

# Association Between Previous Concussion Education and Concussion Care-Seeking Outcomes Among National Collegiate Athletic Association Division I Student-Athletes

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**Context:** Limited data exist concerning differences in concussion-education exposure and how education exposures relate to care seeking and symptom disclosure, specifically by National Collegiate Athletic Association Division I student-athletes.

**Objective:** To investigate demographic characteristics associated with concussion-education exposure and examine whether overall education exposure (*yes* versus *no*) and education-source exposure number (multiple sources versus a single source) affect concussion care-seeking and disclosure factors in Division I student-athletes.

**Design:** Cross-sectional study.

**Setting:** Classroom or online survey.

**Patients or Other Participants:** Division I student-athletes ( $n = 341$ ).

**Main Outcome Measure(s):** Frequencies and proportions were computed for sex, race, school year, sport, and concussion history across concussion-education groups. Prevalence ratios (PRs) and 95% CIs were calculated to quantify the associations between student-athlete characteristics and (1) overall concussion-education exposure and (2) source-exposure number. Separate multivariable linear regression models estimated adjusted mean differences (MDs) and 95% CIs, which allowed us to assess differences in concussion knowledge, attitudes, and perceived social norms relative to concussion-education

exposure and exposure to multiple sources. Separate multivariable binomial regression models were performed to estimate adjusted PRs and 95% CIs in order to evaluate associations of intention, perceived control, and care-seeking or disclosure behaviors and overall concussion-education exposure and exposure to multiple sources. All models controlled for sex, sport, and concussion history.

**Results:** Overall, 276 (80.9%) participants reported previous concussion education, with 179 (64.9%) being exposed to multiple sources. Student-athletes who participated in a contact sport (adjusted PR = 1.24; 95% CI = 1.06, 1.44) and those who had a concussion history (adjusted PR = 1.19; 95% CI = 1.09, 1.31) had higher prevalences of concussion-education exposure. Females had a lower prevalence of reporting multiple sources (adjusted PR = 0.82; 95% CI = 0.68, 0.99). Overall concussion-education exposure was significantly associated with more favorable perceived social norms surrounding concussion care seeking (adjusted MD = 1.37; 95% CI = 0.13, 2.61).

**Conclusions:** These findings highlighted the potential differences in overall concussion-education exposure and provide clinicians with information on groups who may benefit from additional targeted education.

**Key Words:** mild traumatic brain injuries, concussion disclosure, concussion prevention

## Key Points

- The majority of National Collegiate Athletic Association Division I athletes reported receiving previous concussion education.
- Student-athletes with a concussion history and those who participated in a contact sport had higher prevalences of concussion-education exposure.
- Student-athletes' concussion-education exposure was associated with more favorable perceived social norms surrounding concussion care seeking.

Unreported sport-related concussions (SRCs) remain a critical concern with respect to the safety and wellbeing of all athletes. Anywhere from 30% to 50% of SRCs remain unreported,<sup>1-3</sup> leaving a significant number of athletes without proper care and support after injury. Assessment and immediate care after a suspected concussion are critical; underreporting may lead to decreased or inappropriate care postinjury, posing a threat to the short- and long-term wellbeing of athletes.<sup>2-4</sup>

Previous researchers<sup>3-5</sup> suggested that key factors leading to high rates of concussion underreporting were pressure to play, lack of medical resources, negative attitudes and stigma surrounding concussion, not believing the injury was serious, fear of letting the team down, and lack of knowledge about the injury. Consistent with these findings, favorable perceived social norms and perceived control over disclosure were often associated with improved concussion care-seeking outcomes.<sup>3,5-9</sup> Furthermore, evidence<sup>6,9,10</sup> supported the use of concussion education to improve concussion knowledge, attitudes, and perceived social norms, which in turn may improve timely care seeking postconcussion.

The National Collegiate Athletic Association (NCAA) requires dissemination of concussion-education materials to all Division I, II, and III student-athletes each year.<sup>11</sup> However, the mode and type of education are at the institution's discretion. This autonomy has the potential to lead to differences in who receives information and the type of information being supplied, both of which remain largely understudied. Despite the NCAA mandate, only 80% of collegiate student-athletes<sup>6</sup> and two-thirds of coaches<sup>12</sup> reported receiving any type of concussion education. Furthermore, among those who received education, discrepancies in acknowledging education exist. Eighty percent of athletic trainers indicated they required education-acknowledgment forms to be signed at the beginning of the season, whereas only 60% of student-athletes reported this requirement.<sup>13</sup> Delivery of complete concussion education is critical to ensuring that all student-athletes are provided with the information necessary to help improve concussion care-seeking and disclosure behaviors.

Differences also exist in how concussion education is provided. Although the NCAA mandates education, the materials used and the delivery method vary by institution,<sup>11</sup> as athletes, coaches, and athletic trainers reported receiving education from a wide variety of sources, including formal meetings or lectures, informal conversations, written materials, online materials, emails, videos, and posters.<sup>9,12-14</sup> Moreover, the content provided on the various platforms differed: 91.6% of collegiate coaches were provided with a list of symptoms; 87.3%, information about proper concussion management; 68.7%, information on the long-term consequences of injury; and 61.3%, the effect on athletic performance of continuing to play with an undiagnosed concussion.<sup>12</sup> A wide variety of educational types and information may result in inconsistent messages.<sup>9,12-14</sup> Conversely, having access to multiple effective educational sources may be beneficial.<sup>15</sup> However, limited data exist on the effect of receiving education from multiple sources and the effect of source-exposure number on care-seeking or disclosure behaviors. A recent study<sup>15</sup> of first-year military service academy cadets showed that, for cadets with a concussion history, exposure to multiple

educational sources was clinically associated with disclosing all recalled concussions at the time of injury. Although these findings indicated the potential benefit of multiple source exposures among military service academy cadets, it should be noted that differences exist in who receives concussion education in a variety of settings. Concussion education, in some form, is required in each state for youth athletes.<sup>13</sup> This requirement greatly affects the level of concussion knowledge and awareness student-athletes have before attending an NCAA institution, and recent data<sup>9,16</sup> suggested that youth athletes and coaches in lower income areas and communities with a higher percentage of families with children under 18 living below the poverty line, a lower percentage of parents with a college education, and a lower percentage of White non-Hispanic residents were less likely to have received concussion education. Therefore, some collegiate student-athletes may be at more of a disadvantage than their peers. The overall educational exposure and content differences that exist at all levels could greatly affect student-athletes' concussion-education exposure as well as the potential benefits from exposure to multiple sources.

Unfortunately, limited data are available on concussion-education exposure among collegiate student-athletes. Therefore, we aimed to investigate (1) student-athletes' demographic characteristics associated with overall concussion-education exposure and exposure to multiple sources and (2) how overall concussion-education exposure and exposure to multiple sources affected concussion-disclosure factors in NCAA student-athletes. We hypothesized that overall concussion-education exposure and exposure to multiple sources would be associated with more concussion-related knowledge and more favorable concussion-related attitudes, perceived social norms, intention, perceived control, and care-seeking or disclosure behaviors.

## METHODS

### Study Design and Participants

This cross-sectional survey design involved student-athletes from a single NCAA Division I institution. The study team received full institutional review board approval before beginning data collection. A total of 379 collegiate student-athletes at a single Division I university were invited to participate during concussion baseline testing or via team emails, and 350 (92.3%) agreed. All participants provided informed consent. Seven participants did not complete the survey beyond the demographic questions, and 2 additional participants were excluded because they did not report concussion-education information. Therefore, the final sample for analysis was 341 (90.0%) participants.

### Questionnaire and Procedures

The survey was conducted in a classroom setting via hard copy. An online option was available in the event that participants were unable to complete the survey in the classroom setting. Online surveys were completed by 30/341 (8.8%) student-athletes. The study questionnaire was based on previously validated items on concussion care seeking.<sup>8,15,17</sup> All multi-item scale measures had internal consistency (Cronbach  $\alpha$ ) of .8 or higher. Details about the

questionnaire were previously published.<sup>8,15,17</sup> Survey items included questions regarding demographics (eg, sex, race, school year, sport) and concussion history. Additional items regarding concussion-education exposure and concussion-related knowledge, attitudes, perceived social norms, intention, perceived control, and care-seeking or disclosure behaviors are further explained in the following paragraphs.

Student-athletes were asked to report if they had received previous concussion-education exposure (*yes* or *no*) in their lifetime. Those who answered *yes* were then asked to identify which source(s) of education they had been exposed to previously. Options were *education via a video, talking to a coach, talking to a medical professional, other*, or a combination of these. Based on the student-athletes' responses, they were categorized by source-exposure number as being exposed to only a single source (ie, selected 1 of the sources) or multiple sources (ie, selected 2 or more of the sources).<sup>15</sup>

*Concussion knowledge* was assessed using 39 validated yes-or-no items concerning symptom recognition, potential long-term effects of concussion, effects of premature return to play, and the consequences of incurring multiple concussions. Correct answers were scored as 1 point each. All correct scores were summed, resulting in a knowledge composite score that ranged from 0 to 39 (higher scores meant better concussion knowledge).<sup>8,15,17</sup>

*Attitude questions* consisted of 6 validated 7-point scale items on topics encompassing perceptions of concussion-symptom disclosure and concussion. Answers were summed, resulting in a composite attitude score that ranged from 6 to 42 (higher scores meant more favorable symptom-disclosure attitudes).<sup>8,15,17</sup>

*Perceived social norms* were addressed in 7 validated 7-point scale items identifying perceptions of the organization, social referent expectations, and actions concerning concussive injury. Answers were summed, resulting in a composite social norm score that ranged from 7 to 49 (higher scores meant more favorable perceived social norms).<sup>8,15,17</sup>

*Intention to disclose concussion symptoms* consisted of a single validated 7-point scale question regarding a student-athlete's intention to disclose concussion-related symptoms after injury. An intention score was categorized with higher scores (6 or 7) reflecting *agree* or *strongly agree* to disclose symptoms after concussion and lower scores (1–5) reflecting *somewhat agree* to *strongly disagree* with intention to disclose symptoms after concussion.<sup>8,15,17</sup>

*Perceived control* over disclosing concussion symptoms was examined via a single validated 7-point scale question regarding how much control student-athletes believed they had over disclosing concussion symptoms. A higher score (6 or 7) reflected agreement or strong agreement with having symptom-disclosure control, and lower scores (1–5) reflected some agreement to strong disagreement with symptom-disclosure control.<sup>8,15,17</sup>

We dichotomized intention and perceived control in this way to remain consistent with previous authors.<sup>8,15,17</sup> Additionally, this provided a theoretical cut in our data, with those scoring 6 or 7 indicating higher versus lower agreement toward intention and perceived control.<sup>8,15,17</sup>

The concussion-history and injury care-seeking or -disclosure evaluation began by giving student-athletes

the following concussion definition based on previous studies<sup>4,8,15,17</sup>:

A change in brain function following a force to the head, which may be accompanied by temporary loss of consciousness and is identified in awake individuals with measures of neurologic and cognitive dysfunction. Common concussion symptoms include headache, feeling slowed down, difficulty concentrating or focusing, dizziness, balance problems/loss of balance, fatigue/loss of energy, feeling in a fog, irritability, drowsiness, nausea, memory loss, sensitivity to light/noise, and blurred vision. Importantly, a concussion can occur without being “knocked out” or unconscious; getting your “bell rung” or “clearing the cobwebs” is a concussion.

This definition was followed by the question, “Given the definition above, have you ever had a concussion related to sport or other activities?” Student-athletes who answered *yes* were then asked to report the number of concussions incurred and how many of these concussions were disclosed to a medical professional or someone in authority at the time of injury. The number of disclosed concussions was divided by the number of total concussions for each student-athlete to quantify disclosure (ie, the proportion of reported concussions that were disclosed). Disclosure was then dichotomized as student-athletes who disclosed all suspected concussions at the time of injury versus those who did not.<sup>18</sup> Additional care-seeking behaviors were assessments of ever removing oneself from play due to concussion symptoms and continuing to play despite symptoms; both items were answered as *yes* or *no*.

## Statistical Analysis

Descriptive statistics were computed for all variables and outcomes of interest. Frequencies and proportions were calculated for sex (female versus male), race (White versus non-White), school year (first year versus upper-classman), sport (contact versus noncontact), and concussion history (yes versus no). We used classic tabular methods to estimate prevalence ratios (PRs) and 95% CIs in order to quantify how these student-athlete characteristics were associated with overall concussion-education exposure (groups: exposure versus none) and source exposure number (groups: multiple sources versus single source).

Separate multivariable linear regression models estimated adjusted mean differences (MDs), and 95% CIs were used to assess differences in concussion knowledge, attitudes, and perceived social norms by concussion-education exposure and exposure to multiple sources of education. We calculated separate multivariable binomial regression models to estimate adjusted PRs and 95% CIs and quantify associations of intention to disclose symptoms, perceived control over symptom disclosure, self-removal due to concussion symptoms, continued play with concussion symptoms, and disclosure of all recalled concussions at the time of injury with concussion-education exposure and exposure to multiple sources of education. All multivariable linear and binomial regression models were adjusted for sex, sport,

**Table 1. Prevalence Ratios (PRs) and 95% CIs for Associations of Student-Athlete Characteristics With Concussion-Education Exposure<sup>a</sup>**

Characteristic	Concussion-Education Exposure? No. (%)		PR (95% CI) for Concussion-Education Exposure (Yes Versus No)
	Yes	No	
<b>Sex</b>			
Female	122 (79.2)	32 (20.8)	0.98 (0.88, 1.09) 1.0
Male	142 (81.1)	33 (18.9)	
<b>Race</b>			
White	212 (80.3)	52 (19.7)	1.01 (0.88, 1.16) 1.0
Non-White	51 (79.7)	13 (20.3)	
<b>School year</b>			
First year	81 (75.0)	27 (25.0)	0.90 (0.79, 1.01) 1.0
Upperclassman	194 (83.6)	38 (16.4)	
<b>Sport</b>			
Contact	214 (85.3)	37 (14.7)	1.24 (1.07, 1.44) <sup>b</sup> 1.0
Noncontact	62 (68.9)	28 (31.1)	
<b>Concussion history?</b>			
Yes	86 (91.5)	8 (8.5)	1.19 (1.09, 1.31) <sup>b</sup> 1.0
No	189 (76.8)	57 (23.2)	

<sup>a</sup> Percentages were based on row totals. Total samples for each variable differed due to missing data: sex was missing 12 responses; race, 13 responses; school year, 1 response; and concussion history, 1 response.

<sup>b</sup> The PR was statistically significant (1.00 excluded in 95% CI).

and concussion history. All models assessed the likelihood of positive outcomes (eg, more concussion-related knowledge, prevalence of disclosure of all recalled concussions at time of injury); the one exception was the model that evaluated the prevalence of continuing to play despite symptoms.

Analyses were conducted using SAS (version 9.4; SAS Institute Inc, Cary, NC). For all analyses, missing data were excluded in the models on an analysis-by-analysis basis. Any MDs with 95% CIs that excluded 0.0 and PRs with 95% CIs that excluded 1.0 were considered statistically significant.

## RESULTS

### Frequencies and Descriptive Statistics

Overall, 341 student-athletes were included in the analyses. The majority were male ( $n = 175$ , 51.3%), White ( $n = 264$ , 77.4%), upperclassmen ( $n = 234$ , 68.6%), and involved in contact sports ( $n = 252$ , 73.9%). Of the 341 participants, 27.6% ( $n = 94$ ) described a concussion history. Most ( $n = 276$ , 80.9%) reported previous concussion-education exposure. Of these 276 student-athletes, 274 noted the education sources to which they had been previously exposed; commonly reported concussion-education sources were watching a video ( $n = 200$ , 73.0%), talking with a medical professional ( $n = 200$ , 73.0%), and talking with a coach ( $n = 141$ , 51.5%). Of these 274 student-athletes, 179 (65.3%) reported previous exposure to multiple concussion-education sources, and 95 (34.7%) reported previous exposure to only a single source. Tables 1 through 4 provide descriptive statistics across study groups.

**Table 2. Adjusted Mean Differences (MDs), Prevalence Ratios (PRs), and 95% CIs Assessing Association of Overall Concussion-Education Exposure With Concussion-Related Outcomes**

Continuous Outcomes (Linear Regression Models)	No.	Outcome for Each Group, Mean $\pm$ SD		Adjusted MD (95% CI)
		CEE	No CEE	
<b>Concussion knowledge</b>				
CEE	247	33.2 $\pm$ 5.6		0.04 (-1.46, 1.54) 0.0
No CEE	62	33.4 $\pm$ 4.1		
<b>Attitudes</b>				
CEE	258	33.1 $\pm$ 7.1		1.28 (-0.69, 3.24) 0.0
No CEE	63	32.4 $\pm$ 6.9		
<b>Perceived social norms</b>				
CEE	262	45.1 $\pm$ 4.4		1.37 (0.13, 2.61) <sup>a</sup> 0.0
No CEE	65	44.1 $\pm$ 5.1		
<b>Categorical Outcomes (Binomial Regression Models)</b>				
<b>Disclosure intention</b>				
CEE	264	236 (89.4)		0.96 (0.87, 1.06) 1.0
No CEE	64	58 (90.6)		
<b>Perceived disclosure control</b>				
CEE	264	248 (93.9)		1.06 (0.97, 1.16) 1.0
No CEE	64	58 (90.6)		
<b>Removed oneself from play</b>				
CEE	264	68 (25.8)		1.21 (0.67, 2.19) 1.0
No CEE	64	7 (10.9)		
<b>Continued to play</b>				
CEE	264	64 (24.2)		0.80 (0.47, 1.36) 1.0
No CEE	64	12 (18.8)		
<b>Disclosed all concussions</b>				
CEE	79	63 (79.8)		0.90 (0.58, 1.39) 1.0
No CEE	8	7 (87.5)		

Abbreviations: CEE, concussion-education exposure.

<sup>a</sup> The MD was statistically significant (0.00 excluded in 95% CI).

### Association of Concussion-Education Exposure With Student-Athlete Characteristics and Concussion-Related Outcomes

Previous concussion-education exposure was more prevalent among student-athletes who participated in a contact versus a noncontact sport (85.3% versus 68.9%; PR = 1.24; 95% CI = 1.06, 1.44), and among student-athletes with versus without a concussion history (91.5% versus 76.8%; PR = 1.19; 95% CI = 1.09, 1.31; Table 1). Concussion-education exposure did not differ by sex, race, or school year. From the multivariable regression models assessing the association of concussion-education exposure and concussion-related outcomes, we determined the only significant finding was that concussion-education exposure was associated with greater (more favorable) perceived social norms surrounding concussion care seeking (adjusted MD = 1.37; 95% CI = 0.13, 2.61; Table 2).

### Association of Exposure to Multiple Concussion-Education Sources With Student-Athlete Characteristics and Concussion-Related Outcomes

Females had a lower prevalence of reporting having received concussion education from multiple sources than

**Table 3. Prevalence Ratios (PRs) and 95% CIs for Associations of Student-Athlete Characteristics With Number of Concussion-Education Sources<sup>a</sup>**

Characteristic	Source(s), No. (%)		PR (95% CI) for Concussion Education Number (Multiple Sources Versus Single Source)
	Multiple	Single	
<b>Sex</b>			
Female	70 (57.9)	51 (42.2)	0.82 (0.68, 0.99) <sup>b</sup>
Male	99 (70.2)	42 (29.8)	1.0
<b>Race</b>			
White	136 (64.5)	75 (35.6)	0.98 (0.78, 1.22)
Non-White	33 (66.0)	17 (34.0)	1.0
<b>School year</b>			
First year	55 (68.8)	25 (31.3)	1.07 (0.89, 1.28)
Upperclassman	124 (64.3)	69 (35.8)	1.0
<b>Sport</b>			
Contact	145 (68.1)	68 (31.9)	1.22 (0.96, 1.56)
Noncontact	34 (55.7)	27 (44.3)	1.0
<b>Concussion history?</b>			
Yes	58 (68.2)	27 (31.8)	1.07 (0.89, 1.28)
No	120 (63.8)	68 (36.2)	1.0

<sup>a</sup> Percentages were based on row totals. Total samples for each variable differed due to missing data: sex was missing 12 responses; race, 13 responses; school year, 1 response; and concussion history, 1 response.

<sup>b</sup> The PR was statistically significant (1.00 excluded in 95% CI).

**Table 4. Adjusted Mean Differences (MDs), Prevalence Ratios (PRs), and 95% CIs Assessing Association of Concussion-Education Source Number With Concussion-Related Outcomes**

Continuous Outcomes (Linear Regression Models)	Outcome for Each Group, Mean ± SD		Adjusted MD (95% CI)
	No.		
<b>Concussion knowledge</b>			
Multiple sources	158	33.0 ± 6.0	-0.01 (-1.46, 1.44)
Single source	87	33.4 ± 4.8	
<b>Attitudes</b>			
Multiple sources	165	33.0 ± 7.0	0.01 (-1.81, 1.82)
Single source	91	33.2 ± 7.5	
<b>Perceived social norms</b>			
Multiple sources	168	45.1 ± 4.2	0.26 (-0.85, 1.37)
Single source	92	45.0 ± 4.7	
Categorical outcomes (binomial regression models)	No. (%) of Outcome for Each Group		Adjusted PR (95% CI)
	No.		
<b>Higher disclosure intention</b>			
Multiple sources	169	149 (88.2)	0.97 (0.90, 1.05)
Single source	93	85 (91.4)	
<b>Higher perceived disclosure control</b>			
Multiple sources	169	156 (92.3)	0.95 (0.85, 1.07)
Single source	93	90 (96.8)	
<b>Removed oneself from play</b>			
Multiple sources	169	47 (27.8)	0.99 (0.70, 1.39)
Single source	93	19 (20.4)	
<b>Continued to play</b>			
Multiple sources	169	44 (26.0)	1.14 (0.74, 1.75)
Single source	93	19 (20.4)	
<b>Disclosed all concussions</b>			
Multiple sources	52	43 (82.7)	1.11 (0.86, 1.43)
Single source	26	19 (73.1)	

males (57.9% versus 70.2%; PR = 0.82; 95% CI = 0.68, 0.99; Table 3). The number of concussion-education sources did not differ by race, school year, or sport (Table 3). Based on the multivariable regression models assessing the association of exposure to multiple concussion-education sources and concussion-related outcomes, we observed no significant findings (Table 4).

## DISCUSSION

Our results highlighted possible differences among those who recalled concussion-education exposure. These data provide clinicians in the collegiate setting with information on groups who may benefit from additional targeted concussion education. Specifically, student-athletes who participated in contact sports and those with a concussion history had a higher prevalence of overall concussion-education exposure. Furthermore, females had a lower prevalence of receiving education from multiple sources. An additional key result was that student-athletes who recalled concussion-education exposure reported more favorable perceived social norms surrounding concussion care seeking. Previous researchers<sup>17,19</sup> suggested that more favorable social norms were associated with improved concussion care-seeking behaviors.

Only 80.9% of the NCAA student-athletes in this study described previous concussion-education exposure, a number that is consistent with past literature.<sup>6</sup> Many of our student-athletes (n = 108, 31.6%) were first-year students and completed the survey near the time of preseason baseline testing. Therefore, they may not yet have received the NCAA-mandated education. However, all 50 states and the District of Columbia have enacted laws that address concussion and require education (in some capacity) of coaches, athletes, or parents or all of these.<sup>13,20</sup> Although no difference was present in overall concussion-education exposure between first-year and upperclassman student-athletes (PR = 0.90; 95% CI = 0.79, 1.01), only 75.0% (n =

81) of first-year student-athletes reported receiving previous education. This number is inconsistent with the requirement that all youth and high school athletes should be receiving concussion education<sup>13,20</sup> and highlights differences from previous studies<sup>9,16</sup> regarding who actually received education at the youth level. The finding that some student-athletes either did not recall or did not receive concussion education in high school before arrival in the collegiate setting emphasizes the importance of providing salient, timely, and effective concussion education for student-athletes across all levels of sport. Furthermore, these results offer collegiate clinicians insight regarding which student-athletes might need immediate concussion education. Similar recommendations for concussion education have been made by earlier authors.<sup>6,13,14,16</sup>

The purpose of concussion education is to improve concussion knowledge and care-seeking or disclosure behaviors as a way to improve overall outcomes after injury.<sup>6,9,10</sup> The mean concussion knowledge score for all student-athletes included in the analyses was  $33.3/39 \pm 5.3$ , a result that was consistent with previous studies.<sup>8,15</sup> In addition, the mean concussion knowledge score for student-athletes with a single exposure to concussion education was  $33.4/39 \pm 4.7$  versus a score of  $33.1/39 \pm 5.9$  for those with multiple-source exposures, both of which are also consistent with past literature.<sup>15</sup> Unlike the earlier researchers,<sup>21</sup> we did not observe racial differences in overall education exposure or exposure to multiple sources. It should be noted, however, that our sample was 77.4% White, which did not represent the racial demographic breakdown of all NCAA Division I institutions (56.0% White).<sup>22</sup> We also did not demonstrate any differences by school class (first year versus more senior) for the outcomes of interest. All 30 student-athletes who completed the survey online were upperclassmen; therefore, a reasonable assumption is that the mode of survey completion did not affect key study outcomes. Still, student-athletes with a concussion history and those who participated in a contact sport were more likely to report previous concussion-education exposure. The finding that student-athletes with a concussion history were more likely to have recalled concussion-education exposure indicated that the dissemination of education may happen more after injury, in those with previous concussions, or both, which is clinically expected. Although this is important, education that occurs only postinjury may squander the opportunity to help ensure that student-athletes self-disclose and receive appropriate care. We determined that contact-sport student-athletes reported a higher prevalence of education exposure, and males described a higher prevalence of exposure to multiple sources. Previous authors<sup>23-25</sup> showed that student-athletes who participated in contact sports and males were also more likely to have a concussion history.

Our demographic findings were consistent with the known association of contact-sport participation with concussion history (30.4% of contact-sport student-athletes versus 20.0% of noncontact-sport student-athletes reported a concussion history). These observations could demonstrate that contact-sport student-athletes are more likely to receive concussion education because they are at higher risk for being exposed to injury. Furthermore, contact-sport athletes could be exposed to more extensive concussion baseline testing due to the increased exposure to injury,

making them more aware of concussion and possibly more likely to receive preseason education. As concussion education is mandated for student-athletes of all sports,<sup>11</sup> these findings further emphasize ineffective execution of the NCAA policy. Summary statistics showed that the study sample represented the overall sex breakdown for all NCAA Division I institutions (53.0%).<sup>22</sup> However, our data did not reflect the difference in concussion history as strongly between sexes (27.4% of males versus 26.5% of females had a concussion history). Yet the fact that males were more likely than females to have been exposed to multiple sources of education could indicate that those who participated in contact sports were more likely to report having received concussion education, as a vast majority of the males were involved in contact sports (85.7%). Differences in these data for receiving concussion education highlighted that athletic trainers and other sports medicine clinicians may need to take additional measures to ensure that female student-athletes, those who participate in sports involving less or no contact, and those without a concussion history receive effective concussion education.

Student-athletes who recalled concussion-education exposure described more favorable perceived social norms surrounding concussion care seeking. Perceived social norms are a key factor when looking at concussion care-seeking or disclosure behaviors.<sup>3,5-10,19</sup> Social and sport cultures, especially at the collegiate level, have a major effect on the decision making and overall behaviors of student-athletes.<sup>5,26</sup> Therefore, new concussion-education strategies use theory-based approaches, including the theory of planned behavior<sup>27,28</sup> and social norms theory,<sup>19</sup> as a way to improve misperceptions surrounding concussion care-seeking or disclosure behaviors. Improving disclosure behaviors is essential to improving overall injury outcomes; therefore, it is imperative that concussion-education programs use a theory-based approach. It should also be noted that social norms may differ among sports, institutions, and levels of play, a notion that should be taken into account when shaping future educational programs. Team-specific platforms could provide an educational tool for building on social norms to further improve care-seeking or disclosure behaviors while tailoring the content to the specific norms and culture of each team.

We found no significant associations between overall reported concussion-education exposure and concussion knowledge, attitudes, intention, perceived control, and care-seeking or disclosure behaviors. In addition, no significant associations were present between the number of concussion-education sources and concussion knowledge, attitudes, perceived social norms, intention, perceived control, and care-seeking or disclosure behaviors. Evaluating the effect of current concussion-education sources is essential to ensuring that student-athletes are being exposed to resources that will positively affect their care-seeking or disclosure behaviors. Previous researchers<sup>10,14,29</sup> suggested that most current concussion-education sources were not significantly affecting concussion care-seeking or disclosure behaviors. Our student-athletes' reports were based on previous educational exposures, which could provide further evidence regarding the lack of salience that surrounds current educational sources. This could also explain the finding regarding the number of educational sources, ie, even though student-athletes were exposed to

more education, these sources might not have been effective. In a recent randomized controlled trial,<sup>10</sup> investigators assessed the difference in student-athletes' concussion-reporting intentions and behaviors among those who received a theory-based, multifaceted concussion-education module versus those who received the NCAA concussion fact sheet. Student-athletes in the theory-based group had greater odds of displaying improved concussion knowledge, attitudes, self-efficacy, and reporting intentions.<sup>10</sup> Thus, not only does education matter when the goal is to improve care-seeking or disclosure behaviors, but the types of educational content and delivery method are important in affecting those behaviors, further emphasizing the need for theory-based educational sources.

### Limitations and Future Implications

The use of a cross-sectional survey carries the limitation of response bias (ie, student-athlete recall that was correlated among key items could induce spurious associations). The questions pertaining to concussion education did not specify when the education was received (ie, at the youth versus high school versus collegiate level or time during the season) or how many times an athlete might have been exposed to specific types of educational sources. Therefore, we were unable to identify any connection between care-seeking behaviors and the time since educational exposure or the total number of educational exposures or being exposed to one source multiple times. Finally, our sample was from a single institution. At 77.4% White, the sample did not represent all NCAA Division I institutions (56.0% White),<sup>22</sup> which may limit the generalizability beyond similar institutions. Future researchers should investigate the longitudinal and observed effects of concussion education on care-seeking or disclosure behaviors and collect more information regarding the type, timing, duration, and source of education received.

### CONCLUSIONS AND CLINICAL RELEVANCE

Ensuring that all student-athletes receive effective concussion education is essential to improving injury outcomes. Differences in who receives education and which materials are used may affect a student-athlete's ability to prevent injury and improve outcomes. These findings may help athletic trainers identify student-athletes at risk for not receiving education or those who are in need of improved, additional, or both types of education at their institutions. Understanding the effect of perceived social norms on care-seeking or disclosure behaviors and the connection between concussion-education exposure and social norms could greatly affect future educational offerings.

As key individuals, athletic trainers are often in charge of designing and delivering educational programming at their institutions.<sup>6</sup> These results may help to inform the structure of future concussion education and affect how athletic trainers deliver education to student-athletes at all levels. Future authors should investigate ways to eliminate existing concussion-education differences and identify which types of concussion education are most beneficial to improving care-seeking and disclosure behaviors.

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