

# Influence of Concussion Education Exposure on Concussion-Related Educational Targets and Self-Reported Concussion Disclosure among First-Year Service Academy Cadets

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## ABSTRACT

### Introduction

Concussion disclosure is often essential for military personnel to receive appropriate care following concussive injury. Concussion-related education and training may play a role in improving disclosure and recognition among peers, allowing for more timely concussion identification and treatment. The objectives of this study were to: (1) describe concussion education exposure among first-year service academy cadets and (2) examine the association between exposure to concussion education sources (multiple vs. only one) and concussion-related knowledge, attitudes, perceived social norms, intention to disclose symptoms, and disclosure behaviors.

### Materials and Methods

First-year service academy cadets completed a cross-sectional survey to assess perceptions of concussion disclosure during preseason concussion baseline testing sessions. Associations between key cadet characteristics and exposure to multiple concussion education sources were examined using odds ratios and 95% confidence intervals. Linear regression was used to model the continuous measures of concussion-related knowledge, attitudes, and perceived social norms. Log-binomial regression was used to model the categorical outcomes of high perceived control over concussion disclosure (higher vs. lower), intention to disclose (higher vs. lower), and disclosure of all possible concussive events at the time of injury (yes vs. no). The primary predictor for all models was exposure to multiple sources of concussion education (video, coach, medical professional, or other) vs. exposure to only one educational source. All models were adjusted for gender, high school contact sport participation, and previous concussion history.

### Results

Of the 972 first-year cadets (85% response; age = 18.4 ± 0.9 years; 21.7% female, 29.0% NCAA student-athlete), 695 (71.5%) reported receiving some type of previous concussion education and 229 (23.6%) reported a previous concussion history (206/229 reported the actual number they experienced). Of those reporting previous concussion-related education ( $n = 695$ ), 542 (78.0%) watched a video, 514 (74.0%) talked with a coach about concussion, 433 (62.3%) talked with a medical professional, and 61 (8.8%) reported other sources of education ranging from anatomy teachers to brochures. Overall, 527 (75.8%) reported receiving more than one source of concussion education. Having played a contact sport in high school and having a history of concussion were associated with having multiple concussion education exposures. Being female was associated with lower odds of multiple exposures. Exposure to multiple sources of concussion education was not associated with knowledge, attitudes, perceived norms, or higher intention to disclose concussion symptoms. However, among those with a concussion history, exposure to multiple sources of concussion education was associated with a nearly 40% higher prevalence of disclosing all concussions at the time of injury compared to only one source of educational exposure (67.1% vs. 48.3%; prevalence ratio = 1.4; 95% confidence interval: 0.9, 2.1). Thus, although multiple sources of education may not influence intermediate variables of knowledge, attitudes, perceived norms and intentions, exposure to multiple sources of concussion education may influence actual decision-making around concussion disclosure among first-year service academy cadets.

### Conclusions

These data suggest disparities in concussion education exposure that can be addressed in first-year cadets. Additionally, findings support the importance and use of multiple sources of concussion education in improving cadet's concussion-related decision-making.

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## INTRODUCTION

Early care-seeking and disclosure of concussive injury are key to proper identification and management of concussion. This is especially true in a military environment where optimal cognitive capacity and performance are necessary to protect an individual, his/her team, and the overall mission at hand. In the military setting, recent work suggests that key factors influencing disclosure include cost vs. benefit analysis,<sup>1</sup> social expectations/perceptions,<sup>2</sup> and strong beliefs around negative outcomes concerning disclosure.<sup>3</sup> Despite this recent work aimed at understanding concussion disclosure, there are few studies in the military environment targeting educational efforts to improve such outcomes. Thus, collegiate aged student-athlete research has informed much of the work in this space. Sport-related concussion education efforts focus on improving basic educational targets such as knowledge, attitudes, and behavioral norms, as well as actual concussion care-seeking (disclosure) behaviors. Current studies evaluating passive types of concussion education in student-athletes observed these materials to be largely ineffective at improving even basic knowledge.<sup>4-6</sup> Additionally, one study found that certain types of messaging may even make normative perceptions related to disclosure worse.<sup>5</sup>

Studies inclusive of more active educational interventions, such as interactive platforms, suggest that these types of educational interventions may be more effective. Glang et al.<sup>7</sup> observed improvement in knowledge and self-efficacy among coaches toward healthy concussion behaviors following an interactive online training. Evaluations of the Centers for Disease Control's Heads-Up Toolkit suggest that coaches at least believe that it improves their knowledge and that it is useful, but few studies have evaluated the actual changes resulting from the program.<sup>8,9</sup> The previous body of work has largely evaluated content, only in an athletic setting, and did not consider exposure to multiple educational sources. Currently, no studies of this nature exist in the military environment and much of what is known is grounded in studies among student-athletes. Although many of the physical demands and injury risks of student-athletes and military personnel are similar, additional unique challenges exist for military personnel such as long-term overall career implications and the nature of military work.

Additionally, although educational content is important, it is also key to understand the effects of multiple exposures on desired outcomes for improved concussion care-seeking and overall identification. A single type of modality over

the course of a military career or even once a year is not likely to influence concussion identification over time. Additionally, given the multiple situations in which concussion and concussion-related decisions may occur (training, deployment, etc.) varied modalities may be particularly important to optimize disclosure behaviors among military personnel. Understanding the factors that cause military personnel to disclose concussion will inform the development of more effective education strategies and improve the culture concerning concussive injury. This is of heightened importance for personnel transitioning from a civilian setting to a military training environment such as the transition for first-year service academy cadets or new recruits. Recent data in a service academy cadet population<sup>2</sup> and collegiate athletes<sup>10,11</sup> illustrate that the role that perceived social norms (expectations) about the environment may play in intention to disclose concussive symptoms.

As stated, few to no studies have examined previous concussion education experiences among service academy cadets or other military personnel. This information could optimize the educational materials and delivery of content to improve concussion-related knowledge, attitudes, social norms, and behaviors in the military environment. Therefore, the objectives of this study were to (1) describe the previous concussion education experiences of first-year service academy cadets, and (2) examine the association between the number of education exposure types and concussion education targets, disclosure intentions, and concussion disclosure-related behaviors. The primary hypothesis was that service academy cadets reporting more sources of exposure to concussion education would have more positive/higher knowledge, attitudes, perceived norms, perceived control, and intentions to disclose concussion injuries. A second hypothesis was that those with a higher number of exposures would have better self-reported concussion disclosure-related behaviors.

## METHODS

### *Research Design and Sample*

The study was cross-sectional and conducted among first-year service academy cadets. The survey, administered at a single time point, captured data on cadet's demographics, previous concussion history, and basic concussion education targets as well as disclosure behaviors. A sample of first-year service academy cadets completed the survey. All first-year service academy cadets were eligible to participate because of the study goal being to understand perceptions of all incoming cadets. As such, no other exclusion criteria were used. Institutional Review Board approvals were obtained before research initiation.

### *Measures and Procedures*

A single survey was used as the primary data collection tool for the study and included the following key areas: demo-

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**TABLE I.** Overview of Study Constructs of Interest

Variable	Description	Scoring and Range
<i>Concussion Education Overall</i>	Education included whether participants had been formally educated about concussions.	No vs. Yes
<i>Educational Exposures</i>	If participants had been formally educated, they were asked what type of education they received: (1) watched a video, (2) talked with a medical provider, (3) talked with a coach, and (4) other.	Checked yes for each exposure (if checked more than one, considered multiple exposures)
<i>Knowledge</i>	Knowledge included the identification of signs and symptoms related to concussion as well as consequences of returning to play too soon and consequences of suffering multiple concussions.	Summed total of correct answers for 39 knowledge questions, range: 0–39
<i>Attitudes</i>	Attitudes were rated on a Likert scale and included participant perceptions of concussion reporting, ie, easy/difficult, cowardly/brave, bad/good, etc.	Summed total of 6 questions each scored 1–7, range: 6–42
<i>Perceived Social Norms</i>	Perceived Social Norms included participant perceptions of how they are expected to respond following a concussion as well as how they think their fellow cadets would respond.	Summed total of 7 questions each scored 1–7, range: 7–49
<i>Perceived Behavioral Control</i>	Perceived behavioral control related to how much control cadets felt they had over the decision to report concussive injuries.	Single question scored 1–7 (grouped higher: 6–7 vs. lower 1–6)
<i>Intention to Disclose</i>	Intentions to disclose included whether or not cadets intended to disclose concussion-related signs and/or symptoms to someone in authority.	Single question scored 1–7 (grouped higher: 6–7 vs. lower 1–6)

graphics, previous concussion history, and factors associated with concussion disclosure including concussion knowledge, attitudes concerning concussion disclosure, perceived social norms concerning concussion identification and disclosure, perceived control over disclosure, concussion disclosure intentions, and concussion disclosure behaviors. Race and ethnicity were collected because of being key variables reported in concussion disclosure and education studies. These characteristics were reported by participants when given the following options (*Race*: White, Black or African American, American Indian or Alaska Native, Asian, native Hawaiian or Pacific Islander, Unknown, Other-Specified; *Ethnicity*: Hispanic, non-Hispanic). Race and ethnicity were not forced responses and participants could elect not to answer. All construct outcomes had a Cronbach's alpha of  $> 0.80$ .<sup>2</sup> The survey also included questions concerning previous concussion education across an individual's lifetime (yes/no). Those who answered yes then checked from a provided list of concussion education sources (video, coach, medical professional, or other). A detailed description of the survey and associated constructs has been published elsewhere.<sup>2</sup> Table I includes a description of key constructs. All cadets completed the survey during preseason baseline concussion testing sessions that were overseen by study research personnel. The research team was available to answer questions during survey administration. The survey was completed via a Qualtrics (Provo, UT) platform with hard copies available in the event of technical difficulty.

Descriptive statistics were run for all key variables, educational exposure sources, and number of educational

exposures. Odds ratios (ORs) were used to assess associations between key demographic characteristics and exposure to multiple concussion education sources. For the primary analysis, the primary predictor was exposure to multiple sources ( $> 1$ ) of concussion education (video, coach, medical professional, or other) vs. exposure to only one educational source. Individuals who checked more than one of these sources were categorized as having multiple exposures and those only checking one were categorized as having a single exposure (Table I).

Linear regression was used to model the continuous measures of concussion-related knowledge, attitudes, and perceived norms. Similar to previous research,<sup>2,12</sup> log-binomial regression was used to model the categorical outcomes of high perceived behavioral control (higher vs. lower: score of 6 or 7 vs. 1–5), high intention to disclose (higher vs. lower: score of 6 or 7 vs. 1–5), and disclosure of all possible concussive events at the time of injury (yes vs. no). Alpha level was set to 0.05 *a priori* for the linear regression models. To address multicollinearity, variance inflation factors were utilized and found none above the recommended cut-off point of 10. For the binomial regression models, a PR of 1.4 is considered moderate and deemed clinically meaningful.<sup>13</sup>

## RESULTS

A total of 972 first-year cadets completed the survey (972/1143; 85% response). The mean age of the cadet respondents was  $18.4 \pm 0.9$  years. A total of 695 (71.5%) of the cadet sample reported receiving at least one source

**TABLE II.** OR and 95% Confidence Intervals (CI) for Demographics and Concussion Characteristics Associated with Multiple and Single Sources of Concussion Education Exposure

	<i>n</i> (%) With Multiple Education Source Exposures ( <i>n</i> = 527)	<i>n</i> (%) With Only One Education Source Exposure ( <i>n</i> = 168)	OR and 95% CI for Characteristics and Exposures
<i>Female*</i>	86 (68.3)	40 (31.7)	Female vs. Male: OR = 0.7 95% CI: 0.4, 0.99
<i>Male</i>	415 (76.8)	125 (23.2)	
<i>NCAA Athlete</i>	174 (78.0)	49 (22.0)	NCAA vs. Non-NCAA: OR = 1.2 95% CI: 0.8, 1.8
<i>Non-NCAA Athletes</i>	353 (74.8)	119 (25.2)	
<i>Contact Sport in High School*</i>	442 (78.8)	119 (21.2)	Contact vs. Non.: OR = 2.5 95% CI: 1.6, 3.9
<i>No Contact Sport Exposure in High School</i>	58 (59.8)	39 (40.2)	
<i>Hispanic</i>	49 (71.0)	20 (29.0)	Hispanic vs. Non-Hispanic: OR = 0.8 95% CI: 0.5, 1.4
<i>Non-Hispanic</i>	445 (75.4)	145 (24.6)	
<i>Caucasian</i>	374 (76.2)	117 (23.8)	Caucasian vs. Non.: OR = 1.3 95% CI: 0.8, 1.89
<i>Non-Caucasian</i>	123 (71.9)	48 (28.1)	
<i>Previous Concussions*</i>	165 (83.8)	32 (16.2)	Previous Concussion vs. No: OR = 1.9 95% CI: 1.3, 3.0
<i>No Previous Concussions</i>	361 (72.6)	136 (27.4)	
<i>Higher Perceived Behavioral Control</i>	471 (76.2)	147 (23.8)	Higher vs. Lower: OR = 1.4 95% CI: 0.8, 2.4
<i>Lower Perceived Behavioral Control</i>	47 (70.1)	20 (29.9)	
<i>Higher Intention to Disclose</i>	397 (76.4)	123 (23.6)	Higher vs. Lower: OR = 1.1 95% CI: 0.7, 1.7
<i>Lower Intention to Disclose</i>	121 (74.2)	42 (25.8)	

\*denotes significant Odds Ratio

of concussion education in their lifetime. Of the 695 with concussion education (and the focus of this study), 126 (18.1%) were female, 223 (32.1%) were rostered National Collegiate Athletic Association student-athletes, 561 (80.7%) played contact sports in high school, and 197 (28.4%) reported a previous concussion history. Also, 69 (9.9%) were identified as Hispanic and 491 (70.6%) were Caucasian; 79 (11.4%) were Black or African American, 50 (7.2%) were Asian, 9 (1.3%) were American Indian or Alaska Native, 4 (0.6%) were Native Hawaiian or Pacific Islander, 24 (3.5%) indicated other categories of race, 5 (0.7%) indicated race as unknown, and 33 (4.7%) did not report race. Additionally, 618 (88.9%) reported high perceived behavioral control over concussion disclosure, and 520 (74.8%) had higher intention to disclose concussion symptoms. Cadets who participated in a contact sport in high school and those with a previous history of concussion had a higher odds of multiple concussion education exposure sources. Females had a lower odds of multiple concussion education exposure sources. [Table II](#) outlines these key descriptive variables by educational exposure group and highlights associations of more concussion education exposures with key demographic characteristics.

Overall knowledge about concussion, attitudes concerning concussion disclosure, perceived social norms (expectations) around concussion disclosure, and perceived control over disclosure and intentions to disclose concussion symptoms were high (direction toward safety) across the sample ([Table III](#)). The most common methods for educational delivery included watching a video (78.0%), talking with

a coach about concussion (74.0%), talking with a medical professional (62.3%), and other sources of education ranging from speaking with anatomy teachers to reading brochures (8.8%). The most common combination of exposures was watching a video and talking with a coach (59.1%), talking with a coach and a medical professional (51.2%), and watching a video and talking with a medical professional (48.5%).

Multiple educational source exposures were not statistically associated with any of the study outcomes ([Table IV](#)). However, when adjusting for gender, high school contact sport history, and previous history of concussion, exposure to multiple sources of concussion education was associated with a nearly 40% higher prevalence of disclosing all concussions at the time of injury compared to only one source of educational exposure (67.1% vs. 48.3%).

## DISCUSSION

The most important findings of the current study were that males, those who played a contact sport in high school, and those with a previous history of concussion were more likely to be exposed to multiple sources of concussion education. Additionally, exposure to multiple concussion educational sources was not associated with intermediate educational factors such as knowledge, attitudes, perceived norms, perceived behavioral control, or intentions to disclose concussion symptoms. However, there was clinical importance in the relationship between exposure to multiple educational sources and increased prevalence of disclosing all concussions at the time

**TABLE III.** Key Concussion-Related Construct Means, Standard Deviations (SD), Medians, and Interquartile Ranges (IQR) by Concussion Education Exposure Source Group

	Multiple Source Exposures ( <i>n</i> = 527)		Single Source Exposure ( <i>n</i> = 168)	
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)
Knowledge	32.2 (6.4)	34 (29, 37)	31.7 (6.7)	34 (28, 37)
Attitudes	33.6 (6.5)	35 (30, 38)	34.2 (5.9)	36 (31, 38)
Perceived social norms	42.6 (5.3)	43 (40, 47)	42.8 (4.9)	44 (40, 47)
Perceived behavioral control	6.4 (0.8)	7 (6,7)	6.4 (1.0)	7 (6,7)
Intention to disclose concussion symptoms	6.0 (1.3)	6 (6, 7)	6.0 (1.2)	6 (6, 7)

**TABLE IV.** Adjusted Models for Exposure to Multiple vs. Single Educational Sources and Their Association with Concussion Disclosure Outcomes

<i>Multiple vs. Single Sources</i>			
<b>Outcomes in Binominal Regression Models <sup>a</sup></b>	<i>Adjusted PR</i>	<i>95% CI</i>	<i>P-value</i>
Higher perceived behavioral control over disclosure	1.0	1.0, 1.1	0.149
Higher intention to disclose concussion symptoms	1.1	1.0, 1.2	0.144
Disclosed all concussions at the time of injury	1.4	0.9, 2.1	0.103
<b>Outcomes in linear regression models <sup>a</sup></b>	<i>Adjusted Mean Diff.</i>	<i>95% CI</i>	<i>P-value</i>
Knowledge	0.6	-0.7, 1.8	0.373
Attitudes	-0.1	-1.2, 1.1	0.949
Perceived norms	-0.1	-0.8, 1.0	0.833

<sup>a</sup>All models were adjusted for the following covariates: gender, high school contact sport history, and previous history of concussion; PR = prevalence ratio for multiple vs. single sources of the primary outcome; Mean Diff. = mean difference for multiple vs. single sources of the primary outcome; CI = confidence interval

of injury. These findings highlight the importance of more than one type of educational resource exposure for concussion in the military environment. Additionally, these findings identify subsets of individuals that may be less likely to report to military service environments with multiple sources of educational exposure. Overall, these data are novel, as no study has addressed these components in a military training environment. Studies in the athletic environment do not account for key elements of military culture, including the chain-of-command and both long- and short-term career implications.

Although over 70% of cadets reported at least one exposure to concussion education in their lifetime, nearly 30% do not remember any exposure. These data highlight the need to provide valuable and meaningful experiences that are more widely available to individuals across diversity in athletic backgrounds, across genders, and athletic settings. Specifically, there should be a focus on non-contact sport participants, females, and those without a previous history of concussion. Additionally, of those with concussion education exposure, over 75% reported more than one source of exposure. These findings suggest that if concussion education is available, it may be available in multiple avenues for individuals before reaching the academy. Watching a video and talking with a coach were the two most common exposure sources for concussion education. These findings are not surprising given that

concussion-related videos are common and more accessible.<sup>5</sup> Coaches are also often left to discuss concussions among high school athletes because of the lack of medical professional presence in many high school sport settings across the United States.<sup>14</sup> These data also support the need for further coach and chain-of-command education, given they are a prevalent source of concussion information. These key individuals often play a large role in shaping the culture for military cadets and service members.<sup>2</sup> Previous studies suggest the desire of young adults to have interactions with individuals such as coaches around concussion as it illustrates a supportive environment.<sup>15-17</sup> Combined, these findings highlight opportunities for intervention among service academy cadets, particularly those with no or only one source of exposure.

The findings illustrating disparities in those with previous exposure to concussion education provide data to inform future educational strategies in the military environment. Specifically, females in many activity types and in the military environment have a higher risk of concussion,<sup>18</sup> thus making education and contact with this population essential to improve outcomes. Furthermore, because of the limited focus on concussion education outside of common collision sports, many first-year cadets may perceive less risk for concussion and/or not know appropriate steps to take should one occur. This may be especially true for individuals

beginning their military careers to ensure that appropriate knowledge, attitudes, and norms for concussion awareness and disclosure are present.<sup>1,2</sup>

Exposure to multiple sources of education was not associated with any of the intermediate concussion education outcomes typically measured including knowledge, attitudes, perceived norms, or disclosure intentions among first-year service academy cadets. This suggests that overall, the content of educational materials from these individuals' high school years did not inform the typical intermediate concussion education variables of concussion-related knowledge, attitudes, perceived social norms, and expectations concerning concussion disclosure or perceived control over concussion disclosure. This may be because of lack of interest, content, or time elapsed since exposure to these sources. These findings are relatively consistent with recent literature suggesting that current concussion education standards may not shift many of the originally desired outcomes.<sup>4,6,16</sup> These findings also suggest that perhaps these outcomes may not reflect what was learned, but may also be the result of ceiling or floor effects on such outcomes. Furthermore, it may suggest that these intermediate variables are not the ideal measure of concussion education effectiveness in this population.

However, there was a clinically significant association with disclosing all concussions at the time of injury in those with a history of concussion. This may be because of the fact that although the intermediate variables were not affected, multiple exposures do resonate and inform behavioral decisions among these cadets. Additionally, these exposures do not necessarily indicate formal education sessions, but may reflect conversations and discussions around concussion. This is important, as education can be a continual process through discussions and other daily activities that share and promote the right information concerning concussion identification in the military environment.

## LIMITATIONS

This study is limited as it is cross-sectional in nature. Additionally, content or timing of educational sources was not examined, which may influence the studied outcomes. Future research should include prospective studies of controlled educational exposures on targeted outcomes for disclosure and behaviors in the military environment as well as key content that results in desired outcomes.

## CONCLUSIONS

There are disparities in concussion educational background among new cadets upon entrance to U.S. Service Academies that should be addressed to ensure that all cadets have proper concussion education throughout their military training. Although multiple sources of education may not influence intermediate variables of knowledge, attitudes, perceived norms, and intentions, exposure to multiple sources of concus-

sion education may influence actual decision-making around concussion disclosure among first-year service academy cadets. These data support the importance and use of multiple sources of concussion education, with a focus on equal access across the military and sport environments. Findings may inform educational strategies in military settings. However, more research is needed to understand the causative nature of the relationship between exposure to multiple educational sources and prospective concussion disclosure behaviors. These outcomes are anticipated to be integrated into broader concussion efforts informed by the additional findings from the National Collegiate Athletic Association-Department of Defense (NCAA-DoD) Mind Matters program.

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