athletes with this presentation.³³ A history of prior concussions was associated with an increased time to health care in both the full cohort and the football-excluded subgroup, which could potentially be explained by increased confidence in initial SRC symptomatic care, management, and precautions. These athletes may also elect to seek initial care directly at the SRC clinic where they were previously treated, which may have associated care delays if there is a provider preference or challenges in scheduling. However, prior concussion was not a significant predictor for time to SRC clinic presentation. Further elucidation of this relationship between concussion history and time to health care presentation is an area for future investigation.

Athletic trainer on-field evaluation did not significantly affect athletes' presentation times to the specialized SRC clinic. However, uncaptured factors may play into an athlete's SRC clinic presentation time, such as differences in AT referral practices, clinic scheduling logistics, clinical recovery course, and reporting bias.¹⁹ Significant predictors for time to the SRC clinic were a history of psychiatric disease (eg, anxiety, depression, bipolar disorder) and an initial visit to an ED or urgent care center. Both of these findings are consistent with prior research that has indicated that athletes with a psychiatric history or those who initially present to an ED are at higher risk of worse SRC outcomes.^{11,14,34,35}

Overall, female athletes are underrepresented in the research data that inform SRC consensus statements and

guide clinical care, so more work must be done to achieve guidelines that are inclusive of nonmale athletes, which could ultimately drive more equitable resource allocation.³⁶

LIMITATIONS

This study has several limitations. First, certain demographics and school characteristics are limited in the data captured. The data for an athlete's sex were represented as a dichotomous variable based upon available demographic listings in patient charts, which does not include nuances with which an athlete may identify. Attendance at private or public school also does not provide adequate information to assess the degree of AT access on a school level (eg, full- or part-time availability). Different schools and school systems additionally have varied sports programs that do not encompass all the sports reported. Thus, conclusions about allocative ability, protocols, and triaging by an AT are not feasible to make, as these are school specific and vary accordingly. Second, this study was limited to athletes who sought care at our SRC clinic. As such, we could not include all youth athletes in the region who sustained an SRC, as many may not have received injury-specific care or may have presented to other facilities (eg, AT only, ED or urgent care only, local primary care providers, outside providers). Including only athletes who presented to our SRC clinic may also present biases related to an athlete's sex that we are unable to detect within our specific cohort. Third, a portion of the cohort (15%) had previously received care at our SRC clinic, which could potentially influence their care pathways and times to care presentation upon subsequent injury. Fourth, several variables used were subject to recall bias, such as amnesia and LOC, or may not have been well documented. For instance, 182 athletes (22%) had "unknown" listed for whether or not an onfield evaluation was made at the time of injury because of a lack of mention in patient forms and charts. These were all analyzed as not having received on-field evaluation, which in reality may be a smaller number that is underreported. Although this limits accurate assessment of AT evaluation, our sample size is large enough to account for the potential of missed data points. Lastly, certain patient demographics, such as school type, were omitted from regression models, as we considered them to be outside the scope and influence of the potential to affect an athlete's time to present to either an initial health care provider or to the SRC clinic.

CONCLUSIONS

Among 832 concussed youth athletes, female athletes were less frequently evaluated by an AT immediately after injury. Furthermore, not being evaluated by an AT on field was significantly associated with a longer time to health care presentation, which has the potential for deleterious effects on SRC management and outcomes in female athletes. Future investigations should elucidate resource equity and AT coverage between male and female athletes.

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SUPPLEMENTAL MATERIAL

Supplemental Table 1. Sport and On-Field Evaluation Frequencies by Season.

Supplemental Table 2. Regression Coefficients for Predicting Time to Initial Health Care Contact, Excluding Football Athletes. **Supplemental Table 3.** Regression Coefficients for Predicting Time to Sport-Related Concussion Clinic, Excluding Football Athletes.

Found at https://dx.doi.org/10.4085/1062-6050-0280.23.S1

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