

Concussion reporting behaviors in student athletes across sexes and levels of contact

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Haley M Chizuk^{1,2} , Mohammad N Haider¹,
Matthew Solomito³, Regina Kostyun³, Barry S Willer^{2,4},
John J Leddy^{1,2} and David Wang⁵

Abstract

Context: Sport-related concussions (SRC) are common in student athletes. However, current literature suggests that many athletes do not accurately report their symptoms. The under-reporting of concussion symptoms can result in an increased risk of further injury and an underestimation of concussion prevalence.

Objective: This study aims to identify perspectives on concussion reporting behaviors in student athletes across levels of contact and by sex.

Design: Cross-sectional study.

Setting: Elementary and high school, college.

Patients or other participants: 1126 female (52%) and male (48%) athletes, mean age 16.6 years.

Main outcome measure(s): Standardized questionnaire on concussion reporting during a series of hypothetical scenarios.

Results: Student athletes participating in sports with higher levels of contact had more education about concussions, yet professed they were less likely to report a concussion. The most common reasons athletes chose not to report were 'not wanting to miss the game' and 'not wanting to let the coach down.' Minimal differences were found between sexes, with females being just as unlikely, or sometimes more unlikely, to report a concussion than males. Lastly, females playing contact and non-contact sports appear to be more concerned about not wanting to let their coach down than males.

Conclusions: Although perspective on concussion reporting behavior varied across sports of different levels of contact, we did not find any conclusive evidence of differences in willingness to report a concussion between sexes when compared within the same level of contact.

Keywords

Sport-related concussion, student athlete, levels of contact, concussion reporting

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Introduction

Sport-related concussion (SRC), a type of mild traumatic brain injury (mTBI), is a public health concern.¹ SRC is defined as transient neurological dysfunction caused by either a direct blow to the head or body with an impulsive force transmitted to the head in the absence of gross brain lesions.^{2,3} Student athletes are especially vulnerable to SRC; it is estimated that 1.1 to 1.9 million SRCs occur each year in patients age eighteen or younger in United States alone.⁴ It has also been hypothesized student athletes with SRC fail to

¹UBMD Orthopedics and Sports Medicine, Jacobs School of Medicine and Biomedical Sciences, State University of New York at Buffalo, Buffalo, USA

²Department of Rehabilitation Sciences, School of Public Health and Health Professions, State University of New York at Buffalo, Buffalo, USA

³The Bone and Joint Institute, Hartford Health Care, Hartford, USA

⁴Department of Psychiatry, Jacobs School of Medicine and Biomedical Sciences, State University of New York at Buffalo, Buffalo, USA

⁵Department of Orthopedics, UConn Health Farmington, Farmington, USA

Corresponding author:

David Wang, MD, 275 Mt Carmel Ave Hamden CT, 06518, USA. Email: Dhwang10@gmail.com



report symptoms up to one third of the time.⁵ The diagnosis of SRC is dependent on the reporting behaviors athletes exhibit due to lack of objective testing.⁶ Accurate reporting of SRC symptoms is crucial because early interventions have been shown to improve recovery.⁷ Continuing to play while the brain is concussed, however, is associated with serious consequences such as Second Impact Syndrome, prolonged recovery, and Overlapping Concussion Syndrome.^{8–10}

Although SRC can occur in any sport, the incidence is higher in sports with increased levels of contact.¹¹ However, a study by McCrea *et al.* found that high school football players failed to self-report SRC 53.7% of the time.¹² The most common reasons these athletes failed to report SRC was because they did not believe their injury was serious enough (66%) or did not know they had a SRC (36%). However, that study could not include those students who did not report their concussion. Other reasons why athletes may fail to report include: not wanting to miss games/practices; removal from sport; and/or letting their team; family or coach down.^{13,14}

Sex differences in concussion reporting is currently inconclusive in the current literature; some research suggests there may be no differences,^{15,16} and some studies suggest there are difference.^{17,18} For example, Sullivan *et al.* suggests males are more likely to hide concussions.¹⁷ Concussion reporting patterns can also differ between sports with differing levels of contact and sport-specific culture, but these results are inconclusive.^{17,18} Overall, there is a gap in the current literature regarding differences, if any, a student's sex and type of sport played have on concussion reporting habits. To assess this, we performed a cross-sectional study in elementary and high school and collegiate student athletes and compared responses to a series of standardized vignettes that asked if they would report a possible concussive head injury during various scenarios and to list reasons why they would be unlikely to report. Prior concussions and level of competition were a priori decided to be potential confounders,¹⁸ hence all analyses were controlled for concussion history and highest level of competition. We hypothesized there would be differences in concussion reporting behaviors between sports of different levels of contact and no differences between the sexes.

Methods

This cross-sectional study was approved by Connecticut Children's Medical Center IRB. Participation was voluntary and standardized questionnaires were completed anonymously by participants to encourage truthful responses. Self-reported

surveys were collected from three locations; the first being a project from Pink Concussions, a nonprofit organization whose mission is to improve pre-injury education and post-injury medical care for those effected by mTBI.¹⁹ Due to minimal risk in taking the survey, written parental consent was waived if the participant was a minor (<18 years). Parents were notified of the survey in advance and were allowed to opt out of their child(ren) taking the survey.

Participants

Participants were student athletes from elementary, middle and high schools and one university. Inclusion criteria was age between 10 – 23 years and played at least one organized sport. Participants who did not play at least one organized sport or submitted an incomplete survey were excluded. Pink Concussions collected survey data from male and female elementary, middle and high school students between April and May 2018 and sent them to the research team. Surveys were also collected from Quinnipiac University where they were given to athletic trainers to give to their athletes, who sent their responses directly to the research team. If the students missed the first opportunity to take the survey, another day was offered. Due to this method of data collection, we cannot identify how many student athletes were informed about the study or calculate response rate.

Level of contact groups

Sports are classified into different degrees of contact: contact, limited contact, and non-contact.²⁰ This classification system has been used frequently in previous literature.^{20,21} The classifications include sports with unintentional contact (e.g. cheerleading) and intentional contact (e.g. boxing). The National Collegiate Athletic Association (NCAA) has classified contact sports into (1) collision/combat sports and (2) contact sports. The NCAA states these sports should be treated differently because of their different concussion risk and outcomes.²² Therefore, in this study sports were grouped into four categories: (1) collision/combat, (2) contact, (3) limited contact, and (4) non-contact. Sports included in each group are presented in Supplementary Table 1.

Data collection tool

A standardized, written questionnaire was used to collect demographics. This survey was field tested in 2017 with 365 students aged 12 and above for understanding and readability.¹⁹ The following hypothetical scenario was provided to participants: "If you were playing your sport and had a head injury that was not observed by

others and started having symptoms that might represent a concussion but felt like you could continue to play, would you or would you not tell your coach/trainer knowing they would take you out for the entire game to rest?" The scenario was repeated for the following conditions: team practice; important championship game against rival team or had a scout present; regular season game; and unimportant game against lesser team or friendly match. Participants who opted not to report their symptoms were asked to select their reason(s) from the following: you are not sure what concussion symptoms are; you do not want to let your team down; concussions are part of the game; you do not want to leave/miss a game; you do not want to let your family down; or you do not want to let your coach down. No effort tests were performed to assess the integrity of responses.

Statistical analysis

Participants were grouped and compared by level of contact sport played. The continuous variable (age) was not normally distributed and Kruskal-Wallis Test was used to compare mean ages between groups. χ^2 tests were used to compare categorical variables (sex, concussion history, concussion reporting patterns for each scenario, and reasons to not report). Sex comparisons were performed at each level of contact sport group. Only those sports with similar male and female participation (or opposite-sex counterparts) were included in the secondary analysis. Continuous variables were compared using Mann-Whitney U-tests and categorical variables were compared using χ^2 tests. History of concussion (binary, yes/no) and level of competition (recreational, town/club league, freshman/junior varsity, varsity and inter-collegiate)

were a priori identified as possible confounders. An ANCOVA analysis was performed on all significant differences to control for the pre-identified confounders individually. A p-value of 0.05 was considered significant. Statistical analysis was performed using SPSS Version 25 (IBM Corp, USA).

Results

One thousand one hundred and twenty-six completed surveys were received. All participants played at least one sport and there were no incomplete surveys, hence all responses were included in the analysis. Fifty two percent of the complete sample were female and 48% were male. The age range of participants was 10 – 23, with a median of 16.0 years (mean: 16.57 years, SD: 2.30, IQR: 15, 18). Group-wise demographics are presented in Table 1. Collision/combat sport athletes were the oldest (mean age = 17.26), had more percentage of males (67% male), and had more previous concussions (36.49% with 1 \geq concussion) than the other groups.

Concussion reporting behavior compared between levels of contact is presented in Figure 1. Collision/combat sport athletes reported having formal concussion education more frequently. Contact sport athletes were the least likely to report a possible concussion during practice and regular season games, but collision/combat sport athletes were least likely to report during an important game. This relationship was associated with concussion history ($F = 18.37, p < .001$) and level of competition ($F = 19.19, p < .001$), respectively. Athletes in sports with higher contact levels often reported they did not want to miss a game as a reason to not report concussive symptoms, and this

Table 1. Group-wise demographics by sport group.

	Collision/Combat	Contact	Limited Contact	Non-Contact	p-Value
n	285	420	215	206	-
Age in years (SD)	17.27 (2.6)	16.49 (2.3)	16.32 (2.1)	16.06 (1.8)	<0.001
Sex	33% Female 67% Male	56% Female 44% Male	55% Female 45% Male	67% Female 33% Male	<0.001
Previous Concussion					<0.001
0	181	299	168	171	
1	59	57	31	25	
2	16	39	10	7	
3	16	18	3	3	
4 or more	13	7	3	0	
Level of Competition					<0.001
Recreation	13	45	30	23	
Town/Club League	23	71	34	37	
Junior Varsity	64	70	50	26	
Varsity	85	147	64	99	
Inter-Collegiate	100	87	37	21	

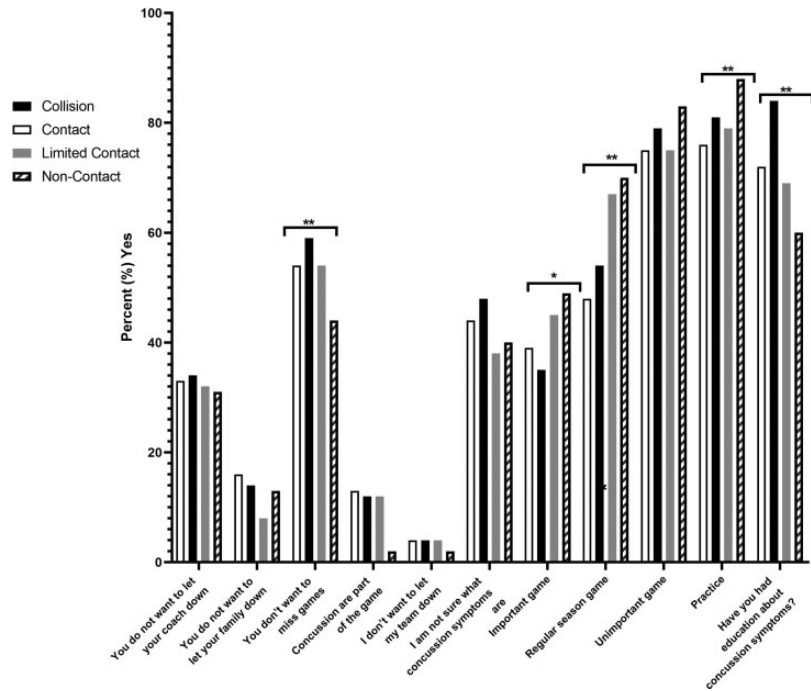


Figure 1. Group-wise Concussion Reporting by Sport Group. *: Defined as a p-value of 0.05 **: Defined as a p-value of 0.01.

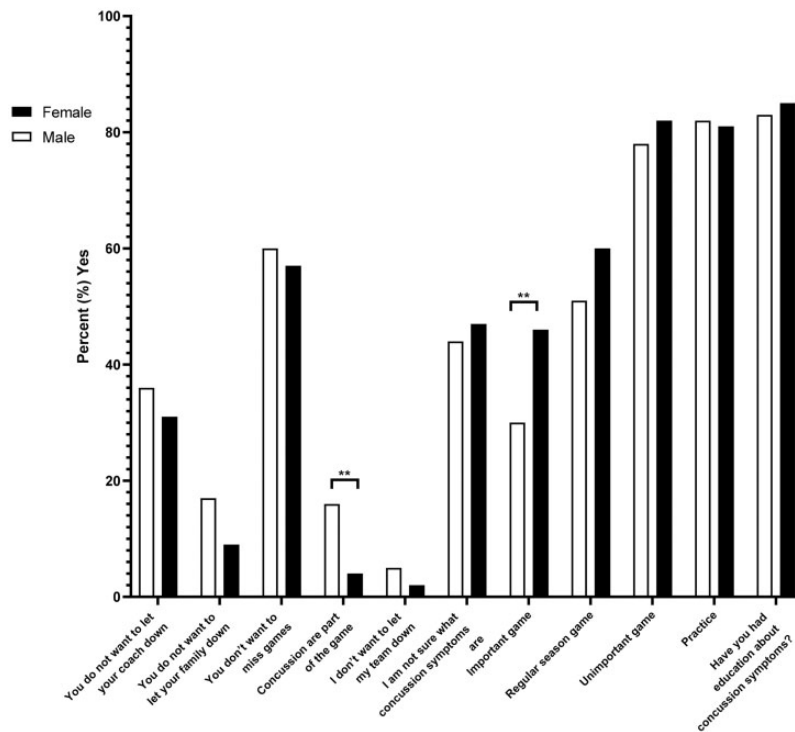


Figure 2. Sex Differences in Collision/ Combat Group. n = 285 (M: 192 17.18 ± 2.7) (F: 192 17.44 ± 2.4 years) *: Defined as a p-value of 0.05 **: Defined as a p-value of 0.01.

difference was found to be significant. This relationship was associated with both concussion history ($F = 18.15, p < .001$) and level of competition ($F = 18.62, p < .001$).

Figure 2 presents sex differences in collision/combat sports. Males were significantly less likely to report concussion-like symptoms during an important game, which was associated with competition level ($F = 4.38,$

$p = .013$) and history of concussion ($F = 3.60, p = .029$). Females reported that they believed concussions were “part of the game”, which was significantly associated with competition level ($F = 3.78, p = .005$) and history of concussion ($F = 3.37, p = .010$). Males who played collision/combat sports showed a trend to report more frequently that they did not want to “let their family down”, but this did not reach statistical significance ($p = .053$).

Figure 3 presents sex differences for contact sports. Proportionally, there were more females who reported having a history of concussions. No differences in concussion reporting patterns were observed between sexes who play contact sports. There were also no differences in reasons to not report their concussion except for “do not want to let their coach down”. Females reported this as a reason not to report more frequently than males (37% versus 27%) and this relationship was associated with competition level ($F = 14.80, p < .001$) and concussion history ($F = 5.31, p = .005$).

Figure 4 presents sex differences for limited contact sports. There were no differences observed between age, history of concussion, education, concussion reporting pattern, or reasons not to report.

Figure 5 presents sex differences for non-contact sports. The only difference observed in concussion reporting patterns was that females were less likely to report a concussion during an “important game”. This variable was not associated with competition level

($p = .816$) or history of concussion ($p = .073$). Females also reported more frequently that they “do not want to let their coach down”. This variable was associated with competition level ($F = 3.80, p = .024$) but not with concussion history ($p = .065$).

Discussion

The aim of our study was to compare concussion reporting patterns between sports with different levels of contact and between sexes who play the same sport. We found multiple differences across groups regarding concussion education, concussion history, reporting patterns across different situations, and reasons not to report. Even though student athletes in sports with higher level of contact received more education about concussions, non-contact sport student athletes were most likely to report a possible concussion in all scenarios regardless of their importance. This was contrary to our initial supposition that student athletes participating in sports with more contact and greater risk for concussive head injuries would be more concerned about playing while concussed.¹⁰ One possible explanation for this finding is the unique culture of sports with different levels of contact. An individual’s personal preferences may also affect which sport they choose to play and may be a confounder in this study. Our findings suggest student athletes in collision/combat and contact sports may benefit from more

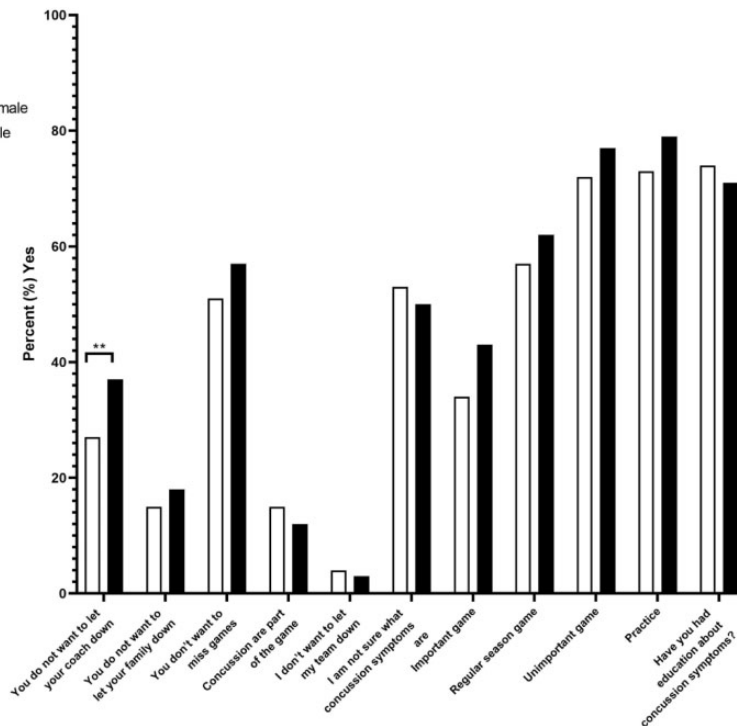


Figure 3. Sex Differences in Contact Group. $n = 420$ (M: $186 \ 16.71 \pm 2.3$) (F: $234 \ 16.31 \pm 2.3$ years) *: Defined as a p-value of 0.05 **: Defined as a p-value of 0.01.

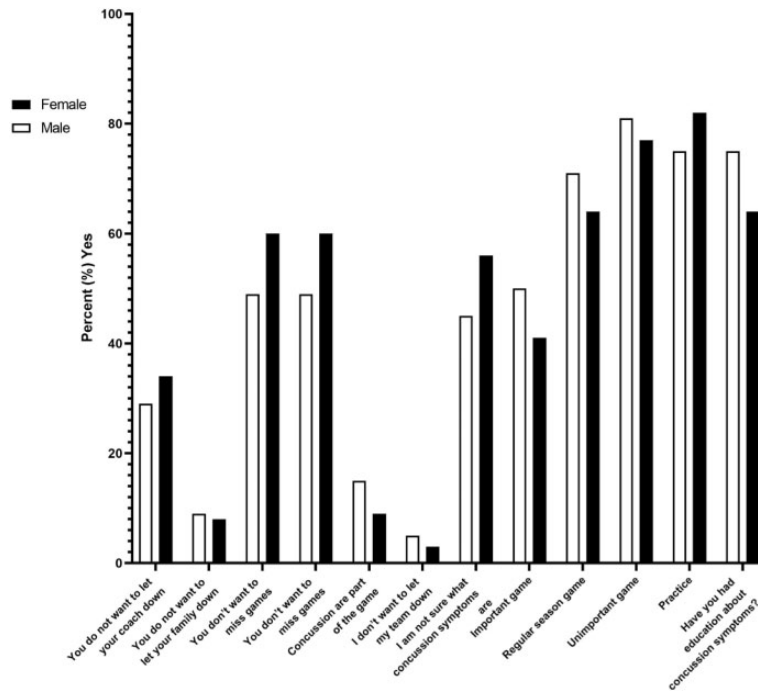


Figure 4. Sex Differences in Limited Contact Group. $n = 215$ (M: 96 16.66 ± 2.5) (F: 119 16.04 ± 1.7 years) *: Defined as a p-value of 0.05 **: Defined as a p-value of 0.01.

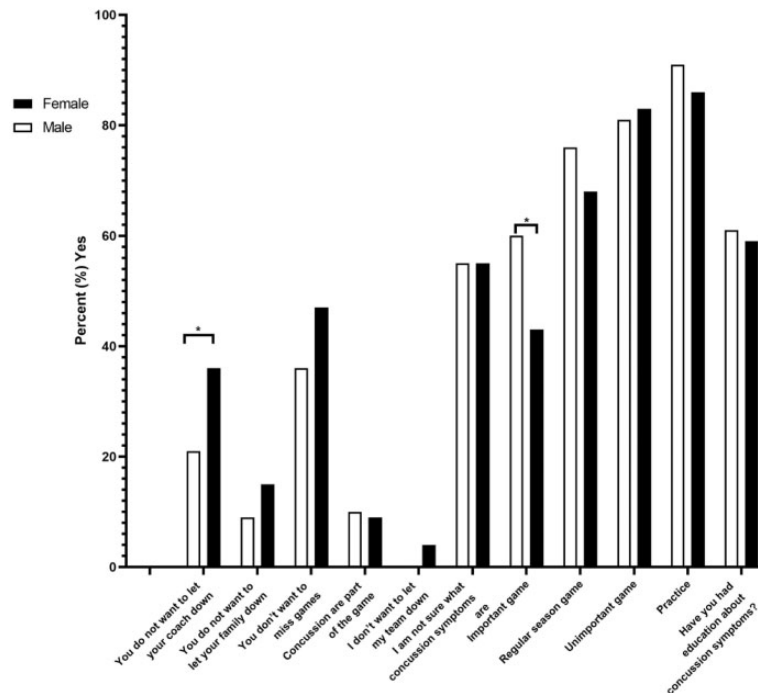


Figure 5. Sex Differences in Non-Contact Group. $n = 206$ (M: 67 15.70 ± 1.3) (F: 139 16.24 ± 2.0 years) *: Defined as a p-value of 0.05 **: Defined as a p-value of 0.01.

awareness of detrimental and potentially fatal consequences of sustaining another head injury while the athlete is suffering from a previous concussion.²³ A repeat head injury while the brain is in a state of altered

metabolism due to a previous concussive head injury has been associated with a prolongation of concussion-like symptoms, development of persistent or permanent dysfunction, and in some cases, death.^{8,10} Ideally,

students participating in sports should receive the same amount of education regardless of levels of contact. Therefore, the finding that all groups did not report similar rates of concussion education was unexpected. This is a potential confounder for concussion reporting behaviors which we had not a priori selected as a confounder. Further research on the effects of concussion reporting is warranted.

Our study also highlights potential insights into concussion history and concussion reporting behaviors of student athletes across levels of contact. Consistent with existing literature,²⁴ our sample of student athletes playing collision/combat and contact sports had the highest incidence of previous concussions. These sports have more intentional and unintentional contact than limited or non-contact sports. Student athletes who played collision/combat sports were also slightly older than other sport groups. One possible explanation for this difference is the higher proportion of student athletes who participated in collegiate hockey and lacrosse. There were also disproportionately more males in combat/collision sports, which might be due to participants who play football, a male-only sport.

Regarding differences between sexes in concussion reporting in various scenarios, our findings demonstrate that males and females do not differ significantly in their anticipated concussion reporting behavior. The only scenario that showed significant differences among sexes in more than one level of contact group was during an important game. The sex that more frequently reported these variables changed between levels of contact. Males reported they would be less likely to report a concussion in combat/collision sports during an important game, however, males playing non-contact sports were more likely to report a concussion. More importantly, both sexes playing collision/combat, contact and limited contact sports responded that they were less than 50% likely to report concussion during an important game. Current literature suggests males report concussions more inconsistently than females,⁵ but our results are inconclusive and confirm our original hypothesis that sex does not unilaterally affect concussion reporting behavior when comparing females and males in similar sports.

Our study found the most common reason male and female student athletes would choose not to report was not wanting to miss a game. This was expected because athletes often feel pressure to continue playing despite concussive symptoms.²⁵ The second most common reason athletes chose not to report was not wanting to let their coach down. This was true for both males and females across multiple levels of contact, however, our study suggest that this may have more of an impact on females than males. The cause for this is unknown. A coach plays a significant role in helping his/her

players obtain higher levels of performance and success and it is important to recognize the influence this relationship has on the perspective of players.²⁶ Lastly, an athlete's decision to report a concussion or the reasons why they would choose not to report a concussion is affected by other factors besides sex and level of contact. Each athlete has their own beliefs and every sport has a unique culture regarding the social dynamics between parents, coaches, players, and healthcare providers.²⁷ Those dynamics may have a larger influence on concussion reporting behaviors than sex and level of contact alone. Further exploration into social dynamics and relationships in sports teams between the sexes should be considered.

Limitations

Although the study design was effective in capturing the anticipated behavior of a large group of diverse athletes of different sport types, contact levels, competition levels, ages and sex, it has several limitations. First, this study does not capture all possible reasons someone may choose not to report. We recognize an athlete's decision to report a concussion is based on a culmination of factors, not all of which were addressed in our questionnaire. Each athlete has their own reasons for choosing whether to report or not. Our study includes a diverse population, various levels of contact, competition and athletes of many ages. These cofounders were controlled for in the statistical analysis of the data however, we recognize that different levels of competition and different sporting leagues have individual rules for allowed contact. We recommend that future research delineate these age groups further to make more specific recommendations for differing age groups. Another limitation is the study's hypothetical nature. We aimed to present a short vignette that was designed to be as simple as possible, and ask how student athletes would respond during a series of scenarios. This questionnaire was tested on adolescents 12 and up so it may not be understandable to our participants aged 10 and 11 ($n = 8$, 0.7% of sample size), but we do not expect this to affect the results of our study. The reasoning to provide a hypothetical scenario as opposed to inquiring about previous experiences was to provide insight on if, and why, a student athlete would choose not to report. Performing a study that only included diagnosed concussion would not be able to capture concussions that were not reported, and responses to inquiring about an athletes' actual past experiences could not have been validated to assess the integrity of their responses. Hence, our study design can provide insight on student athlete's perspective on concussion reporting, but not actual behavior that is reported.

Conclusion

Despite concussion education becoming prevalent with school-aged athletes and mandated in many places in the United States, our study found a significant proportion of athletes would choose to not report a concussion in a series of hypothetical practice and game situations. The rate at which athletes said they would not report concussive symptoms increased for games that were considered more important and sports with increased levels of contact had higher anticipated rates of not reporting. The most common reasons athletes chose why they would not report were not wanting to miss the game and not wanting to let the coach down. This suggests that coaches play a significant role in concussion reporting. Our study did not find any conclusive differences between sexes in willingness to report a concussion, with females being just as unlikely, or sometimes more unlikely, than males to report a concussion during a game when compared within sports of similar level of contact. Lastly, female contact and non-contact sport student athletes appeared to be more concerned about not wanting to let their coach down than males which suggests there may be differences in the coach-athlete dynamic between the sexes. Further delineation of this observation may help improve concussion education strategies for athletes and coaches, particularly with respect to female athletes.

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ORCID iD

Haley M Chizuk  <https://orcid.org/0000-0003-2113-0536>

Supplemental material

Supplemental material for this article is available online.

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