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*Am J Sports Med.* 2016 January ; 44(1): 220–225. doi:10.1177/0363546515612082.**Motivations associated with non-disclosure of self-reported concussions in former collegiate athletes****Zachary Y. Kerr, PhD, MPH<sup>1,2,3,4,5,6</sup>, Johna K. Register-Mihalik, PhD, ATC<sup>2,3,4,5</sup>, Emily Kroshus, ScD, MPH<sup>7</sup>, Christine M. Baugh, MPH<sup>8,9</sup>, and Stephen W. Marshall, PhD<sup>3,4,5,6</sup>**<sup>1</sup>Datalys Center for Sports Injury Research and Prevention, Inc., Indianapolis, IN, USA<sup>2</sup>Department of Exercise and Sport Science, University of North Carolina, Chapel Hill, NC, USA<sup>3</sup>Matthew A. Gfeller Sport-Related Traumatic Brain Injury Research Center, Department of Exercise and Sport Science, University of North Carolina, Chapel Hill, NC, USA<sup>4</sup>Center for the Study of Retired Athletes, Department of Exercise and Sport Science, University of North Carolina, Chapel Hill, NC, USA<sup>5</sup>Injury Prevention Research Center, University of North Carolina, Chapel Hill, NC, USA<sup>6</sup>Department of Epidemiology, University of North Carolina, Chapel Hill, NC, USA<sup>7</sup>Department of Pediatrics, University of Washington, Seattle, WA, USA<sup>8</sup>Harvard Interfaculty Initiative in Health Policy, Harvard University, Cambridge, MA, USA<sup>9</sup>Division of Sports Medicine, Boston Children's Hospital, Boston, MA, USA**Abstract**

**Background**—Previous studies examining non-disclosure among athletes in various settings have found substantial proportions of athletes with undisclosed concussions. Substantial gaps exist in our understanding of the factors influencing athletes' disclosure of sports-related concussions.

**Hypothesis/Purpose**—This cross-sectional study examined prevalence of, and factors associated with, non-disclosure of recalled concussions in former collegiate athletes.

**Study Design**—Cross-sectional survey.

**Methods**—Former collegiate athletes (n=797) completed an online questionnaire. Respondents recalled self-identified sports-related concussions (SISRC) that they sustained while playing sports in high school, college, or professionally, and whether they disclosed these SISRC to others. Respondents also recalled motivations for non-disclosure. We computed the prevalence of non-disclosure among those who recalled SISRC. Multivariate binomial regression estimated adjusted prevalence ratios (PR) with 95% confidence intervals (CI) controlling for sex, level of contact in sport, and year began playing college sports.

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**Results**—Two-hundred-and-fourteen (26.9%) respondents reported sustaining at least one SISRC. Of these, 71 (33.2%) reported not disclosing at least one SISRC. Former football athletes were most likely to report non-disclosure (68.3% of those recalling SISRC); female athletes who participated in low/non-contact sports were the least likely to report non-disclosure (11.1% of those recalling SISRC). The prevalence of non-disclosure was higher among males than females in the univariate analysis, (PR=2.88; 95%CI: 1.62, 5.14) multivariate analysis (PR=2.11; 95%CI: 1.13, 3.96), and multivariate analysis excluding former football athletes (PR=2.11; 95%CI: 1.12, 3.94). The most commonly reported motivations included: did not want to leave the game/practice (78.9%); did not want to let the team down (71.8%); did not know it was a concussion (70.4%); and did not think it was serious enough (70.4%).

**Conclusion**—Consistent with previous studies, a substantial proportion of former athletes recalled SISRC that were not disclosed. Males were less likely to disclose all their SISRC than females.

### Keywords

epidemiology; sport; reporting; traumatic brain injury

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## INTRODUCTION

Over the past decade, our understanding of the many acute, cumulative, and delayed effects of concussion<sup>7-9, 11, 25</sup> has greatly improved. However, more progress is needed. A recent call from the National Athletic Trainers' Association advocates further prevention, recognition, and management of concussions.<sup>2</sup> Interventions have been developed to increase concussion knowledge among athletes,<sup>4, 13, 20</sup> although to date only one of these has demonstrated long-term knowledge retention,<sup>20</sup> and no current interventions have linked improvements in knowledge alone to improved behaviors. Undisclosed concussions create a substantial barrier to good concussion management practice. Concussion disclosure behaviors are hypothesized to be associated with individual attitudes, social norms, and perceived behavioral control,<sup>13, 27</sup> but cognitions have not been the focus of concussion education interventions to-date.

There are significant gaps in our understanding of the factors influencing disclosure of concussions by athletes. Previous studies examining non-disclosure among athletes in various settings have found substantial proportions of athletes with undisclosed concussions.<sup>5, 12, 13, 16, 19, 26</sup> A recent review of studies examining non-disclosure of concussion identified a wide range of possible factors influencing disclosure behavior, including, teammates, coaches, health-care providers, and the media.<sup>12</sup> Many of these factors have been examined in only cursory manner, if at all. For example, no studies have examined the effect of sport and/or playing era on concussion disclosure behavior.<sup>12</sup> In addition, only two studies have examined the role of sex.<sup>16, 30</sup>

Former athletes are an important source of information on disclosure behavior. Unlike current athletes who may experience internal or external pressure that make them unwilling to discuss non-disclosure,<sup>14</sup> former athletes are not currently subject to these pressures and consequently may be more willing to disclose concussions that were undisclosed at the time

of injury. The purpose of this study was to quantify the prevalence of former collegiate athletes with undisclosed concussions, and to examine self-reported motivations for non-disclosure of sport-related concussions.

## METHODS

The study utilized data from a cohort of former collegiate athletes at a Division I National Collegiate Athletic Association (NCAA) university in the southern US. To contact this cohort (n=3,657), we accessed current email addresses from our institution's alumni directory, maintained by the Department of Athletics. The inclusion criteria for eligibility into the study cohort were: (1) played at least one season of a collegiate sport between 1987 and 2012; (2) aged 18 years or older; (3) had an email address provided by the university alumni association; and (4) able to speak and understand English. The Institutional Review Board at <name removed for blinded review> approved all aspects of this study; all respondents provided informed consent.

A letter inviting participation, and containing the URL to an online self-administered questionnaire, was sent to the email addresses of the 3,657 former collegiate athletes. The invitation and questionnaire did not include information about this study's specific research questions. Reminder emails were sent every other week throughout a three-month data collection window. We received data from 808 former collegiate athletes, of which 11 were excluded for incomplete data, leaving 797 for analysis. In addition, ten members of the target population contacted us to inform us that they were former student managers as opposed to former athletes. This resulted in a completion rate of 21.9%.

### Assessment of self-identified sports-related concussions (SISRC) and non-disclosure

Respondents reported the number of self-identified sports-related concussions (SISRC) they sustained during participation in high school, college, and professional (if applicable) sports. Concussions were defined (adapted from McCrea et al.<sup>18</sup>) as occurring typically, but not necessarily, from a blow to the head followed by a variety of symptoms that may include any of the following: headache, dizziness, loss of balance, blurred vision, 'seeing stars', feeling in a fog, or slowed down, memory problems, poor concentration, nausea, throwing-up, getting 'knocked out,' or becoming unconscious. Respondents were instructed to include any SISRC that were not diagnosed, including those that fit the above definition or that they considered to be "bell-ringers, dings, hard hits" at the time of impact. Thus, these SISRC are recalled events that are now perceived by the respondents to be concussions, rather than diagnosed concussions.

Respondents recalling at least one sports-related concussion were asked if they had ever sustained a SISRC and did not tell anyone. Respondents who reported non-disclosure of a SISRC were asked the motivations for non-disclosure, using a check-all-that-apply closed-response list (originating from McCrea et al.<sup>18</sup>).

### Statistical analysis

Results were stratified by sex, level of contact in sports, and era of play. Sex and sport are known determinants of concussion incidence and therefore were considered to be potential

determinants of concussion disclosure behavior.<sup>3, 17, 32</sup> Level of contact was divided into three categories: Collision (with football being the sole collision sport sponsored by the university at which our sample of former athletes played); High/Medium contact sports (basketball, field hockey, lacrosse, soccer, wrestling); and Low/Non-contact sports (baseball, cheerleading, diving, rowing, track and field). Since trends in concussion knowledge and awareness over time may influence disclosure of concussions, we also stratified by era of play, defined as whether the athlete began playing collegiate sports before 2001, or 2001 and later. This cutoff was utilized as concussion awareness in collegiate began to increase around the start of the 2000s. This was magnified in 2010 with the implementation of multi-sport NCAA-wide concussion policy.<sup>22</sup> Other variations of categorizing era of play were also considered; however, our chosen categorization provided the optimal use of data.

Binomial regression models were used to model the prevalence of individuals with undisclosed SISRC by sex, level of contact, and year began playing college sports. The binomial regression models were used to estimate prevalence ratios (PR) and 95% confidence intervals (CI). All binomial regression models used Poisson residuals and robust variance estimation to stabilize model fit.<sup>6, 29, 31</sup> We also confirmed all results using exact binomial regression methods; no meaningful difference was observed using exact models, thus we report only the standard models. Fisher's Exact tests compared the distributions of motivations for undisclosed SISRC by sex, level of contact, and year began playing college sports. The lead author utilized an a priori alpha 0.05 level.

## RESULTS

Of the 797 respondents, a total of 214 former collegiate athletes (26.9%) reported sustaining at least one SISRC during their playing career. The majority of these 214 former collegiate athletes were male (65.9%, n=141), Non-White Hispanic (88.3%, n=189), and began their collegiate sports careers prior to 2001 (69.2%, n=148). Mean age was 35.3 years (SD=7.5). The largest proportions of respondents had played football (19.2%, n=41), lacrosse (17.8%, n=32), or soccer (11.2%, n=24).

Within these 214 former collegiate athletes, 48.1% (n=103) reported only one SISRC; 22.4% (n=48) reported two SISRC; and 29.4% (n=63) reported three or more SISRC. Former collegiate athletes reporting SISRC recalled that these SISRC had occurred during participation in high school (74.5%, n=160) and collegiate sports (52.8%, n=113). A smaller proportion reported SISRC during participation in professional sports (4.2%, n=9).

### Prevalence of undiagnosed SISRC

Of the 214 respondents recalling SISRC, 33.2% (n=71) reported they had sustained a SISRC and did not tell anyone (Table 1). Former football athletes were most likely to report that they did not disclose a SISRC (68.3% of those reporting SISRC), while former female athletes participating in low/non-contact sports were least likely to report that they did not disclose a SISRC (11.1% of those reporting SISRC).

In univariate analyses, the prevalence of non-disclosure was higher among males than females (42.9% vs. 14.9%; PR=2.88; 95%CI: 1.62, 5.14; Table 2). Also, the prevalence of non-disclosure was higher in collision sports (football) compared to full/medium contact sports (68.3% vs. 28.6%; PR=2.39; 95%CI: 1.64, 3.48) and low/non-contact sports (68.3% vs. 20.0%; PR=3.41; 95%CI: 2.07, 5.62). In multivariate models, these findings were attenuated (e.g., males vs. females PR=2.11; 95%CI: 1.13, 3.96). Since football is only played by males, results that excluded football athletes produced similar results for sex (PR=2.11; 95%CI: 1.12, 3.94).

### **Motivations associated with non-disclosure of SISRC**

The respondents that did not disclose all their SISRC provided numerous motivations associated with non-disclosure (Table 3). The most commonly reported motivations included: did not want to leave the game/practice (78.9%, n=56); did not want to let the team down (71.8%, n=51); did not know it was a concussion (70.4%, n=51); and did not think it was serious enough (70.4%, n=51). When examining differences by sex, level of contact, and era of play, the sole difference found was that former football players reported that they were more likely to be motivated by not wanting to be withheld from future games/practices than all other former athletes (82.1% vs. 58.1%; PR=1.41, 95%CI: 1.04, 1.92).

## **DISCUSSION**

There have been several previous examinations of non-disclosure related to sports-related concussion.<sup>1, 5, 13, 16, 18, 26</sup> However, our study is one of the first to explore non-disclosure across a cohort of male and female former collegiate athletes from over 20 sports. This study highlights that sex and sport may be associated with non-disclosure. Our findings concerning non-disclosure may assist in refining public health campaigns seeking to improve disclosure of symptoms. In addition, these findings may aid clinicians in targeted education designed to improve recognition and response among collegiate athletes.

### **Prevalence of non-disclosure**

Former football players had the highest prevalence of non-disclosed SISRC compared to athletes in a variety of other sports. Previous work, including that by McCrea et al.,<sup>18</sup> has characterized reported motivations of concussion disclosure in football athletes more proximal to the time of injury (i.e. end of season). In contrast, our study surveyed athletes years following sports participation. Our study also adds to the literature on football players' motivations for non-disclosure of concussion by comparing the prevalence of non-disclosure in football athletes to athletes competing in other sports. Whereas most previous studies examined athletes in contact sports (e.g., football, ice hockey, rugby, soccer),<sup>1, 5, 13, 18, 26</sup> our study surveyed athletes from a range of sports with varying levels of contact. Our study also suggests that motivations for non-disclosure may be consistent across eras of play. The latter finding indicates there is substantial potential for health behavior messaging that acknowledges the potential loss of sports-related opportunity associated with disclosure of concussion.

Our study found that a larger proportion of males reported non-disclosed SISRC than females. This suggests that the epidemiologic analyses reporting sex differences in concussion incidence could reflect, for the most part, sex differences in concussion disclosure behaviors.<sup>3, 17, 32</sup> Previous behavioral findings related to sex differences in concussion disclosure are mixed. One study of college athletes found that males were more likely to intend to report symptoms of a future concussion symptoms to coaches or AT staff.<sup>30</sup> However, measuring cognitions about future behaviors is not the same as measuring actual behavior, and the other study, also conducted among college athletes, found no sex difference in reporting of concussion symptoms.<sup>16</sup> Further research is necessary to understand the mechanisms underlying sex differences in concussion disclosure, particularly whether differences are explained by greater concussion incidence or differences in gendered behavior with respect to help-seeking. Messaging about the importance of concussion disclosure may also need to be segmented by sex.

### **Motivations underlying non-disclosure**

The instrument utilized in this study (derived from that McCrea et al.<sup>18</sup>) captures two facets of concussion non-disclosure: (1) lack of concussion-related knowledge; and (2) pressure to play while concussed. The instrument is a closed-ended measure. Although we provided a fill-in option, very few participants utilized it. This may indicate that McCrea et al.'s measures are exhaustive, or that former athletes may be reluctant to divulge non-disclosure information without further prompting. Our findings are similar to previous studies,<sup>1, 5, 13, 16, 18, 19, 26</sup> as large proportions of athletes identified a lack of concussion-related knowledge as a reason for not disclosing SISRC to team medical staff. A lack of concussion knowledge may be particularly relevant in the present sample as concussion education was not required for athletes by the NCAA until 2010.<sup>22</sup>

However, it appears that a larger proportion of athletes in our sample endorsed pressure as influencing their non-disclosure. The reason for this difference may be attributable to our study focus being at the collegiate level, where student-athletes may feel pressure to perform at high standards, and at least in some sports, there is the potential for college sport success to lead to a professional athletic career. Kroshus et al.<sup>14</sup> found that when collegiate athletes experienced external pressure (from coaches, parents, teammates, and fans) to continue playing after experiencing a concussion, they were more likely to not disclose concussion symptoms. Our results underscore the importance of perceived pressure on concussion disclosure.

The present study provides support for the importance of examining contextual influences on disclosure behavior rather than solely knowledge. Notably, the study underscores the role that external influences, such as teammates, have in shaping former athletes' perceptions of the impacts sustained during sports participation years or decades ago. Teammates and powerful authorities may influence disclosure behavior in a variety of ways such as modeling disclosure or providing verbal or non-verbal reinforcement for disclosure. Prior research also found that perceived team norms influence disclosure behavior, whether or not these norms are accurately perceived.<sup>15</sup> Thus, athlete appraisals of their environment alongside direct influences from the athlete's environments may be important in influencing



disclosure. There are a variety of behavioral theories that may explain this change in concussion-related knowledge, including social learning theory.<sup>10</sup> Future research that directly examines these theories in the context of concussion self-diagnosis and disclosure are needed.

### Limitations

Our data originates from a small sample of former collegiate athletes from one university. Thus, generalizability may be limited. Data obtained from former athletes about non-disclosure of injuries years prior may be different from asking them at time of injury or immediately following the playing season in which the injury occurred. Recall bias, knowledge gain, and/or changes in the social environment may influence how former collegiate athletes classified these injuries.<sup>12</sup> Notably, we are unable to ascertain the accuracy of the information provided by our participants. In particular, it is unknown whether these potential concussions would have met a clinical definition of concussion. Former collegiate athletes may have mistakenly recalled subconcussive impacts or other sports injury conditions (e.g., dehydration-related headache) as concussions.<sup>21, 24</sup> Our sample size also did not allow for sport-specific analyses, with the exception of football. The categorizations are similar to, but slightly vary from those provided by the NCAA<sup>23</sup> and the American Academy of Pediatrics (AAP);<sup>28</sup> however, findings did not meaningfully change when sports were recoded into these categories. Despite these limitations, we believe our findings indicate further and more in-depth examinations of undiagnosed and non-disclosed concussions during sports participation.

### Conclusion

Among former collegiate athletes reporting SISRC in our study, nearly one-third reported non-disclosure. External influences such as perceived peer expectations and knowledge were influential in former athletes' reporting of SISRC. Future studies should consider using a model that explicitly incorporates external influences, such as the socio-ecological framework, to provide an integrated and multi-level perspective concerning the motivations and behaviors behind concussion symptom disclosure.<sup>12</sup> Incorporating qualitative methods into future multimethod research about concussion disclosure would be valuable to help understand concussion disclosure in context. In particular, a deeper understanding of sex differences in concussion disclosure will assist in formulating future research and informing clinical practice.

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**What is known about the subject**

Previous studies examining non-disclosure among athletes in various settings have found substantial proportions of athletes with undisclosed concussions. However, many of these factors have been examined in only cursory manner, if at all.

**What does this study add to existing knowledge**

As seen in previous research, our study found a substantial proportion of former athletes (approximately one-third of former collegiate athletes) reported that they sustained sports-related concussions that they did not disclose. Common motivations for non-disclosure of sports-related concussions included lack of knowledge and perceived pressure to play while concussed. In addition, males were less likely to disclose all their sports-related concussions compared to females

**Table 1**

Prevalence of disclosing all recalled sports-related concussion at time of injury in former collegiate athletes reporting at least one sports-related concussion

Level of contact & Sport	Overall				Males				Females			
	Disclosed all sports-related concussions at time of injury?		Disclosed all sports-related concussions at time of injury?		Disclosed all sports-related concussions at time of injury?		Disclosed all sports-related concussions at time of injury?		Disclosed all sports-related concussions at time of injury?		Disclosed all sports-related concussions at time of injury?	
	n	Yes % (n)	No % (n)	n	Yes % (n)	No % (n)	n	Yes % (n)	No % (n)	n	Yes % (n)	No % (n)
Collision												
Football	41	31.7 (13)	68.3 (28)	41	31.7 (13)	68.3 (28)	0					
Full/Medium contact	98	71.4 (70)	28.6 (28)	61	65.6 (40)	34.4 (21)	37	81.1 (30)	18.9 (7)			
Basketball	12	83.3 (10)	16.7 (2)	7	71.4 (5)	28.6 (2)	5	100.0 (5)	0.0 (0)			
Field Hockey	10	100.0 (10)	0.0 (0)	0			10	100.0 (10)	0.0 (0)			
Lacrosse	38	68.4 (26)	31.6 (12)	28	62.3 (18)	35.6 (10)	10	80.0 (8)	20.0 (2)			
Soccer	24	62.5 (15)	37.5 (9)	12	66.7 (8)	33.3 (4)	12	58.3 (7)	41.7 (5)			
Wrestling	14	64.3 (9)	35.7 (5)	14	64.3 (9)	35.7 (5)	0					
Low/No contact	75	80.0 (60)	20.0 (15)	38	71.1 (27)	28.9 (11)	37	89.2 (33)	10.8 (4)			
Baseball	15	66.7 (10)	33.3 (5)	15	66.7 (10)	33.3 (5)	0					
Fencing	18	82.3 (15)	16.7 (3)	14	78.6 (11)	21.4 (3)	4	--	--			
Golf	1	--	--	0			1	--	--			
Gymnastics	3	--	--	0			3	--	--			
Rowing	10	100.0 (10)	0.0 (0)	0			10	100.0 (10)	0.0 (0)			
Softball	8	100.0 (8)	0.0 (0)	0			8	100.0 (8)	0.0 (0)			
Swimming & Diving	4	--	--	2	--	--	2	--	--			
Track & Field	13	61.5 (8)	38.5 (5)	7	57.1 (4)	42.9 (3)	6	66.7 (4)	33.3 (2)			
Volleyball	3	--	--	0			3	--	--			
Total	214	66.8 (143)	33.2 (71)	140	57.1 (80)	42.9 (60)	74	85.1 (63)	14.9 (11)			

Distributions of disclosure not presented when n<5

**Table 2**

Prevalence ratios for not disclosing sports-related concussion in former collegiate athletes reporting at least sports-related concussion

	% (n) of non-disclosure	Prevalence ratio (95% confidence interval)		
		Univariate	Multivariate <sup>a</sup>	Multivariate excluding football <sup>b</sup>
Sex				
Male	42.9 (60)	2.88 (1.62, 5.14)*	2.12 (1.13, 3.96)*	2.11 (1.12, 3.96)*
Female	14.9 (11)	1.00	1.00	1.00
Sport contact level				
Football (Collision)	68.3 (28)	3.41 (2.07, 5.62)*	2.55 (1.51, 4.32)*	n/a
Full/Medium contact	28.6 (28)	1.43 (0.82, 2.48)	1.33 (0.77, 2.28)	1.32 (0.77, 2.27)
Low/Non-contact	20.0 (15)	1.00	1.00	1.00
Year began college sports				
Before 2001	36.5 (54)	1.42 (0.89, 2.25)	1.03 (0.66, 1.62)	1.01 (0.59, 1.75)
2001 and after	25.8 (17)	1.00	1.00	1.00

<sup>a</sup> Model includes sex, sport contact level, and year began college sports

<sup>b</sup> Model includes all the variables from Multivariate Model but excludes all former collegiate football players (n=41)

**Table 3**  
 Motivations associated with non-disclosure of sports-related concussions in former collegiate athletes (n=71)

Category	Motivations associated with non-disclosure, % (n)					
	Did not think it was serious enough	Did not know it was a concussion	Did not want to leave the current game/practice	Did not want to be withheld from future game/practice	Did not want to let down team	Would have disclosed if less important game/practice
All respondents	70.4 (50)	70.4 (50)	78.9 (56)	67.6 (48)	71.8 (51)	23.9 (17)
Sex						
Male	68.3 (41)	68.3 (41)	81.7 (49)	71.7 (43)	73.3 (44)	25.0 (15)
Female	81.8 (9)	81.8 (9)	63.6 (7)	45.5 (5)	63.6 (7)	18.2 (2)
<i>P-value</i>	0.49	0.49	0.23	0.16	0.49	>0.99
Sport contact level						
Football (Collision)	60.7 (17)	64.3 (18)	82.1 (23)	82.1 (23)	78.6 (22)	25.0 (7)
Full/high contact	78.6 (22)	71.4 (20)	75.0 (21)	64.3 (18)	71.4 (20)	21.4 (6)
Low/non-contact	73.3 (11)	80.0 (12)	80.0 (12)	46.7 (7)	60.0 (9)	26.7 (4)
<i>P-value</i>	0.35	0.63	0.93	0.06	0.43	0.94
Year began college sports						
Before 2001	72.2 (39)	74.1 (40)	79.6 (43)	72.2 (39)	77.8 (42)	22.2 (12)
2001 and after	64.7 (11)	58.8 (10)	76.5 (13)	52.9 (9)	52.9 (9)	29.4 (5)
<i>P-value</i>	0.56	0.24	0.75	0.15	0.07	0.53