International Journal of EXERCISE SCIENCE

Original Research

Continued Play Following Sport-Related Concussion in United States Youth Soccer

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ABSTRACT

International Journal of Exercise Science 13(6): 87-100, 2020. Medical guidelines and legislation in the US call for immediate removal from play and prohibit continued play on the same day if a concussion is suspected. However, there is limited literature examining whether these guidelines and laws are being followed in youth soccer. The purpose of this study was to identify the frequency at which youth soccer players continued play on the same day following sport-related concussion and factors that may be associated with this behavior. A retrospective review of youth soccer players diagnosed at the initial clinic visit with a sport-related concussion was performed. Participants were categorized into groups, those who continued play on the same day as their concussion (PLAY) and those who did not (NO PLAY). Records were reviewed for demographics, injury characteristics, SCAT3™ symptoms, mBESS and ImPACT® results, symptom resolution and return to play protocol initiation. Fifty-eight girls (mean age: 14 years, range: 7-18 years) and 29 boys (mean age: 14.4 years, range: 6-18 years) participated in this study. Thirty of 58 girls (51.7%) continued play the same day compared to only 5 of 29 boys (17.2%; p=0.002). The odds of continued play in girls were 5 times as high as the odds of continued play in boys (OR=5.05; 95% CI, 1.59-19.3). Overall, 35 (40.2%) soccer players continued play on the same day following a concussion. In conclusion, approximately 40% of youth soccer players continued play on the same day as their concussion. Girl soccer players demonstrated a significantly higher frequency of continued play than boys.

KEY WORDS: Pediatric, adolescent, girls' soccer, healthcare access

INTRODUCTION

Soccer is one of the most popular sports in the world and is rapidly emerging in the United States, especially in youth (11, 20, 36). Since 1990, there has been a 90% increase in registered youth soccer players in the US, reaching over 3 million athletes less than 19 years of age as of 2014 (36). Despite the numerous health benefits of soccer (28), the rise in participation has been

accompanied by an increase in concussions (35). Multiple studies have reported an increase in soccer-related concussion incidence among the pediatric population (22, 23, 27, 33, 35, 38).

The 2016 "Consensus statement on concussion in sport" defines sport-related concussion (SRC) as an injury that represents "the immediate and transient symptoms of traumatic brain injury (TBI)" (24). Most concussions resolve within weeks, but continuing to play before complete recovery could place an athlete at risk for additional injury because the brain has not healed and is in a more vulnerable state (3, 17, 18). Short-term consequences include subsequent concussion (8, 16, 17), prolonged recovery time (12), and second impact syndrome (SIS) (3).

Improved concussion knowledge and awareness has led to the establishment of regulations in the United States to protect young athletes. The first law, the Lystedt law, established in July 2009, contains three essential components: mandatory education of athletes and parents, removal from play at the time of suspected head injury, and return to play only with written permission of a licensed, concussion-trained healthcare provider after a minimum of 24 hours. By 2014, every state established similar legislation with common themes being "immediate removal from play" and "no return to play on the same day" following concussion (4, 5). Following the enactment of this legislation, studies have demonstrated an increase in the percentage of concussions reported (7, 13, 21, 32). However, few studies address if vital components of US laws are being adhered to, specifically if athletes are being immediately removed from play and not allowed to continue to play on the same day. Elbin et al. is one such study that examined this issue and found that athletes who continued playing following concussion exhibited greater symptoms and demonstrated protracted recovery (12). This poses a concern for popular youth sports with high participation and concussion rates, such as soccer.

The purpose of this study was to identify the frequency at which youth soccer players continued play on the same day following sport-related concussion and factors that may be associated with this behavior.

METHODS

This study (STU 032015-056) was approved by the Institutional Review Board (IRB) at the University of Texas Southwestern Medical Center. Informed consent was not required and was waived by the IRB because study activity only consisted of a retrospective review of existing data. This research was carried out fully in accordance to the ethical standards of the *International Journal of Exercise Science* (26).

Participants

A retrospective review of participants who presented with a suspected concussion sustained while playing soccer was performed. A fellowship-trained sports medicine physician treated all participants consecutively from April 2014 to April 2016 at a pediatric sports medicine clinic in north Texas. Participants were included if they were ≤ 18 years old at the time of injury and were diagnosed with a concussion by the physician at their initial clinic visit. Concussions occurred while playing soccer for a school, club, or recreational team and during practice or competition.

All data were collected as part of routine clinical care and documented in medical records by sports medicine clinic personnel.

Participants were categorized into two groups, those who continued play on the same day as their concussion (PLAY) and those who did not (NO PLAY). This data was self-reported by each participant at the initial clinic visit into a standardized concussion intake form. The question in the intake form asked, "Did the athlete return (continue) to play following the injury?" The answer reported was then confirmed by the physician through an evaluation of the participant's history and a determination of continued play was ascertained.

Protocol

Medical records were reviewed for demographic and injury data. Demographic data included age, sex, ethnicity, race, body mass index (BMI), previous history of concussion, number of previous concussions, number of school days missed, and days from injury to presentation. Injury data included mechanism of injury [head to head, head to body part, head to ground, head to fixed object (i.e. wall, goalpost), head to ball], position (forward, midfielder, defender, goalkeeper, unknown), location of head impact (back, front, side, top, unknown), loss of consciousness (LOC), presence of memory loss before or after injury, and evaluation immediately following the injury by a coach or medical personnel (yes or no). Specific access to medical personnel on-site for each participant was unknown. Evaluation immediately following the injury did not indicate diagnosis of a concussion. Information regarding who made the call to remove or return the athlete to play at the time of injury was not available. All injury characteristics were recalled by the participant and reported to the physician at the initial clinic visit.

Standardized concussion measures collected as part of routine care at the initial clinic visit were reviewed. These measures included symptom checklists from the day of injury and day of initial clinic visit, a balance assessment, and a neurocognitive assessment. All participants completed two separate symptom checklists at the initial clinic visit. The first was the day of injury symptom checklist, where participants recalled and reported how they felt on the day their concussion occurred. The second was the initial clinic visit symptom checklist, where participants reported how they felt currently. Symptom checklists and balance scores were derived from the Sports Concussion Assessment Tool 3™ (SCAT3™). The SCAT3™ includes a symptom assessment (0-6 Guttman scale of twenty-two post-concussion symptoms) and a modified balance error scoring system (mBESS) used during evaluation for suspected SRC (34). The mBESS entails three twenty second tests: double leg stance, single leg stance, and tandem stance (34). Psychometrics of the SCAT3™ in high school athletes suggest strong sensitivity of the symptom checklist and modest performance of the mBESS (9).

Neurocognitive scores were derived from the Immediate Post-Concussion Assessment and Cognitive Test® (ImPACT®; ImPACT® Applications Inc., Pittsburgh, PA). The ImPACT® is a computerized neurocognitive concussion tool that includes verbal memory, visual memory, visual motor speed, and reaction time composite scores, along with an impulse control indicator and total symptom scores (19). The ImPACT® is the most widely used computerized

neurocognitive assessment in US athletics and has US FDA approval for post-concussion assessments (1). Psychometric properties of the ImPACT® have been extensively researched and while there have been mixed results regarding validity, there is evidence for its use in detecting concussion-related cognitive decline during the acute injury period (1).

Clinical data recorded during standard of care follow-up visits were reviewed and recovery outcomes were collected when available. The number of days from injury to asymptomatic (free of concussion-related symptoms) and days to initiation of the return to play protocol were reviewed.

Statistical Analysis

Data were analyzed using SPSS® version 15.0 software (SPSS® Science Inc., Chicago, IL). A chi-square test was used to compare categorical variables. These variables included sex, ethnicity, race, previous history of concussion, position, mechanism of injury, location of head impact, loss of consciousness, memory loss before and after the injury, and evaluation immediately following the injury. A Fisher's exact text was performed to determine association between PLAY and NO PLAY with sex, ethnicity, previous history of concussion, location of head impact, and loss of consciousness. Odds ratios were performed for sex and evaluation immediately after the injury. Continuous variables were first examined for normality and the nonparametric test, Mann-Whitney, was used. These variables included age, BMI, number of previous concussions, number of school days missed, days to presentation, individual and composite day of injury and initial clinic visit symptom scores, mBESS scores, ImPACT® composite scores, days to the initiation of the return to play protocol, and days to asymptomatic. Statistical significance was set at $p < 0.05$.

RESULTS

Sample Demographics: Differences in demographic data between the PLAY and NO PLAY group are presented in Table 1. Eighty-seven youth participants were diagnosed with a soccer-related concussion. Fifty-eight (66.7%) were girls and 29 (33.3%) were boys with a mean age of 14.1 years (range: 7-18). Thirty-five (40.2%) soccer players reported they continued play on the same day as their concussion and were placed into the PLAY group. The remaining 52 (59.8%) soccer players reported they did not continue play on the same day as their concussion and were categorized into the NO PLAY group.

More Hispanic soccer players did not continue play following concussion compared to Hispanic players who did continue play (78.3% vs. 21.7%, $p = 0.05$). Furthermore, a trend was observed demonstrating that soccer players who had a previous history of concussion were more likely to not continue play on the same day compared to those who had no previous history (38.5% vs. 22.9%, $p = 0.13$). Overall, no differences were noted in age, race, BMI, number of previous concussions, number of school days missed, or days to presentation between groups.

Of particular interest, 30 of 58 girls (51.7%) continued play on the same day as their concussion compared to only 5 of 29 boys (17.2%, p = 0.002). The odds of continued play in girls were 5 times as high as the odds of continued play in boys (OR = 5.05; 95% CI, 1.59-19.3) (Figure 1).

Table 1. Demographic data of youth athletes with diagnosed soccer-related concussion.

	NO PLAY (n = 52)	PLAY (n = 35)	p-value
Age (years)	14.3 (6-18)	13.9 (7-17)	0.49
Sex			0.002
Girls	28 (53.8%)	30 (85.7%)	
Boys	24 (46.2%)	5 (14.3%)	
Ethnicity			0.05
Non-Hispanic	33 (63.4%)	27 (77.1%)	
Hispanic	18 (34.6%)	5 (14.3%)	
Unknown	1 (2.0%)	3 (8.6%)	
Race			0.32
Caucasian	42 (80.8%)	30 (85.7%)	
Unknown	3 (5.8%)	3 (8.5%)	
Other	4 (7.7%)	0 (0.0%)	
Asian	2 (3.8%)	0 (0.0%)	
Black	1 (1.9%)	1 (2.9%)	
American Indian	0 (0.0%)	1 (2.9%)	
BMI[a] (kg/m^2)	21.5 (15.8-31.5)	22.1 (15.3-31.3)	0.50
Previous Concussion History			0.13
No	32 (61.5%)	27 (77.1%)	
Yes	20 (38.5%)	8 (22.9%)	
Number of Previous Concussion	0.6 (0-3)	0.3 (0-3)	0.15
School Days Missed[b]	2 (0-10)	2.3 (0-20)	0.81
Days to Presentation	15.5 (0-80)	14.2 (1-60)	0.92

Note. [a]One participant from the NO PLAY group was missing data; [b]Four participants from the NO PLAY group and one participant from the PLAY group were missing data.

Injury Characteristics: Differences in injury characteristics between the PLAY and NO PLAY groups are summarized in Table 2. Of head to head and head to ground mechanisms of injury, there were 3 and 1.75 times, respectively, the number of soccer players in the NO PLAY group than in the PLAY group (p = 0.58). Additionally, participants who self-reported LOC were more likely to not continue play on the same day (p = 0.02) and a greater number who experienced memory loss before or after the injury did not continue play on the same day (p = 0.33, p = 0.40). Even though a total of 51 (58.6%) soccer players were evaluated immediately after the injury, 15 (29.4%) continued play despite reporting symptoms on their day of injury symptom checklist. However, soccer players who were evaluated immediately after the injury had 2.96 greater odds to not continue play on the same day (p = 0.01; OR = 2.96; 95% CI, 1.12-8.05). No significant differences were noted in position or location of head impact.

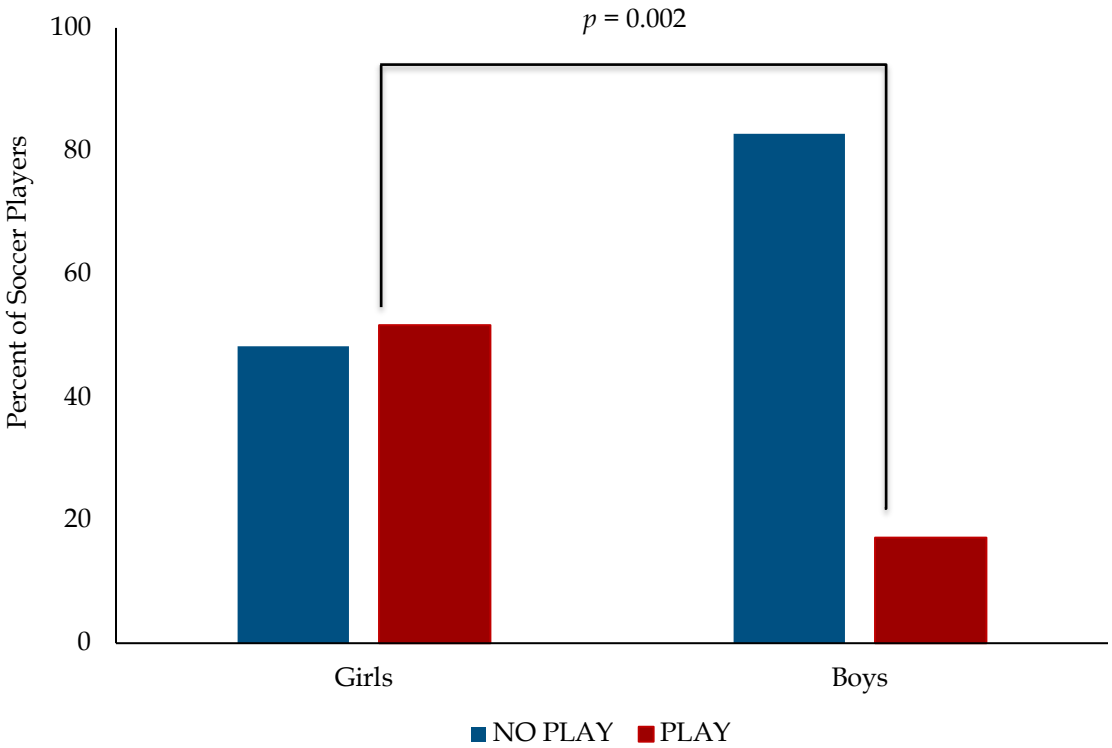

Figure 1. Sex differences in continued play following sport-related concussion sustained during soccer. A greater percentage of girls continued play on the same day following sport-related concussion compared to boys (51.7% vs. 17.2%, $p = 0.002$).

Concussion Symptoms: Differences in symptom scores from the day of injury and initial clinic visit are listed in Tables 3 and 4, respectively. Participants in the NO PLAY group reported more severe scores for "Trouble Remembering" (2.2 vs. 1.3, $p = 0.04$) and "Feeling Irritable" (2.0 vs 0.9, $p = 0.02$) on the day of injury symptom checklist than those in the PLAY group. Additionally, participants in the NO PLAY group reported a median total symptom score of 40.5 on the day of injury compared to a median total symptom score of 41 in the PLAY group ($p = 0.81$). Participants in the NO PLAY group reported a median total symptom score of 13.5 at initial clinic visit compared to 15 in the PLAY group ($p = 0.35$). No significant differences in individual symptom scores at initial clinic visit were noted.

Balance, Neurocognitive, and Recovery Outcomes: There were no significant differences in mBESS balance scores between PLAY and NO PLAY groups (24.7, 23.3; $p = 0.63$). Furthermore, no differences were noted in composite scores from the ImPACT® (Table 5). Follow-up data on 71 (81.6%) participants were available (NO PLAY: $n = 42$; PLAY: $n = 29$). The remaining 16 (18.4%) did not return for their scheduled follow-up visits. Participants in the NO PLAY group reported fewer days to symptom resolution compared to the PLAY group (18.5 days, 20 days, $p = 0.43$), but more days to initiation of the return to play protocol (NO PLAY: 26.5 days; PLAY: 24 days; $p = 0.98$).

Table 2. Injury characteristics of youth athletes with diagnosed soccer-related concussion.

	NO PLAY (n = 52)	PLAY (n = 35)	p-value
Mechanism of Injury			0.58
Head to head	12 (23.1%)	4 (11.4%)	
Head to body part	13 (25.0%)	13 (37.1%)	
Head to ground	14 (26.9%)	8 (22.9%)	
Head to fixed object	1 (1.9%)	1 (2.9%)	
Head to ball	12 (23.1%)	9 (25.7%)	
Position			0.84
Forward	8 (15.4%)	3 (8.6%)	
Midfielder	18 (34.6%)	11 (31.4%)	
Defender	13 (25.0%)	9 (25.7%)	
Goalkeeper	8 (15.4%)	8 (22.9%)	
Unknown	5 (9.6%)	4 (11.4%)	
Location of Head Impact			0.10[a]
Back	16 (30.8%)	8 (22.9%)	
Front	11 (21.2%)	10 (28.5%)	
Side	23 (44.2%)	11 (31.4%)	
Top	1 (1.9%)	5 (14.3%)	
Unknown	1 (1.9%)	1 (2.9%)	
Loss of Consciousness			0.02[a]
No	36 (69.2%)	31 (88.6%)	
Yes	13 (25.0%)	2 (5.7%)	
Unknown	3 (5.8%)	2 (5.7%)	
Memory Loss Before Injury			0.33
No	46 (88.5%)	34 (97.1%)	
Yes	5 (9.6%)	1 (2.9%)	
Unknown	1 (1.9%)	0 (0.0%)	
Memory Loss After Injury			0.40
No	40 (76.9%)	30 (85.7%)	
Yes	10 (19.2%)	5 (14.3%)	
Unknown	2 (3.9%)	0 (0.0%)	
Evaluation Immediately After Injury			0.01
No	16 (30.8%)	20 (57.1%)	
Yes	36 (69.2%)	15 (42.9%)	

Note. [a]Participants who reported "Unknown" were disregarded in analysis.

Table 3. Mean symptom scores from the day of injury of youth athletes with diagnosed soccer-related concussion.

	NO PLAY (*n* = 52)	PLAY (*n* = 35)	*p*-value
Headache	4.1 (0-6)	4.2 (2-6)	0.87
Nausea	1.1 (0-6)	1.1 (0-5)	0.96
Vomiting	0.7 (0-5)	0.7 (0-4)	0.96
Dizziness	3 (0-6)	3 (0-6)	0.94
Balance problems	2.5 (0-6)	1.8 (0-6)	0.15
Fatigue or low energy	2.9 (0-6)	2.6 (0-6)	0.51
Drowsiness	2.8 (0-6)	2.6 (0-6)	0.73
Trouble falling asleep	1.1 (0-6)	0.8 (0-6)	0.46
Blurry or double vision	1.8 (0-6)	1.8 (0-6)	0.79
Sensitivity to light	2.8 (0-6)	2.8 (0-6)	0.94
Sensitivity to noise	2.6 (0-6)	2.7 (0-6)	0.74
Feeling in a fog	1.9 (0-6)	1.9 (0-6)	0.83
Trouble concentrating	2.5 (0-6)	2.4 (0-6)	0.90
Trouble remembering	2.2 (0-6)	1.3 (0-6)	0.04
Feeling irritable	2 (0-6)	0.9 (0-5)	0.02
Feeling sad	1.3 (0-6)	0.8 (0-6)	0.18
Feeling nervous	1 (0-6)	0.9 (0-6)	0.59
Pressure in head	2.7 (0-6)	3 (0-6)	0.54
Neck pain	1.6 (0-6)	1.2 (0-6)	0.44
Feeling slowed down	2.3 (0-6)	1.8 (0-5)	0.21
Do not feel right	2.6 (0-6)	2.9 (0-6)	0.67
Confusion	1.8 (0-6)	1.8 (0-6)	0.81
More emotional	1.4 (0-6)	1.5 (0-6)	0.58
Total symptom score	47.8 (0-105)	44.5 (4-104)	0.81

Table 4. Mean symptom scores from the initial clinic visit of youth athletes with diagnosed soccer-related concussion.

	NO PLAY (*n* = 52)	PLAY (*n* = 35)	*p*-value
Headache	1.8 (0-6)	1.9 (0-5)	0.70
Nausea	0.2 (0-5)	0.1 (0-2)	0.85
Vomiting	0.1 (0-2)	0 (0-1)	0.81
Dizziness	0.8 (0-5)	1 (0-6)	0.38
Balance problems	0.5 (0-5)	0.5 (0-4)	0.90
Fatigue or low energy	1.2 (0-5)	1.4 (0-5)	0.72
Drowsiness	1.4 (0-5)	1.1 (0-5)	0.44
Trouble falling asleep	0.9 (0-5)	0.7 (0-6)	0.69
Blurry or double vision	0.6 (0-5)	0.3 (0-5)	0.17
Sensitivity to light	1.4 (0-5)	1.3 (0-5)	0.72
Sensitivity to noise	1.1 (0-5)	1.4 (0-5)	0.43
Feeling in a fog	0.7 (0-5)	1.1 (0-5)	0.24
Trouble concentrating	1.2 (0-6)	1.2 (0-6)	0.93
Trouble remembering	0.8 (0-6)	0.9 (0-6)	0.63
Feeling irritable	1 (0-6)	0.7 (0-3)	0.32
Feeling sad	0.5 (0-4)	0.3 (0-3)	0.88
Feeling nervous	0.5 (0-5)	0.6 (0-3)	0.40
Pressure in head	1.2 (0-5)	1.7 (0-5)	0.20
Neck pain	0.8 (0-6)	0.9 (0-4)	0.16
Feeling slowed down	1.1 (0-5)	1.1 (0-5)	0.90
Do not feel right	0.9 (0-5)	1.6 (0-6)	0.06
Confusion	0.5 (0-4)	0.8 (0-6)	0.52
More emotional	0.5 (0-4)	0.8 (0-5)	0.27
Total symptom score	19.6 (0-85)	21.4 (0-82)	0.35

Table 5. ImPACT® composite scores from the initial clinic visit of youth athletes with diagnosed soccer-related concussion.

	NO PLAY (*n* = 52)	PLAY (*n* = 35)	*p*-value
Verbal memory (%)	54.3 (2-100)	53.2 (0-99)	0.84
Visual memory (%)	47.7 (0-98)	43.8 (0-98)	0.64
Visual motor speed (%)	34.8 (0-97)	34.7 (0-94)	0.96
Reaction time (%)	30.1 (0-100)	23.7 (0-75)	0.25
Impulse control	6.1 (0-18)	9.8 (1-74)	0.71
Total symptom score	16.4 (0-81)	18.4 (0-82)	0.57

DISCUSSION

Sport-related concussion identification, reporting, and management in youth have become crucial focuses in recent years. Our study revealed two main findings that highlight the importance for advancement in these areas: (1) 40% of youth soccer players in our sample continued play on the same day as their concussion and (2) girl soccer players had 5.05 greater odds than boys to continue play on the same day.

As SRC incidence has increased, the consequences of playing while injured have become apparent. One short-term consequence is a subsequent concussion. Guskiewicz et al. reported that, of within-season repeat concussions, 91.7% occur within 10 days of the first injury and 75% occur within a week of the first injury (17). There is a period of increased vulnerability following a concussion where an increased risk for subsequent concussion exists (14). A second consequence of returning to play too soon is prolonged recovery. Elbin et al. found that athletes with delayed removal from play took twice as long to recover and were 8.8 times more likely to demonstrate protracted recovery than those who were removed immediately (12). A third consequence is Second Impact Syndrome (SIS). Second Impact Syndrome is the catastrophic, and sometimes fatal, cerebral edema that occurs when a second concussion is sustained before complete recovery from a previous concussion (3, 25). Although SIS is rare, the danger of returning to play while still symptomatic must be acknowledged.

Following the enactment of legislation across the country, concussion documentation increased significantly. Bompadre et al. reported that the overall rate of documented concussions in Washington from 2009-2010 was more than two times the rate before the law (7). Additionally, Gibson et al. compared concussion-related healthcare use before and after several states implemented legislation and discovered a 92% increase in healthcare utilization in children aged 12-18 years (13). While evidence points to increased awareness and improved reporting and removal behaviors, studies including ours have found that this may not be the case.

Our study revealed that approximately 40% of youth soccer players continued play on the same day as their concussion. This frequency is similar to results from other studies, although in a specific sample of concussed athletes (2, 32). These high frequencies are concerning because of the susceptible state a brain is in following a concussion and the potential consequences. These findings suggest that while concussion awareness has increased, reporting and management is still lacking to some extent. It remains unclear whether the responsibility falls on the athlete or the coach and medical providers. Studies have reported that athletes do not think their injuries are serious enough to report, do not want to be pulled from the game or practice, and do not want to let their teammates and coaches down (21, 31, 37). Our results demonstrated that soccer players who were evaluated immediately after the injury had 3 times greater odds to not continue play on the same day. While this points toward proper management following the injury, approximately 20% of our sample was evaluated immediately and still continued play following a concussion, which shows there is significant room for improvement on both fronts.

Our study also alluded to several trends and significant differences in factors associated with continued play behaviors. Soccer players who experienced loss of consciousness were more likely to report their injury and not continue play, which supports evidence that young athletes are familiar with LOC as a sign of a concussion (15). Our study also showed a trend of more Hispanic soccer players not continuing play following their concussion compared to non-Hispanic players, suggesting that Hispanic soccer players are more likely to report their concussion and be immediately removed from play. This trend is in contrast with findings from Bloodgood et al., which indicated that Hispanic youth and parents were significantly less likely to be aware of concussions than non-Hispanic youth and parents (6). While these observations

may be due to the smaller sample size of Hispanic soccer players in our sample, the apparent differences with current evidence warrants further investigation.

Even more unexpected, our results indicated that the odds of girl soccer players continuing play are 5 times greater than the odds of boys continuing play on the same day following a concussion. Studies have consistently demonstrated that girls are at greater risk to sustain a concussion and have higher documented concussion rates than boys (10, 22, 23, 31). Bompadre et al. reported the rate of documented concussion for girls increased more than 3.5 times the rate after legislation was implemented, whereas in boys, the increase was less than 2 times (7). This suggests a sex reporting bias, where girls are more likely to report their concussion symptoms than boys. A separate study also determined that girls are more honest in reporting, while boys are more likely to underreport their concussion symptoms (10). The present results suggest that this may not be true in girl soccer players, or if girls are more honest in reporting their injury, it may not be occurring until after they continued play on the same day. We speculate that this may be due to a number of reasons, such as the competitive culture in girls' soccer that emphasizes toughness. This athlete mentality might also be an explanation for why some of the soccer players who were evaluated after the injury still continued play on the same day, despite reporting symptoms.

Another reason may be that the girl soccer teams did not have the same access to medical providers as the boys' teams, which could have impacted their removal from play and subsequent evaluation. A recent study of US high schools revealed that only 37% of public schools and 28% of private schools offered full-time athletic training services, with the main barrier being budget-related (29). If this is the case at the high school level, we speculate that the disparity at the youth club and recreational level is significant as well. Although we did not have information available on medical personnel access, our results potentially highlight a lack of funding and trained medical professionals for youth soccer players, with an even greater lack in all-girl teams. While concussion reporting is the first step and improvements have been made, it is also critical that the athlete does not continue play on the same day (3, 8, 12, 17), and this responsibility needs to fall on trained adults and not young children. Presently, these findings suggest a need for focused education in the girls' soccer community, emphasizing the importance of timely recognition, reporting of concussion signs and symptoms, and no continued play on the same day. Additionally, they warrant investigation into medical provider access in girls' vs. boys' teams and potential policy change to address any discrepancies in resources.

The study design was a retrospective chart review, which comes with many inherent limitations. Of note, there was no information regarding the access each player had to a healthcare professional at the time of their injury. Additionally, data collected at the initial clinic visit regarding the day of injury was subject to recall bias, as participant presentation to clinic ranged from 0 to 80 days and recollection of events decreases over time. Lastly, the sample was small, consisted of only soccer players, and, as a pediatric sports medicine referral center, the complexity of the cases varied. As such, these factors may have an unknown effect on the generalizability of the results.

Overall, our results emphasize that, although robust, current education efforts and apparent awareness may not be enough to help athletes and coaches identify concussion symptoms and understand guidelines for immediate removal from play, no continued play on the same day, and risks of continuing to play after an injury. In conclusion, approximately 40% of youth soccer players continue play on the same day as their concussion and there are many factors that may be associated with this behavior, including sex, ethnicity, loss of consciousness, and evaluation immediately following injury. Primarily, girl soccer players demonstrate greater odds of continued play compared to boys. Further research is needed to understand contributing factors associated with this behavior, specifically access to trained healthcare professionals in girls' vs. boys' soccer. Targeted education and awareness is essential to improve injury identification and the frequency of no continued play following concussion.

ACKNOWLEDGEMENTS

The authors have no conflicts of interest to disclose and received no financial support to conduct this study.

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