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Healthcare Navigation of Black and White Adolescents Following Sport-Related Concussion: A Path Towards Achieving Health Equity

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Healthcare Navigation of Black and White Adolescents Following Sport-Related Concussion: A Path Towards Achieving Health Equity

Abstract:

**Context:** Care-seeking behaviors for sport-related concussion (SRC) are not consistent across demographic subgroups. These differences may not only stem from health inequities but can further perpetuate disparities in care for SRCs.

**Objective:** To determine whether racial differences exist in the care pathway from injury to SRC clinic within adolescent athletes.

**Design:** Retrospective cohort

**Setting:** Regional SRC center

**Participants:** Of 582 total athletes, 486 (83.5%) White and 96 (16.5%) Black adolescent athletes were diagnosed with SRC and evaluated within 3 months at the SRC clinic.

**Main Outcome Measures:** Race was the defined exposure, dichotomized as Black or White. The four primary outcomes included: 1) location of first health system contact, 2) time from injury to first health system contact 3) time to in-person SRC clinic visit, and 4) whether the athlete established care (>1 visit), was released immediately to an athletic trainer, or lost to follow-up.

**Results:** Black and White athletes mostly presented directly to SRC clinic (61.5% vs 62.3%) at a median [interquartile range] of 3[1,5] vs 4[1,8] days respectively (p=0.821). Similar proportions of Black and White athletes also first presented to the ED (30.2% vs 27.2%) at a median of 0[0,1] vs 0[0,1] days (p=0.941). Black athletes more frequently had care transferred to their athletic trainer (39.6% vs 29.6%) and less frequently established care (56.3% vs 64.0%), however these differences were not statistically significant (p=0.138). Lost to follow-up was uncommon among Black and White athletes alike (4.2% vs 6.4%).

**Conclusions:** This study demonstrated that within an established SRC referral network and multi-disciplinary clinic, there were no observed racial disparities in how athletes were initially managed and/or ultimately presented to SRC clinic despite racial differences in school type and insurance coverage. SRC
center assimilation and affiliation with school systems may be helpful in improving access and providing equitable care across diverse patient demographics.

**Key words:** healthcare disparities, care pathways, race, adolescent, mild traumatic brain injury

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**Key points:**

- Being within the SRC clinic referral network at the time of injury appears to mitigate the effect of socioeconomic differences, promotes health equity, and optimizes continuity of care between Black and White athletes.
- Nearly two-thirds of Black and White athletes sought SRC care initially at the concussion clinic compared to the ED or other medical clinic.
- The presence of an AT is integral to the care pathway and may help to reduce disparities, as 40% and 30% of Black and White athletes, respectively, were released to the AT to carry out return to play protocols as a final sequence of care.
Introduction

Sport-related concussions (SRCs) are a public health concern, particularly in the pediatric and adolescent populations. One in five adolescent athletes have reported sustaining a concussion in their lifetime. These athletes often have diverse backgrounds including their race, ethnicity, and socioeconomic status (SES). Diversity among adolescent athletes matters as care-seeking behaviors for SRC are not consistent across demographic subgroups. These differences not only stem from health inequities, but can further perpetuate disparities in care for SRCs.

Race, operationalized as a social construct and determinant of health, is compounded by other social factors that include, but are not limited to inequalities in healthcare, education, economic stability, community contexts, and neighborhood environments. Previous literature across medical fields and diagnoses indicates that even after accounting for factors such as insurance, severity of disease, income status, and educational levels, Black patients suffer worse outcomes and receive lesser quality of care compared to their White counterparts. These findings are suggestive of the pervasive impact of societal racial biases. Structural racism contributes to segregation of resources, which may directly contribute to barriers in achieving racial equality in the initial management of, and access to care for SRC.

Despite a general dearth of literature on the impact of race on pediatric SRC, health disparities have been described in the evaluation and treatment of SRCs in Black and White athletes at the systemic and individual level. Notably, these disparities may reflect reduced access to athletic trainers (AT), fewer school and community-based concussion resources, or differing social pressures. The culmination of these factors are a part of modern American medicine, with a history partly rooted in scientific racism. The concept of scientific racism in America has included virulent tactics of anti-Black racism or biology-based racism through the use of pseudoscientific and flawed methodology to justify racial inequality. Often, scientific racism had led to structural racism seen in medicine that has resulted in many Black patients receiving limited and unacceptable levels of medical care, with SRC care being no exception. At the institutional level, athletes attending Title I schools – institutions receiving financial assistance due to high enrollment from low-income family children – reported less serious attitudes...
regarding concussions than those attending non-Title I schools, with race having a strong association with reported attitudes.\textsuperscript{13} Individually, Black high school athletes have been found to have poorer knowledge about concussion symptoms and were less likely to report concussions that occurred during games compared to White athletes.\textsuperscript{8} Black children presenting to the ED with head trauma were less likely to be diagnosed with a concussion than non-Hispanic White children.\textsuperscript{2,3,14} These diagnostic disparities can have downstream effects such as the potential risk of cognitive impairment and more severe cognitive-related symptoms, which have been previously been described in Black compared to White athletes.\textsuperscript{15} These findings may be partially attributed to differences in access to care, as Black athletes have been shown to be of disproportionately lower SES.\textsuperscript{8}

Given these findings of racial disparities in access to care, resources, SRC knowledge and attitudes, further work is needed to consider the implications of race on initial evaluation of SRCs.\textsuperscript{14} A comprehensive understanding of these racial differences may guide competent protocols to ensure optimal care across all racial/ethnic groups.\textsuperscript{2} Moreover, differences in how athletes enter the SRC pathway represent modifiable targets for improving equity in SRC care, and learning more about the initial medical encounters may lead to improving care and outcomes. Therefore, the purpose of this study was to compare the initial management, referral patterns, timelines and final clinic disposition for Black and White athletes managed at a regional specialty SRC center. Based on aforementioned studies suggesting the existence of racial differences pertaining to SRC, we hypothesized that there would be differences in initial management and care access.

**Methods**

**Study Design and Patient Selection**

A retrospective cohort study was completed using data from the Vanderbilt Sports Concussion Center (VSCC) registry. The Institutional Review Board (No. 192033) determined the study to be exempt and the requirement for consent was waived. Patients seen by VSCC providers between 11/01/2017 and 10/01/2020 for concussion were screened for eligibility (n=1504). Concussion diagnosis was defined
based on the ICD-9 and 10 codes for concussion (e.g. 850.*, S06.0X**) and variants as well as post-concussion syndrome (e.g. 310.2, F07.81). Patients ages 12-23 were included in the registry if the athlete presented to a VSCC provider within 3 months of injury, and the provider confirmed an SRC diagnosis based on the most recent Concussion in Sport Group guidelines. Notably, those with acute intracranial findings (hemorrhage or fracture) on imaging were excluded (n=8). In total, 868 (57.7%) met criteria and were included in the registry. Given this study focuses on racial differences, those with missing or unknown race (n=107) and those belonging to another minoritized racial group where n<20 were excluded (n=23). Additionally, only the first concussion of the study period was analyzed for any given athlete to maintain independence of observations (n=79 repeat concussions). Finally, we limited this study to middle and high school athletes as the treatment pathway for collegiate athletes at the center is considerably different (n=77). A patient flow diagram detailing all exclusion criteria is provided in Figure 1.

A joint venture between Vanderbilt University Medical Center (VUMC) Sports Medicine, Neurosurgery and Orthopedics Departments, the VSCC is a multi-disciplinary center comprising healthcare providers from a variety of specialties (neuropsychology, neurology, neurosurgery, pediatrics, sports medicine, emergency medicine, physical therapy, occupational therapy, speech therapy and psychiatry). VUMC sports medicine provides athletic training outreach services to 26 high schools in the Middle Tennessee area. Those schools are a mixture of city schools, county schools, and private schools. ATs in the VUMC system are given direct access to all VSCC healthcare providers and services. The VSCC providers also have established relationships with ATs at high schools outside of the VUMC Sports Medicine relationships. Referrals flow into the VSCC from the ED, ATs, and community providers. The VSCC provides baseline concussion testing and post-injury concussion management for acute and complex SRC cases.

Data Collection

Manual chart review was performed with data extraction from provider notes into a secure REDCap database. Loss of consciousness (LOC) and/or amnesia was noted as present if mentioned in the
initial concussion visit note or on athlete-completed intake forms. On-field evaluation was defined by explicit mention that the athlete was evaluated or not evaluated for a concussion at the time of injury. If there was no explicit mention, on-field evaluation was recorded as “unknown.”

**Primary Outcomes**

The current study utilized four primary outcomes: 1) time from injury to first health system contact, 2) location of first contact, 3) time to SRC clinic visit, and 4) whether the athlete established care (>1 visit), was released immediately to an AT, or lost to follow-up, termed disposition. First, the first health system contact was defined as the location of the first, non-AT healthcare provider seen after the time of injury (e.g. ED/urgent care, SRC clinic, other clinic). “SRC Clinic” includes any provider (i.e. sports medicine, orthopedics, neuropsychology) that sees patients under the VSCC umbrella. Those who first presented to either an in-system or outside ED, urgent care, or other walk-in clinic were coded as ED/Urgent Care. Those that presented first to general pediatrics, neurosurgery, or another scheduled clinic outside of VSCC were coded as other. We operationally defined ED orders as either a treatment (i.e. medication, IV fluids) or diagnostic procedure (i.e. imaging). ED orders were recorded from provider notes, medication administration records, and outside medical records for those who first presented to ED/Urgent Care. Second, time to first contact was defined as the number of days from injury to first healthcare provider contact not including on-field evaluations. Third, time to clinic was defined as days from injury to presentation at VSCC. Time to first VSCC follow-up was defined as the number of days from the first VSCC visit to the second VSCC visit and was only calculated for those who had follow-up. Fourth, the disposition of athletes following the first VSCC visit. Disposition was coded as established care (i.e. >1 follow-up visit at VSCC), lost-to-follow up, or released to AT. Lost to follow-up was defined as follow-up being requested and not completed. If the VSCC provider indicated that the athlete was being released to the school-based AT for further monitoring and protocelled return to activities, then that athlete was considered released to the AT.

**Statistical Analysis**
The data was grouped by race, Black or White, as a dichotomous variable. Race was self-reported by the patient on intake forms. Descriptive analyses were performed with categorical data reported as frequencies and proportions. Continuous data, with the exception of age, was presented as median with interquartile ranges given the non-normal distribution. Age was presented as mean ± standard deviations (SD). Group comparisons were made using chi-square statistics, Mann-Whitney U or independent samples t-tests, as appropriate. Statistical significance was set, a priori, at p<0.05.

Results

Patient Demographic Data

The final cohort included 582 athletes, of which 83% were White (n=486) and 17% were Black (n=96). Full demographic and past medical history data are presented in Table 1. There were no racial differences in patient age (t(1,580) = 1.286, p = 0.199). More White athletes attended private schools (24.0%) compared to their Black counterparts (9.5%, p = 0.002) and more White athletes were privately insured than Black athletes (86.0% vs. 71.9%, p = 0.003). Race was significantly associated with concussion history (p=0.013) with White athletes more frequently reporting one or more prior concussions (45.0% vs 22.9%). The two groups were otherwise similar in terms of past medical and family histories.

Injury Characteristics and Initial Management

Black athletes more frequently reported LOC than White athletes (21.9% vs. 11.8%, p = 0.008), while amnesia (retrograde and anterograde) were similarly reported by the two groups (14.6% vs. 19.3%, respectively; p = 0.273). The healthcare navigation pathway of two groups of athletes is presented diagrammatically in Figure 2. Black and White athletes demonstrated no significant difference in prevalence of on-field evaluation (39.6% vs. 28.8%, p = 0.099) post-injury or time to first health system contact (U=22209.50, p=0.595) (Table 2). The type of initial health system contact setting was not dependent on race (p = 0.723). The majority of both Black and White athletes sought care initially in the
concussion clinic (61.5% vs. 62.3%, p=0.723), followed by the ED/urgent care (30.2% vs. 27.2%, p=0.723).

Overall, Black athletes reporting to the ED received similar ED orders compared to their White counterparts. Looking at the breakdown of individual ED orders, 50% of White athletes received diagnostic head imaging compared to 36% of Black athletes, but this was not statistically significant (p = 0.211). There were also no statistically significant differences in ED orders that included pain or nausea medication administrations (p = 0.559 and p = 0.128, respectively). Additionally, there was no significant difference in rates of hospital admission between the two groups (p = 1.000). In summary, of those that initially presented to the ED, 66.7% of White athletes received 1 or more ED orders compared to 55.2% of Black athletes (p = 0.241), with 25.7% of White athletes and 13.8% of Black athletes receiving at least 2 ED orders (p = 0.169).

*Follow-up SRC Management*

Both Black (median = 4 days, IQR 2.5-7.5) and White athletes (median = 5 days, IQR 2.0-12.0) presented to the concussion clinic within a similar time frame (U=22757.50, p = 0.704) (*Table 2*). Following the initial evaluation in concussion clinic, Black and White athletes demonstrated similar disposition (p=0.138) with low rates of lost to follow-up (4.2% vs 6.4%) and the majority established care (56.3% vs 64.0%). For those who established care, follow-up occurred at a median of 13 days for both Black and White athletes (U=8555.50, p=0.0558).

*Discussion*

Healthcare disparities often emerge through the interactions between race, SES, and access to care. Thus, disentangling these factors can be challenging, and without data that is inclusive of minoritized groups, the scientific, scholarly, and clinical communities cannot actively advance equitable health policy or healthcare. To contextualize racial disparities in SRC management, this study compared initial care, referral pathways and timelines for SRC management in Black and White adolescent athletes within a regional healthcare network. Nearly two-thirds of Black and White athletes sought SRC care
initially at the concussion clinic versus the ED or other medical clinic. However, of those that first went to the ED, a greater proportion of White athletes received 1 or more ED orders compared to Black athletes (67% vs 55%). Further, 26% of White athletes received at least 2 ED orders compared to only 14% of Black athletes. Otherwise, there were no significant differences between Black and White athletes in referral patterns or care timelines. A minimal percentage of patients were lost to follow up and no differences were observed by race. These findings suggest that racial disparities may be appropriately minimized within an established regional SRC care network by facilitating healthcare navigation.

Contextualizing the importance of understanding race within a framework of health equity addresses key social issues surrounding the process of reducing health disparities in the U.S. Healthcare infrastructure that includes the organization, financing, and availability of services has historically been unequal between Black and White communities. Prior to the 1964 Civil Rights Act, Black and White people were mandated by national law to seek care in separate facilities or on separate floors within a facility. Consequently, health inequity and inequality resulting from structural racism have produced unequal access to medical care, provider-level challenges and disparities, and disparities in health outcomes. Greater perceived racial discrimination has also been associated with delayed care-seeking among Black individuals. Within our sample, a notable disparity included fewer Black athletes having private insurance compared to White athletes. Previous analyses have found that individuals with public insurance, or particularly a lack of private insurance, are less likely to seek care in a tertiary specialty concussion clinic, more likely to initiate point of entry at the ED, or present > 14 days post-injury. These disparities are potentially related to barriers in the referral process or providers not participating in Medicaid. Notably, despite insurance differences between Black and White athletes in this study, we saw no differences between groups in the direct care path to the SRC clinic and no differences in loss to follow-up. While we hypothesized that anticipated racial differences in insurance status may materialize in differences in access or delays in care, we found that being within the SRC clinic referral network at the time of injury appears to mitigate the effect of socioeconomic differences, promotes health equity and optimizes continuity of care. Potential reasons for accepting the null hypothesis may be that
adolescent athletes may have better access to healthcare due to the scholastic-sponsored nature of their injury, whereas individuals playing in non-school sanctioned sports may have a harder time establishing care. The ED is frequently the first health system contact and ED utilization for SRC can lead to unnecessary imaging, inefficient patient handoffs, or fragmented care.\(^{21}\) ED physicians have been shown to be marginally aware of concussion consensus statement recommendations and return to play protocols,\(^ {22}\) which can interfere with care trajectories and timelines for recovery. Relative to the results of this study, ED utilization for SRC was similar by race. An explanation for similar proportions of ED utilization between Black and White athletes could be due to the presence of ATs within the concussion center network that are recognizing on-field symptoms or diagnosing concussions and assisting with referrals directly to the concussion clinic. However, these results relatively contrast previous literature illustrating that Black children and adolescents seeking care at the ED following a head injury are less likely to be diagnosed with a concussion compared to their White counterparts.\(^ {2,23}\) Notably though, these prior findings are not incompatible with ours, as Black patients who were seen and discharged without a concussion diagnosis would not have been included in the present study. Yet, one may expect some portion of these patients who were not initially diagnosed to later present in a delayed fashion\(^ {23}\) and we found no evidence of this phenomenon (i.e. longer times to clinic). Seeking initial care at the ED could be a symptom of not having a primary care relationship, or could be related to those that experienced a LOC, persistent or delayed nausea and vomiting as those patients are more likely to recognize their injury as a concussion and present to the ED.\(^ {24}\) Over 20% of Black athletes and nearly 12% of White athletes experienced a LOC, and these values are inflated compared to previously published estimates.\(^ {16}\) These specific symptoms may have increased the rate of appropriately diagnosing SRC, whereas those with mild symptoms may have been discharged without a diagnosis or diagnosed and not referred to the concussion center. Given sampling methodology, we cannot exclude the possibility that Black athletes without LOC are disproportionately discharged without a diagnosis of SRC following head injury and this would explain the racial differences in LOC. Unfortunately, aside from LOC, it is unknown what other on-field
symptoms the athletes experienced leading to either a referral to the ED or a family decision to seek care at the ED.

Despite similarities in presentation to the ED between Black and White athletes, there were inconsistencies in diagnostic procedures and treatments provided to Black and White athletes that raise questions and suggest room for improvement to provide equitable care. Fifty percent of Black athletes that sought care at the ED were sent home without a single ED order. In contrast, White athletes received more ED orders overall, including head imaging, pain medication, nausea medication, and IV fluids. For example, over 50% of White athletes that sought care at the ED received imaging compared to 36% of Black athletes. Although not statistically significant, we believe the raw data is a more robust and transparent indicator of health equity. This difference in imaging as a diagnostic procedure also aligns with previous cross-sectional research using nationally representative data with non-hospitalized patients from 52 tertiary children’s hospitals. Imaging was performed in 33.5% of ED visits by White patients in contrast to 24.1% of Black patients; and, despite stratification by insurance status, Black patients were 31% less likely to receive diagnostic imaging as part of their ED evaluation compared to White patients. Although these findings suggest that race may be independently associated with imaging decisions at the ED, more research is needed to understand imaging, and other services provided specifically for concussion patients using nationally representative ED data.

Racial disparities have been documented along the spectrum of clinical care; however, representation of Black people or other minoritized groups is often missing in published SRC studies making this difficult to discern. Although previous research demonstrates disparities in access to ATs, accessible baseline neurocognitive testing, use of subspecialty concussion care, and concussion symptom knowledge, understanding care paths between groups can help to answer questions regarding recovery timelines and treatment pathways. Research by Bretzin and colleagues showed that the median time to medical clearance after a SRC varied by healthcare provider and medical facility. Results were not inclusive of racial diversity, but those that sought initial care at the ED or urgent care were cleared sooner than those that sought initial care with a team physician or specialist. Our results illustrate that timelines
and pathways to care were similar between Black and White athletes for on-field evaluation, time to first health system contact, time to the concussion clinic, or time to first follow-up visit. On field evaluation is most often conducted by an AT and previous research has shown that ATs were one of the initial examiners in 72% of SRC cases across a large state-wide epidemiological study. Presence of an AT may promote direct referrals and allow for more proximal SRC services (i.e. at the athlete’s school rather than traveling to clinic for follow-up) thereby helping to reduce disparities. Moreover, 40% and 30% of Black and White athletes, respectively, were released to the AT to carry out return to play protocols as a final sequence of care.

The limitations of this study warrant discussion. First, these results are bound by disproportionate numbers of Black and White athletes that reflect regional demographics; and, besides attendance at a private or public school, school-based demographics of the patients are unknown. These demographics could include the degree of AT access (e.g. full or part-time staffing) and SES of the school population. Second, this study is limited to patients who received care at our SRC clinic, thus it may not fully capture all patients that sustain a SRC and either do not present at all or present only to an outside provider, AT only, or outside ED only. Therefore, we are unable to comment on whether diagnosis and access to care is equitably distributed in the community at large, only that the patients who were seen followed similar referral patterns, timelines, and dispositions. Specifically, disparate care paths and health care utilization for mild traumatic brain injury has been exacerbated by geographic disparities for patients in rural locations, of which may not be portrayed in this analysis. Similarly, we do not know the full community or neighborhood characteristics for patients, which may better explain variation in health system navigation than race alone. Moreover, this data is limited to a single regional healthcare system and results may not be generalizable to other health care systems around the United States. Future research would benefit from expanding care path patterns to communities or geographic regions not well represented in this study to better understand care paths and timing-related outcomes related to care-seeking. However, these results can serve as a care path example to networks looking to expand to provide more equitable care. Finally, not all SRC guidelines advocate for sending individuals with SRC to
a specialty center such as the one in this study; however, previous literature suggests that a concussion center visit within the first week post-injury improves the odds of a more rapid recovery.\textsuperscript{29,30} Therefore, a multidisciplinary network that includes ATs and ED physicians that can make a quick referral to the SRC clinic for non-complicated SRC patients can equitably expedite care and recovery.

Conclusion

Equitable SRC care is possible when similar resources are provided to diverse communities. With established relationships that include a network of schools, ATs, and a concussion clinic, it can be easier for patients to navigate medical spaces and provides a path to care/treatment for SRC. The direct field-to-clinic care path was responsible for 62% of SRC patients in our regional SRC center over 3 years. Despite school type and insurance differences between Black and White athletes, there were no significant racial disparities in time from injury to first health system contact, location of first contact, time to SRC clinic visit, and whether the athlete established care (>1 visit), was released immediately to an AT, or lost to follow-up. Moreover, although not statistically significant, Black athletes received fewer ED orders compared to White athletes. Care path results from this study provide a health-equity focused example of a healthcare network model that can reduce disparities and facilitate the continuity of care for SRC. A care path can optimize resource utilization, value-based care, interdisciplinary communication, and equitable outcomes. However, the results of this study are mindful that they are only inclusive of patients that sought care at the SRC center and do not capture care paths of patients that did not receive care, nor address possible disparities in access or care for those that never present to the health system.

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**Figure Legends:**

**Figure 1 – Patient Inclusion and Exclusion Flow Diagram**

**Figure 2 – Healthcare Navigation Pathways for Black and White Athletes**
Table 1: Demographics and Medical History

|                     | Black (n=96, 16.5%)* | White (n=486, 83.5%)* | P value |
|---------------------|----------------------|------------------------|---------|
| **Demographics**    |                      |                        |         |
| Age (mean±SD)       | 15.85 (1.34)         | 15.64 (1.46)           | 0.199   |
| Sex (male)          | 68 (70.8)            | 302 (62.1)             | 0.106   |
| Ethnicity           |                      |                        | 0.420   |
| Hispanic            | 1 (1.0)              | 17 (3.5)               |         |
| Non-Hispanic        | 79 (82.3)            | 383 (78.8)             |         |
| Unknown             | 16 (16.7)            | 86 (17.7)              |         |
| **School Type**     |                      |                        | 0.002   |
| Private             | 9 (9.4)              | 112 (23.0)             |         |
| Public              | 59 (61.5)            | 201 (41.4)             |         |
| Unknown             | 28 (29.2)            | 173 (35.6)             |         |
| **Insurance Type**  |                      |                        | 0.003   |
| Private             | 69 (71.9)            | 417 (86)               |         |
| Medicaid            | 21 (21.9)            | 43 (8.9)               |         |
| Unknown/other       | 6 (6.2)              | 25 (5.2)               |         |
| **Medical History** |                      |                        | 0.013   |
| Prior concussions   |                      |                        |         |
| 0                   | 78 (81.3)            | 320 (66.7)             |         |
| 1                   | 14 (14.6)            | 104 (21.7)             |         |
| 2+                  | 4 (4.2)              | 56 (11.7)              |         |
| ADHD\(^1\)          | 13 (13.5)            | 55 (11.4)              | 0.545   |
| LD\(^2\)            | 6 (6.3)              | 14 (2.9)               | 0.100   |
| Migraine            | 8 (8.3)              | 52 (10.7)              | 0.479   |
| FHx\(^3\) migraine  | 22 (22.9)            | 131 (27.1)             | 0.399   |
| Psychiatric history\(^4\) | 9 (9.4) | 52 (10.8) | 0.681 |
| FHx\(^3\) psychiatric disorder | 6 (6.3) | 60 (12.4) | 0.082 |

\(^1\)ADHD - attention deficit hyperactivity disorder; \(^2\)LD - learning disabilities; \(^3\)FHx - family history; \(^4\)Includes depression, anxiety, bipolar disorder and variants. *Column data presented as n (%) or median [interquartile range] unless otherwise stated.
Table 2: Initial Concussion Characteristics and Management

|                               | Black (n=96)* | White (n=486)* | P value |
|-------------------------------|--------------|---------------|---------|
| **On-Field Characteristics**  |              |               |         |
| LOC†                          | 21 (21.9)    | 57 (11.8)     | 0.008   |
| Amnesia                       | 14 (14.6)    | 94 (19.3)     | 0.273   |
| Evaluated on the field        | 38 (39.6)    | 140 (28.8)    | 0.099   |
| Unknown                       | 25 (26)      | 162 (33.3)    |         |
| **Management Characteristics**|              |               |         |
| Time to first contact (days)  | 2 [0-4]      | 2 [0-5]       | 0.595   |
| First health system contact   |              |               | 0.723   |
| ED²/urgent care               | 29 (30.2)    | 132 (27.2)    |         |
| Concussion clinic             | 59 (61.5)    | 303 (62.3)    |         |
| Other clinic³                 | 8 (8.3)      | 51 (10.5)     |         |
| **ED² treatments⁴**           |              |               |         |
| Imaging                       | 11 (37.9)    | 67 (50.8)     | 0.211   |
| Pain Medication               | 7 (24.1)     | 39 (29.5)     | 0.559   |
| Zofran                        | 0 (0.0)      | 13 (9.1)      | 0.128   |
| Intravenous fluids            | 5 (16.9)     | 16 (12.1)     | 0.533   |
| Labs                          | 3 (6.1)      | 8 (6.1)       | 0.419   |
| Hospital admission            | 1 (3.4)      | 7 (5.3)       | 1.000   |
| Time to concussion clinic (days) | 4 [2.5-7.5] | 5 [2-12]      | 0.704   |
| Disposition after concussion clinic |          |               | 0.138   |
| Lost to follow-up             | 4 (4.2)      | 31 (6.4)      |         |
| Released to athletic trainer  | 38 (39.6)    | 144 (29.6)    |         |
| Established care              | 54 (56.3)    | 311 (64.0)    |         |
| Time to 1st concussion clinic follow-up (days) | 13 [7-21]   | 13 [7-20]     | 0.558   |

¹LOC - loss of consciousness; ²ED - emergency department; ³Other clinics - general pediatrics, neurosurgery, ophthalmology; ⁴Recorded only for those who first presented to the ED (Black n=29, White n=132). *Column data presented as n (%) or median [interquartile range] unless otherwise stated.
Concussion Visits Screened from 11/1/2017 to 10/1/2020 (n = 1504)

Eligible for Inclusion (n = 868)

After excluding missing race (n = 761)

After excluding minority races (n = 738)

First concussions of study period (n = 659)

Included in the study (n = 582)

Excluded after screening (n = 636)
- Non-sport mechanism (n=274)
- Injury prior to study period (n=120)
- Not seen in specialty clinic (n=85)
- Age <12 or >23 (n=80)
- Delayed presentation (>3mo) (n=44)
- Positive Acute Head Imaging (n=8)
- Other (n=25)

Excluded for missing race (n = 107)

Excluded for super minority race (n = 23)
- Native American (n = 1)
- Asian/Pacific Isl. (n = 6)
- Other (n = 16)

Not first concussion of study period (n = 79)

Excluded for age over 18 (n = 77)
Figure 2

Sport-Related Concussion

Black (n=96, 17%)
- Evaluated on Field (40%)
- ED/Urgent Care (30%)
  - Imaging 36%
  - Pain medication 21%
  - Zofran 3%
  - IV fluids 9%
  - Labs 9%
  - Admission 3%
  - Median time: 6 Days [3-10]
- Other Clinic (8%)
- VSCC Clinic
  - Median time: 13 Days [7-20]
  - Lost to Follow up (4%)
  - Follow-up (56%)
  - Release to AT (40%)

White (n=486, 83%)
- Evaluated on Field (29%)
- ED/Urgent Care (27%)
  - Imaging 51%
  - Pain medication 28%
  - Zofran 3%
  - IV fluids 9%
  - Labs 9%
  - Admission 3%
  - Median time: 7 Days [3-12]
- Other Clinic (11%)
- VSCC Clinic
  - Median time: 13 Days [7-20]
  - Lost to Follow up (6%)
  - Follow-up (64%)
  - Release to AT (30%)

Median time:
- Black: 6 Days [0-1]
- White: 6 Days [0-1]
- Follow-up: 13 Days [7-20]
- VSCC Clinic: 13 Days [7-20]
- Lost to Follow up: 4%
- Follow-up: 56%
- Release to AT: 40%