



The Internet Journal of Allied Health Sciences and Practice

A Peer Reviewed Publication of the College of Health Care Sciences at Nova Southeastern University

Dedicated to allied health professional practice and education

<http://ijahsp.nova.edu> Vol. 11 No. 1 ISSN 1540-580X

New Jersey Coaches' Knowledge in Recognizing and Managing Concussion

Phil Hossler, ATC¹

Kerry-Ann Phang, MPH²

Marian Passannante, PhD³

1. Certified Athletic Trainer, East Brunswick High School, East Brunswick, New Jersey
2. Contractor, Aerotek Scientific, Piscataway, New Jersey
3. Associate Professor, University of Medicine and Dentistry of New Jersey, Newark, New Jersey

United States

CITATION: Hossler P, Phang K, Passannante M. New Jersey Coaches' Knowledge in Recognizing and Managing Concussion. *The Internet Journal of Allied Health Sciences and Practice*. Jan 2013. Volume 11 Number 1.

ABSTRACT

High school coaches' knowledge regarding the recognition and management of concussive injuries in adolescent athletes has not been assessed in New Jersey. The purpose of this study was to assess high school coaches' knowledge, attitudes, and practices regarding recognition and management of concussive injuries in athletes. A cross-sectional anonymous 15-item web-based survey of high school coaches in New Jersey was performed between May 2010 and June 2010. Chi-square and Fisher's exact tests were used to compare proportions, and t-tests and analysis of variance were used to analyze group differences for normally distributed continuous data. When data were missing, these responses were excluded from the analysis. All significance testing was conducted at the alpha.05 level. This study yielded a response rate of 45% (537/1197) among coaches who were contacted. Respondents were primarily male (60%) from the largest public schools. The average number of years of coaching was 11 years. Substantial gaps in knowledge were identified among responding coaches. Only 16.9% of coaches correctly described concussion as a chemical disruption; 16% knew that adults recover more quickly from a concussion than teens, and less than half (42.5%) knew that the size of a teen's skull in proportion to their neck and frame would make them more vulnerable to whiplash-like effects. The results indicate the need for formal coaching education programs.

INTRODUCTION

With nearly 1.5 million head injuries occurring in the US each year, the Center for Disease Control and Prevention (CDC) estimates that U.S. emergency departments treat 135,000 sports- and recreation-related traumatic brain injuries annually, including concussions among children ages 5 to 18.^{1,2} Some 8000 children and teens are treated in emergency rooms each day for sports-related injuries.³ Concussions represent approximately 9% of all athletic injuries.⁴ By the time their high school athletic career is over, more than 60% of all teenage athletes will experience some type of concussive injury.⁵

Given the prevalence of concussions among adolescent athletes, there has been a push to educate coaches about the dangers associated with concussions (see for example http://magicvalley.com/news/article_1a11e1d2-ff0c-5dc9-b008da769a0aaa98.html) as well as the proper way to manage concussions should they occur.⁶ A proper understanding of coaches' knowledge is necessary to create appropriate educational programs. However, only a few studies have been conducted to assess the knowledge of high school coaches in the area of concussive injuries, all of which were conducted in the Mid-Western states and the New England area.⁷⁻⁹ To the knowledge of the researchers, there were no such published studies conducted in the densely populated New Jersey-Pennsylvania-New York area. Further studies should be conducted to evaluate the differences in the knowledge, attitudes, and practices of high school coaches throughout the nation.

As of April, 2012, there were 38 states that passed legislation stating the need for and methods by which scholastic coaches should have annual education in the area of concussion (see <http://nflhealthandsafety.com/zackery-lystedt-law/states/>). The purpose, therefore, was to conduct a pilot study to gather quantitative data on the knowledge, attitudes, and practices of high school coaches in New Jersey regarding their recognition and management of concussive injuries in athletes. In response to the heightened awareness for safety and recognition of adolescent concussive injuries, this pilot study was developed to assess coaches' knowledge in the era prior to mandated education.

METHODS

Names and e-mail addresses of athletic directors (ADs) at New Jersey public (funded by the government, where students attend free of charge), private (funded by a private entity, where there is a fee for attendance) and parochial (funded by religious organization- i.e. Catholic Schools) high schools were utilized from the printed New Jersey State Interscholastic Athletic Association (NJSIAA) School Directory 2008-2009 edition. When e-mail addresses were unavailable, ADs were contacted by phone to request this information. All ADs were sent a personalized e-mail letter explaining the purpose of the survey. The ADs were also asked to forward a request to complete a web-based encrypted concussion survey, developed using SurveyMonkey, to all of the athletic coaches at their schools. In addition to asking these ADs to forward the e-mail request to their coaches, they were asked to provide the number of coaches on staff and the number of coaches on staff who were sent the e-mail by entering this information into a separate web-based and encrypted SurveyMonkey form. ADs were prompted electronically with follow-up e-mails to re-send the request to their coaches 3 times at 1-2 week intervals so that those who had not completed the survey would be reminded to do so. The reminder e-mails instructed coaches to ignore the repeat requests if they had already completed the survey. All participants were made aware that their participation in the survey was completely voluntary. Email requests were sent to ADs beginning on May 25th, 2010 and continuing through the middle of June 2010. Survey responses were collected through June 30th, 2010.

The New Jersey High School Coaches Concussion Survey included 25 multiple choice (some with multiple sub-questions) and one open-ended question (Appendix 1). The survey questions were developed using concussion information available on the Centers for Disease Control and Prevention website (<http://www.cdc.gov/concussion/HeadsUp/youth.html>) and questions used by previous researchers in this area.⁷ We obtained permission to replicate questions from Guilmette et al.⁷ Experts in the field were utilized to test the survey for clarity of wording and content (measures of content validity) before finalizing the survey. The UMDNJ Newark Campus IRB determined this project to be Non-Human Subjects Research (IRB Protocol Number: 0120100093).

The study data were analyzed using the JMP statistical software package (SAS, Cary NC).¹⁰ Ninety-five percent (95%) confidence intervals were generated for proportions; chi-square and Fischer's Exact test were used to compare proportions along with t-tests and analysis of variance to analyze group differences for normally distributed continuous data. When data were missing, the responses were excluded from the analysis. All significance testing was conducted at the alpha.05 level.

RESULTS

Response Rates

Two hundred and twenty-eight (228) athletic directors (ADs) in New Jersey were contacted via e-mail. Incorrect e-mail addresses were corrected when information was available. After 3 attempts, only 9 ADs could not be contacted. A total of 38 ADs responded to the survey, either by completing the SurveyMonkey form or simply by replying to our e-mail letter. This represents a 17% (38/219) response rate for ADs who could be contacted via e-mail. Thirty-three ADs provided information on the number of coaches at their school. Based on the information provided by the ADs, the minimum number of coaches at a school was 5 and the maximum number was 134, with a median value of 25 coaches. These 33 athletic directors sent request letters, developed by us, to 1197 coaches asking them to complete the New Jersey High School Coaches Concussion Survey online; 544 responded by completing the survey. Of these 544 respondents, 7 surveys were removed from the dataset because respondents stated that they were not coaching a high school sport. The final response rate for the survey was 45% (537/1190) among those coaches that were contacted by their ADs.

Sample Characteristics

The majority of coach respondents were from NJSIAA Group III (28.3%) and IV (36.5%), with Group IV being schools with the largest student body and Group I being the smallest. Coaches working for public (vs. private) high schools accounted for 88.3% of the responding coaches. Of 537 responders, 91.5% (440/481) reported having an athletic trainer available during practices at their school, and 81.2% (388/478) reported having an athletic trainer present at their games. Finally 42.4% (202/476) of these coaches reported having 1 or more student athletes experience a concussion in an average year (see Table 1).

Table 1. Responding Coaches School Characteristics

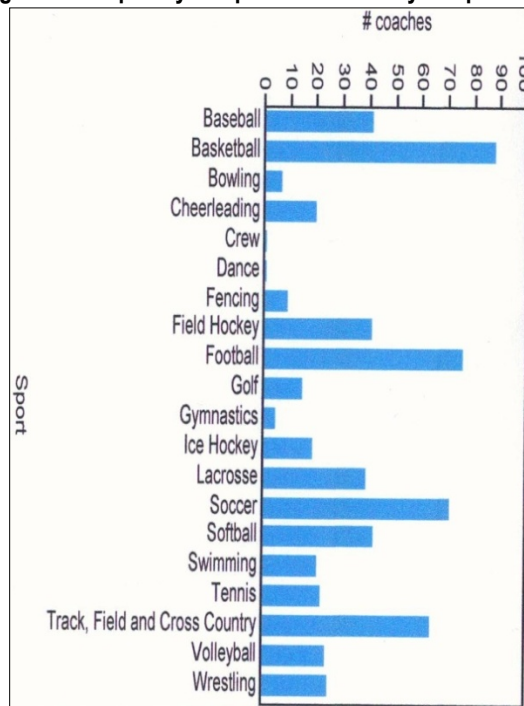
Question	(N=537)	Proportion (95% CI)
High School NJSIAA group?		
Group A	18	3.9% (2.5-6.1)
Group B	24	5.2% (3.5-7.7)
Group I	69	15.0% (12.0-18.6)
Group II	51	11.1% (8.5-14.3)
Group III	130	28.3% (24.3-32.5)
Group IV	168	36.5% (32.3-41.0)
Missing	77	
Type of high school?		
Private	56	11.6% (9.1-14.8)
Public	425	88.4% (85.2-90.9)
Missing	56	
Athletic trainer present at practices?		
Yes	440	91.5% (88.6-93.7)
Missing	56	
Athletic trainer present at games?		
Yes	388	81.2% (77.4-84.4)
Missing	59	
Frequency with which student-athletes experience a concussion? (on average)		
0 per year	274	57.6% (53.1-61.9)
1-2 per year	134	28.2% (24.3-32.4)
3-4 per year	53	11.1% (8.6-14.3)
≥5 per year	15	3.2% (1.9-5.1)
Missing	61	

The respondents were primarily male [60.9%, (290/476)]. The mean number of years of coaching was 11.3 years (Standard Deviation 9.0) and the median number of years coaching was 9 years. There was substantial variability in the number of years of coaching with a minimum of 1 year and a maximum of 40 years of coaching experience. In addition, 20.1% (97/482) of coaches reported receiving some formal training in concussion recognition or management (Table 2). Respondents represent coaches of 20 different sports with basketball, football, soccer, and cross country being the most frequently coached sports (Figure 1).

Table 2. Descriptive Statistics and Comparison of Treatment and Control Group at Pre and Post (n=7)

	% male (95% Confidence Interval)	Mean	Median	Standard Deviation
Gender of respondents (61 missing)	60.92% (56.47%-65.20%)			
Years Spent as a coach (59 missing)		11.33	9.0	8.98
% of coaches who reported ever receiving formal training in concussion recognition or response (55 missing)	20.12% (16.79%-23.93%)			

Figure 1. Frequency of Sports Coached by Respondents



Concussion Knowledge

Coaches were asked to respond to a series of 21 multiple choice questions aimed at assessing their knowledge related to concussion. Only 16.9% [(90/534) 95% CI 13.9% - 20.3%] of coaches correctly described concussion as a chemical disruption altering brain nerve transmission. Furthermore, 16% [(87/534) 95% CI 13.4% - 19.7%] of coaches knew that adults recover more quickly from a concussion than teens, and slightly less than half, 42.5% [(227/534), 95% CI 38.4%-42.5%], knew that the size of a teen's skull in proportion to their neck and frame would make them more vulnerable to whiplash-like effects. The vast majority, 98.4% [(529/537), 95% CI 97.1% - 99.2%], knew that concussive episodes have a cumulative effect, and 76.9% [(390/507), 95% CI 73.1%-80.4%] knew the National Federation of State High School Association's (NFHSA) guidelines that state if a student athlete is suspected of having sustained a concussion during an athletic activity, that the first response should be to keep him/her out of activity.^{1,11}

Questions related to the recognition of the signs and symptoms of concussion in a student athlete and recommendations following a concussive injury were also included in our survey. Correct responses to 21 multiple choice knowledge questions were given a score of 1, and all 21 questions were summed to create a total knowledge score. (Responses to survey items 1, 2, 3, 4, 5, 7, 8 and 9 were included in knowledge score- Appendix I.) Only those coaches who answered all 21 questions were included in our calculation (missing observations=85). Knowledge scores ranged from a low of 6 to a high score of 21, with a median score of 14 and mean score of 14.3 (95% CI 14.17-14.49) (Figure 2).

Figure 2. The Distribution of Knowledge Score for High School Coaches



Knowledge level was not statistically associated with NJSIAA group affiliation, school type (public vs. private), presence of athletic trainer at practices or games, gender of the coach, years coached (grouped by quartile), or the approximate number of

student-athletes experiencing a concussion each year at the coach's school. The only variable that was significantly associated with knowledge was whether the coach reported having received any formal training in concussion recognition and response (t-test, $p=0.0042$). The mean knowledge score among those who had formal training in concussion recognition and response was 14.82 (95% CI 14.47-15.17) compared to those who had no formal training in this area 14.24 (95% CI 14.07-14.42).

Misconceptions Regarding Concussion

Prior concussion studies examined some common misperceptions regarding concussions among coaches and the general public.⁷ In this study, choosing an absolute "True" or "False" response to the questions pertaining to common misperceptions held by coaches would support those misperceptions. Only a small proportion of respondents chose an absolute "True" or "False" response. However, a larger percentage did choose "Probably True" or "Probably False" in these cases (Table 3). For each statement, the misconception is stated below it. The opposite of the statement is actually correct.

Table 3. Common Misperceptions Regarding Concussion Among Responding Coaches

Question	False	Probably false	Probably true	True
A person who has recovered from a head injury is less able to withstand a second blow to the head. Common Misconception: False (N=490)	8.2%	8.8%	39.4%	43.7%
It is easy to tell if a person has brain damage from a head injury by the way a person looks or acts. Common Misconception: True (N=489)	46.4%	35.2%	14.3%	4.1%
People who have had one head injury are more likely to have another. Common Misconception: False (N=489)	8.8%	14.7%	38.0%	38.5%
A head injury can cause brain damage even if the person is not knocked out. Common Misconception: False (N=485))	0.4%	1.4%	22.3%	75.9%
A concussion is harmless and never results in long-term problems or brain damage. Common Misconception: True (N=487)	90.1%	6.0%	2.5%	1.4%
Sometimes a second blow to the head can help a person remember things that were forgotten. Common Misconception: True (N=487)	74.7%	20.1%	3.9%	1.2%

Injury Scenarios

Coaches were asked to respond to three injury scenarios to gauge how they might respond to a possible concussion situation involving their student-athletes. The majority of coaches chose the recommended response to each scenario. The vast majority 86.6% [(421/486), 95% CI 83.3-89.4%], knew that a student athlete who came off the field dazed and unsteady should be kept out of physical activity for the day, even if the headache was gone and the athlete's vision had cleared up after 10 minutes. However, only 58.9% [(284/482), 95% CI 54.4%-63.3%] of coaches knew that they should provide a mother, who was concerned that her son had sustained a head injury during a soccer game, with a pamphlet and advise her to review the signs and symptoms of concussion. In fact, another 35.5% (171/482) of coaches (95% CI 31.3%-39.8%) thought that they should tell the concerned parent that "a CT scan is always a good idea because it can detect minor concussions." Finally, in a scenario where a team is returning home on a bus and an athlete starts to complain of severe headaches, nausea, and feeling faint, only 56.8% [(274/482), 95%CI 52.4%-61.2%] knew that they should NOT lay the athlete down on his back with his feet elevated to prevent shock due to increase blood flow to the head (Figure 3). Coaches were asked to provide their opinion as to how likely most student-athletes are to report a possible concussion to their coach. Fifty percent (247/492) believed student-athletes reporting a concussion was unlikely (combining "very unlikely" with "somewhat unlikely") to happen and only 6.7% (33/492) believe that this was "very likely" (Figure 4).

Figure 3. Coaches Respond to Injury Scenarios

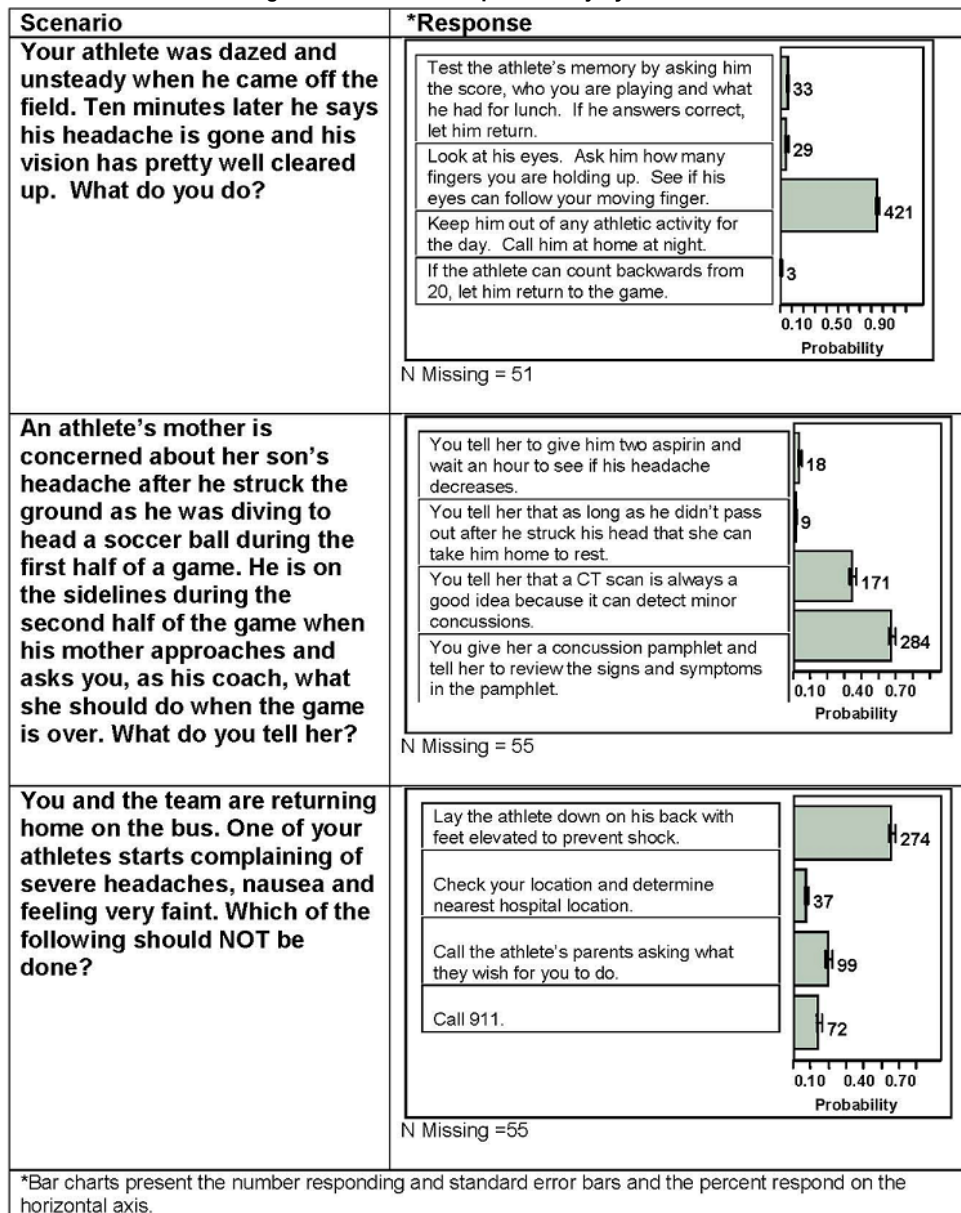
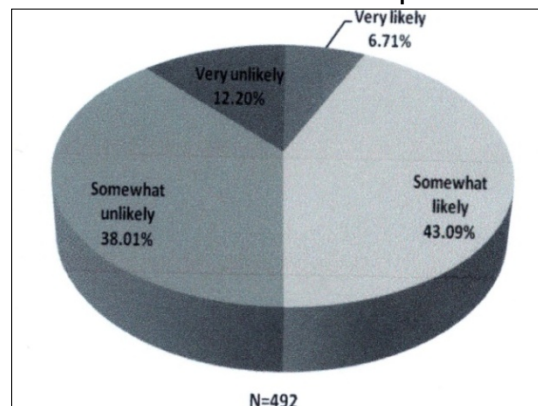


Figure 4. How Likely Do You Think Most Student-Athletes Are to Report a Possible Concussion to Their Coach?



DISCUSSION

The CDC estimates that U.S. emergency departments treat 135,000 sports- and recreation-related traumatic brain injuries annually, including concussions among children ages 5 to 18.² What's more, despite several initiatives by the CDC and other organizations to train and inform coaches about concussive injuries, many coaches are still lacking the knowledge and skill needed to identify these injuries in their athletes.^{1,7,12} Furthermore, there are more than 3.5 million youth coaches in the U.S.; however, no programs for certifying these coaches have been adopted nationally.⁸ Researchers recommend that coaches, parents, and athletes educate themselves in recognizing and managing concussions.¹³ Over 90% (440/481) of the coaches who responded reported that their school had the services of a state licensed athletic trainer. Ninety-one percent (440/481) of respondents reported that they had a certified athletic trainer available for practices, and 81% reported have an AD (388/478) present at games. However, the appearance of a certified athletic trainer at every game is unlikely because more than one game can occur simultaneously or other games are being held at off campus sites. In addition, it must be remembered that for these questions, there was likely more than one coach who responded about the same school. Given this, it is important to evaluate the knowledge of coaches in the area of concussive injuries, especially since coaches are likely to be one of the first people that the student-athletes will encounter after an injury. However, very few studies have been conducted to assess the knowledge of high school coaches in the area of concussive injuries.⁷ The purpose of our study was to assess the knowledge, attitudes, and practices of high school coaches in New Jersey regarding their recognition and management of concussive injuries in athletes.

As noted previously, according to the information provided by the ADs, the minimum number of coaches at schools who were asked to complete this survey was 5 and the maximum number was 134, with a median value of 25 coaches. Therefore, the proportion of coaches who report having an athletic trainer available for practices and at games does not represent all schools in New Jersey and seems likely to be an over-estimate of what is happening at schools throughout the state.

The coaches surveyed averaged 11 years of coaching experience, but to date, only 20% (97/482) reported having any formal education on concussion. So, while experienced in coaching, the coaches may not have been educated in concussion recognition. The results of our study showed a small but statistically significant association between knowledge and receiving formal training in recognizing and responding to concussions. In general, knowledge of adolescent student-athletes' anatomy as it relates to concussive injury potential was lacking. Approximately 17% (40/534) knew that concussive injuries resulted in a chemical rather than a physical disruption.¹ Thirty-five percent (171/482) would recommend a CT scan to a parent, despite the fact that CT and MRI scans will not detect a concussion.¹⁴ Only 16% (87/534) knew that adults typically recover faster from concussions compared to teenagers.^{15,16} In addition, only 42.5% (227/534) correctly knew that the difference between an adolescent's head size with body size and neck strength compared to an adult's may predispose them to greater whiplash effects.¹ Slightly more than half [57%, (274/482)] knew that laying a concussed athlete on his back and raising his legs to treat shock would be contraindicated as it would increase blood flow to injured brain tissue.¹⁷ This suggests that greater and broader first aid for sports injuries education would be appropriate. Finally, the results may actually overestimate the knowledge of coaches somewhat because we chose not to include missing values as incorrect responses. It is possible that those who did not know the answers to some of these questions simply left the responses blank.

The study found that when "False" and "Probably False" were combined as one category and "True" and "Probably True" were combined, 3.9% (19/487) and 5.1% (25/487) believed a "concussion was harmless and never results in long term problems or brain damage" and "sometimes a second blow to the head can help a person remember things that were forgotten", respectively (Table 3). Results from the Guilmette study showed that none of the responders believed that either of those misperceptions was correct.⁷ However, even though a small proportion of coaches in the present study believed that a concussion is harmless and that sometimes a second blow could be helpful, overall, a majority of the responding coaches were able to dispel many of the current misperceptions regarding concussive injuries. This suggests that many New Jersey coaches are acquiring information on the facts regarding concussions.

The survey also examined how each coach would respond to specific scenarios they might encounter where the athlete has experienced a concussion during a game and the coach was asked to choose the correct response for each scenario. The majority, 77% (390/507), knew National Federation of State High School Association's recommendation to remove any suspected concussed athlete from play immediately.¹⁸ Unfortunately, only 59% (284/482) thought to provide the parent with a fact sheet describing the signs and symptoms for which they should watch.

Watching the concussed athlete for signs and symptoms is extremely important, as many athletes choose to ignore or hide these signs and symptoms out of fear of not returning to play soon enough, and this makes the task of recognizing and responding to a concussion particularly challenging for coaches.⁸ In this study, 50.2% (247/492) of New Jersey coaches

responding reported that athletes would be unlikely to report a possible concussion. This is a little higher than what was reported in the Guilmette et al study, which reported that 41% (25/62) of coaches believed players rarely report concussions.⁷ This is of importance because 30% of all high school and collegiate football players sustaining concussions return to competition on the same day of injury.¹⁹ Many older return-to-play guidelines call for the athletes to be symptom free for at least 7 days before returning to participation after a mild to moderate concussion.²⁰ In an earlier study, Guskiewicz et al reported that certified athletic trainers reported 5.1% (888/17 549) of football players sustained a concussion during a season, and approximately 15% (131/888) sustained a second concussion during the same season.²¹ Football players who sustained a concussion during the season were 3 times more likely to sustain multiple concussions during the same season.²¹ This may be because concussions are underreported by the athletes.²² McCrea et al reported the most common reasons athletes give for not reporting an injury is they don't think the injury is serious enough to be reported (66.4%), they don't want to be kept out of play (41.0%), and lack of awareness of possible concussion (36.1%).²² This should alert the athlete's caregivers and coaches that athletes do not always willingly and accurately address concussions. Therefore, it is particularly important to also educate athletes about concussions. In addition, coaches having adequate knowledge of concussion could inevitably decrease the number of athletes who return to play symptomatic as they would be better equipped to recognize the signs and symptoms of a concussion.⁸

Study Limitations

The sampling methods used in this study resulted in a sub-optimal participation rate among ADS [17%, (38/219)]. However, the response rate among the coaches who were contacted by their ADS was much higher, 45%, (537/1190). This study suggests that in future studies of coaches, a more direct method should be used to identify the coaches themselves and that relying on a third party to transmit the survey participation requests should be avoided. The response rate may also have been impacted by the fact that the survey was conducted at the end of the school year when coaches/teachers are busy with end of the year obligations. Although a higher response rate is preferable, the study's response rate of 45% is higher than that of a comparable study, reporting a 30% (62/207) response rate.⁷ A more serious concern is that coaches could only be contacted if their athletic director agreed to participate in the study. Therefore, not all NJ scholastic coaches were given the opportunity to participate in the survey. A further limitation of the study, related to the sampling scheme, threatens the generalizability of the results because coaches from the same school may be more like each other in terms of their knowledge related to concussion. Unfortunately, because this was an anonymous survey, we were unable to adjust for a possible clustering of responses by school.

CONCLUSIONS

Concussive injuries are a growing public health issue in the US, as the statistics reveal that more and more youth athletes are at risk of experiencing a concussion and their effects. This study showed the need for broader educational initiatives among scholastic coaches. Studies have shown the reluctance of teenage athletes to report concussive injuries.^{1,7,22} It therefore behooves their caregivers and coaches to be cognizant of signs and symptoms indicative of a concussion. Coaches on all levels of athletic participation should be able to recognize a possible concussion, act accordingly, and refer a concussed athlete to a trained healthcare provider. It should be noted that it was not assumed that coaches should have advanced knowledge in order to diagnose severity or determine return to play standards. This study shows a small but significant association between formal education and greater knowledge related to the recognition and management of concussions. Educating coaches will hopefully decrease the number of concussed athletes who return to play prematurely, improve both safety and first aid skills.

DECLARATION OF INTEREST

The authors report no declarations of interest.

REFERENCES

1. Theye F, Mueller KA. "Heads up": Concussions in high school sports. *CM&R*. 2004;2(3):165-71. [PMID 15931353]
2. Centers for Disease Control and Prevention. Brain Injury Awareness Month- March 2011. *MMWR*. 2011;60:249.
3. National Athletic Trainers' Association Website. Available at: <http://www.nata.org/NR120710b>. Accessed June 20, 2011
4. Halstead ME, Walter KD, Council on Sports Medicine and Fitness. Sports related concussion in children and adolescents. *Pediatrics*. 2010;126(3):597-615. [PMID 20805152]
5. Collins MW, Hawn KL. The clinical management of sports concussion. *Curr Sports Med Rep*. 2002;1(1):12-22. [PMID 12831642]
6. Times-News MagicValley.com Website. Available at: http://magicvalley.com/news/article_1a11e1d2-ff0c-5dc9-b008-da769a0aaa98.html. Accessed February 29, 2012.
7. Guilmette TJ, Malia LA, McQuiggan MD. Concussion understanding and management among New England high school football coaches. *Brain Inj*. 2007;21(10):1039-47. [PMID 17891566]
8. Valovich McLeod TC, Schwartz C, Bay RC. Sport-Related Concussion Misunderstandings Among Youth Coaches. *Clin J Sport Med*. 2007;17(2):140-2. [PMID 17414483]

9. Ransone J, Dunn-Bennett LR. Assessment of First-Aid Knowledge and Decision Making of High School Athletic Coaches. *J Athl Train*. 1999;34(3):267-71. [PMID 16558575]
10. JMP Version 9.0. Cary, North Carolina, 2010.
11. Guskiewicz KM, McCrea M, Marshall MW, et al. Cumulative effects associated with recurrent concussions in high school football: The NCAA Concussion Study. *JAMA*. 2003;290(19):2549-55. [PMID 14625331]
12. Centers for Disease Control and Prevention. Concussion toolkit for high school coaches. *MMWR*. 2005;54:934.
13. Viegel JD, Pleacher MD. Injury Prevention in youth sports. *Curr Sports Med Rep*. 2008;7(6):348-52. [PMID 19005358]
14. Guskiewicz KM, Bruce SL, Cantu RC, et al. National Athletic Trainers' Association Position Statement: Management of Sport Related Concussion. *J Athl Train*. 2004;39(3):280-97. [PMID 15514697]
15. McCrory P, Collie A, Anderson V, Davis G. Can we manage sports related concussions in children the same as adults. *Br J Sports Med*. 2004;38(5):516-9. [PMID 15388528]
16. Field M, Collins MW, Lovell MR, Maroon J. Does age play a role in recovery from sports-related concussion? A comparison of high school and collegiate athletes. *J Pediatr*. 2003;142(5):546-53. [PMID 12756388]
17. Stubbe HD, Greiner C, Van Aken H, et al. Cerebral Vascular and Metabolic Response to Sustained Systemic Inflammation in Ovine Traumatic Brain Injury. *J Cereb Blood Flow Metab*. 2004;24(12):1400-8. [PMID 15625414]
18. National Federations of State High School Associations Website. Available at: <http://www.nfhs.org/content.aspx?id=5786>. Accessed June 20, 2011.
19. Gennarelli TA. Mechanisms of brain injury. *J Emerg Med*. 1993;11(suppl 1):5-11. [PMID 8445204]
20. Cantu RC. Return to play guidelines after a head injury. *Clin Sports Med*. 1998;17(1):45-60. [PMID 9475970]
21. Guskiewicz KM, Weaver NL, Padua DA, Garrett WE Jr. Epidemiology of concussion in collegiate and high school football players. *Am J Sports Med*. 2000;28:643-50. [PMID 11032218]
22. McCrea M, Hammeke T, Olsen G, Leo P, Guskiewicz K. Unreported concussion in high school football players. *Clin J Sport Med*. 2004;14(1):13-7. [PMID 14712161]

KEY TERMS

Concussion, Questionnaire, Knowledge, High School, Coaches, Management, Recognition, Survey