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ARTICLE *in* CLINICAL JOURNAL OF SPORT MEDICINE: OFFICIAL JOURNAL OF THE CANADIAN ACADEMY OF SPORT MEDICINE · NOVEMBER 2015

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Content, Delivery, and Effectiveness of Concussion Education for US College Coaches

Emily Kroshus, ScD,*†‡ Christine M. Baugh, MPH,§¶ and Daniel H. Daneshvar, MA||

Objective: The primary objective of this study was to examine the proportion of US college coaches who receive annual concussion education from their institution and to describe the content and delivery modalities of this education. This study also tested the hypothesis that coaches receiving concussion education from their institution will have greater knowledge about concussions independent of other individual and institutional characteristics.

Design: Cross-sectional online survey.

Setting: US college sport.

Participants: College coaches in National Collegiate Athletic Association Division I, II, and III (n = 1818).

Independent Variables: Self-reported receipt of education from institution, sex, sport coached, division of competition.

Main Outcome Measures: Concussion identification and management knowledge.

Results: Two-thirds of coaches reported receiving informational materials about concussion from their institution. The content of the education most frequently referred to symptoms of a concussion and information about proper management of a concussion. Coaches who received educational materials from their institution were better able to identify symptoms and had more conservative responses to concussion management scenarios. Male coaches of male contact or collision teams less frequently endorsed safe or correct response as compared with female coaches of noncontact or collision teams.

Conclusions: Not all US college coaches receive concussion education from their institution. Male Division I coaches of male contact/collision sport are a population for whom targeted educational outreach may be particularly valuable.

Clinical Relevance: Education for coaches, delivered by clinicians at many institutions, is an important component of ensuring that coaches are prepared to be informed partners in supporting concussion safety.

Key Words: concussion, college, coach, education

(*Clin J Sport Med* 2015;0:1–7)

Concussion occurs frequently in many contact and collision sports^{1,2} and can have acute and long-lasting effects including diminution of executive function, alterations to the blood brain barrier, changes in the structure and function of the brain.^{3–7} Reducing the health burden of these injuries is a task involving multiple stakeholders in prevention, early detection and medically indicated injury management.^{8–12} Coaches of contact and collision sports teams at all levels of competition can play an important role in this process.^{13–18} Critically, they can work cooperatively with clinicians to ensure that athletes follow a medically indicated identification and recovery protocol and do not feel pressured to return to play before fully recovered.^{17,19,20} The National Athletic Trainer's Association (NATA) recently stated that even in the presence of an athletic trainer, coaches have the responsibility for recognizing the signs and symptoms of concussion.⁹ Early identification and removal from play is particularly critical as many athletes continue play while symptomatic,^{21,22} and there is a period of metabolic vulnerability after an initial impact during which the neurological consequences of sustaining an additional impact are magnified.^{23,24}

Given the important role that coaches can play in concussion safety, it is critical to understand whether existing mechanisms of concussion education are positively impacting their concussion identification and management knowledge and behaviors.^{25–27} Evidence suggests that not all coaches of contact and collision sports teams have appropriate knowledge about concussions,^{26,28–31} although data among college coaches are limited. The National Collegiate Athletic Association (NCAA) recommends, but currently does not require, that institutions provide coaches with information about concussions on an annual basis.³² There is little information available about the nature of the concussion education college coaches are receiving from their institutions and whether coaches who receive this education are more knowledgeable about concussions than coaches who do not receive this education. Currently, the NCAA requires that athletes receive educational materials from their institution on an annual basis. However, even this mandatory policy is not implemented at all institutions,³³ and when implemented, there is variable delivery and effectiveness.³⁴

Submitted for publication July 2, 2014; accepted May 4, 2015.

From the *University of Washington, Department of Pediatrics, Seattle, Washington; †Seattle Children's Research Institute, Center for Child Health, Behavior and Development, Seattle, Washington; ‡Harborview Injury Prevention Research Center, Seattle, Washington; §Harvard University, Interfaculty Initiative in Health Policy, Cambridge, Massachusetts; ¶Boston Children's Hospital, Division of Sports Medicine, Boston, Massachusetts; and ||Center for the Study of Traumatic Encephalopathy, Boston University School of Medicine, Boston, Massachusetts.

The authors report no conflicts of interest.

Corresponding Author: Emily Kroshus, ScD, Seattle Children's Research Institute, Center for Child Health, Behavior and Development, 2001 8th Ave, Suite 400, Seattle, WA, 98121 (ekroshus@u.washington.edu).

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At the high school level, all states have adopted legislation related to concussions, and many require concussion education for coaches.^{35,36} A recent analysis of implementation of this type of concussion legislation in the state of Washington indicates that nearly all high-school coaches are in fact receiving some form of concussion education.³⁷ In the state of Michigan, the likelihood of coaches having received concussion education varies by sport and sex of the team, with nearly all football coaches (97%) receiving concussion education as compared with fewer than half (47%) of the girls' soccer coaches.³⁸

In samples of community youth sport and high-school coaches, evidence suggests that coaches who have received some form of concussion education are more knowledgeable about concussions than those who have not.^{29,30,39} Concussion knowledge is one important determinant of the likelihood that coaches engage in safety behaviors such as correctly identifying, and removing from play, symptomatic athletes.^{28,30,39} Several evaluations of concussion education programs for coaches of youth and high-school sports teams provide some evidence of efficacy in changing concussion safety knowledge and other relevant cognitions such as safety intentions.⁴⁰⁻⁴³

At the collegiate level, reasons for potential variability in whether coaches are educated about concussions could be related to variability in resources. In resource-constrained environments, allocating person-hours to delivery of coach education may be considered less important than resource allocation to other tasks. Variability might also be at least in part explained by differences in the perceived benefit of or need for coach education by the athletic administrator in charge of mandating the provision of coach education. Neither of these possible barriers to coach education would necessarily reflect an institutional culture that did not value concussion safety; they could in fact reflect an assumption that coaches already receive concussion knowledge through their professional training or through self-study, making institutionally delivered concussion education a less necessary place to allocate potentially constrained institutional resources.

Given the important role that coaches can play in concussion safety, it is critical that we understand how the NCAA's recommendation that institutions provide coaches with annual information about concussions is being implemented and whether there are unmet knowledge needs in this population. This purpose of this study was to examine the proportion of college coaches who receive annual concussion education from their institution and to describe the content and delivery modalities of this education. Additionally, this study tested the hypothesis that coaches receiving annual concussion education from their institution have greater knowledge about concussions, independent of other individual and institutional characteristics such as coach sex, years of experience, sport coached, or division of competition.

METHODS

Sample

Twenty-eight thousand one hundred eighty-three coaches of US collegiate sports teams competing in NCAA Division I, II, or III were contacted by e-mail using the e-mail

distribution service of the NCAA's Sports Science Institute and invited to complete an online survey about concussion management. Respondents were 1818 coaches from 755 institutions (minimal individual response rate = 6.5%, school participation rate = 70.8%). Data were collected during September 2013 as part of a broader study of institutional concussion management practices.³³ All research activities were approved by the Harvard School of Public Health and Boston University School of Medicine Institutional Review Boards.

Measures

Concussion Education

Coaches were asked (yes or no) whether they receive educational information about concussions from their school on an annual basis. Coaches who indicated that they had received educational information were asked from whom they received this education, how the information was delivered, and the content of the information provided, selecting from a list of prespecified response categories. They were also asked to indicate the extent to which they agreed with 5 statements about the effectiveness of the education, such as "The education helped me be able to identify symptoms of a concussion." Response options were on a 7-point Likert scale, ranging from strongly disagree to strongly agree. All survey items related to concussion education are listed in Table 2.

Concussion Knowledge

Concussion knowledge was assessed with the questionnaire used in the survey of primary care physicians by Chrisman et al.⁴⁴ Nine general concussion knowledge questions were scored on a 5-point Likert scale, with response options ranging from strongly disagree to strongly agree. Four scenarios assessing concussion identification knowledge asked respondents to indicate whether they think an individual in question has a concussion, with 5-point response options, ranging from likely not a concussion to definitely a concussion. Five scenarios assessing concussion management knowledge asked coaches to indicate with a binary response whether they think it would be safe or not safe for an individual to return to play.

Demographics

Coaches were also asked their sex, years of experience as a college coach, school name, division of competition, and what sports team they coach. Sports were classified as contact/collision using the list provided in the NCAA Sports Medicine Handbook.³²

Analysis

Multivariable logistic regression was used to evaluate whether the odds of receiving annual concussion education were associated with division of competition or the category of team coached: male contact/collision, female contact/collision, or noncontact/collision. Subsequently, mean scores for each knowledge item between coaches who did and did not report having received concussion education from their institution were calculated with independent sample *t* tests

using Levene's test for equality of variances. For these analyses, the sample was restricted to only contact/collision coaches to limit the potential for biased estimates based on possible differences in concussion knowledge for reasons unrelated to institutional concussion education. For example, coaches of contact/collision teams may be more likely to be exposed to concussion information at coaching conferences or through informal learning when a member of their team sustains a concussion. In this sample of contact/collision coaches, one-way analysis of variance with Bonferroni adjustment for multiple comparisons was used to compare knowledge item scores by the modality in which education was delivered. In the full sample of coaches, among knowledge variables for which there were significant differences between coaches who received and did not receive concussion education, generalized linear model (GLM) regression was used to determine whether these differences may have been driven by other factors: years of experience as a coach, division of competition, or the interaction of the coach's sex and the category of sport coached. An alpha level of ≤ 0.05 was considered significant. Analyses were conducted in SPSS version 21.

RESULTS

Respondents were 62% males and 38% females, with around half (55.1%) coaching a contact or collision sport. On average, respondents had 16.13 years of experience as a college coach (SD = 9.91), with male coaches having significantly more years of experience than female coaches (mean = 17.16, SD = 9.96 vs mean = 13.55, SD = 8.69, $P < 0.001$). Additional sample characteristics are reported in Table 1.

Two-thirds (66.7%) of all coaches and a similar percentage of contact and collision coaches (65.1%) indicated that they receive educational information about concussions from their institution on an annual basis. Detail about the content and delivery of these materials is presented in Table 2. Education was most frequently provided by an athletic trainer (91.3%), sometimes in conjunction with a physician on the sports medicine staff (18.3%) or an athletic department administrator (17.7%). The format was most frequently written materials (66.8%) or a formal meeting or

TABLE 1. Descriptive Characteristics of Sample of US College Coaches (n = 1818)

	Percentage of Respondents
Coach of contact or collision team	55.1
Coach of male contact or collision team	23.9
Coach of female contact or collision team	31.2
Gender	
Male	62.0
Female	38.0
Division of competition	
Division I	47.8
Division II	17.3
Division III	34.9
Receive concussion education from school	67.0

TABLE 2. Content and Delivery of Concussion Education to US College Coaches Who Receive Education From Their Institution on an Annual Basis (n = 1139)

	n (%)
At your institution, who has provided you with education about concussions?*	
Athletic trainer	1040 (91.3)
Physician on the sports medicine staff	218 (19.1)
Outside physician	39 (3.4)
Athletic department administrator	223 (19.6)
How is this education about concussions delivered?*	
Formal meeting/lecture	745 (66.4)
Informal conversation	329 (28.9)
Written material	761 (66.8)
Online material	318 (27.9)
E-mail	395 (34.7)
Video	262 (23.0)
Poster	111 (9.7)
Formal meeting/lecture and written materials	531 (46.6)
What type of information was provided?*	
List of symptoms of a concussion	1043 (91.6)
Information about proper management of a concussion (eg, concussion evaluation, return to play)	994 (87.3)
Information about the long-term consequences of concussions	782 (68.7)
Impact on athletic performance of continuing playing with an undiagnosed concussion	698 (61.3)
The coach's role in the concussion management plan	747 (65.6)
We are interested in knowing what you think about the concussion education you received from your institution†	
This education provided me with information I did not already know about concussions	647 (61.7)
The education helped me be able to identify symptoms of concussions	808 (77.5)
The education taught me about the importance of proper concussion management	883 (84.5)
The education taught me more about our institution's concussion management plan	872 (83.6)
I would like to learn more about concussions	567 (54.5)

*Respondents selected all options that applied.

†Responses on a 7-point Likert scale ranging from strongly disagree to strongly agree; percent reported is for scores of ≥ 5 (slightly agree, agree, and strongly agree).

lecture (66.4%), with 46.6% of coaches receiving information in both modalities. The 28.9% of coaches who indicated that they received information about concussions through informal conversations all also received educational materials in at least one other modality.

The educational materials most frequently included content about symptoms of a concussion (91.6%) and information about proper management of a concussion (87.3%). Less frequently provided was information about long-term consequences of a concussion (68.7%), the coach's role in the concussion management plan (65.6%), or the impact on athletic performance of continued play with an undiagnosed concussion (61.3%). Although the majority of coaches indicated that the education taught them about the importance of proper concussion management (84.5%),

helped them identify symptoms of concussions (77.5%), and provided them with information they did not already know about concussions (61.7%), over half (54.5%) indicated that they would like to learn more about concussions.

Multivariable logistic regression indicated that the odds of a coach receiving concussion education from their institution were not significantly associated with their sex or the category of team coached. Coaches with more years of experience had significantly higher odds of having received concussion education from their institution (odds ratio = 1.019; 95% confidence interval, 1.006-1.031; $P = 0.004$). Odds of having received concussion education were significantly different by division of competition ($P = 0.033$), with the lowest odds of having received educational materials among coaches at Division II schools.

Differences in concussion knowledge, as measured by responses to the 9 general knowledge questions, 4 identification scenarios and 5 management scenarios, are reported in Table 3. Among contact or collision coaches, there were significant differences between those who received concussion education and those who did not for 2 of the 9 general knowledge items, 2 of 4 the identification scenarios, and 2 of the 5

management scenarios, with those having received education more likely to provide the correct or “safe” response. However, it is critical to highlight that the effect sizes for all of these differences fell below Cohen’s threshold for a small effect size, drawing into question the practical significance of any of these differences.

Coaches who had received concussion education were less likely than coaches who had not received concussion education to think that it was safe for an athlete to go back in the game if concussion symptoms last less than 15 minutes ($P = 0.012$), and more likely to think that an athlete who feels dizzy and has a headache for 5 or 30 minutes has sustained a concussion ($P = 0.005$ and $P = 0.001$, respectively). Coaches who had received education were also less likely to think that wearing a helmet prevents concussions ($P = 0.030$) and more likely to think it is safe for an athlete who sustained a concussion 1 week ago, started running a few days after the event, and has been feeling fine, to resume play ($P = 0.009$). Despite the significance of these differences, the effect sizes were very small (Cohen’s $d \leq 0.12$ for all items). After Bonferroni corrections for multiple comparisons, there were no significant differences across any of the knowledge

TABLE 3. Knowledge About Concussion Identification and Management Among Coaches of US College Contact or Collision Sports Teams (n = 1818)

	With Education, Mean (SD)	Without Education, Mean (SD)	P^*	Cohen’s d
Knowledge items†				
Most (>80%) concussions resolve within 7-10 d	4.57 (1.55)	4.40 (1.67)	0.097	0.081
Most (>80%) concussions last a few weeks to a month	3.94 (1.53)	3.94 (1.58)	0.985	0.006
It is safe for a player to go back in the game if concussion symptoms lasted less than 15 min	2.13 (1.23)	2.35 (1.39)	0.012	0.117
Computed tomographies are normal in the majority of patients with concussions	3.54 (1.37)	3.60 (1.44)	0.480	0.061
Concussions can cause permanent cognitive deficits	5.91 (1.06)	5.88 (1.13)	0.624	0.012
After having a concussion, an athlete has a higher risk of getting a second concussion	5.96 (1.16)	6.03 (1.09)	0.341	0.045
Loss of consciousness is required to diagnose a concussion	1.82 (1.47)	1.83 (1.45)	0.900	0.071
Returning to play while symptomatic from a concussion can prolong recovery	6.23 (1.21)	6.19 (1.10)	0.600	0.051
Wearing a helmet prevents concussions	2.74 (1.77)	3.00 (1.84)	0.030	0.130
Each of these hypothetical scenarios relates to an athlete on your team who sustains an impact to the head...‡				
He feels dizzy and has a headache for 5 min	3.24 (1.16)	3.02 (1.21)	0.005	0.117
He feels dizzy and has a headache for 30 min	4.09 (0.87)	3.87 (1.04)	0.001	0.127
He cannot remember what happened, the score of the game, or the opponent	4.73 (0.54)	4.72 (0.59)	0.846	0.017
He has a loss of consciousness	4.49 (0.84)	4.51 (0.84)	0.671	0.030
Each of these hypothetical scenarios relates to a college athlete who has sustained a concussion today§				
His symptoms resolve in 15 min and he has a normal medical exam	1.50 (0.50)	1.43 (0.50)	0.053	0.110
His symptoms resolve in 30 min and he has a normal medical examination	1.76 (0.43)	1.73 (0.45)	0.277	0.100
His concussion was 1 wk ago. He still has a persistent headache	2.00 (0.06)	1.99 (0.08)	0.533	0.053
His concussion was 1 wk ago. He has been feeling fine, but developed a headache and dizziness while running	2.00 (0.07)	1.99 (0.12)	0.162	0.064
His concussion was 1 wk ago. He started running a few days after the event and has been feeling fine	1.20 (0.40)	1.13 (0.34)	0.009	0.123

Results adjusted for multiple comparisons (Bonferroni).

* P value for independent samples t test of the difference in mean score for contact/collision coaches receiving education and contact/collision coaches not receiving education.

†Responses range from 1 = strongly disagree to 7 = strongly agree.

‡Responses range from 1 = likely not a concussion to 5 = definitely a concussion.

§Responses are 1 = safe to return to play and 2 = not safe to return to play.

items among the 3 most frequent modalities of education delivery: written materials only, formal meeting or lecture only, or both written materials, and formal meeting or lecture.

For the 6 items in which there were significant differences between contact/collision sport coaches who did and did not receive concussion education from their institution, multivariable GLM regression was conducted to determine whether other individual, team, and institutional characteristics explained these differences. Coaches of both contact/collision and noncontact/collision sports teams were included in these analyses. Full regression results are reported in Table 4. Receipt of concussion education remained significantly associated with the knowledge item score in 4 models ($P \leq 0.05$) and trending toward significance in 2 models ($P \leq 0.10$). Coaches with more years of experience were significantly more likely to endorse the correct or safe response option for 5 of the 6 multivariable models, whereas division of competition was not significantly associated with any of the knowledge response options. The interaction of coach sex and category of team coached was significant in 3 of the multivariable models, with male coaches of male contact/collision teams less frequently endorsing the safe or correct response as compared with female coaches of noncontact/collision teams.

DISCUSSION

At the present time the NCAA recommends, but does not require, that institutions provide coaches with informational

materials about concussions on an annual basis.³² Around two-thirds of US college coaches who responded to this survey indicated that they receive concussion education from their institution; however, there was substantial variability in the content of this education and how it was delivered. Although coaches who received educational materials from their institution had safer responses to 4 of the 5 concussion management scenarios, the effect size for these differences was very small, bringing into question the clinical significance of the differences in knowledge related to differences in concussion education, as it is currently delivered to college coaches. Given the seemingly limited benefit associated with having received concussion education, the heterogeneity in its delivery and content, and the fact that many coaches did not receive any concussion education from their institution, a new approach to concussion education for college coaches may be warranted. A new approach could involve making concussion education for coaches a required, rather than optional, element of institutional concussion policy, and providing direction on the content and delivery of this education.

Provvidenza et al²⁵ and Finch et al⁴⁵ have described the importance of considering the ways in which concussion information is disseminated to relevant stakeholders including coaches. Educational materials were delivered to coaches in a variety of modalities, including lectures, written materials, posters, and online materials, almost always by an athletic trainer. Some coaches received information about concussions from a team physician or an athletic department

TABLE 4. Results of GLM Regression Predicting 6 Concussion Knowledge Variables Among US College Coaches

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	B	P	B	P	B	P	B	P	B	P	B	P
Overall		0.005		<0.001		0.004		0.093		<0.001		<0.001
Variables												
Concussion education												
Yes	Ref	0.067	Ref	0.105	Ref	0.028	Ref	0.009	Ref	0.017	Ref	0.049
No	0.135		0.170		-0.148		-0.143		0.285		0.306	
Division of competition												
Division I	0.085	0.236	0.136	0.368	-0.130	0.169	-0.093	0.280	0.224	0.204	-0.119	0.623
Division II	0.171		0.173		-0.125		-0.043		0.174		0.056	
Division III	Ref		Ref		Ref		Ref		Ref		Ref	
Coach gender, team gender, and sport type												
M and M cc	0.253	0.032	-0.322	0.057	-0.331	0.076	-0.058	0.642	0.003	0.017	0.573	<0.001
M and W cc	0.338		-0.605		-0.111		-0.073		0.175		0.579	
M and all non-cc	0.006		-0.178		-0.208		-0.162		-0.387		-0.255	
W and W cc	0.240		-0.319		-0.206		-0.089		0.192		0.849	
W and all non-cc	Ref		Ref		Ref		Ref		Ref		Ref	
Years of experience	-0.008	0.039	-0.020	<0.001	0.009	0.006	0.002	0.426	-0.020	0.001	-0.015	0.038

Parameter estimates unstandardized estimates with 95% Wald confidence intervals.

P values represent Wald χ^2 test of model effects.

Model 1 dependent variable: It is safe for a player to go back in the game if concussion symptoms lasted less than 15 minutes (range, 1-7).

Model 2 dependent variable: Wearing a helmet prevents concussions (range, 1-7).

Model 3 dependent variable: He feels dizzy and has a headache for 5 minutes (range, 1-5).

Model 4 dependent variable: He feels dizzy and has a headache for 30 minutes (range, 1-5).

Model 5 dependent variable: His symptoms resolve in 15 minutes and he has a normal medical exam (range, 1-2).

Model 6 dependent variable: His concussion was 1 week ago. He started running a few days after the event and has been feeling fine (range, 1-2).

cc, contact and collision sport; M, male; W, female.

administrator, but of those coaches almost all also received information from an athletic trainer. The recent position statement of the NATA⁹ describes to athletic trainers their important role in educating other stakeholders about concussions. The present findings reinforce the importance of athletic trainers in this process.

Most coaches indicated that the content of the education that they received pertained to concussion identification and management. Fewer coaches described educational materials covering content areas such as the influence of continued play with undiagnosed concussions on athletic performance or the possible long-term consequences of concussions. Although these content areas are not directly related to the safety behaviors that a coach can engage in—such as working cooperatively with clinicians in concussion identification and management—it is possible that they influence coaches' attitudes about the importance of concussion safety and thus may indirectly influence their safety-oriented behaviors.

It is worth considering that the apparent benefit of education may have been driven by differences between individual or institutional factors that are not related to the receipt of formal concussion education. For example, institutions that voluntarily elect to educate their coaches about concussions may have individuals in administrative positions promoting concussion safety through informal communication channels. Coaches who remember receiving concussion education from their institution—or who seek out information from their institution that may perhaps be available on an elective basis—may already have greater knowledge about concussions than other coaches. Nonetheless, education remained significantly associated with knowledge items in the majority of the multivariable analyses even when the coach's years of experience, their institution's division of competition, and the interaction of the coach's gender and the category of team coached were included in the regression model.

Independent of educational receipt, these individual, team, and institutional characteristics were important predictors of knowledge. Coaches of at Division I institutions and male coaches of male contact/collision teams tended to be less knowledgeable about concussion identification and management than their Division III, female, and noncontact/collision coaching peers. These findings are concerning but perhaps not surprising. Qualitative evidence suggests that in Division I football programs, all of which are coached by men, competitive pressures can lead to conflict of interest in the care of concussed athletes, with pressure from coaches on clinicians and athletes.¹⁸ It is possible that this type of pressure from coaches is in part related to these coaches having less knowledge about concussions. Additional empirical research is warranted to explore this potential association.

Limitations

The most central limitation of this study is its external validity. Despite the fact that it is the largest concussion education-related study of US college coaches, only a very small fraction of those coaches who received the initial recruitment e-mail elected to complete the survey. Participating coaches may have been more interested in and knowledgeable about concussions than nonparticipants, something

that may or may not have been related to their receipt of concussion education from their institution. Nonetheless, the difference in knowledge scores for individuals who received and did not receive education suggests that even if the absolute values are not generalizable, there is a relative advantage to having received education from one's institution. An additional threat to the external validity of the findings is related to the lack of certainty over whether the individuals completing the surveys were in fact the coaches to whom the recruitment e-mail was sent. It is possible that some coaches may have, for example, asked a graduate assistant coach or other employee to answer the questions.

The questionnaire asked coaches whether they received concussion education from their institution on an annual basis. The wording of the question did not quantify the number of years that educational materials had been received, or whether individuals who received written materials actually reviewed these materials. A response of "no" to education receipt may reflect education that is inconsistently delivered rather than absent entirely, meaning that the results of this study may be conflating inconsistencies in education with the absence of education. Future research in this area is encouraged to more clearly specify the time period for receipt of educational materials. Additional longitudinal research is needed to understand the extent to which concussion knowledge predicts the actual safety-related behaviors of coaches. Finally, responses may have been subject to social desirability bias should coaches have been concerned about a possible breach of confidentiality.

CONCLUSIONS

Coaches have the potential to play an important role in reducing the health burden of concussions. Ensuring that all coaches of contact or collision sports teams have adequate knowledge about concussions is an important first step in this process. Despite differences in the concussion knowledge of coaches who received concussion education versus those who did not, the small effect size suggests that these differences may be of little practical significance and that there may be an opportunity to design more effective concussion education for college coaches. The findings of this study identify male Division I coaches of male contact/collision sport as a population for whom targeted outreach may be particularly valuable. Sports leagues are encouraged to require concussion education for all coaches. They are also encouraged to provide guidance about the content and delivery of this education, ideally recommending the use of population-specific educational materials with demonstrated effectiveness.

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