

# Sex Differences in High School Athletes' Knowledge of Sport-Related Concussion Symptoms and Reporting Behaviors

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**Context:** Recent researchers have reported that athletes' knowledge of sport-related concussion (SRC) has increased but that athletes still lack knowledge of all the signs and symptoms of SRC. Understanding the signs and symptoms of SRC and the dangers of playing while symptomatic are critical to reporting behaviors in high school athletes.

**Objective:** To examine sex differences in knowledge of SRC symptoms and reasons for not reporting a suspected SRC to an authoritative figure in high school athletes.

**Design:** Cross-sectional study.

**Setting:** Survey.

**Patients or Other Participants:** A total of 288 athletes across 7 sports (198 males [68.8%] and 90 females [31.2%]).

**Main Outcome Measure(s):** A validated knowledge-of-SRC survey consisted of demographic questions, a list of 21 signs and symptoms of SRC, and reasons why athletes would not report their SRC. The independent variable was sex. Athlete knowledge of SRC symptoms was assessed by having participants identify the signs and symptoms of SRC from a list of 21 symptoms. Knowledge scores were calculated by

summing the number of correct answers; scores ranged from 0 to 21, with a score closer to 21 representing greater knowledge. Reporting-behavior questions asked athletes to choose reasons why they decided not to report any possible SRC signs and symptoms to an authoritative figure.

**Results:** A sex difference in total SRC symptom knowledge was found ( $F_{286} = 4.97$ ,  $P = .03$ ,  $d = 0.26$ ). Female high school athletes had more total SRC symptom knowledge (mean  $\pm$  standard deviation =  $15.06 \pm 2.63$ ; 95% confidence interval = 14.54, 15.57) than males ( $14.36 \pm 2.76$ ; 95% confidence interval = 13.97, 14.74). Chi-square tests identified significant relationships between sex and 8 different reasons for not reporting an SRC.

**Conclusions:** High school males and females had similar SRC symptom knowledge; however, female athletes were more likely to report their concussive symptoms to an authoritative figure.

**Key Words:** mild traumatic brain injuries, secondary school, sport culture

## Key Points

- High school males and females had similar concussion knowledge, but females were more likely to use that knowledge to report a sport-related concussion.
- Males were 4 to 11 times more likely than females to not report a sport-related concussion for reasons focused on the reactions and perceptions of others.
- Large percentages of male and female athletes did not report a sport-related concussion because they did not think it was serious.
- Theory-based interventions are warranted to overcome the stigmas associated with the male sport culture.

In the last decade, concussion awareness has dramatically increased.<sup>1</sup> Sport-related concussion (SRC) has been recognized as a public health concern<sup>2</sup> among young athletes. Several consensus statements have been developed to provide the most current and accurate research to inform the public on the recognition, evaluation, and management of concussion.<sup>3–5</sup> As the general public's awareness continues to improve, it is important that athletes, coaches, parents, referees, and school administrators be educated regarding the detection of SRC through the recognition of signs and symptoms and about guidelines for safe return to play.<sup>3</sup> Furthermore, SRC education and knowledge transfer are critical because many concussive injuries go unidentified.

Unidentified and underreported SRCs can lead to an increased risk of subsequent injury and long-term consequences in the adolescent athlete.<sup>6</sup> Athletes who do not report their SRCs are at a greater risk for a prolonged recovery.<sup>7</sup> Therefore, it is imperative that athletes report their concussive symptoms to authoritative figures, including athletic trainers (ATs), coaches, and parents. Discrepancies have occurred between the number of SRCs reported and the actual number of SRCs believed to have been sustained.<sup>1,8–10</sup> These discrepancies may be due to differences in symptom knowledge or reporting behavior (or both) by sex within individual sport cultures and environments, but further research is needed to clarify the relationships. Understanding male and female differences in knowledge and reporting behaviors could be crucial for

the development of specialized SRC education materials and risk-reduction interventions.

Most concussed athletes experience signs and symptoms immediately after injury; however, approximately 20% of concussed athletes experience a delayed onset of symptoms at around 48 hours postinjury.<sup>11</sup> After incurring an SRC, an athlete may experience any of 22 signs and symptoms. Headache is the hallmark symptom of SRC<sup>12</sup> and the primary symptom most commonly reported by concussed athletes.<sup>13,14</sup> Although headache is present in most patients with SRC,<sup>12</sup> athletes may experience less frequent signs and symptoms such as amnesia or foginess.

Athletes are moderately aware of the more common signs and symptoms of SRC, such as headache, dizziness, loss of consciousness, memory loss, and confusion, but less familiar with symptoms such as difficulty sleeping and difficulty concentrating in school.<sup>1,15</sup> In a survey of high school varsity football players, Cournoyer and Tripp<sup>15</sup> found that players did not understand the consequences of SRC and struggled to recognize less prominent symptoms of SRC, such as nausea and vomiting, difficulty concentrating, and behavioral changes. Moreover, due to the heterogeneous nature of SRC<sup>16</sup> and the subjectivity of symptoms, SRC is often challenging to detect because many concussive injuries show no outwardly visible signs.<sup>17</sup> Symptoms are typically used as the first subjective criteria for SRC evaluation and management, and although many clinical tests exist to detect an SRC, many SRCs may go unidentified due to the variability in presentation and general lack of awareness of SRC in the athletic community.<sup>18</sup> As many as 50% of SRCs go unreported at the high school level,<sup>1,8</sup> leaving student-athletes vulnerable to another SRC or musculoskeletal injury due to postural instability or decreased neurocognitive function.<sup>19–21</sup>

Raising awareness of SRCs and improving SRC knowledge is critical, yet these outcomes do not guarantee changes in attitudes and reporting behaviors.<sup>1,7,10,22</sup> The few investigators<sup>1,7</sup> who have empirically evaluated reasons why high school athletes would not report an SRC to an authoritative figure indicated that the athletes did not think the injury was serious enough to warrant medical attention, had fear of being removed from play, lacked awareness of a likely SRC, and did not want to let their teammates down.<sup>1,8</sup> Thus, athletes continued to prioritize sport participation over their own health.<sup>1,10,22</sup> This risk-taking behavior and general disregard for personal health is part of the culture of sport. However, more research is warranted to determine if this “play-through-pain” and “show-no-weakness” culture exists among both male and female athletes.

To date, sex differences in SRC incidence and recovery outcomes are documented in the literature.<sup>14,23–25</sup> Female athletes reported more SRC symptoms and demonstrated worse recovery outcomes than male athletes at both the high school and collegiate levels.<sup>23–25</sup> However, few authors have examined SRC knowledge, attitudes, and reporting behaviors among male and female athletes. Female high school athletes had more knowledge<sup>26,27</sup> and were more likely to self-report their SRCs than male high school athletes.<sup>27</sup> A recent investigation of reporting behaviors in male collegiate ice hockey players showed that athletes with higher levels of athletic identity (ie, the degree to which an athlete identifies with the athlete role)<sup>28</sup> were less likely to report concussion symptoms.<sup>29</sup> More-

over, collegiate football players who strongly identified with their athlete role refrained from help-seeking behaviors due to the male gender norms within football.<sup>30</sup> The male stigma within the football culture values domination of opponents, win-at-all-costs behavior, and subduing personal needs.<sup>30</sup> Additionally, athletes value the opinions of coaches, teammates, and parents, and these social influences may also directly influence the decision to report an SRC.<sup>31</sup>

Therefore, the purpose of our study was to examine sex differences in knowledge of SRC symptoms and reasons for high school athletes participating in football, wrestling, volleyball, girls’ or boys’ basketball, or girls’ or boys’ soccer to not report a suspected SRC to an authoritative figure. Based on previous findings, we hypothesized that female athletes would have greater knowledge of SRC symptoms and male athletes would be less likely to report symptoms of an SRC to an authoritative figure.

## METHODS

### Participants

Athletes enrolled in 3 urban mid-Michigan high schools participating in football, wrestling, volleyball, girls’ or boys’ basketball, or girls’ or boys’ soccer were recruited for this study. Athletes who played multiple sports were allowed to complete the survey only once during the study. Participants were not excluded for any preexisting learning disabilities or attention-deficit disorder/attention-deficit hyperactivity disorder. Each school employed a full-time certified AT who was accessible to athletes daily.

### Instrumentation

A single survey served as the instrument for the study. The instrument was developed by Register-Mihalik et al<sup>1</sup> and slightly modified for this study. The original survey by Register-Mihalik et al<sup>1</sup> was pretested for face validity by 3 content experts and determined to be reliable and valid. The Cronbach  $\alpha$  calculated for knowledge construct was 0.72.<sup>1</sup> The survey included demographic questions and reasons why athletes would not report their SRC. No questions were removed from the validated instrument; we added reasons for not reporting to gain a better understanding of reporting behaviors in the population surveyed. The additional 7 questions were validated by content experts, including licensed ATs, concussion researchers, and sports medicine professionals. Five demographic questions were included in the questionnaire to address age, sex, race, grade in school, and sport. Concussion history, recalled SRC events that occurred in both practices and games, and reporting of those events were then assessed. For example, questions that assessed recalled SRC events and the reporting of those events were worded as follows: “In your high school years, how many SRCs do you think you have experienced?” and “How many of the possible SRCs you have experienced did you report to a medical professional or a coach?” The last reporting-behavior question asked student-athletes to select reasons why they chose not to report or would not choose to report SRC signs and symptoms to an AT, coach, parent, or teammate.

Athlete knowledge of SRC symptoms was assessed by having participants correctly identify the signs and symptoms

of SRC from a list of 21 symptoms. To prevent athletes from simply selecting all signs and symptoms, incorrect symptoms were included in the knowledge test. We decided to capture symptom knowledge because symptom recognition is typically the first step to reporting. Knowledge of SRC symptoms was calculated by summing the number of correct answers; scores ranged from 0 to 21, with a score closer to 21 representing greater knowledge of SRC symptoms.

## Procedure

Institutional review board approval was obtained. This study was a cross-sectional survey of high school athletes across 7 sports. Data were collected over 1 academic school year spanning the fall, winter, and spring athletic seasons. Approval from each school and the school district was obtained before the start of the study. The ATs at each school scheduled dates to distribute parental consents and surveys. The principal investigator attended all parental-consent and survey-distribution sessions. Parental consent and child assent were obtained for each participant. In an attempt to increase response rate, parental consent was pursued at parental meetings for each sport, and consent forms were sent home with athletes 2 weeks before survey distribution.

Survey distribution took place within 2 weeks of the final competition for each sport. All test sessions were performed using a standardized script to ensure similar instructions for all participants and surveys were administered in a group setting within a monitored classroom at each school. Monitoring of data-collection sites ensured that the room environment was quiet and without distractions. The questionnaire was a paper-and-pencil survey completed at a single time point that took participants approximately 10 to 15 minutes to complete. Participants were allowed to skip questions they did not wish to answer and could withdraw from the study at any time without repercussions.

## Data Analysis

We calculated descriptive statistics for age, sex, race, sport, and concussion history to gain a better understanding of our participant sample. Differences between male and female high school athletes' total SRC symptom knowledge scores were investigated using analysis of covariance. Age and the number of previous self-reported concussions were included as covariates. Additionally, the effect size was calculated for the mean difference in total SRC symptom knowledge scores between the male and female athlete groups. The effect size was defined by the Cohen recommendations of 0.20 or less as a *small effect*, around 0.50 as a *medium effect*, and 0.80 or greater as a *large effect*. We calculated frequencies for each individual SRC symptom and for the entire sample. Chi-square analyses were used to identify any relationships between sex and 13 reasons for not reporting an SRC. All analyses were completed using SPSS (version 20; IBM Corp, Armonk, NY) with statistical significance set at  $P \leq .05$ .

## RESULTS

### Participant Demographics

Of the 600 student-athletes recruited to participate, 288 completed the survey, for a 48% response rate. The

**Table 1. Participant Demographics**

Characteristic	Mean $\pm$ SD		
	Males (n = 198)	Females (n = 90)	Total (n = 288)
Age, y	15.6 $\pm$ 1.3	15.6 $\pm$ 1.1	15.6 $\pm$ 1.2
Frequency, No. (%) <sup>a</sup>			
Grade			
8	1 (0.01)	—	1 (<0.01)
9	70 (35.4)	28 (31.1)	98 (34.0)
10	39 (19.7)	22 (24.4)	61 (21.2)
11	48 (24.2)	24 (27.8)	72 (25.0)
12	39 (19.7)	15 (16.7)	54 (18.8)
Not reported	1 (0.01)	1 (1.1)	2 (0.01)
Race			
African American	99 (50.0)	36 (40.0)	135 (46.9)
White	22 (11.1)	16 (17.8)	38 (13.2)
Hispanic	20 (10.1)	8 (8.9)	28 (9.7)
Asian	7 (3.5)	8 (8.9)	15 (5.2)
American Indian	—	2 (2.2)	2 (0.01)
Mixed	15 (7.6)	7 (7.8)	22 (7.6)
Other	26 (13.1)	12 (13.3)	38 (13.2)
Not reported	9 (4.5)	1 (1.1)	10 (3.5)
Sport			
Football	82 (41.4)	2 (2.2)	84 (29.2)
Wrestling	31 (15.7)	—	31 (10.8)
Volleyball	1 (0.01)	43 (47.8)	44 (15.3)
Basketball	46 (23.2)	30 (33.3)	76 (26.4)
Soccer	28 (14.1)	12 (13.3)	40 (13.9)
Other	—	1 (1.1)	1 (<0.01)
Not reported	10 (5.1)	2 (2.2)	12 (4.2)
Concussion history			
0	151 (76.3)	79 (87.8)	230 (79.9)
1	27 (13.6)	6 (6.7)	33 (11.5)
2+	20 (10.1)	5 (5.6)	25 (8.7)

<sup>a</sup> Percentage of group. Dash indicates no data available.

participant sample consisted of 198 males (68.8%) and 90 females (31.2%) with a mean age of 15.6  $\pm$  1.2 years. Most (n = 98, 34%) were in 9th grade, followed by 11th grade (n = 72, 25%). Race was predominantly African American (n = 135, 46.9%), followed by white (n = 38, 13.2%). The sports played by the most participants were football (n = 84, 29.2%), boys' basketball (n = 47, 16.3%), and volleyball (n = 44, 15.3%). The majority of the participants reported that they had never sustained a concussion (n = 230); 33 had sustained 1 concussion, and 25 had sustained 2 or more concussions. See Table 1 for complete demographic information.

### Sport-Related Concussion Symptom Knowledge

A sex difference in total concussion symptom knowledge was found ( $F_{1,286} = 4.97$ ,  $P = .03$ ). Female high school athletes had a higher total SRC symptom knowledge score (mean  $\pm$  standard deviation = 15.06  $\pm$  2.63; 95% confidence interval = 14.54, 15.57) than male high school athletes (14.36  $\pm$  2.76; 95% confidence interval = 13.97, 14.74; Table 2). The effect size for this analysis ( $d = 0.26$ ) fell within the Cohen<sup>32</sup> small to moderate range. Additionally, the analysis of covariance did not identify age ( $F_{6,286} = 0.02$ ,  $P = .90$ ) or the number of previous concussions



**Table 2. Correct Recognition of Concussion Signs and Symptoms by Sex**

Concussion Knowledge Item (True or False)	Frequency of Answering Correctly, No. (%) <sup>a</sup>		
	Males (n = 198)	Females (n = 90)	Total (n = 288)
Chest pain (false)	174 (87.9)	81 (90.0)	255 (88.5)
Abnormal sense of taste (false)	169 (85.4)	85 (94.4)	254 (88.2)
Black eye (false)	166 (83.8)	79 (87.8)	245 (85.1)
Blurred vision (true)	165 (83.3)	72 (80.0)	237 (82.3)
Nosebleed (false)	157 (79.3)	81 (90.0)	238 (82.6)
Loss of consciousness (true)	154 (77.8)	69 (76.7)	223 (77.4)
Sharp burning pain in neck (false)	152 (76.8)	81 (90.0)	233 (80.9)
Difficulty breathing (false)	146 (73.7)	77 (85.6)	223 (77.4)
Dizziness (true)	145 (73.2)	63 (70.0)	208 (72.2)
Stiff neck (false)	140 (70.7)	77 (85.6)	217 (75.3)
ringing in ears (true)	140 (70.7)	60 (66.7)	200 (69.4)
Neck muscle weakness (false)	136 (68.7)	71 (78.9)	207 (71.9)
Sensitivity to light (true)	135 (68.2)	63 (70.0)	198 (68.8)
Numbness/tingling in neck (false)	129 (65.2)	71 (78.9)	200 (69.4)
Confusion (true)	117 (59.1)	47 (52.2)	164 (56.9)
Abnormal sense of smell (false)	114 (57.6)	49 (54.4)	163 (56.6)
Jaw pain (false)	111 (56.1)	55 (61.1)	166 (57.6)
Memory loss (true)	104 (52.5)	40 (44.4)	144 (50.0)
Sleep problems (true)	103 (52.0)	41 (45.6)	144 (50.0)
Nausea (true)	102 (51.5)	48 (53.3)	150 (52.1)
Fogginess (true)	84 (42.4)	38 (42.2)	122 (42.4)

<sup>a</sup> The frequencies and percentages represent the proportion of the sample groups responding correctly to each item.

( $F_{6,286} = 2.57$ ,  $P = .11$ ) to be significant covariates for concussion symptom knowledge.

Blurred vision was the SRC symptom that was correctly recognized by the highest percentage of both male ( $n = 165$ , 83.3%) and female ( $n = 72$ , 80.0%) high school athletes. Fogginess was the SRC symptom that was correctly recognized by the lowest percentages of both male ( $n = 84$ , 42.4%) and female ( $n = 38$ , 42.2%) high school athletes. Abnormal sense of smell (males = 114 [57.6%]; females = 49 [54.4%]) and jaw pain (males = 111 [56.1%]; females = 55 [61.1%]) were the non-SRC symptoms that were correctly recognized by the lowest percentages. To clarify, 42.4% ( $n = 84$ ) of male and 45.6% ( $n = 41$ ) of female high school athletes thought an abnormal sense of smell was a sign or symptom of SRC, which is incorrect. Additionally, 43.9% ( $n = 93$ ) of male and 38.9% ( $n = 35$ ) of female high school athletes reported that jaw pain was a sign or symptom of SRC, which is also not correct.

### Reasons for Not Reporting an SRC

Chi-square tests identified significant relationships between sex and 8 reasons for not reporting a concussion. Male high school athletes were more likely than female high school athletes to not report a concussion because they thought their coach would get mad ( $\chi^2_1 = 11.55$ ,  $P < .01$ ), their teammates would think that they were weak ( $\chi^2_1 = 11.11$ ,  $P < .01$ ), their coach would think that they were weak ( $\chi^2_1 = 6.81$ ,  $P = .01$ ), and their parents would be upset ( $\chi^2_1 = 4.52$ ,  $P = .03$ ). Additionally, male high school athletes were more likely than female high school athletes to not report a concussion because it was the end of the season and they did not want to miss a game ( $\chi^2_1 = 9.99$ ,  $P < .01$ ), they did not want to lose playing time ( $\chi^2_1 = 8.16$ ,  $P$

$< .01$ ), and their team was going to the playoffs when it happened ( $\chi^2_1 = 3.86$ ,  $P = .05$ ). Finally, male high school athletes were more likely to not report a concussion compared with females because they did not want to let their team down ( $\chi^2_1 = 7.10$ ,  $P = .01$ ). The remaining reasons for not reporting a concussion were not significant between the sexes.

For the sample as a whole, the top 3 reasons for not reporting an SRC were the same for both male and female high school athletes: they did not think it was serious (49.5% of males, 38.9% of females), they did not want to lose playing time (41.9% of males, 24.4% of females), and they did not want to let their team down (34.3% of males, 18.9% of females). See Table 3 for the complete list of reasons for not reporting an SRC.

### DISCUSSION

We conducted this study to add information to the literature on sex differences in SRC symptom knowledge and reporting behaviors of high school athletes. As we hypothesized, high school female athletes were more knowledgeable about SRC symptoms than their male counterparts. For both sexes, blurred vision, loss of consciousness, and dizziness were the most recognized SRC symptoms, whereas memory loss, nausea, and fogginess were the most commonly unrecognized SRC symptoms. Also, male high school athletes were less likely than female high school athletes to report an SRC to an authoritative figure. The most frequent reason for both sexes to not report an SRC was because they did not think it was serious enough. Overall, our results support previous findings and have practical importance for those working in high school athletics.

### Concussion-Knowledge Score

Kurowski et al<sup>27</sup> observed that female sex was likely to be associated with increased SRC knowledge, as did we. However, in our study, the effect size was small and, therefore, the difference was not clinically significant. Thus, our results did not demonstrate a meaningful sex difference for knowledge of SRC in high school athletes and should be interpreted with caution. Although the difference between sexes was not significant, our scores for knowledge of SRC symptoms were average to below average for both males and females compared with those of previous studies,<sup>1,15,27</sup> with scores ranging from 11 to 18. This suggests that symptoms of SRC need to be explained to and clarified for high school student-athletes, regardless of sex, participating in all sports. With all of the educational resources available to high school athletic programs, the low scores for knowledge of SRC symptoms are discouraging and add to the evidence that SRC education needs to be more assertively directed at high school student-athletes. Often the medical terminology associated with SRC signs and symptoms is unfamiliar to the general public, and these terms may also be difficult for high school athletes to recognize and understand.

Across both sexes, symptom knowledge was lacking. This is consistent with the results of other researchers<sup>1,15</sup> who have examined concussion-symptom identification and demonstrated vast discrepancies between what high school athletes know about SRC and what they should know. Our

**Table 3. Reasons for Not Reporting a Concussion by Sex**

Reason	Frequency of Reasons for Not Reporting a Concussion, No. (%) <sup>a</sup>			$\chi^2$ Value	P Value
	Males (n = 198)	Females (n = 90)	Total (n = 288)		
I thought my coach would get mad.	32 (16.2)	2 (2.2)	34 (11.8)	11.55	$\leq .01^b$
I thought my teammates would think I'm weak.	35 (17.7)	3 (3.3)	38 (13.2)	11.11	$\leq .01^b$
It was the end of the season; I didn't want to miss a game.	61 (30.8)	12 (13.3)	73 (25.3)	9.99	$\leq .01^b$
I did not want to lose playing time.	83 (41.9)	22 (24.4)	105 (36.5)	8.16	$\leq .01^b$
I did not want to let the team down.	68 (34.3)	17 (18.9)	85 (29.5)	7.10	.01 <sup>b</sup>
I thought my coach would think I'm weak.	30 (15.2)	4 (4.4)	34 (11.8)	6.81	.01 <sup>b</sup>
I thought my parents would be upset.	18 (9.1)	2 (2.2)	20 (6.9)	4.52	.03 <sup>b</sup>
My team was going to the playoffs when it happened.	20 (10.1)	3 (3.3)	23 (8.0)	3.86	.05 <sup>b</sup>
I did not want to have to go to the doctor.	55 (27.8)	16 (17.8)	71 (24.7)	3.33	.07
I did not think it was serious.	98 (49.5)	35 (38.9)	133 (46.2)	2.80	.09
I was trying to get a scholarship to play in college.	28 (14.1)	7 (7.8)	35 (12.2)	2.35	.13
I did not know at the time it was a concussion.	44 (22.2)	17 (18.9)	61 (21.2)	0.41	.52
I do not have health insurance and could not go to the doctor.	7 (3.5)	3 (3.3)	10 (3.5)	11.55	$< .001^b$

<sup>a</sup> The frequencies and percentages represent the proportion of the sample groups that selected each statement as a reason why they did not or would not report a concussion.

<sup>b</sup>  $P \leq .05$ .

participants' scores for knowledge of SRC symptoms were lower than previously reported scores,<sup>1,15</sup> and athletes were unable to identify prominent signs and symptoms such as sleep difficulties, difficulty concentrating in school, behavioral changes, nausea, and vomiting.<sup>1,15</sup> This truly represents the knowledge gap regarding SRC. Due to recent educational initiatives and heavy media coverage of SRC, it is discouraging that these symptoms were so frequently missed. Again, this finding is an example of how critical SRC education is for all high school athletes. Symptoms of SRC must be thoroughly described to high school athletes.

### Concussion-Reporting Behaviors

To our knowledge, this is one of the first studies to specifically evaluate sex differences in SRC reporting behaviors. Overall, male high school athletes were less likely to report an SRC to an authoritative figure than female high school athletes for 8 of the reasons we investigated. Kurowski et al<sup>27</sup> similarly reported that female sex was associated with better SRC self-reporting behaviors in the high school setting. The male sport culture and stigmas within sports such as football and ice hockey contribute to the perceptions of masculinity.<sup>30</sup> We observed large sex deficits in reporting for the following reasons: "I thought my coach would get mad," "I thought my teammates would think I'm weak," "I didn't want to let my team down," "I thought my coach would think I'm weak," and "I thought my parents would get upset." Compared with females, males were greater than 4 to 11 times more likely to not report an SRC for these reasons. Such rationales are focused more on the reactions and perceptions of others than on internal factors. Social referents such as coaches, teammates, and parents appear to significantly influence SRC reporting among male athletes.<sup>31</sup> The dynamics of the coach-athlete relationship demonstrate that male athletes may not report the injury to avoid influencing how the coach perceives the athlete's masculinity. In addition, the coach has control over who participates. Athletes often conform to a coach's belief system,<sup>31</sup> and our findings highlight that males may place

greater importance on coaching opinions and beliefs. Moreover, the interpersonal relationships among teammates may create an environment that stigmatizes reporting. Athletes value the opinions of their teammates and parents,<sup>31</sup> and reporting a mental illness or concussion symptom is often associated with a stigma.<sup>33</sup> Lack of reporting due to being perceived as weak by teammates may suggest that male athletes are more likely than female athletes to fear being stigmatized for seeking help. Similar findings have been demonstrated in male collegiate football players seeking psychological help.<sup>34</sup> From this, we speculate that male high school athletes in our population may have been more concerned than females about their image and their reputation on the team.

Sex differences in reporting were also observed for reasons that could be considered internal motivators. Males were 4 to 10 times more likely to not report an SRC because (1) they did not want to lose playing time, (2) it was the playoffs and they did not want to sit out, or (3) they did not want to miss playing time because it was the end of the season. These internal motivations observed in male high school athletes suggest that withholding SRC symptoms may support the stereotypical male gender norms that they must overcome obstacles and play through pain due to increasing pressures to win.<sup>30</sup> The male self-image is often associated with a glorified athletic identity.<sup>35</sup> In male collegiate ice hockey players, the likelihood of underreporting was higher in athletes who had a stronger athletic identity.<sup>29</sup> Moreover, male athletes with stronger athletic identities had higher levels of gender role conflict and viewed help-seeking behaviors as a sign of weakness.<sup>30</sup> Although missing playing time was one of the top reasons females did not report an SRC, this suggests that many females also strongly identify with their athletic identity but potentially have different motivations for not reporting.

The top reasons both male and female high school athletes in our study did not report an SRC were because they did not think it was serious (49.5% of males, 38.9% of females) and they did not want to lose playing time (41.9% of males, 24.4% of females). These findings are similar to those noted previously.<sup>1,8,36</sup> According to McCrea et al,<sup>8</sup>

66.4% of their high school football sample did not report an SRC because they did not think it was serious enough to warrant medical attention, whereas 41.0% did not report an SRC because they did not want to be withheld from athletic participation. In a qualitative study of high school football and boys' and girls' soccer athletes, the student-athletes knew SRCs were dangerous but all reported that they would continue playing despite concussive symptoms because they did not want to stop playing and found it hard to tell if they were actually injured.<sup>36</sup>

It is concerning that athletes are still not reporting SRCs because they do not identify them as being serious enough injuries to require medical attention. It is also worrisome that the failure to report a concussion due to fear of removal from play remains an obstacle that needs to be overcome in high school athletics. Even if concussion knowledge can be increased, the determination and competitive spirit of our athletes cannot be altered. Unfortunately, some athletes may always try to conceal their symptoms in order to stay in the game, regardless of the consequences. The SRC reporting behaviors of both sexes show us that more education is needed to inform young athletes of the effects and seriousness of SRCs. This education should take sex differences into consideration and emphasize decreasing the negative social effects associated with this invisible injury in the male sport culture. Alternative strategies using theory-based approaches to target coaches are warranted.<sup>29</sup> Education geared at coaches should focus less on knowledge about concussion identification and more on creating a team culture in which reporting SRC symptoms is considered normative.<sup>29</sup> Interpersonal and intrapersonal approaches to concussion education<sup>31</sup> may help to address the underreporting epidemic by creating a sport environment in which care-seeking and safe reporting behaviors are endorsed.<sup>29,31</sup>

## Limitations

This study was not without limitations. This was a small convenience sample of high school athletes in the mid-Michigan region. In addition, we had unequal sample sizes of male and female high school athletes. The environment in which student-athletes completed the survey was different for each school (ie, different classroom used at each school). We expected that each participant read the survey carefully and reported honestly; however, as with any survey data, there may be inaccuracies. Finally, this research was completed in an urban school district; therefore, the results may reflect only that demographic.

## CONCLUSIONS

Our findings on sex differences lead to the conclusion that male and female high school athletes had similar SRC symptom knowledge, but females seemed to be more likely to use that information to self-report symptoms during athletic participation than males. The top reasons for not reporting an SRC across both sexes were that they did not recognize their symptoms as being serious and they did not want to lose playing time; however, males were 4 to 11 times more likely to not report for many reasons compared with females. Sport-related concussion education is an aspect of many state concussion laws, and this study highlights the need for a comprehensive SRC education

program that aims to change the culture of reporting. High school athletic department staffs should emphasize symptom knowledge by explaining what each symptom means and incorporate theory-based interventions to overcome stigmas within the male sport culture. Moreover, all school sport programs must encourage optimal reporting environments in which every male or female athlete feels safe and confident in reporting symptoms of SRC to an authoritative figure.

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