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The Identification and Comparison of Factors Affecting Musculoskeletal and Concussion Injury Disclosure

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Context: Despite the increased risk of musculoskeletal (MSK) injury after a concussion, little is known about the determinants of such a risk. Moreover, the authors of previous reports of increased risk of MSK injury after a concussion have neglected to account for the high level of undisclosed concussions.

Objective: To explore the association between the intention to disclose a possible concussion and the intention to disclose an MSK injury.

Design: Cross-sectional study.

Setting: Online survey.

Patients or Other Participants: One hundred seven National Collegiate Athletic Association Division I athletes (females = 79%, age = 19.4 ± 1.4 years).

Main Outcome Measure(s): Online survey exploring determinants such as injury knowledge, attitudes, perceived social norms, and perceived behavioral control surrounding concussive and MSK injury disclosure.

Results: A significant association between high intention to disclose a concussion and high intention to disclose an MSK injury ($\chi^2 = 19.276$, $P < .001$, Cramer V = 0.482) was observed. Spearman rank correlations suggested no correlation between concussion nondisclosure (25%) and MSK injury nondisclosure (52%). Multivariate binomial regressions indicated that perceived social norms were the strongest determinant ($\beta = 1.365$, $P = .002$) of high intention to disclose concussion, while attitudes toward MSK injury ($\beta = 1.067$, $P = .005$) and perceived social norms ($\beta = 1.099$, $P = .013$) were the strongest determinants of high intention to report MSK injury.

Conclusions: Individuals with high intention to report concussion symptoms also demonstrated high intention to report MSK injury. Strong positive associations were seen between known determinants of intention to disclose concussion and adapted versions of those same determinant domains in intention to disclose MSK injury. As those with high intention to disclose concussion also displayed high intention to disclose MSK injury, intention to disclose injuries generally may play a role in explaining the increase in MSK injury after a concussion.

Key Words: barriers to disclosure, hiding injury, early disclosure

Key Points

- High intention to disclose a concussive injury was associated with high intention to report a musculoskeletal injury.
- Perceived social norms and attitudes toward reporting significantly influenced musculoskeletal injury disclosure.
- Investigators interested in reducing the social, emotional, and economic costs of musculoskeletal injuries could look to concussion disclosure research as a tool to inform interventional strategies to improve early reporting.

Musculoskeletal (MSK) injuries are characterized as injuries that elicit pain in the bones, ligaments, tendons muscles, or nerves and affect up to 12 million individuals annually in the United States, accounting for an estimated 20 to 25 million school and work days lost and an estimated $33 billion in health care costs.[1,2] Similarly, concussions are a growing epidemic characterized by a sequela of symptoms after an impact to the head or body that negatively affects the performance, social experience, and academic well-being of millions of athletes, while also accounting for an estimated economic cost of $22 billion each year.[3–5] A growing body of evidence from a diverse range of study methods and populations is demonstrating a correlation between these epidemics: athletes who sustain a concussion are at a subsequent increase in the likelihood (as much as 1.3–3.4 times) of experiencing an MSK injury in the following year.[6–15] Presently, the leading explanation for the observed increased risk of MSK injury is persistent neurologic deficits, such as decreased cognitive function or neuromuscular control after a concussion.[3,16–19]

Whereas a theoretical rationale supports persistent neurologic deficits as the leading contributing factor and

explanation for the observed increased risk of MSK injury after a concussion,[16,19] clinical predictors, assessment techniques, and determinants of such an increased risk have not been established.[7,8,12,15] Despite a preponderance of evidence for decreased clinical reaction time, decreased postural control, and impaired cognition after a concussion, currently, limited evidence correlates those outcomes with the future MSK injury risk.[12] In the absence of a direct link between observed alterations in neurologic deficits after a concussion and the future MSK injury risk, other potential contributing factors should be explored. One key factor that previous authors failed to account for was the high rate of concussions that go undisclosed. An estimated 35% to 50% of concussions are undisclosed,[20,21] and therefore, the subsequent MSK injury risk among concussion nonreporters (who likely would be experiencing the same declines in neurologic function despite not disclosing the injury) was unaccounted for in previous studies. Moreover, earlier researchers included observations of athletes who were more likely to have sustained an MSK injury in both the years before and after a concussion. This inverse relationship suggests some athletes may just be more injury prone or simply more likely to disclose injuries of any kind.[9,13]

Many determinants have been found to influence concussion disclosure behavior, including a history of a concussion, external pressure from coaches and teammates, knowledge of concussion symptoms and consequences, perceived importance of reporting, gender, socioeconomic status, attitudes toward disclosure, perceived social norms, and perceived behavioral control.[22–25] In contrast, little is known about the factors that influence MSK injury disclosure, although anecdotal reports supported a high degree of nondisclosure of MSK injuries as well.[26,27] Considering the established relationship between concussion and subsequent MSK injury, it is important to better understand the context in which athletes decide to disclose both types of injuries.

Drawing on observed determinants of intent to disclose a concussion and literature suggesting some athletes were more likely to disclose any injury than others, an alternative contributing factor to the observed increase in risk of MSK injury after a disclosed concussion may include athletes' perceptions, attitudes, and behaviors toward disclosure of injuries in general. This hypothesis suggests certain athletes may be more inclined to disclose any injury, consequently influencing the observed increase in disclosure of MSK injuries after a disclosed concussion. Conversely, some athletes may not intend to disclose either type of injury. Therefore, the purpose of our study was to explore the association between intention to disclose a concussion and intention to disclose MSK injury as well as actual disclosure behaviors among collegiate student-athletes. Additionally, we compared known determinants of intention to disclose concussion with these same determinants as proposed determinants of intention to disclose MSK injuries. We proposed that high intention to disclose concussion would be significantly associated with high intention to disclose MSK injury. Furthermore, we hypothesized that determinants such as previous injury, knowledge of injury symptoms and consequences, attitudes toward disclosure, perceived social norms, and perceived behavioral control of disclosure would be correlated and similarly influence high intention to disclose both concussion and MSK injury.

METHODS

Study Design and Participants

For this cross-sectional study, we recruited a convenience sample from a single National Collegiate Athletic Association (NCAA) Division I institution. Participating student-athletes were administered self-report surveys asking about their history of concussion and MSK injury. Specifically, they were asked how many injuries they perceived sustaining as well as how many of those perceived injuries they reported and to whom. Moreover, the athletes were asked about their knowledge of signs and symptoms for each injury and their personal beliefs and attitudes toward disclosure of injury. The study was approved by the Institutional Review Board at the University of Texas at San Antonio and all individuals provided written, informed consent before participation. Collegiate student-athletes were invited to join the study during the fall preparticipation physical examination before the academic year. All individuals who were receiving fall physicals (146) were approached; 115 (78%) agreed to participate, and 107 (73%) athletes completed all components of the survey used for this assessment and were therefore included in the final analysis. The average completion time for the survey was 16 minutes.

Questionnaire and Procedures

The questionnaire was administered during the preparticipation physical examination using an online survey platform (Qualtrics). Recruits who consented to be involved in the study were invited to sit in a quiet room where they were given a tablet on which to complete the online questionnaire. The online questionnaire consisted of 3 parts: (1) comprehensive demographic information, including lifetime concussion and MSK injury history; (2) concussion disclosure behaviors and potential determinants of intention to disclose concussions; and (3) MSK injury disclosure behaviors and potential determinants of intention to disclose MSK injuries. The concussion disclosure portion of the survey contained previously validated items to explore disclosure behaviors and intention to disclose concussions.[28–30] Using existing concussion disclosure literature, we created the MSK disclosure portion of the survey based on a similar framework to examine potentially influential factors. Given the novelty of MSK injury disclosure concepts, a panel of 5 experts (certified athletic trainers, including those with doctoral degrees), with more than 100 combined publications related to the diagnosis and treatment of MSK injury, reviewed the survey for face and content validity. As part of the validation process, experts were asked to grade questions for relevance and clarity (1 = *not clear or relevant* to 5 = *very clear and relevant*) and if anything should be included that was not originally considered. This process identified 4 additional signs and symptoms of an MSK injury (compensating to complete a task, pain at night, headache, and difficulty falling asleep). Lastly, the survey was piloted with 5 student-athletes. They were given an opportunity to

comment on any items that were confusing. Based on the feedback, we revised the instrument. Additionally, internal consistency between individual questionnaire domains was assessed. Specific determinants adapted for the MSK injury portion of the survey are explained in detail in the subsequent section.

Musculoskeletal Injury Knowledge. Knowledge of MSK injury was evaluated using 21 yes-or-no items concerning symptom recognition, potential signs and symptoms, potential long-term side effects, effects of premature return to play, and consequences of incurring multiple MSK injuries. Correct answers received 1 point, and incorrect answers received 0 points, with a maximum composite score of 21 (higher scores meant better MSK injury knowledge).

Attitudes Toward MSK Injury Disclosure. Questions about attitudes toward disclosing MSK injuries were adapted from previously validated questions about disclosing concussions.[28–30] The same 8 validated 7-point scale items were adapted and used to determine attitudes toward and perceptions of MSK injury disclosure. Values for the answers were summed, resulting in a composite attitude score ranging from 8 to 56 (higher scores meant more favorable attitudes toward MSK injury disclosure). For example, the concussion attitude question read: "Disclosing possible concussive symptoms to a medical professional or someone in authority during physical activity is. . .," while the MSK attitude question replaced "concussive symptoms" with "possible MSK symptoms." The same eight 7-point items were then presented: cowardly : brave, shameful : prideful, harmful : beneficial, extremely difficult : extremely easy, bad : good, unimportant : important, waste of time : worthwhile, and weak : strong.

Perceived Social Norms Regarding MSK Injury. The items on MSK injury perceived social norms were adapted from the concussion perceived social norm questions and consisted of the same 7 validated 7-point scale items adapted to reflect the perceptions of the organization, social referent expectations, and actions concerning MSK injury instead of concussion. Scores for the answers were summed, resulting in an MSK composite social norm score ranging from 7 to 49 (higher scores meant more favorable perceived social norms surrounding MSK injury).

Perceived Behavioral Control Over Disclosing an MSK Injury. This section consisted of a single 7-point scale question regarding how much control student-athletes believed they had over disclosing MSK injury. A perceived control score was categorized as *high* (score 6 or 7), reflecting agreement or *low* (scores 1–5), reflecting some agreement to strong disagreement with having control over MSK injury disclosure.

Intention to Disclose MSK Injury. This section consisted of a single 7-point scale question regarding a student-athlete's intention to disclose symptoms of an MSK injury. Intention scores were categorized as *high* (score 6 or 7), reflecting agreement or strong agreement with disclosing symptoms of an MSK injury, or *low* (scores 1–5), reflecting some agreement to strong disagreement with the intention to disclose symptoms of an MSK injury.

Disclosure Behavior Regarding MSK Injury. Musculoskeletal injury disclosure behavior was measured by asking the question "How many of these musculoskeletal injuries did you report/disclose to a medical professional or someone in authority at the time of injury?" to anyone who reported having had an MSK injury.

Statistical Analysis

We calculated descriptive statistics for all variables. Medians and interquartile ranges (IQRs) were computed for all continuous variables and frequencies and percentages for all categorical variables. The a priori α level was set to .05 for each analysis. Before running models, we examined the variables for multicollinearity. Consistent with previous concussion research, we assessed multicollinearity using condition indices and corresponding variance inflation factors (VIFs). If a condition index was >30, individual assessments of multicollinearity were performed using VIFs. Variables were determined to be *collinear* if the VIF was >2.5. The *disclosure percentage* was defined by the number of previous injuries disclosed to a medical professional by each athlete divided by the total number of injuries the athlete recalled having sustained. *Nondisclosure* was determined by athletes recalling ≥ 1 injury that was not disclosed at any point in time. Lastly, the intention to disclose a concussion and intention to disclose an MSK injury were converted into categorical variables and dichotomized as *high* (6 or 7) or *low* (0–5), which allowed for exploration of differences between those who selected high versus low intention to report injury in accordance with previous literature.[30]

We initially assessed the association between high intention to disclose concussion and high intention to disclose MSK injury using a χ^2 test. Spearman rank correlations were conducted to compare the relationships between (1) concussion disclosure intention and previous concussion disclosure percentage, (2) MSK disclosure intention and previous MSK injury disclosure percentage, and (3) previous concussion disclosure percentage and previous MSK injury disclosure percentage. Cronbach α tests were performed to evaluate the internal consistency between explored determinants (previous injury, knowledge of injury symptoms and consequences, attitudes toward disclosure, perceived social norms, and perceived behavioral control of disclosure) of concussion and MSK disclosure. The strength of the Spearman rank correlations was determined using the magnitude classifications developed by Schober et al,[31] while χ^2 tests were interpreted following suggestions from McHugh.[32]

We then generated univariable logistic regression models to examine each individual determinant and how it affected high disclosure intentionality for both concussion and MSK injury. Two multivariate binomial regression models were then used to identify which of the hypothesized determinants influenced high intentionality for disclosure of each concussion and MSK injury. Perceived behavioral control and gender were not included in the multivariate binomial model exploring concussion disclosure intentionality due to collinearity and reduced sample size. Perceived behavioral control was not included in the MSK injury disclosure intentionality model due to reduced sample size. Odds ratios (ORs) with corresponding 95% CIs were computed to model high intention to disclose.

Table 1. Participants' Demographic Information[a]

Question	No. (%)	Mean ± SD	Median (Interquartile Range)
What is your current age (y)?		19.82 ± 1.49	20.0 (18.0–21.0)
What is your gender identity?			
Male	32 (29.4)		
Female	74 (67.9)		
Which of the following races or ethnicities best describes you?			
Black or African American	16 (15.0)		
Latino or Hispanic	22 (20.6)		
Multirace	14 (13.1)		
White	53 (49.5)		
Other	1 (0.9)		
What is your current academic year?			
Freshman	33 (30.8)		
Sophomore	22 (20.6)		
Junior	20 (18.7)		
Senior	20 (18.7)		
Fifth-year senior	5 (4.7)		
Graduate student	3 (2.8)		
How many total years (from birth) have you played your NCAA or collegiate sport?		8.94 ± 6.35	10.0 (2.3–15.0)

Abbreviation: NCAA, National Collegiate Athletic Association.

[a] Some participants did not answer all items.

RESULTS

Participants

Overall, 107 student-athletes completed the survey and were included in the analyses (Table 1). Details pertaining to each participant's primary NCAA sport and high school sport involvement are shown in the Figure. Most respondents were female (n = 74, 69.2%) and White (n = 53, 49.5%) and participated in collision or contact sports (n = 59, 55.1%). Additionally, 24.3% (n = 26) reported a history of concussion, while 68.2% (n = 73) reported a history of an MSK injury. Strong internal consistency ($\alpha = 0.918$–0.968) was present for each domain in the questionnaire. Student-athletes' MSK and concussion injury knowledge, attitudes, perceived norms, and descriptive statistics are described in Tables 2 and 3.

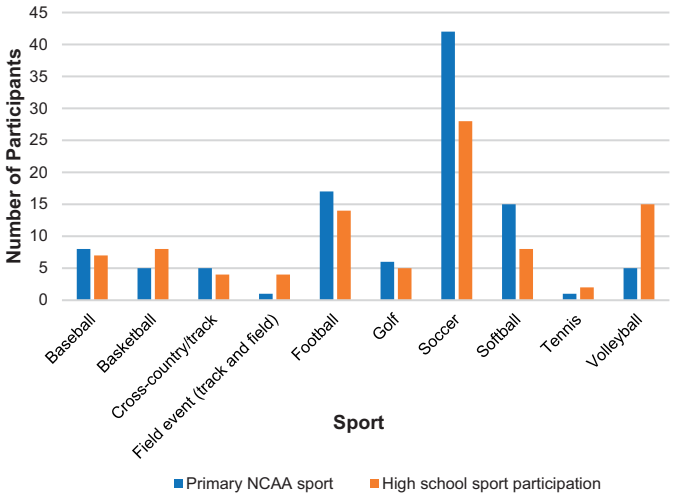

Figure. Respondents' primary National Collegiate Athletic Association (NCAA) sport and high school sport participation.

Relationship Between Intention to Disclose a Concussion Versus an MSK Injury

High intention to disclose a concussion and high intention to disclose an MSK injury were moderately associated ($\chi^2 = 19.276$, $P < .001$, Cramer V = 0.482). The Spearman rank order test revealed a correlation between intention to disclose MSK injury and a history of disclosing MSK injury ($\rho = 0.299$, $P = .019$), whereas the intention to disclose a concussion was not correlated with previous concussion disclosure behaviors ($\rho = -0.005$, $P = .982$). Despite a trend toward significance in the correlation between actual disclosure in individuals who reported a history of both a concussion and an MSK injury, no relationship was found ($\rho = 0.314$, $P = .061$).

Determinants of Intention to Disclose a Concussion Versus an MSK Musculoskeletal Injury

Our sample's knowledge, attitudes, perceived norms, and behaviors pertaining to concussion disclosure were comparable with previous values.[28,29] The median total concussion knowledge score was 39.0/50.0 (IQR = 32–41), while the median total MSK knowledge score was 29.5/40.0 (IQR = 25.5–33.0). In general, higher concussion knowledge scores were positively correlated with higher MSK injury knowledge ($\rho = 0.586$, $P < .001$). Pertaining to attitudes, a strong positive relationship was noted between the median concussion attitude score (median = 49.5, IQR = 44.3–56.0) and median attitude score toward MSK injury (median = 47.0, IQR = 37.0–53.0; $\rho = 0.788$, $P < .001$). Lastly, when exploring the relationship between median perceived social norm scores for concussion (median = 40.0, IQR = 34.0–42.0) and MSK injury (median = 38.0, IQR = 33.0–41.0), we observed a strong positive relationship ($\rho = 0.741$, $P < .001$). Regarding disclosure behavior, participants reported having failed to disclose 25% of perceived concussions compared with 52% of perceived MSK injuries.

Table 2. Student-Athletes' MSK Injury Knowledge, No. (%)

Knowledge Construct[a]	Yes	Maybe	No
Signs and symptoms			
Question: Do you consider the following a primary sign or symptom of MSK injury?			
Pain at rest	64 (58.7)[b]	19 (17.4)	11 (10.1)
Pain during nonsport activity (eg, walking, going to the store)	72 (66.1)[b]	10 (9.2)	12 (11.0)
Pain during sport activity	75 (68.8)[b]	9 (8.3)	11 (10.1)
Pain that goes away during activity (or after warm-up)	12 (11.0)[b]	44 (40.4)	38 (34.9)
Pain after sport-related activity	57 (52.3)[b]	26 (23.9)	12 (11.0)
Pain at night	58 (53.2)[b]	27 (24.8)	9 (8.3)
Radiating pain or pain that travels	64 (58.7)[b]	17 (15.6)	13 (11.9)
Restricted movement	68 (62.4)[b]	15 (13.8)	10 (9.2)
Muscle weakness	43 (39.4)[b]	34 (31.2)	16 (14.7)
Compensating to perform tasks	59 (54.1)[b]	23 (21.1)	12 (11.0)
Soreness <48 h	10 (9.2)[b]	27 (24.8)	57 (52.3)
Soreness >48 h	39 (35.8)[b]	32 (29.4)	23 (21.1)
Bilateral soreness (soreness on both sides of body part)	21 (19.3)[b]	35 (32.1)	38 (34.9)
Swelling	57 (52.3)[b]	28 (25.7)	9 (8.3)
Bruising	36 (33.0)[b]	34 (31.2)	24 (22.0)
Joint pain	44 (40.4)[b]	36 (33.0)	15 (13.8)
Headache	12 (11.0)[b]	36 (33.0)	46 (42.2)
Trouble falling asleep	17 (15.6)[b]	37 (33.9)	40 (36.7)
More emotional	15 (13.8)[b]	27 (24.8)	52 (47.7)
Irritability	18 (16.5)[b]	39 (35.8)	37 (33.9)
Sadness	14 (12.8)[b]	34 (31.2)	46 (42.2)
Total signs and symptoms knowledge score			
Mean ± SD		11.46 ± 4.956	
Median (interquartile range)		12.25 (9.6–14.3)	
Consequences			
Question: What do you think can happen if you don't report/disclose a possible MSK injury and continues playing "through the pain"?			
No bad things	3 (2.8)	21 (19.3)	68 (62.4)[b]
More likely to get another MSK injury	82 (75.2)[b]	8 (7.3)	4 (3.7)
Current injury could worsen	87 (79.8)[b]	4 (3.7)	2 (1.8)
Decreased athletic performance	80 (73.4)[b]	9 (8.3)	4 (3.7)
May put others (eg, teammates) at risk of injury	40 (3.7)[b]	31 (28.4)	22 (20.2)
I don't know what might happen	12 (11.0)	24 (22.0)	56 (51.4)[b]
Question: What do you think can happen from someone returning to their sport or physical activity too soon after a MSK injury?			
No bad things	3 (2.8)	15 (13.8)	73 (67.0)[b]
More likely to get another MSK injury	71 (65.1)[b]	18 (16.5)	3 (2.8)
Current injury could worsen	80 (73.4)[b]	10 (9.2)	2 (1.8)
Decreased athletic performance	78 (71.6)[b]	12 (11.0)	2 (1.8)
May put others (eg, teammates) at risk of injury	45 (41.3)[b]	23 (21.1)	23 (21.1)
I don't know what might happen	11 (10.1)	27 (24.8)	53 (48.6)[b]
Questions: What do you think can happen to someone because of suffering multiple MSK injuries over their lifetime?			
No bad things	5 (4.6)	17 (15.6)	71 (65.1)[b]
Develop long-term problems (eg, chronic pain, tissue degeneration, arthritis)	77 (70.6)[b]	15 (13.8)	2 (1.8)
Need for surgery	64 (58.7)[b]	27 (24.8)	3 (2.8)
More likely to get another MSK injury	69 (63.3)[b]	22 (20.2)	3 (2.8)
Forced to retire from sport	59 (54.1)[b]	31 (28.4)	4 (3.7)
Difficulty with everyday activities	63 (57.8)[b]	27 (24.8)	4 (3.7)
Changes in social life	39 (35.8)[b]	37 (33.9)	16 (14.7)
I don't know what might happen	6 (5.5)	34 (31.2)	54 (49.5)[b]
Total knowledge of consequences score			
Mean ± SD		16.35 ± 3.1	
Median (interquartile range)		17.0 (14.7–18.5)	
Total knowledge score			
Mean ± SD		28.79 ± 6.3	
Median (interquartile range)		29.5 (25.5–33.0)	

Abbreviation: MSK, musculoskeletal.

[a] Items are presented in their original format.

[b] True symptom or sign of MSK injury.

Determinants of High Intention to Disclose a Concussion

The results of the individual univariate regression models to identify individual predictors of high intention to disclose a concussion as well as the multivariate binomial regression model to explore the shared variance between predictors of high intention to disclose a concussion are provided in Table 4. The strongest significant individual predictors of high intention to disclose a concussion were concussion knowledge ($\beta = 1.133$, $P = .0041$, 95% CI = 1.041, 1.233), attitudes toward concussion disclosure ($\beta = 1.059$, $P =$

Table 3. Student-Athletes' MSK Attitudes and Perceived Norms[a]

Construct[b]	Mean ± SD	Median (Interquartile Range)
Attitudes		
Question: Reporting possible MSK injury symptoms to a medical professional or someone in authority is:		
Cowardly : brave	5.49 ± 1.843	6.0 (4.0–7.0)
Shameful : prideful	4.92 ± 1.811	5.0 (4.0–7.0)
Harmful : beneficial	5.60 ± 1.979	7.0 (5.0–7.0)
Extremely difficult : extremely easy	4.53 ± 1.947	5.0 (3.0–6.8)
Bad : good	5.71 ± 1.840	7.0 (5.0–7.0)
Unimportant : important	6.01 ± 1.722	7.0 (6.0–7.0)
Waste of time : worthwhile	5.69 ± 1.912	6.5 (5.0–7.0)
Weak : strong	5.42 ± 1.974	6.0 (4.0–7.0)
Total attitude score	43.10 ± 12.88	47.0 (37.0–53.0)
Perceived norms		
Question: For the following, select the level of agreement that corresponds with how you feel about each statement:		
In my current activity or sporting environment, most people I know would report their symptoms of possible MSK injuries to a medical professional or someone in authority if they experience them.	5.47 ± 1.654	6.0 (5.0–7.0)
Schools like mine provide appropriate care for individuals with MSK injuries.	6.14 ± 1.416	7.0 (6.0–7.0)
If I suffered a MSK injury, I would feel supported by my school.	6.16 ± 1.397	7.0 (6.0–7.0)
When I experience symptoms of possible MSK injuries, people who are important to me would approve of me reporting them to a medical professional or someone in authority.	6.14 ± 1.487	7.0 (6.0–7.0)
When other athletes I know experience symptoms of possible MSK injuries, they report them to a medical professional or someone in authority.	5.59 ± 1.637	6.0 (5.0–7.0)
I should report symptoms of possible MSK injuries, when I experience them, to a medical professional or someone in authority.	6.08 ± 1.464	7.0 (6.0–7.0)
Total perceived norm score	35.70 ± 7.858	38.0 (33.0–41.0)
Perceived control		
I have control over reporting symptoms of MSK injuries to a medical professional or someone in authority.	6.26 ± 1.150	7.0 (6.0–7.0)
Disclosure intention		
When I experience possible symptoms of MSK injuries, I intend to report them to a medical professional or someone in authority.	5.92 ± 1.313	6.0 (5.75–7.0)

Abbreviations: IQR, interquartile range; MSK, musculoskeletal.

[a] Rated on a 1–7 scale with 7 being *more favorable*.

[b] Items are presented in their original format.

.014, 95% CI = 1.012, 1.109), and perceived norms toward concussion disclosure ($\beta = 1.102$, $P = .004$, 95% CI = 1.032, 1.178). Further, the multivariate regression model explained 68% of the observed variance in high intention to disclose a concussion. Perceived social norms for concussion was the strongest determinant ($\beta = 1.365$, $P = .002$, 95% CI = 1.121, 1.663) of high intention to disclose concussion after accounting for the shared variance. Due to the limited number of females (n = 1) with low intention to disclose a concussion, gender was not incorporated into this model.

Determinants of High Intention to Disclose an MSK Injury

The results of the individual univariate regression models to identify individual predictors of high intention to disclose an MSK injury as well as the multivariate binomial regression to explore the shared variance between predictors of disclosing MSK injuries are available in Table 5. Musculoskeletal injury knowledge ($\beta = 1.121$, $P = .012$, 95% CI = 1.025, 1.224), attitudes toward MSK injury disclosure ($\beta = 1.065$, $P = .002$, 95% CI = 1.024, 1.193), and perceived social norms surrounding MSK injury ($\beta = 1.102$, $P = .004$, 95% CI = 1.032, 1.178) were the strongest significant individual predictors of high intention to disclose MSK injury. The multivariate regression was able to account for 43% of the observed variance in high intention to disclose MSK injury with 78% sensitivity and 87% specificity. The strongest determinants of high intention to disclose an MSK injury after accounting for shared variance were attitudes toward MSK injury ($\beta = 1.067$, $P = .005$, 95% CI = 1.020, 1.117) and perceived social norms toward MSK injury ($\beta = 1.099$, $P = .013$, 95% CI = 1.020, 1.185).

DISCUSSION

The purpose of our study was to explore the association between intention to disclose concussion and intention to disclose MSK injury. Furthermore, we sought to compare the association between previously identified determinants of high intention to disclose a concussion and proposed determinants of high intention to disclose MSK injury using the same domains. A moderate association between high intention to disclose concussion and high intention to disclose MSK injury was demonstrated.

Table 4. Multivariate Binomial Regression Model for High Intention to Disclose a Concussion

Variable	Exp(B)	*P* Value	95% CI
Univariate analysis			
Gender	1.349	.6035	0.437, 4.170
Race	3.257	.0444	1.029, 10.305
Concussion knowledge	1.133	.0041[a]	1.041, 1.233
Attitude toward concussion disclosure	1.059	.0142[a]	1.012, 1.109
Perceived social norms toward concussion disclosure	1.275	.0016[a]	1.139, 1.429
Previous concussion disclosure behavior			
Inconsistent	0.598	.598	0.102, 3.499
Consistent	1.196	.803	0.294, 4.865
Multivariate logistic regression			
Race[b]	0.847	.860	0.133, 5.379
Previous concussion disclosure behavior[b]			
Inconsistent disclosure	0.085	.052	0.007, 1.017
Consistent disclosure	1.579	.780	0.064, 38.957
Concussion knowledge	1.023	.765	0.880, 1.190
Attitude toward concussion disclosure	1.067	.070	0.995, 1.145
Perceived social norms toward concussion disclosure	1.365	.002[a]	1.121, 1.663

[a] Significant at $\alpha = .01$.

[b] The referent group for race was non-White, and the referent group for previous concussion disclosure behavior was never hurt or no opportunity to disclose.

In assessing the hypothesized relationship between known determinants of high intention to disclose a concussion and potential determinants of MSK injury disclosure, we found strong relationships between attitudes and perceived social norms in the same domain. Moreover, correlations identified a moderate relationship between concussion and MSK injury knowledge. Perceived social norms was a strong predictor of intention to disclose both concussion and MSK injury, with attitudes further affecting the intention to disclose MSK injury. Of our participants with a concussion history, 25.0% described having purposefully failed to disclose a concussion symptom, a value that is lower than the previously observed 35.0%–50.0% rate of concussion nondisclosure.[20,21] In contrast, our participants with a history of MSK injury indicated having not disclosed 52.0% of their prior perceived MSK injuries.

Table 5. Multivariate Binomial Regression Model for High Intention to Disclose an MSK Injury

Variable	Exp(B)	*P* Value	95% CI
Univariate models			
Gender	0.826	.722	0.288, 2.368
Race	0.938	.898	0.350, 2.510
MSK knowledge	1.121	.012	1.025, 1.224
MSK attitudes	1.065	.002[a]	1.024, 1.193
Perceived norms	1.102	.004[a]	1.032, 1.178
Multivariate binary logistic regression			
Sex	0.486	.372	0.100, 2.364
Race[b]	0.605	.485	0.147, 2.480
Previous MSK disclosure behavior[b]			
Inconsistent disclosure	0.338	.270	0.049, 2.323
Consistent disclosure	1.752	.531	0.304, 10.114
MSK injury knowledge	1.072	.266	0.948, 1.213
MSK attitude	1.067	.005[a]	1.020, 1.117
Perceived social norms for MSK injury	1.099	.013[c]	1.020, 1.185

Abbreviation: MSK, musculoskeletal.

[a] Significant at $\alpha = .01$.

[b] The referent group for race was non-White, and the referent group for previous concussion disclosure behavior was never hurt or no opportunity to disclose.

[c] Significant at $\alpha = .05$.

To our knowledge, this is the first study to explore determinants of MSK injury disclosure in any population. Although a moderate association existed between intention to disclose a concussion and intention to disclose MSK injury, MSK injury was twice as likely to go undisclosed as a concussive injury (52.0% versus 25.0%, respectively). This finding may have been influenced by participants' attitudes toward reporting MSK injuries. Musculoskeletal injury represents a broad spectrum, with some injuries leading to significant disability, whereas others present with minimal discomfort that resolves quickly. Therefore, some athletes may perceive some MSK injuries as minor, with no need to be reported. In contrast, widespread media attention and education programs have stressed the dangers of concussion to student-athletes, possibly influencing them to perceive a potential concussion as a more reportable event. Despite the lack of statistical significance in the difference between intention to disclose MSK injury and intention to disclose concussion, MSK injuries and concussion may not be viewed as equally necessary to report based on each athlete's individual knowledge and perceptions or other potential determinants. Future researchers should strive to identify differences in reporting behaviors between these distinct injuries to improve the behavior of early disclosure. However, a stronger correlation was evident between high intention to report MSK injury and the behavior of reporting a concussion. This finding suggests that MSK injuries are more common than concussions, and significant knowledge gaps pertaining to what does and does not constitute a reportable MSK injury may exist. Moreover, although we found associations between injury disclosure determinants, strong individualized factors, such as attitudes and perceived social norms, may affect the behavior of true disclosure as it relates to MSK injury and concussions differently.

Knowledge of symptoms and potential consequences, attitudes, and perceived social norms toward concussions have been identified as strong determinants of high intention to disclose a concussive injury as well as true disclosure of concussive injury.[22,23,25,28,30,33] Authors of

recent studies[33–36] have shown decreases in the rate of concussion symptom nondisclosure, highlighting the significance of interventions designed to improve knowledge of the injury itself while enhancing the social environment and context of sport participation to make disclosure more socially accepted. Local ecosystem-level factors such as university policies, support from coaches and administrators, as well as freedom for athletic trainers to do their job appropriately without fear of external pressure have increased concussion disclosure.[33,37] As high as 52% of perceived MSK injuries in our study population went undisclosed at the time of injury. Although various logical explanations could be offered (ie, lack of knowledge about potential consequences, perceived severity, disclosure not being socially acceptable, or fear of letting friends or family or coaches down), future research is necessary to explore and identify determinants of MSK injury disclosure in athletes. Previous results regarding the disclosure of concussion symptoms should be leveraged as a starting point for investigating interventions to improve MSK injury disclosure and, in turn, better understand the role disclosure behavior plays in the observed increased risk of MSK injury after a concussion.

In considering future educational programs on MSK injury disclosure, it is crucial to note the large observed deficit in knowledge of MSK injury symptoms in our sample. The median concussion symptom knowledge score was 18.7/24 versus a median MSK injury symptom score of 12.2/21. The most prevalent deficits in MSK injury knowledge pertained to the perception of pain as well as the role of emotional symptoms in identifying an MSK injury. Nearly all participants falsely dismissed symptoms such as headache, trouble falling asleep, [becoming] more emotional, irritability, and sadness as potential symptoms of MSK injury. Moreover, pain that goes away during activity, pain after activity, and pain at night were also frequently falsely dismissed as symptoms of MSK injury by most respondents. This is perhaps perpetuated by the stigma of "no pain, no gain" or the social context surrounding pain in sport.[38] Because these are key early-stage indicators of MSK injury, if they remain undisclosed, the condition may worsen.[38,39] These outcomes suggest that health care professionals seeking to improve MSK injury reporting could educate athletes on the signs and symptoms of MSK injury to help them better understand symptoms that may necessitate reporting or further evaluation.

As indicated earlier, MSK injuries in the United States are associated with significant consequences.[14,15] Given the high percentage of MSK injuries that went undisclosed in our sample, stakeholders who desire to further understand the increased risk of MSK injury after a concussion should start by focusing on community-based participatory research projects to improve MSK injury knowledge and help athletes better understand MSK injury. Previous interventional research targeted at improving concussion symptom knowledge, perceived social norms, attitudes, and perceived behavioral control offers an evidence-based starting point for an interventional strategy to improve MSK injury disclosure.[21,24] As our respondents revealed a 52% nondisclosure rate of MSK injury, perhaps the correlation between concussion and MSK injury is even more robust than presently understood. Creating an environment in which student-athletes feel support from coaches and other personnel in their athletics department to report MSK injury may help to mitigate some of the economic, social, and cultural burden of MSK injury by permitting detection of injuries in the early stages. These initiatives should seek to facilitate interpersonal communication among and between members of the health care team, student-athletes, and other stakeholder groups at the local level to influence the attributes of groups that drive safety-related behavior and improve shared values pertaining to the disclosure of MSK injury.[34–36]

Limitations

This study was cross-sectional and from a single institution. Therefore, we could not measure serial changes in disclosure perceptions or behavior or address generalizability to different populations. The cross-sectional nature of the study also inhibited our ability to establish a causal relationship between disclosure behavior and increased likelihood of MSK injury after a disclosed concussion. Due to the paucity of research, little is known about which criteria must be met pertaining to the severity of an injury for an athlete to report the injury or what other determinants (eg, perceived norms, socioeconomic class, gender, coaches' pressure) may alter that person's decision, further limiting the interpretability of the present findings. Moreover, very few women disclosed a history of concussion, so we could not consider gender as a predictor variable. As with any survey, the potential also exists for response, recall, and social desirability bias. We attempted to reduce response bias by approaching all student-athletes who were undergoing the preseason screening at the time of the survey, achieving a 78% response rate. Additionally, we tried to address social desirability bias by ensuring the survey results were anonymous and by reminding the student-athletes that neither the research nor medical staff would be able to identify their responses.

CONCLUSIONS

Although we observed strong relationships between high intention to disclose concussion and high intention to disclose MSK injury, concussions were disclosed more frequently than MSK injuries. Some similarities between intention to report concussion and intention to disclose MSK injury were seen in the explored determinants, namely, the importance athletes' attitudes toward disclosure played in both concussion and MSK injury disclosure. To better determine the role of injury disclosure in the known increased risk of sustaining an MSK injury after a concussion, a clearer understanding of the factors influencing MSK disclosure is necessary. Characterizing determinants of MSK injury disclosure will help stakeholders identify targets to include in interventional steps aimed at improving MSK injury disclosure in the early stages to help reduce the social, emotional, and economic costs of these conditions.

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