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Sports-related concussion

Anonymous survey of a collegiate cohort

Podcast

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Summary

Studies suggest that a lack of standardized knowledge may lead to underreporting and undertreatment of sports-related concussion. However, there has been little work done to establish how this knowledge may affect athletes' behaviors toward reporting their concussions and removing themselves from play. We conducted an anonymous online survey to assess athletes' knowledge of signs and symptoms of concussion, and also sought to estimate the potential frequency of underreporting in a collegiate athlete cohort. Among 262 athletes who responded to the survey, 43% of those with a history of concussion reported that they had knowingly hidden symptoms of a concussion to stay in a game, and 22% of athletes overall indicated that they would be unlikely or very unlikely to report concussion symptoms to a coach or athletic trainer in the future. These data suggest that there may be a substantial degree of underreporting of concussion among collegiate athletes, despite most acknowledging that they have been formally educated about the risks of concussion.

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Education has been emphasized as a crucial first step toward the prevention of short- and long-term sequelae of sports-related concussion.[1–7] While the majority of athletes who experience a concussion are expected to recover, the danger is greatly increased by a second concussion.[8,9] Suffering a second concussion before recovering from an initial one may have catastrophic consequences. The phenomenon of second-impact syndrome has led to approximately 30–40 deaths over the past decade.[8,9] Athletes with concussion may also experience long-term cognitive and neurobehavioral difficulties. Symptoms may include chronic headache, fatigue, sleep difficulties, personality changes (increased irritability, emotionality), sensitivity to light and noise, dizziness when standing quickly, and deficits in short-term memory.[7,10,11] The negative effects from a concussion may be potentially minimized if 1) the problem is identified immediately following injury; and 2) the athlete does not participate in physical and cognitive activities until a medical evaluation clears him or her to return.

Previous studies suggest that a lack of standardized knowledge may lead to underreporting and undertreatment of sports-related concussion in the acute phase.[4,6,12] However, there has been little work done to establish how this knowledge may affect athletes' behaviors toward reporting their concussions and removing themselves from play. The purpose of this anonymous online survey was to assess athletes' knowledge of signs and symptoms of concussion. This exploratory study also sought to estimate the potential frequency of underreporting in a collegiate athlete cohort.

METHODS

The link to a 35-question online survey was e-mailed to all varsity athletes (n = 919) at the University of Pennsylvania (Division I school) by the Head Athletic Trainer. Responders were provided a $5 Starbucks gift card in exchange for participating in the survey. The University of Pennsylvania Institutional Review Board approved all protocols and communications as acceptable for the student population surveyed, including the $5 Starbucks gift card incentive.

Supplemental Data
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The survey contained questions on concussion history, including specific symptoms, number of times diagnosed, and whether they had missed academic or athletic time (appendix e-1 at neurology.org/cp). To assess concussion education, participants were asked about knowledge of symptoms and long-term sequelae, and whether or not physicians or athletic trainers had discussed risks. Finally, participants were asked about their likelihood of reporting a concussion during a future game using a Likert scale format with 1 being "extremely unlikely" to 5 being "extremely likely" to report symptoms of concussion to an athletic trainer or coach or teammate during a game.

Data analyses and calculations were performed using Stata 12.1 statistical software. Proportions of athletes with particular responses to questions were the primary summary measure used, along with 95% confidence intervals (CI) for Likert scale responses (figure 1). The Pearson linear χ^2 test was used to compare proportions of athletes with vs without concussion history as well as between sexes with respect to dichotomous survey responses.

RESULTS

Characteristics and survey responses for the 262 Penn athletes who completed the survey (29% response rate) are shown in the table.

Reported concussion history

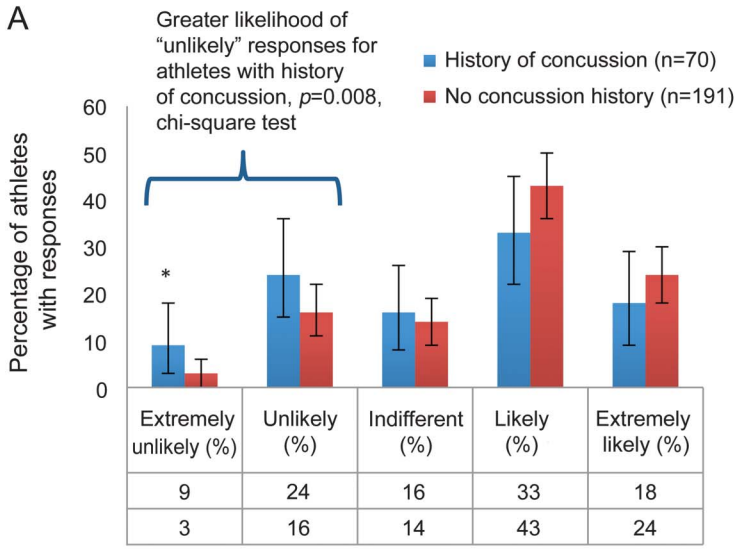
Approximately one-quarter (70 of 262, 27%) of responders indicated they believed they had sustained a concussion in their athletic careers. Among the questions only presented to responders who reported a history of concussion (n = 70), 32 (46%) indicated concussions had negatively impacted their performance academically and 45 (64%) reported missing practice or games for concussion symptoms. Similarly, 28 of these athletes (41%) reported having needed extensions for schoolwork (table). The number of reported concussions that were formally diagnosed ranged from 0 to 6 (median 1 during the athlete's career to date), while the number of suspected concussions (suspected by athlete but not formally diagnosed) had an even greater range of 1 to 10 (median 1 during athlete's career).

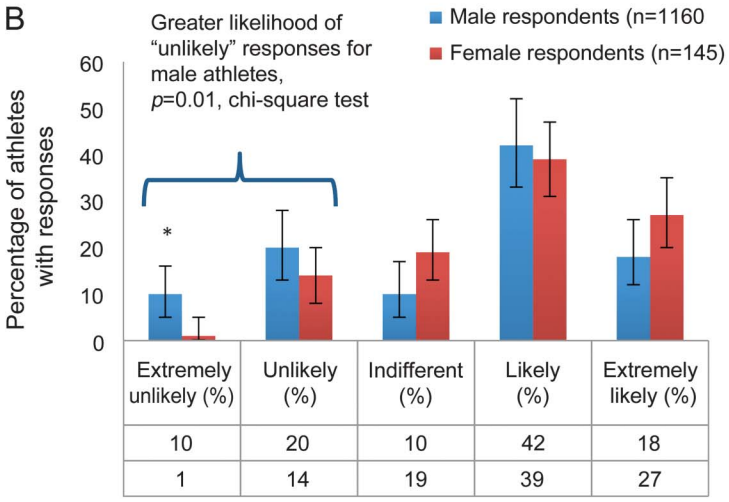
Among athletes reporting a history of concussion, 30/70 (43%) indicated that they had hidden symptoms of a concussion to stay in a game.

Knowledge

Headache was the most common symptom of concussion for which the athletes reported having knowledge, and was acknowledged with relatively similar frequencies by athletes with (60/70, 86%) and without a history of concussion (171/192, 89%, table). Symptoms of confusion, dizziness, loss of consciousness, forgetfulness, nausea, and blurred vision were also frequently acknowledged, although some somewhat less so among athletes with no concussion history (table). Most strikingly, the proportion of athletes who reported that they had been formally

Figure 1 **Likelihood of athletes to report a concussion to a coach or athletic trainer according to history of concussion (A) and sex (B)**





*Error bars indicate 95% confidence intervals on the proportions of athletes in each response category.

Table Characteristics and survey responses for collegiate athlete cohort (n = 262)[a]

Survey question	Response choices, n (%) of respondents[b]	Athletes reporting history of concussion, n (%) of respondents[c] (n = 70)	Athletes reporting no history of concussion, n (%) of respondents (n = 192)
Sport (self-identified)[b]	Football (n = 30)/108 (28)	6 (20)	24 (80)
	Basketball (n = 11)/47 (23)	1 (9)	10 (91)
	Lacrosse (n = 18)/76 (24)	9 (50)	9 (50)
	Soccer (n = 20)/47 (43)	2 (10)	18 (90)
	Wrestling (n = 6)/29 (21)	1 (17)	5 (83)
	Others (n = 177)/612 (29)	51 (29)	126 (71)
Sex	Male (n = 117)	29 (25)	88 (75)
	Female (n = 145)	41 (28)	104 (72)
	Headache	60 (86)	171 (89)
Symptoms of concussion of which the athlete is aware[d]	Confusion	54 (77)	158 (82)
	Dizziness	54 (77)	162 (84)
	Loss of consciousness	50 (71)	134 (70)
	Forgetfulness	56 (80)	143 (74)
	Nausea/vomiting	56 (80)	140 (73)
	Blurred vision	56 (80)	142 (74)
	Flashing stars	35 (50)	91 (47)
	Glare/light sensitivity	51 (73)	146 (76)
No. of times formally diagnosed with concussion[b]	Median (range)	1 (0–6)	—
No. of times concussion suspected but not formally diagnosed[b]	Median (range)	3 (1–10)	—
Ever had to miss practice or game due to concussion[d]	Yes	45 (64)	—
	No	25 (36)	
Ever had to get extensions on papers, tests, schoolwork due to concussion[d]	Yes	28 (41)	—
	No	41 (59)	
Ever felt academic achievement was less after concussion[d]	Yes	32 (46)	—
	No	38 (54)	
Ever experienced symptoms of concussion but continued to play[d]	Yes	39 (56)	—
	No	31 (44)	
Ever hidden a concussion to stay in a game[d]	Yes	30 (43)	—
	No	40 (57)	

Continued

Table Continued

Survey question	Response choices, n (%) of respondents[b]	Athletes reporting history of concussion, n (%) of respondents[c] (n = 70)	Athletes reporting no history of concussion, n (%) of respondents (n = 192)
Formally educated about the risks of concussions[e]	Yes	63 (90)[e]	124 (65)
	No	7 (10)	67 (35)

[a] Survey sent via email to 919 Penn collegiate athletes (29% overall response percentage).
[b] Response format was free text rather than multiple choice for survey questions 1, 6, and 7.
[c] Classification based on athlete's response to question 5 of survey, "Have you ever had a concussion during your athletic career?"
[d] Percentages are proportions of athletes with or without history of concussion who chose that particular response.
[e] Proportion of athletes reporting that they had been formally educated about the risks of concussions was greater among those who reported a history of concussion, $p = 0.0001$, χ^2 test.

educated about the risks of concussion was greater among those with a concussion history (63/70 [90%] vs 124/192 [65%], $p = 0.0001$, χ^2 test).

Attitudes toward reporting

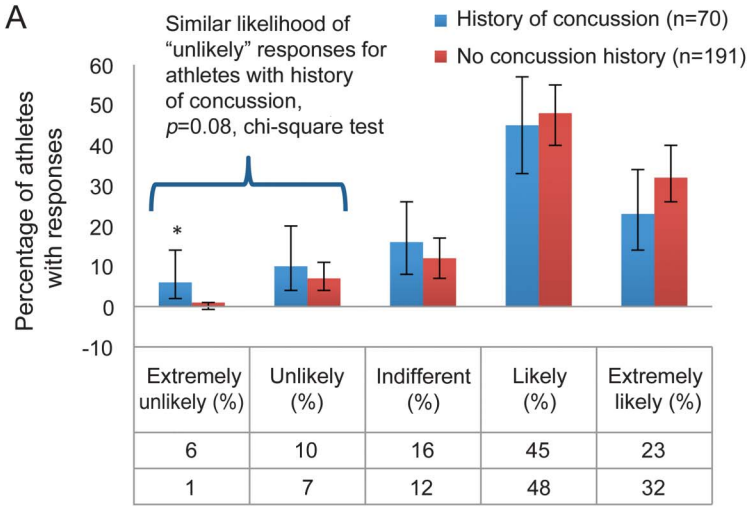
Overall, 22% of athletes indicated that they would be unlikely or very unlikely to report concussion symptoms to a coach or athletic trainer in the future. Among all athletes in the cohort (those reporting and not reporting a history of concussion), the anticipated likelihood of reporting symptoms of concussion to a coach or athletic trainer (self-reported by the athletes on a Likert scale with 1 = extremely unlikely to 5 = extremely likely) was less among athletes with a history of concussion (figure 1A) and among male respondents (figure 1B). These groups had a greater likelihood of choosing "unlikely" responses (extremely unlikely or unlikely) compared to those without concussion history or female athletes in this cohort. Male respondents were similarly more likely to say they would be "unlikely" to report symptoms to a teammate compared to female athletes (19/119 [16%] vs 8/145 [5%], $p = 0.005$, χ^2 test, figure 2B). Stated differently, athletes who reported a prior history of one or more concussions, and male athletes, were more likely to choose survey responses of "unlikely" or "extremely unlikely" for the 2 questions regarding future likelihood of reporting symptoms of concussion to a coach or trainer or to a teammate. In logistic regression models, male sex and history of concussion were independent predictors of unlikelihood of future reporting ($p = 0.01$ for each variable). Among athletes reporting a history of concussion, 30/70 (43%) indicated that they had hidden symptoms of a concussion to stay in a game.

DISCUSSION

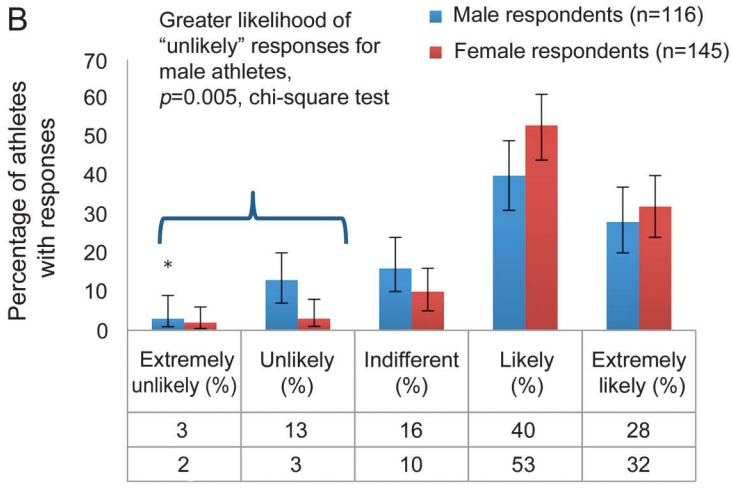
Data from this anonymous online survey suggest that there may be a substantial degree of underreporting of concussion among athletes in a collegiate cohort. These findings were present despite most athletes acknowledging that they have been formally educated about the risks of concussions. While the importance of such education has been emphasized, particularly recently, there has been little work to date on establishing a link between concussion knowledge and attitudes and the likelihood of athletes reporting symptoms to athletic trainers, coaches, or teammates.

Exploratory analyses of our survey data suggest that athletes' likelihood of future reporting, especially to teammates, may be lower for male athletes and among those with a history of concussion. In our collegiate cohort, 43% of athletes with a history of concussion reported that they had knowingly hid a concussion to stay in a game, and 22% of athletes overall indicated that they would be unlikely or very unlikely to report concussion symptoms to a coach or athletic trainer during a game in the future. Previous studies involving athletes have suggested that between 50% and 75% of sports-related concussions go unreported.[6] Our data suggest that some athletes even with formal education about the negative consequences of concussion may not have changed their attitudes toward reporting. Importantly, athletes in

Figure 2 **Likelihood of athletes to report a concussion to a teammate according to history of concussion (A) and sex (B)**



Extremely unlikely (%)	Unlikely (%)	Indifferent (%)	Likely (%)	Extremely likely (%)
6	10	16	45	23
1	7	12	48	32



Extremely unlikely (%)	Unlikely (%)	Indifferent (%)	Likely (%)	Extremely likely (%)
3	13	16	40	28
2	3	10	53	32

*Error bars indicate 95% confidence intervals on the proportions of athletes in each response category.

our cohort indicated that they would be less likely to hide symptoms of a concussion from a teammate (only 10% choosing responses of "unlikely" or "extremely unlikely" in this setting). This finding suggests that there is potential value in including peers in future educational efforts. Future surveys could capture potential overreporting or symptoms unrelated to concussion in order to assess the role for survey-taking differences in evaluating responses and the recent attention focused on the potential consequences of concussion.

Perceptions and attitudes regarding concussion reporting among athletic trainers, coaches, and parents are likewise important for shaping the culture surrounding concussions among collegiate athletes. While providing education is clearly important, in our group the education they received did not necessarily motivate them to be unanimously resolute about future reporting of symptoms. Knowledge of concussion may not be the primary problem leading to underreporting; this is consistent with recently published and ongoing investigations of student athletes implicating non-education-related factors, such as coach approachability.[12] Perhaps somewhat similar to efforts to educate consumers about the possible long-term effects of any activity involving risk, concussion education efforts could not only work toward building trust, but also aim to better motivate athletes to consider the balance of prevention and immediate reward. Incorporating the efforts and research of those in the population and

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public health fields, in combination with more detailed epidemiologic studies, may help us to refine and target these important educational programs.

As with any study that uses survey methods to assess self-reported history, attitudes, and estimates of future behavior, there is potential for bias. To the extent that our survey response percentage was close to one-third of those e-mailed (n = 262 completed, 29%), this rate was similar across the sports surveyed. As such, our data represent a reasonable cross-sectional sample of athletes in collegiate athletics at an Ivy League university. With the $5 Starbucks gift card incentive, our response rate is similar to that noted in studies of college students and recent college graduates who were offered small up-front rewards (college logo pen, 29%),[13] yet lower than response rates when a larger, prepaid incentive ($10) was offered (42%).[14] Frequencies for the top sports listed in the recently published American Academy of Neurology guideline (football, soccer, and basketball)[7] were similar to our cohort with regard to relative proportions of athletes with concussion. Our survey did not include ice hockey players since this is classified as a club sport at Penn. However, our cohort did include lacrosse players, who have a high rate of concussion according to National Collegiate Athletic Association data (unpublished). The present cohort therefore likely reflects the collegiate population at large despite the <1/3 survey return rate.

While the potential effects of bias are lessened by greater response rates, athletes with a tendency for "risk taking" may have been more likely to respond to the online survey. Our response rate, although similar across sports surveyed, may therefore be reflective of underreporting overall as athletes may not have wanted to discuss their previous history or future intentions, even in the context of an anonymous survey. It is possible that our survey actually underestimated the likelihood of underreporting if in fact most athletes who feel strongly against telling a coach, athletic trainer, or teammate about symptoms did not respond. Societal avoidance of the possibility of concussion being a serious health concern may have played a role. Furthermore, while the highest incidence rates of concussion in collegiate competitions are in football,[7] this sport accounted for only 8.5% of respondents in our survey who reported a prior history of concussion. This suggests that underreporting or avoidance of survey participation using an e-mail or online format may be sport-dependent. A more comprehensive survey, with greater representation of injury reporting in sports with the highest rates of concussion, is likely to be achievable by an in-person administration with de-identified response forms collected by research staff not associated with team play decisions.

Collaborations are now being formed among Ivy League institutions as well as among larger leagues within collegiate athletics to not only study the epidemiology of sports-related concussion and its potential outcomes, but to design educational efforts that will provide effective counsel to the next generations of athletes. While educating athletes will be a crucial first step, perceptions and attitudes regarding concussion reporting among athletic trainers, coaches, and parents may be even more important for shaping the culture of concussion at all levels of play.

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