

Underreporting of Concussions and Concussion-Like Symptoms in Female High School Athletes

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ABSTRACT

Underreporting of concussions and concussion-like symptoms in athletes continues to be a serious medical concern and research focus. Despite mounting worry, little evidence exists examining incidence of underreporting and documenting characteristics of head injury in female athletes participating in high school sports. This study examined the self-reporting behaviors of female high school athletes. Seventy-seven athletes participated, representing 14 high school sports. Nearly half of the athletes (31 participants) reported a suspected concussion, with 10 of the 31 athletes refraining from reporting symptoms to training staff after injury. Only 66% reported receiving concussion education. Concussion education appeared to have no relationship with diagnosed concussion rates in athletes, removing athletes from play, or follow-up medical care after injury. In conclusion, female high school athletes underreport signs and symptoms of concussions. Concussion education should occur at higher rates among female athletes to influence reporting behaviors.

Key Words

Adolescents, Concussion education, Female athletes, Mild traumatic brain injury, Sport-related concussion

Underreporting of concussions by athletes occurs at an estimated rate of 50%–75% of all injury incidence (McCrea, Hammeke, Olsen, Leo, & Guskiewicz, 2004; Register-Mihalik et al., 2013) and continues to be a concern for clinicians and athletic training staff (Kaut, DePompei, Kerr, & Congeni, 2003; McCrea et al., 2004; McCrory et al., 2013; Williamson & Goodman, 2006). Concussions may occur subtly during play, increasing difficulty for even trained observers to

identify a potentially injured athlete and thus rely heavily on an athlete's self-report of symptoms. Subjective symptom reporting by injured athletes to coaches and trainers is a necessary component for injury identification and subsequent removal of the athlete from play (McCrory et al., 2013). Greater compliance in reporting of symptoms by players is necessary for limiting further neurological trauma. Furthermore, the need for improved injury reporting may be highest in young athletes, as these individuals may be more susceptible to injury (Buzzini & Guskiewicz, 2006; Patel & Greydanus, 2002; Patel, Shivdasani, & Baker, 2005) and may be at higher risk for a second concussion (Broshek et al., 2005; Dick, 2009; Marar, McIlvain, Fields, & Comstock, 2012). An estimated 44 million children play at least one form of an organized recreational sport in the United States (Moreno, 2011), with up to 3.8 million sports-related pediatric concussions reported annually (Moreno, 2012). Despite growing numbers of recreationally active youth, evaluating adolescent sports has received relatively little emphasis.

Adding to the need for research in younger populations is the possibility of sex differences in concussion rates and recovery between male and female athletes. Evidence suggests that females may sustain concussions at higher rates than their male counterparts in the same sport (Dick, 2009; Marar et al., 2012) and may possess a higher risk for recurrent concussions (Marar et al., 2012). Young female athletes are at a greater risk for a longer recovery period following injury and tend to require additional treatment outside the standard of care (Kostyun & Hafeez, 2015). Available research reports offer limited evidence addressing the reporting rates of female athletes sustaining concussive injuries and symptoms, with even fewer studies focused on younger populations. Register-Mihalik et al. (2013) investigated the influence of concussion knowledge and attitude toward reporting rates of both male and female high school athletes. The study found that most concussions sustained by athletes were not reported and that both concussion knowledge and attitudes play a crucial role in the reporting behaviors of athletes. These results did not differentiate between male or female survey responses, negating an ability to determine female reporting propensity. Only 3 female sports (cheerleading, soccer, lacrosse) were included in the study, limiting generalizability to other high school sports often played by female student athletes.

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Despite concerns related to underreporting of concussions in young athletes, little evidence currently exists examining the intersection of reporting behaviors and the characteristics of female athletes who choose to participate in high school sports. Understanding behaviors that influence injury reporting is critical for increasing the rates of athletes reporting their injuries to training staff and may provide the foundation for more effective educational approaches. The primary aim of this study was to explore the prevalence of underreporting concussions and concussion-like symptoms among different sports played by female high school athletes and potential factors influencing their reporting behavior.

METHODS

Participants

A convenience sample of 77 female athletes was recruited from 3 large suburban high schools located in large metropolitan areas during the 2011–2013 academic years (3 years total; Table 1). Inclusion criteria required female student-athletes in 9th–12th grades to participate in at least one school-organized sport at the varsity, junior varsity, or freshman level. All parent/guardians provided informed consent and the participants (all were younger than 18 years) provided their assent before completing

the survey. The total number of surveys distributed was not collected, and thus, participation rate could not be determined.

Materials and Procedure

Approval from the university's institutional review board and from each school was obtained before initiation of the study. Study enrollment was completed by school athletic trainers during preseason training for all female sports. A cross-sectional, self-report survey was developed for this study with the aim of identifying the incidence of head injuries and concussion symptoms in sport (see the Appendix). The survey was adapted from the symptom-based concussion survey used with collegiate athletes (LaBotz, Martin, Kimura, Hetzler, & Nichols, 2005). Paper surveys were distributed by school athletic trainers during preseason training for all female sports. In an effort to explain the consent process, athletic trainers were not blinded to participants' participation. Lack of blinding does introduce bias, but we believed that the cross-sectional design was robust to protect the validity of results.

The survey inquired about each athlete's previous injury history and sports participation. Briefly, the survey recorded basic demographic information, history of diagnosed or suspected concussions, presence and duration

TABLE 1 Sport Participation and Potential Concussions

Sport	Number of Respondents (%)	Potential Concussions Reported by Athletes	Potential Injury Rate (%)
Soccer	28 (36.4)	12	42.9
Softball	26 (33.8)	3	11.5
Basketball	15 (19.5)	8	53.3
Volleyball	15 (19.5)	1	6.7
Track	11 (14.3)	0	0.0
Cross Country	11 (14.3)	0	0.0
Dance	3 (3.9)	1	33.3
Cheerleading	3 (3.9)	4	100 ^a
Equestrian	2 (2.6)	0	0.0
Swimming	1 (1.3)	0	0.0
Gymnastics	1 (1.3)	0	0.0
Tennis	1 (1.3)	0	0.0
Bowling	1 (1.3)	0	0.0
Motocross	1 (1.3)	2	100 ^a

Note. Some participants competed in multiple sports during the academic calendar; thus, there are 119 responses for 77 participants. Potential concussions include both diagnosed and suspected concussions reported on the survey. Seven athletes reported concussions outside of school-sponsored sports and were excluded. One athlete reported a diagnosed concussion without identifying sport in which the injury occurred.

^aMultiple concussions during participation.

of concussion-like symptoms following a hit to the head, the sports played by the athlete, whether the athlete received concussion education at school, coach response to a suspected injury, and previous reporting behavior. No personal medical information or identifiers were included in the survey. Face validity of the instrument was established informally from academic and clinical concussion experts, along with content testing among 15 female high school athletes (unpublished). After review, further clarification was added to include reporting injuries to coaches and athletic training staffs, not just parents and caregivers. Participants were instructed to complete the survey only once, regardless of whether they played multiple sports during the academic year. Surveys were completed anonymously, thus eliminating the ability for researchers to verify that each participant completed the survey only once.

Statistical Analysis

General descriptive statistics characterized survey responses. Associations among categorical variables were evaluated with chi-square tests or Fisher's exact tests. Nonparametric Wilcoxon rank sums tests were used to assess differences in age across athletes reporting a diagnosed concussion and symptoms. The alpha level was set a priori at .05 for all tests. All analyses were conducted using SAS version 9.3 (SAS Institute Inc., Cary, NC).

RESULTS

Table 1 summarizes sport participation characteristics among the student athletes. The average age of participating athletes was 15.7 (SD = 1.20) years, with 14 sports represented. Soccer (36.4%), softball (33.8%), basketball (19.5%), and volleyball (19.5%) received the highest participation totals. Twenty-three athletes (29.9%) reported a previously diagnosed concussion, while eight athletes (10.3%) reported a suspected concussion that was not medically diagnosed, leading to a total of 31 athletes reporting a potential concussion. Two participants reported multiple diagnosed concussions and brought the total number of potential concussions to 33. Two athletes (cheerleading, motocross) were the only participants to report multiple concussions while taking part in a single sport. The sports producing the highest number of potential concussions, which included both diagnosed and suspected concussions, were basketball (53.3% of basketball respondents) and soccer (42.9% of soccer respondents). Although motocross is not a school-sponsored activity, participants were allowed to include other physical activities where head injury might have taken place. Seven potential concussions reported by athletes occurred outside of sports, and one athlete did not specify which sport she was playing when the injury occurred. These injuries were excluded from analysis. Symptoms reported by subjects after injury and duration of symptoms are reported in Table 2.

TABLE 2 Athlete Responses to Selected Concussion Survey Questions

Concussion Survey Question	Responses (% of Total)
Symptoms reported after contact	
Headache	51 (66.2)
Dizziness	32 (41.6)
Sensitivity to light	20 (26.0)
Sensitivity to noise	15 (19.5)
Blurred vision	13 (16.9)
Nausea	10 (13.0)
Balance problems	10 (13.0)
Memory changes	10 (13.0)
Confusion	6 (7.8)
Loss of consciousness	2 (2.6)
Duration of symptoms	
Less than 30 min	18 (32.1)
Less than a day	19 (33.9)
Less than a week	14 (25.0)
Less than a month	4 (7.1)
Greater than a month	1 (1.8)
Reported symptoms to coach/guardian	51/61 (83.6) ^a
Received concussion education at school	51 (66.2)

^aNot all athletes reported symptoms. Only frequencies from reporting athletes were calculated.

Among athletes who reported experiencing symptoms after contact ($n = 58$), 10 indicated that they never informed a parent, guardian, or coach of their symptoms. These athletes stated that they chose not to report symptoms for multiple reasons, including the athlete's perception of the "injury was not a big deal" ($n = 5$), athlete wanted to keep playing ($n = 3$), and symptoms "wouldn't last long" ($n = 2$). Of the athletes who did report symptoms to the training staff ($n = 48$), 34 were removed from play and 20 were referred to a physician for medical evaluation. A majority (51 of 77; 66.2%) of respondents reported that they had received concussion education at their school.

Separate chi-square tests of independence revealed no statistical significance in the relation of concussion education with the number of diagnosed concussions ($\chi^2(1, N = 77) = 0.58, p = .45$), with removal from play after reporting symptoms ($\chi^2(2, N = 77) = 0.68, p = .71$), or

with follow-up medical care after a suspected concussion ($\chi^2(2, N = 77) = 0.62, p = .73$).

The average age of athletes reporting a concussion was compared with that of athletes not reporting injury to determine if a difference in age might contribute to reporting behavior. Wilcoxon rank sums tests indicated a significant difference for the average age of athletes reporting a concussion diagnosis ($Z = 2.35; p = .02$), with older athletes reporting more diagnosed concussions. No significant differences were found between the ages of athletes reporting or not reporting a suspected concussion ($Z = 1.85; p = .06$), or the average age and if symptoms were reported following injury ($Z = 1.68; p = .09$).

DISCUSSION

Nearly half of the participating female athletes reported either a diagnosed or suspected concussion during their school sports activities. The high reporting rate may be explained as arising from reported concussion diagnoses being combined with undiagnosed concussive injuries perceived by athletes. Combining these two variables was done to evaluate what might be the “potential” concussion rate in the study population, although the perceived concussions may have been symptomatic events without neurological involvement. It is impossible to state retrospectively whether some of the suspected concussions reported actually were diagnosable as concussions, although all of the symptoms reported by athletes are the same as those used for concussion diagnosis (Levin & Diaz-Arrastia, 2015; McCrory et al., 2013).

Some athletes (17%) reported experiencing symptoms of a concussion but did not report these symptoms to their coaches or training staff, a rate lower than previously reported in male athletes (Marar et al., 2012). Athlete responses such as “I wanted to keep playing” coincide with reports by a previous study identifying barriers to concussion symptom reporting in male and female high school athletes (Chrisman, Quitquit, & Rivara, 2013). However, athletes in the present study stated other reasons for not reporting that have not been noted previously. Several said that they did not think their symptoms or the injury was serious, or that their symptoms would not last long. These responses indicate a limited understanding of the risks associated with concussion injuries. This level of knowledge may be related to our finding that only 66% of the student athletes reported receiving prior concussion education as part of their school curriculum or athletic program. Current state legislation does not require schools to provide concussion education to athletes. However, prior to sports participation in Kansas, guardians and athletes are required to sign a Concussion and Head Injury Information Release Form, which explains the

risks associated with possible concussions, symptoms experienced after injury, and return to play guidelines after injury.

Concussion frequency across female sports coincided with previously reported studies (Marar et al., 2012; Meehan, d’Hemecourt, Collins, & Comstock, 2011). Soccer and basketball players appear to sustain sports concussions most frequently in our sample population, while basketball produced the highest rate of diagnosed concussions in our population. We note older athletes in our study reported concussion diagnoses in higher numbers, possibly due to a longer history of risk exposure playing contact sports. Similar comparisons have been made between collegiate and high school athletes (Field, Collins, Lovell, & Maroon, 2003). Another explanation may be that older athletes have more opportunities to experience concussion education than did our study participants (Bramley, Patrick, Lehman, & Silvis, 2012; Guthrie, 2015).

No relation was apparent between students receiving concussion education and the number of diagnosed concussions, frequency of symptom reporting to coaches, trainers, or guardians, instances of athletes being removed from play after reporting symptoms, or to seeking subsequent medical evaluation following potential injurious contact. Independence among these factors suggests a need to enhance effectiveness of current concussion educational practices directed toward adolescents. The purpose of educating young athletes about concussions is multifaceted: to increase knowledge about the injury as a means to understand the potential seriousness of the condition and the challenges for recovery (Register-Mihalik et al., 2013), to encourage reporting of symptoms after injury to avoid the potential for subsequent neurological trauma (McCrory et al., 2013), and to reduce the burden of concussion history as young athletes age if they continue to play sports and risk successive injuries (Covassin, Elbin, Kontos, & Larson, 2010). If current concussion education efforts were effective, we would expect to see a stronger relation of awareness from education and student reporting behaviors. Although not a focus in this study, the lack of clear relation of education and removal of symptomatic athletes from play also suggests a lack of knowledge on the part of coaches and training staff about the risks of continued play after injury. Other social and societal factors certainly play a role in the decision process and have been explored by other studies (Kirschen, Tsou, Nelson, Russell, & Larriviere, 2014; Tomei, Doe, Prestigiacomo, & Gandhi, 2012).

The surveys were completed voluntarily and anonymously, and findings are limited by the reporting honesty and accuracy of the participants’ retrospective responses. Similarly, a convenience sample recruited from local high schools and a small sample size limits external

validity and generalizability of these results. A related element important for interpretation is a low number of participants in some sports, which may not reflect participation or reporting behaviors by the general population. The overall participation rate of all athletes could not be calculated because the total number of surveys distributed by the school athletic trainers could not be determined, thus selection bias may be possible, as athletes with a concussion history could be more invested in participating. Providing a clear definition of a “concussion” and the associated symptoms at the onset of recruiting may be especially important when interpreting the rate of individuals reporting a suspected concussion. In hindsight, we realized no description of what a concussion injury entails was provided as part of this study in the instructions to participants. The latter factor, however, reinforces our belief that there exists a critical need for more effective concussion awareness education for all people associated with youth sports, including coaches, training staffs, parents, administrators, teachers, and the athletes themselves.

CONCLUSION

Underreporting of concussions and concussion-like symptoms is common in female high school sports, although this may be attributable to low reporting rates resulting from less effective concussion education programs. Creating uniform, evidence-based educational practices across youth sports programs, regardless of sex, may lead to improved concussion reporting and ultimately fewer secondary complications.

KEY POINTS

- Underreporting of concussions and concussion-like symptoms is common in female high school sports and may even exceed underreporting rates of their male counterparts.
- Common themes of why female high-school athletes chose not to report symptoms were the athlete's perception that the injury was not serious and that the athlete did not want to be removed from play.
- The limited understanding of risks associated with concussions suggests the need for further concussion education targeted for young female athletes.

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APPENDIX

Concussion Survey

1. **Have you ever been diagnosed with a concussion by a doctor or nurse?** (A concussion is a violent hit or injury to the brain. This hit can sometimes lead to dizziness, sickness in your stomach, confusion, or trouble remembering what happened)
2. **Do you think you have ever had a concussion but it was *not* diagnosed by a doctor?**
3. **Have you ever experienced any of the following symptoms after being hit, shoved or fallen in a game, during or after practice or a game or any recreational activity including activities you do for fun?**

<input type="checkbox"/> Nausea/vomiting	<input type="checkbox"/> Sensitivity to noise	<input type="checkbox"/> Dizziness	<input type="checkbox"/> Confusion
<input type="checkbox"/> Headache	<input type="checkbox"/> Loss of consciousness	<input type="checkbox"/> Blurred vision	<input type="checkbox"/> Sensitivity to light
<input type="checkbox"/> Balance problems	<input type="checkbox"/> Difficulty remembering	<input type="checkbox"/> “Rung your bell,” “stinger,” “dinged”	
4. **If you have experienced any of the above symptoms, did you tell your parent, guardian, or coach?**
5. **If you had any of the above symptoms and did not report them to a parent, guardian, or coach, why not?**
6. **If you reported an injury, did your coach remove you from play?**
7. **If you were removed from play, did your coach send you to see a doctor to be evaluated?**
8. **If you had symptoms, how long did they last?**

<input type="checkbox"/> Less than 30 minutes	<input type="checkbox"/> Less than a day
<input type="checkbox"/> Less than a week	<input type="checkbox"/> Less than a month
<input type="checkbox"/> Other: _____	
9. **Have you been educated on concussions or head injuries at school?**
10. **Did your parent/guardian have to sign a concussions contract this year?**
11. **How old are you?** _____
12. **What sport(s) do you participate in?**

<input type="checkbox"/> Basketball	<input type="checkbox"/> Softball	<input type="checkbox"/> Baseball	<input type="checkbox"/> Gymnastics	<input type="checkbox"/> Rugby	<input type="checkbox"/> Lacrosse
<input type="checkbox"/> Soccer	<input type="checkbox"/> Swimming	<input type="checkbox"/> Hockey	<input type="checkbox"/> Wrestling	<input type="checkbox"/> Equestrian	<input type="checkbox"/> Track
<input type="checkbox"/> Volleyball	<input type="checkbox"/> Football	<input type="checkbox"/> Other_____			
13. **If you had a head injury or concussion, what sport or activity were you participating in at the time of injury?**

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