

FACTORS THAT INFLUENCE COLLEGIATE VARSITY ATHLETES'
KNOWLEDGE OF CONCUSSIONS

A THESIS

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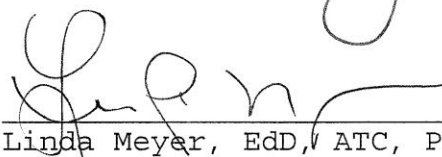
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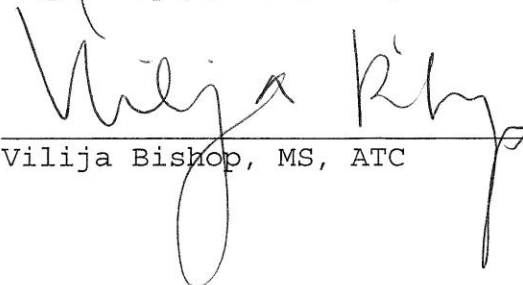
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INTRODUCTION

It is estimated that there are 3.8 million sports-related concussions diagnosed each year.¹ Due to the increasing incidence rate and the latest research, concussions have become a hot topic in the sports and medical communities. Most research thus far has focused on educating allied health and medical professionals such as athletic trainers and team physicians on how to effectively recognize, diagnose, and treat concussions with an emphasis on return to play criteria. However, the many factors that affect athletes' knowledge of concussions, most specifically the causes, signs and symptoms, serious long-term effects, and the return to play criteria, as well as the role of the athlete throughout the entire process, has not been identified. The purpose of the study was to examine factors that affect concussion knowledge in collegiate varsity athletes. Factors that were examined include participation in a concussion education training session, sport, number of years of experience as a college varsity athlete, and personal history of concussions. It was important to examine this because the data may show which factors affect concussion knowledge in athletes, and

allow Team Physicians and Certified Athletic Trainers to address these factors during the preparticipation exam if a lack of concussion knowledge is found.

The 2004 National Athletic Trainers' Association (NATA) Position Statement on Management of Sport Related Concussion defines a concussion as a mild Traumatic Brain Injury (mTBI) which can either be diffuse or focal in nature.² Another definition of a concussion was written in the Zurich Consensus document³ at the Third International Conference on Concussion in Sport held in 2008. This definition is as follows: "a concussion is defined as a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces."³ However, the most recent definition of a concussion was given by the American College of Sports Medicine (ACSM)¹ article entitled "Concussion (Mild Traumatic Brain Injury) and the Team Physician: A Consensus Statement." The ACSM defines a concussion as a pathophysiological process that affects the brain induced by direct or indirect biomechanical forces. All of these definitions are very similar and accurately define a concussion.

The prevalence of reported concussions is very high. However, there are even a higher number of undetected and undiagnosed concussions. According to Bloom et al,⁴ the

number of diagnosed concussions each year is thought to be much lower than the actual rate of incidences. The researchers found that the average number of concussions a male sustained in one year was 3.39, while the average number of diagnosed concussions per year was 0.36. The results show that males suffer more concussions that were undiagnosed. A very similar trend was found in the female subjects as well. The researchers stated that recognition and correct diagnosis of a concussion is one of the most difficult obstacles in the sports medicine field.⁴

Therefore, a significant stress must be put on recognizing the signs and symptoms and using an effective diagnostic technique. Concussions can occur in almost any activity or sport, including both female and male sports. Male athletes are susceptible to concussions because of aggressive and faster pace of play, while females are at a high risk because of their smaller physical size and decreased cervical muscular strength.⁵

The Zurich Consensus Statement on Concussion in Sport³ has also written recommendations for initial assessment and diagnosis of a concussion. The authors stated that when there are any signs that an athlete has sustained a concussion the athlete should be: 1) safely removed from activity, 2) immediately evaluated onsite, 3) a concussion

evaluation tool should be used as soon as possible, 4) constantly monitored and not left alone during the remainder of the athletic event, and 5) if the athlete is diagnosed with a concussion he/she should not be allowed to return to play the same day.³ Using these recommendations and evaluation techniques aids in the diagnosis and management of concussions.

Notebaert and Guskiewicz⁶ conducted a study that investigated the current trends in concussion assessment and management among Certified Athletic Trainers who were randomly emailed through the National Athletic Trainers' Association database. The main results of the survey included: 95% of AT's use a clinical evaluation, 85% use symptom checklists, and 18% use neurocognitive testing to assess concussions. Using this information, the researchers concluded that while there are many different methods to assess and manage a concussion, a multifaceted approach must be used.⁶ This article demonstrates that even though diagnosis can be difficult, recognizing the mechanisms of injury, utilizing a symptom checklist, performing a clinical evaluation, and using a neurocognitive examination are all elements that should be implemented so that a correct diagnosis can be made and effective management can begin.

The ACSM Consensus statement¹ also has guidelines for return to play criteria for concussed athletes. The biggest guideline is that a concussed athlete is never allowed to return to activity the same day as diagnosis. The other return to play guidelines include that all athletes must be asymptomatic, no return of symptoms during strenuous activity or cognitive effort, and neurocognitive testing should be back to baseline results.

The results of this study will inform health care professionals who deal within the athletic population, more specifically team physicians and Certified Athletic Trainers, what factors affect concussion knowledge the most. This will help Team Physicians and Athletic Trainers in the recognition of these factors before the sports season begins and allow them to be addressed so that concussion knowledge can be increased.

METHODS

The purpose of the study was to examine factors that affect concussion knowledge in collegiate varsity athletes. Factors that were examined include participation in a concussion education training session, whether the athlete played football or not, number of years of experience as a college varsity athlete, and personal history of concussions. This section will include the following subsections: research design, subjects, instruments, procedures, hypotheses, and data analysis.

Research Design

A descriptive design was used for this study. The independent variables were concussion education training, experience in a varsity sport, sport, and personal history of concussions. Education training had two levels - varsity athletes with concussion education training and varsity athletes without concussion education training. Experience in a varsity sport had five levels - 1 year, 2 years, 3 years, 4 years, and 5 years. Sport had two levels - football athletes and non-football athletes. History of

concussions had two levels - athletes with no diagnosed concussions and athletes with one or more diagnosed concussions. The dependent variable was the knowledge score as measured by the Concussion Knowledge Survey (Appendix C1). The strength of this study was the reliability and validity of the concussion knowledge survey.

Subjects

The survey was distributed to 500 male and female varsity student-athletes from four colleges and universities in all three NCAA divisions and NAIA division. All subjects were current members of a varsity athletic team at a Division I, II, III, or NAIA collegiate institution. Participation in the study was voluntary based upon completion of the survey. The study was approved by the Institutional Review Board (Appendix C2) at California University of PA.

Preliminary Research

A panel of experts was organized before any research was conducted. The panel consisted of five Certified Athletic Trainers with experience and knowledge of

concussions and survey construction. The panel members were sent the Concussion Knowledge survey and instructions on their responsibilities regarding the survey. The panel members reviewed the survey instrument and cover letter. They added to the content validity and made any recommendations for improvement. After reviewing the survey, the panel members provided critiques and changes that will be reviewed for revision. Necessary changes were made to the survey based on critiques by panel of experts.

Instruments

The Concussion Knowledge survey (Appendix C1) was created by the researcher for the purpose of testing concussion knowledge. The format and ideas for this survey are based off of five studies in which concussion knowledge was tested in different populations.⁷⁻¹¹ The survey was created electronically via www.surveymonkey.com. The subjects were asked to complete demographic information including age, varsity sport, years of experience at NCAA varsity sport, what division their college institution is, whether they have participated in a concussion education training session, what type of training session it was, and their personal history of concussions. Additional questions

tested the subject's knowledge of concussions, signs and symptoms, diagnosis, management, treatment, long term effects, neurocognitive testing, and return to play criteria. The entire survey took approximately 15 minutes to complete.

Procedure

The researcher contacted Athletic Directors at various NCAA Division I, II, III, and NAIA collegiate institutions to obtain written consent and permission to use their varsity athletes in this study. Once obtaining approval from four Athletic Directors, one at each NCAA division and NAIA division, the study was reviewed by the California University of Pennsylvania Institutional Review Board (IRB). Following approval, an email was sent out to all Athletic Directors of the participating institutions to forward to all athletes currently participating in a varsity sport. The email was sent to the subjects via the Athletic Director with a Cover Letter (Appendix C3) explaining the purpose and significance of the study. A link on the cover letter provided the NCAA varsity athletes with direct access to begin the survey. Informed consent was implied when the subject clicked on the link at the

bottom of the cover letter. One additional email was sent one week after the initial one as a reminder. There was no obligation of the subjects to participate. All subjects who completed the survey remained anonymous with no way to trace answers back to one subject. The risk was minimal in this study. The possible risk of harm associated with this knowledge research was psychological and dignitary in nature. Since the responses of each individual were confidential, the risk posed is small. Gathered data was analyzed in terms of the hypotheses.

Hypotheses

The following hypotheses were based on the researcher's intuition and on a review of the literature.

1. Varsity athletes with concussion education training will score higher on the concussion knowledge test than varsity athletes without training.
2. Concussion knowledge will increase with greater years of collegiate experience as a varsity athlete.

3. Athletes with a history of concussions will score higher on the concussion knowledge test than athletes with no history of concussions.
4. Football players will score the highest on concussion knowledge test among all sports.

Data Analysis

All data was analyzed by SPSS Version 18.0 for Windows at an alpha level of 0.05. An independent t-test was used to analyze Hypotheses 1, 3, and 4 to determine if they significantly affect concussion knowledge. A correlation was used to analyze Hypothesis 2. This determined if there was any significant relationship between the number of years as a varsity athlete and the score on the concussion knowledge survey.

RESULTS

The purpose of this study was to examine factors that affect concussion knowledge in collegiate varsity athletes. The data was obtained using a survey created by the researcher. This section contains the following subsections: Demographic Information and Hypothesis Testing.

Demographic Information

The Concussion Knowledge Survey was sent to all student-athletes at the four participating collegiate institutions. A total of 75 surveys were returned with 67 fully completed. The sample consisted of collegiate athletes from Division II California University of Pennsylvania (n=20), NAIA Goshen College (n=41), and Division III Penn State Fayette (n=6). No surveys were returned from Division I Indiana University (n=0). All participants were 18 years of age or older. Table 1 represents the gender classification of participants.

Table 1. Gender Classification

Classification	Frequency	Percent
Male	26	38.8
Female	41	61.2

Table 2 represents the number of varsity athletes who had participated in a concussion education training session.

Table 2. Participation in Concussion Education Training

Classification	Frequency	Percent
Participated	17	25.4
Not Participated	50	74.6

Table 3 represents the number of varsity athletes who participated in football and all other sports (some athletes participated in multiple sports).

Table 3. Sport Classification

Classification	Frequency	Percent
Football	7	11.3
All other sports	55	88.7
Soccer	16	25.8
Volleyball	9	14.5
Track and field	8	12.9
Basketball	7	11.3
Softball	7	11.3
Tennis	4	6.5
Baseball	2	3.2
Swimming	2	3.2

Table 4 below represents the classification of years of experience as a varsity athlete.

Table 4. Years of Varsity Athlete Experience Classification

Classification	Frequency	Percent
1 year	18	33.3
2 years	16	29.6
3 years	11	20.4
4 years	8	14.8
5 years	1	1.9

Table 5 represents the number of athletes with a previous personal history of concussions.

Table 5. History of Concussions

Classification	Frequency	Percent
No previous history (0)	49	73.1
Previous history (1+)	18	26.9

The Concussion Knowledge Survey was used to test the athlete's knowledge of concussions. Each survey was graded as an exam and was worth 67 points with the final score determining the athlete's knowledge score. Each correct answer was given 1 point, while each incorrect answer was awarded 0 points. The athlete's score was then divided by the total possible points (67) and given a percentage with 100% being a perfect score, much like a classroom exam. The following table (Table 6) shows the range of scores in percentages.

Table 6. Concussion Knowledge Scores

Classification	Frequency	Percent
90-100%	23	34.3
80-90%	25	37.3
70-80%	15	22.4
60-70%	3	4.5
<60%	1	1.5

Hypothesis Testing

The following hypotheses were tested in this study. All hypotheses were tested with a level of significance set at $\alpha \leq 0.05$.

Hypothesis 1: Varsity athletes with concussion education training will score higher on the concussion knowledge test than varsity athletes without training.

Conclusion: An independent-samples t-test was calculated comparing the mean concussion knowledge score of varsity athletes with concussion education training to the mean concussion knowledge score of varsity athletes with no concussion education training. No significant difference was found ($t = 1.712, p > .05$). The mean score of the athletes with training ($m = 88.2, sd = 8.47$) was not significantly different from the mean score of the athletes without training ($m = 83.6, sd = 9.65$). This is represented in Tables 7 and 8 below.

Table 7. Independent t-test group statistics: Hypothesis 1

Classification	N	Mean	Std. Deviation
Training session	17	88.2	8.47
No training	55	83.6	9.65

Table 8. Independent t-test: Hypothesis 1

Classification	t	df	Sig. (2-tailed)
Percentage (Equal Variances assumed)	1.712	65	.092

Hypothesis 2: Concussion knowledge will increase with greater years of collegiate experience as a varsity athlete.

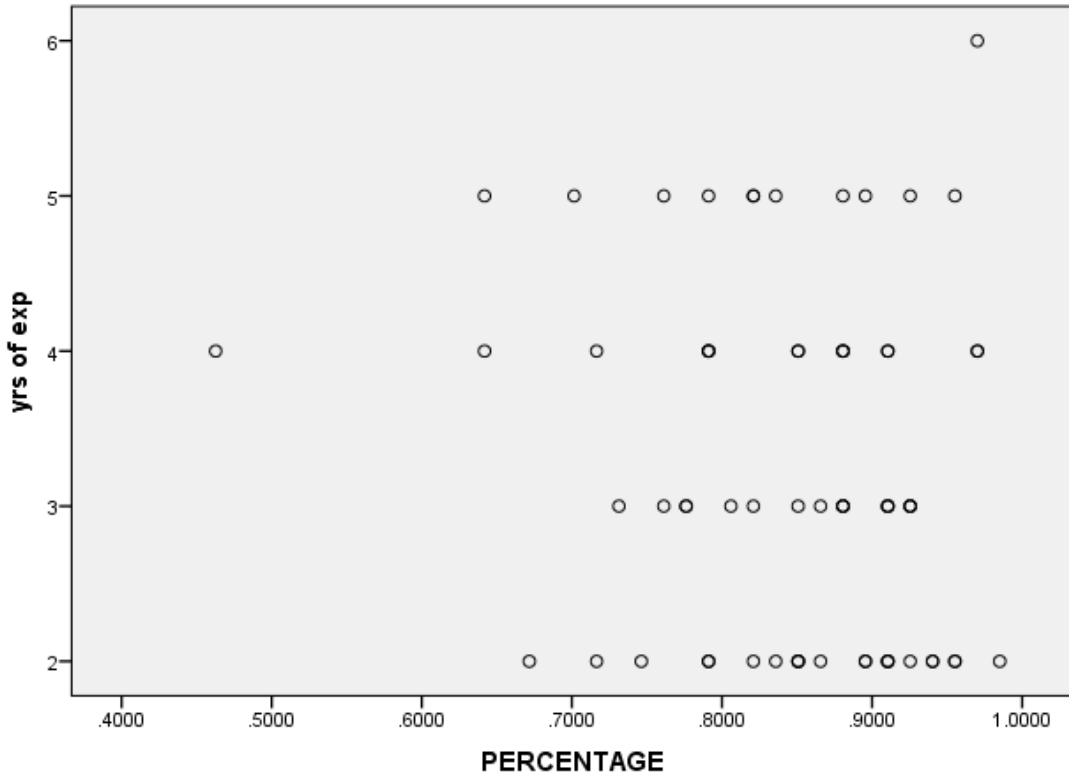
Conclusion: A Pearson correlation was calculated examining the relationship between years of experience as a varsity athlete and concussion knowledge score. A weak correlation that was not significant was found ($r = -.139$, $p > .05$). Years of collegiate varsity experience is not related to concussion knowledge score. This can be seen in Table 9 and Graph 1 below.

Table 9. Pearson Correlation: Hypothesis 2

Classification		Years of Exp.	Score (%)
Yrs of exp	Pearson Cor.	1	-.139
	Sig. (2-tailed)		.267
	N	66	66
Score (%)	Pearson Cor.	-.139	1
	Sig. (2-tailed)	.267	
	N	66	67

Graph 1.

Plot Graph Showing Correlation Between Years of Experience and Percentage on Concussion Knowledge Test



Hypothesis 3: Athletes with a history of concussions will score higher on the concussion knowledge test than athletes with no history of concussions.

Conclusion: An independent-samples t-test was calculated comparing the mean concussion knowledge score of varsity athletes with a personal history of sustaining a concussion to the mean concussion knowledge score of varsity athletes with no personal history of a concussion. A significant difference was found ($t = -3.708, p < .05$). The mean score of the athletes with a history of concussions ($m = 91.3, sd = 5.47$) was significantly higher

than the mean score of the athletes with no history of concussions ($m = 82.4$, $sd = 9.59$). This is represented in Tables 10 and 11 below.

Table 10. Independent t-test group statistics: Hypothesis 3

Classification	N	Mean	Std. Deviation
No History	49	82.4	9.59
History	18	91.3	5.47

Table 11. Independent t-test: Hypothesis 3

Classification	t	df	Sig. (2-tailed)
Percentage (Equal Variances assumed)	-3.708	65	<.05

Hypothesis 4: Football players will score the highest on concussion knowledge test among all sports.

Conclusion: An independent-samples t-test was calculated comparing the mean concussion knowledge score of collegiate varsity football players to the mean concussion knowledge score of collegiate varsity athletes in all other sports. No significant difference was found ($t = 1.361$, $p > .05$). The mean score of the football athletes ($m = 89.3$, $sd = 6.24$) was not significantly different from the mean score of the all other sports athletes ($m = 84.1$, $sd = 9.95$). This is represented in Tables 12 and 13 below.

Table 12. Independent t-test group statistics: Hypothesis 4

Classification	N	Mean	Std. Deviation
Football player	7	89.3	6.24
All other sports	55	84.1	9.95

Table 13. Independent t-test: Hypothesis 4

Classification	t	df	Sig. (2-tailed)
Percentage (Equal Variances assumed)	1.361	60	.179

DISCUSSION

This study has produced findings related to the factors affecting concussion knowledge in varsity collegiate athletes. The following section will discuss these findings and is divided into the following subsections: Discussion of Results, Conclusions, and Recommendations.

Discussion of Results

This study focused on factors that could affect concussion knowledge in collegiate varsity athletes. Factors that were examined were participation in a concussion education training session, whether the athlete played football or not, number of years of experience as a college varsity athlete, and personal history of concussions.

The researcher's first hypothesis was that varsity athletes with concussion education training would score higher on the concussion knowledge test than varsity athletes without training. There was no previous research published or identified on the effectiveness of concussion

education training for collegiate athletes. Based on the researchers own experiences and intuition, it was thought that athletes with a concussion education training session would score higher on the concussion knowledge test. It was found that the athletes who reported participating in concussion education training did score higher on the concussion knowledge test. However, the difference was not significant and does not support this hypothesis. With the lack of significance to show that concussion education training increases knowledge of concussions, the results do not support the research conducted by O'Donoghue et al⁷. O'Donoghue et al⁷ found that coaches who attended a workshop on concussions scored significantly higher on their concussion knowledge test. The results also do not support the findings of Goodman et al.¹² Goodman et al¹² conducted a study to determine the effectiveness of a computer game in increasing youth hockey athletes knowledge of concussion symptoms. There was a significant difference found in those youth athletes who had participated in the *Symptom Shock* computer game and those who had not.

The second hypothesis examined in this study stated that concussion knowledge will increase with greater years of collegiate experience as a varsity athlete. The researcher hypothesized that the athletes with more years

as a varsity athlete would have more experience around concussions than athletes with fewer years at the collegiate level. The researcher also hypothesized that with greater experience comes greater knowledge.

Concussions occur in all sports, so an athlete with four years of experience would have witnessed more concussions than an athlete with one year of experience and therefore have increased knowledge. Surprisingly, it was found that not only was there no significant difference in the correlation between the years as a varsity athlete and the concussion knowledge score, but there was also a weak negative correlation found. This means that on average, athletes with fewer years of varsity experience scored higher than athletes with more years of experience.

The third hypothesis stated by the researcher was that athletes with a history of concussions will score higher on the concussion knowledge test than athletes with no history of concussions. It was thought that athletes with a history of sustaining a concussion would be more familiar with the signs and symptoms, management, and return to play criteria of concussions thus increasing their overall knowledge. There is no previous research identified that has directly studied the effect that previous history of concussions has on the collegiate athlete's knowledge of concussions. In

this study, it was found that collegiate athletes with a personal history of concussions scored significantly higher compared to the collegiate athletes without a personal history. This supports the researcher's hypothesis. These results also coincide with results found by O'Donoghue et al⁷ in which high school coaches' knowledge of concussions was tested. O'Donoghue⁷ found that coaches with a history of concussions scored significantly higher in concussion knowledge. However, in a study conducted by Gourley et al⁸ that examined youth athletes knowledge of concussions, no significant difference was found between youth athletes who reported having their "bell rung" and those who did not.

The researcher's final hypothesis stated that football players would score the highest on the concussion knowledge test among all sports. Crisco et al¹³ conducted a study to determine the frequency and location of head impacts on football players during one season and found that the total number of hits a player received during one season varied by team, type of athletic event (practice, game, etc), and position; and, the maximum number of head impacts ranged from 1022 to 1444 per season. Crisco concluded the type of session and position influences the frequency and location of head impacts. This study indicates that the head impacts, especially repeated impacts, are occurring at an alarmingly

high rate and are a main mechanism of injury for a concussion. Based on the researcher's intuition, experience, and the study conducted by Crisco, it was thought that football players are at the highest risk of sustaining concussions and also have the highest incidence rates, so they would be the most familiar with concussions and would therefore have the highest scores on the concussion knowledge test. It was found that football players did score higher on the test when compared to all other sports. However, the scores were not significantly higher.

Conclusions

The results of this study both support and oppose the results of previous studies. The overall results indicated that participating in a concussion education training session, having greater years of experience as a collegiate varsity athlete, and being a collegiate football player do not significantly impact concussion knowledge, but having a personal history of concussions does significantly increase concussion knowledge. Based on the results of this study, it may be suggested that concussion education training needs to be improved and should be a focus before the

sports season begins. If the concussion education training is improved and completed, it should have a positive, significant effect on concussion knowledge.

Recommendations

The purpose of this study was to identify what factors affected concussion knowledge in collegiate varsity athletes. After reviewing the results, one recommendation would be to increase response rate. This could be accomplished by a greater number of collegiate institutions participating in the study. Also, decreasing the number of steps it took to get the email with the cover letter and link to the survey to the athletes could enlist more participation. Another recommendation would be to implement concussion education programs into collegiate institutions. Every college athlete should be shown a video or given a lecture by a Certified Athletic Trainer before every sports season. The last recommendation would be to have non-athletes participate in the study and to compare the concussion knowledge scores of athletes to non-athletes. This could determine if athletes have a significantly higher knowledge of concussions.

REFERENCES

1. Herring SA, Cantu RC, Guskiewicz KM, Putukian M, Kibler WB. Concussion (Mild Traumatic Brain Injury) and the Team Physician: A Consensus Statement – 2011 Update. *Medicine & Science in Sports & Exercise* [serial online]. 2011;43(12):2412-2422. Available at: www.acsm.org
2. Guskiewicz KM, Bruce SL, Cantu RC, et al. National Athletic Trainers' Association Position Statement: Management of Sport Related Concussion. *J. Athletic Training* [serial online]. 2004;39(3):280-297. Available at: www.journalofathletictraining.org.
3. McCrory P, Meeuwisse W, Cantu R, et al. Consensus Statement on Concussion in Sport: The 3rd International Conference on Concussion in Sport Held in Zurich, November 2008. *J. Athletic Training* [serial online]. July 2009;44(4):434-444. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed September 29, 2011.
4. Bloom GA, Loughead TM, Shapcott EJ, Johnston KM, Delaney JS. The prevalence and recovery of concussed male and female collegiate athletes. *European Journal of Sport Science*. 2008;8(5):295-303.
5. Gessel LM, Fields SK, Collins CL, Dick RW, Comstock RD. Concussions among United States high school and collegiate athletes. *J. Athletic Training* [serial online]. 2007;42(4):495-503. Available at: www.journalofathletictraining.org.
6. Notebaert AJ, Guskiewicz KM. Current trends in athletic training practice for concussion assessment and management. *J. Athletic Training* [serial online]. 2005;40(4):320-325. Available at: www.journalofathletictraining.org.
7. O'Donoghue EM, Onate JA, Van Lunen B, Peterson CL. Assessment of high school coaches' knowledge of sport-related concussions. *Athletic Training & Sports Health Care* [serial online]. 2009;1(3):120-132. Available at: atshc.com

8. Gourley MM, Valovich McLeod TC, Bay RC. Awareness and recognition of concussion by youth athletes and their parents. *Athletic Training & Sports Health Care* [serial online]. 2010;2(5):208-218. Available at: atshc.com
9. Cusimano MD. Canadian minor hockey participants' knowledge about concussion. *The Canadian J. Neurological Sciences* [serial online]. 2009;36(3):315-320.
10. Rosenbaum AM, Arnett PA. The development of a survey to examine knowledge about and attitudes toward concussion in high-school students. *J. Clinical and Experimental Neuropsychology* [serial online]. 2010;32(1):44-55. Available at: <http://www.psypress.com/jcen>
11. Guilmette TJ, Malia LA, McQuiggan MD. Concussion understanding and management among New England high school football coaches. *Brain Injury* [serial online]. 2007;21(10):1039-1047
12. Goodman D, Bradley NL, Paras B, Williamshon IJ, Bizzochi. Video gaming promotes concussion knowledge acquisition in youth hockey players. *J. Adol.* 2006;29:351-360.
13. Crisco JJ, et al. Frequency and location of head impact exposures in individual collegiate football players. *J. Athletic Training* [serial online]. 2010;45(6):549-559. Available at: www.nata.org/jat

APPENDICES

APPENDIX A
Review of Literature

REVIEW OF LITERATURE

Mild traumatic brain injuries, more commonly known as concussions, have become a hot topic in the athletic and medical communities. Currently, there is little information about what student-athletes know about concussions. Most research thus far has been focused on educating allied health and medical professionals such as athletic trainers and team physicians in how to effectively recognize, diagnose, and treat concussions with an emphasis on return to play criteria. However, the significance of examining athlete's knowledge of concussions, most specifically the causes, signs and symptoms, serious long-term effects, return to play criteria, as well as the role of the athlete throughout the entire process has not been published or identified. The purpose of the study was to examine factors that affect concussion knowledge in collegiate varsity athletes. Factors that were examined include participation in a concussion education training session, sport, number of years of experience as a college varsity athlete, and personal history of concussions. Examining the many factors that can affect athlete's knowledge of concussions, as well as assessing athlete's overall knowledge of concussions,

determined if concussion education is needed and helped in the recognition of signs and symptoms, the diagnosis of concussions, the compliance of the athletes, and the prevention of negative long term effects

Therefore, the purpose of this literature review is to inform the reader and gain a greater understanding of concussions. This will be accomplished in the following sections: Concussions, Recognition, Management and Neurocognitive Performance, Long Term Effects, and Return to Play.

Concussions

The understanding of the medical community in regards to the best practices in evaluating and managing concussions is varied for several reasons. Reasons include the difficulty in researching the pathophysiology of brain injury, variation in the presentation of concussed athletes, and the varied recommendations provided by position statements from various medical organizations. This section of the literature review is intended to inform the reader about the definition of a concussion, the impact of a concussion on the brain, the possible mechanisms of

injury, and the prevalence rate of concussions in athletics.

Definition

The 2004 National Athletic Trainers' Association (NATA) Position Statement on Management of Sport Related Concussion defines a concussion as a mild Traumatic Brain Injury (mTBI) which can either be diffuse or focal in nature.¹ Focal injuries are more severe and include hematomas and hemorrhages in the brain, but are very uncommon in sports. Diffuse brain injuries are more commonly seen in sports and are usually referred to as a concussion, sports concussion, and/or mTBI.¹

The American College of Sports Medicine² takes their definition of a concussion from the U.S. Center for Disease Control and Prevention (CDC). The CDC defines a concussion as a "complex pathophysiologic process affecting the brain, induced by traumatic biomechanical forces secondary to direct or indirect forces to the head".² However, the most widely known and unanimously agreed upon definition of a concussion was written in the Zurich Consensus document³ at the Third International Conference on Concussion in Sport held in 2008. This definition is very similar to the CDC definition and is as follows: "a concussion is defined as a

complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces.”³

Impact on the Brain

The brain is a complex vital organ that requires an extensive amount of glucose to function effectively and be able to process cognitive skills. Any force exerted on the brain during a concussion can cause cell deformation, cellular membrane disruption, and ionic imbalances in the brain.^{4,5} During this type of brain injury, no structural damage is incurred by the cell. However, at a cellular level, there is a large exodus of potassium ions coupled with an influx of calcium ions. The ionic imbalance increases the demand for energy (ATP) production to correct the damage. An increase in ATP demand causes an increase in glucose metabolism, meaning glucose in the brain is being used faster and results in an energy crisis.⁴

As stated earlier, glucose is the main fuel the brain uses to cognitively function. Thus, when a mTBI occurs and most of the glucose is being used to correct the tissue damage, a very small amount of fuel is left for the brain to function correctly and at its normal level. Damage to the brain can be caused by several different mechanisms of injury.

Mechanisms of Injury

According to the NATA position statement¹, a sports related concussion most often results from a quick acceleration and deceleration mechanism, either in a linear or rotational plane when the head hits a stationary object or is hit by moving object. This rapid momentum change from acceleration to deceleration causes the brain to incur damage.¹ Any mechanism of a concussion causes the brain to experience compressive, tensile, or shear forces.¹ A compressive force involves a crushing of brain tissue, wherein no additional impact can be absorbed. A tensile force involves stretching of brain tissue. A shearing force involves the stretching of the tissue in opposite directions. Tensile and shear force concussions are considered more severe than compressive force concussions because the tissue can withstand compressive forces easier than stretching forces.¹

Meehan et al⁶ wanted to analyze the mechanisms of injury of concussions with the highest occurrence, most common symptoms, and management of concussions in high school athletes. The population included high school athletes who had sustained a sports-related concussion in the 2008-2009 school year. The results of this study that pertained to the mechanisms of injury were the following:

contact with another player (76.2%) was the highest occurring mechanism of injury, contact with the ground was second (15.5%), and contact with another surface was third most common (7.7%). The specific kind of contact that occurred the most was head to head contact at 52.7%.⁶

Criso et al⁷ conducted a study to determine the frequency and location of head impacts on football players during one season. The population included 188 collegiate football players. There were numerous results that the researchers obtained through this study. The total number of hits a player received during one season varied by team, type of athletic event (practice, game, etc), and position. The maximum number of head impacts ranged from 1022 to 1444 between the three teams tested while linemen and linebackers had the largest number of hits per practice and game. Offensive lineman had a higher percentage of hits to the front of the helmet while quarterbacks had a higher percentage of impacts to the back of the helmet. There was also a much higher average amount of hits per game than per practice for each team. The researchers concluded that the type of session and position influences the frequency and location of head impacts.⁷ This study indicates that head impacts, especially repeated impacts, are occurring at an alarmingly high rate and are a main mechanism of injury for

a concussion. The study also suggests why football has been shown to have a very high incidence rate of concussions.

Incidence Rates

Concussions can occur in contact and non-contact sports, as well as in both females and males. According to the University of Pittsburgh Department of Neurological Surgery,⁸ there are 1.6 million sports-related concussions occurring each year. It is also estimated that an athlete playing in a contact sport has a 19% chance of suffering a concussion sometime in his/her career. Thirty four percent of high school athletes have had at least one concussion and 20% have had multiple.⁸ This informative article showed how prevalent concussions are in the athletic population and that the risk of sustaining one is very high. This section investigates the prevalence rates among different sports in high school, collegiate, and professional settings, as well as between female and male athletes.

Gessel et al⁹ conducted a study to determine the prevalence of concussions and compare the rates among the high school and collegiate settings. The population of this study included high school and collegiate athletes. The researchers analyzed two injury surveillance programs to determine the prevalence of concussions and any patterns

associated within the data. The results were as follows: concussions consisted of 8.9% of all high school injuries and 5.8% of collegiate injuries, football and soccer had the highest incidence rate in both high school and college, and females had a higher rate of concussions in the high school setting. The researchers also found that college athletes had a greater incidence rate of concussions than high school athletes, but that concussions represented a higher proportion of all injuries among high school athletes.⁹

In a meta-analysis by Tommasone and Valovich,¹⁰ the researchers examined which sports have the highest incidence rate of concussions. They examined the prevalence rates of American football, boxing, ice hockey, judo, karate, tae kwon do, rugby, and soccer in female athletes, if applicable, and male athletes within the high school, collegiate, and professional settings. The investigators reviewed 23 articles that fit all of their criteria and found that at the high school level for male athletes, ice hockey had the highest level of incidence while soccer had the lowest. However, at the professional level for males, ice hockey, boxing, and rugby had the highest incidence rates. For females, in the sports reviewed, tae kwon do had the highest incidence rates of concussions.¹⁰

Bloom et al¹¹ conducted an investigation with two main purposes: 1) to identify if gender affects the number of concussions an athlete sustains and the amount time until recovery and 2) to analyze gender and type of sport on occurrence and time to return to play. The participants consisted of 170 college student athletes who had sustained at least one concussion in the previous year at the time of the study. The participants completed two questionnaires used to determine their previous history of concussions. The results were the following: males sustained more overall concussions than females, males sustained more unrecognized concussions than females, male basketball players took longer to return than female basketball players, and female hockey players took longer than males to recover. The researchers concluded that gender does influence the number of concussions sustained because males were found to have sustained more concussions overall. They also concluded that males have more unrecognized concussions because males are generally less likely to report symptoms. The authors determined that the main reason male athletes have a higher incidence rate of concussions is because of their aggressive and faster pace of play and participation in collision sports such as football, hockey, and rugby while the reason females are so

susceptible to concussions is because they normally are smaller physically and have weaker neck strength.¹¹

Recognition

As reported above, the prevalence of reported concussions is very high. However, there are even a higher number of undetected and undiagnosed concussions. According to Bloom et al,¹¹ recognition and correct diagnosis of a concussion is one of the most difficult barriers in the medical profession, and the number of diagnosed concussions each year is thought to be much lower than the actual rate of incidences.¹¹ Therefore, a significant stress must be put on recognizing the signs and symptoms and correct diagnosis techniques. This section will inform the reader on the signs and symptoms and diagnosis of concussions.

Signs and Symptoms

According to the University of Pittsburgh Medical Center⁸ and NATA Position Statement,¹ the early signs and symptoms of a concussion can include the following: confusion, amnesia, loss of consciousness, headache, dizziness, nausea, vision problems, vomiting, balance problems, and tinnitus. Other symptoms that can occur after

the initial injury could include memory problems, trouble sleeping or falling asleep, lack of concentration, fatigue, personality changes, depression, decrease in ability to think critically and cognitively, and irritability.⁸ These signs and symptoms do not encompass every possible sign or symptom but are a general list used to help in the diagnosis and assessment of a sports related concussion.

Frommer et al¹² conducted a research study with the purpose investigating the similarities and differences of concussion symptoms and return to play time between males and females. The population for this study consisted of 812 high school athletes who had sustained a concussion in the previous two school years. Data was collected through an online injury reporting website and then analyzed by researchers. The results of this study included the following: no significant differences between genders in the number of symptoms reported, males reported amnesia and confusion more often than females, females reported drowsiness and noise sensitivity more than males, and no significant differences were found for time to return to play. The researchers came to the conclusion that both genders have the same number of symptoms and time to return to play, but that there is a difference in the type of symptoms experienced by each sex.¹²

In a study by Mansell et al,⁵ the relationship between a documented history of concussion in an athlete and experiencing signs and symptoms after sustaining head trauma was investigated. The population in this study was made up of 168 collegiate male football players and 33 collegiate female soccer players. The results of this retrospective study were that only 60% of athletes with no history of concussions reported signs and symptoms following a head injury while 80% of athletes with a history of concussion reported signs and symptoms following a head injury. The researchers concluded that there is a significant association between having a history of concussions and the occurrence of signs and symptoms with a head injury.⁵ This study shows that the previously reported amount of athletes who have sustained a concussion or who will sustain multiple concussions has a significant effect on the signs and symptoms.

The researchers of this study wanted to investigate how individuals who had sustained a concussion could perform when given a gait/cognition dual task. The subjects consisted of 10 concussed individuals and 10 healthy (control) individuals. The main result of this study was that there was a significant deficit in performance among those with a concussion on the first testing day (within 48

hours of injury). The researchers concluded from this deficit that attentional capacity deficits could be a contributor to gait abnormalities following sustaining a concussion.¹³ This study shows that there can be great variability in concussion symptoms and deficits.

Meehan et al⁶ analyzed the mechanisms, symptoms, and management of concussions in high school athletes. The symptom results of this study were the following: 93.4% of participants experienced a headache, 74.6% complained of dizziness, 56.6% had difficulty concentrating, 46.0% experienced confusion, 37.5% had vision complications, 28.9% had nausea, 26.5% had drowsiness, 24.3% experienced amnesia, 18.9% complained of sensitivity to noise, 10.7% had tinnitus, 9.8% experienced irritability, and 4.6% had a loss of consciousness. Also, the researchers found that 83.4% of participants had no symptoms within one week and 1.5% had symptoms last longer than one month. The researchers concluded that headache is the most common symptom experienced and that some athletes with concussions can have symptoms last up to a month or longer.⁶

Diagnosis

Diagnosing a sports-related concussion can be difficult to accomplish because of the many different signs

and symptoms and also the fact that sometimes signs and symptoms may be delayed or not present at all.

The Zurich Consensus Statement on Concussion in Sport³ has also written recommendations for initial assessment and diagnosis of a concussion. The authors stated that when there are any signs that an athlete has sustained a concussion, the athlete should be safely removed from activity, immediately evaluated onsite, a concussion evaluation tool should be used as soon as possible, the athlete should be constantly monitored and not left alone during the remainder of the athletic event, and if the athlete is diagnosed with a concussion should not be allowed to return to play the same day.³ Using these recommendations and evaluation techniques aids in the diagnosis of concussions.

Notebaert and Guskiewicz¹⁴ conducted a study that investigated the current trends in concussion assessment and management among Certified Athletic Trainers. The participants in this study consisted of 927 Certified Athletic Trainers who were emailed a survey. The main results of the survey included: 95% of ATC's use a clinical evaluation, 85% use symptom checklists, and 18% use neurocognitive testing to assess concussions. Other results showed that the American Academy of Neurology was the most used grading scale, the most important tools for return to

play criteria (according to ATC's surveyed) were clinical examination, symptoms checklist, and return to play guidelines, and that only 3% of ATC's surveyed complied with the NATA guidelines which supported the use of symptoms checklist, neurocognitive testing, and balance testing for managing and return to play decision making. Using this information, the researchers concluded that a very low number of ATC's are following the position statement on concussions and that while there are many different methods to assess and manage a concussion, a multifaceted approach must be used.¹⁴ This article demonstrates that even though diagnosis can be difficult, recognizing the mechanisms of injury, utilizing a symptom checklist, performing a clinical evaluation, and using a neurocognitive examination are all elements that should be implemented so that a correct diagnosis can be made and effective management can begin.

Management and Neurocognitive Performance

This section of the literature review is intended to inform the reader about the management of concussions and the importance of neurocognitive testing and performance.

Management

A study was conducted by Covassin et al¹⁵ to determine the current concussion management and treatment methods taught to athletic training students in the classroom and on clinical rotations. The participants in this study consisted of 513 athletic training education program directors and athletic trainers. All participants were given a survey that asked about education level, years of experience, preferences of position statements and concussion grading, and guidelines for concussion assessment and return to play criteria at their place of employment. The results of this study were the following: 61% use the NATA position statement as a guide to assessment, management, and return to play criteria. The authors found that the use of neuropsychological testing is steadily on the increase and its importance in return to play decisions is being emphasized more. The overall conclusion of this research study is that the education of the assessment and management of concussions needs to be a multifaceted approach.¹⁵ Therefore, the management information provided in this section will be from the NATA Position Statement¹⁶ because it is what the majority of Athletic Trainers use and teach with.

The NATA Position Statement¹ has several recommendations for management of a sports related concussion. These consist of instructing the athlete in the following areas: take Acetaminophen and no other medications without a doctor's approval, no intake of alcohol or any other drugs, resume daily activities as tolerated but rest as often as possible, no physical activity until cleared by doctor, continue eating a well balanced diet, and continually monitor signs and symptoms and report to medical professional with updates.¹

In a study by Guilmette et al,¹⁶ the main objective was to determine high school football coaches' knowledge of concussions, the assessment, and management in schools without a Certified Athletic Trainer. The population for this research study was New England high school football coaches. The results of the survey found that the main source of information about concussion came from coaching associations and conferences and 70-95% coaches stated that they would consult with a sports medical professional before allowing an athlete to return to play. The conclusions of the researchers was that most football coaches follow a conservative approach with concussion management and when making return to play decisions.¹⁶ This suggests that education is not being stressed in importance

on non-medical professionals in the area of concussions and concussion management, but coaches are willing to be conservative with concussed athletes and at least get a medical opinion before having an athlete return to play.

The objective of this article written by McGrath¹⁷ was to provide a reference for athletic trainers to use when advising and communicating to academic colleagues about concussion treatment for student athletes. The author discussed the importance of physical as well as mental rest when an athlete is trying to recover from a concussion. The author also gave a multi-layered approach that involves many school faculty and officials and other medical professionals in order to aid athletes in their recover from a concussion. The main message was that school officials need to work with the ATC and the athlete to ensure a balance between cognitive rest and academic work.¹⁷

Neurocognitive Testing

Neurocognitive performance refers to how well the brain can process thoughts, awareness, perception, reasoning, judgment, and knowledge. A neurocognitive assessment or test is most often taken through a computer based program, such as ImPACT, and evaluates the brain's ability to function and react. ImPACT has six tests that

assess "attention, verbal recognition memory, visual working memory, visual processing speed, reaction time, numerical sequencing ability, and learning."¹⁸ As stated above, one aspect of the assessment, management, and return to play criteria is utilizing neurocognitive testing. This section will provide evidence through multiple research articles on the effectiveness and importance of neurocognitive testing in return to play decision making.

The use of neurocognitive tests as a concussion tool is steadily increasing, however there are some questions regarding the validity and reliability of them. In a repeated measure study conducted by Broglio et al,¹⁹ the purpose was to determine the test-retest reliability of three neurocognitive tests (ImPACT, Concussion Sentinel, and Headminder Concussion Resolution Index tests). There were 118 healthy student volunteers who participated in this study. The participants took each neurocognitive test three times (baseline, day 45, and day 50) to test the reliability. The results showed a low to moderate test-retest reliability coefficients. This means that all three tests have high test-retest reliability.¹⁹ The research proves that the use of neurocognitive assessments as part of the diagnosis and recognition of concussions is highly recommended and should be implemented.

In a cross-sectional study conducted by Pihan et al,²⁰ the purpose was to examine the relationship between multiple factors (sex, history of concussions, physical illness, etc) and responses on two baseline concussion symptom scales. The population of this study was collegiate athletes. The results that were found were as follows: participants with a history of concussions had higher composite scores, no gender differences were found, and athletes with acute fatigue, physical illness, or orthopedic injury had higher scores on both tests. The researchers concluded that a history of concussions, acute fatigue, physical illness, or orthopedic injury can increase baseline scores, so medical professionals need to be aware of this before allowing athletes to take a baseline concussion test.²⁰

The main objective of a research study conducted by Broglio et al²¹ was to evaluate the relationship between scores on a neurocognitive test (ImPACT) and the individual's reported history of concussions. The population consisted of collegiate athletes with a history of concussions and those without a history. The researchers found no significant differences in the scores between the groups. Therefore, the conclusions drawn from the results were that there may be no relationship between a history of

concussions and long term neurocognitive test scores or the deficits are too subtle to be detected on the test.²¹

The objective of a study conducted by Covassin et al²² was to investigate the current trends of sports medicine professionals regarding neurocognitive testing as a baseline for concussion assessment and management. The population consisted of Certified Athletic Trainers at college and high school settings. The results of the researchers' online survey were as follows: 94.7% of AT's used a baseline neurocognitive test for their athletes, 51.9% used these baseline tests for validity, 95.5% responded that they would not permit an athlete to return to play if the athlete's score was not back to baseline, and 86.5% of AT's responded that they would still not allow an athlete to return to play even if symptom free until scores were back to baseline while 9.8% responded they would and 3.8% stated it depended on the importance of the competition. The researchers concluded that the use of neurocognitive testing is on the rise but a majority of ATC's still rely more on symptoms than on test scores when making return to play decisions.²²

Another important aspect of neurocognitive testing is using it in return to play decisions. Collie et al²³ conducted a study to analyze and compare neurocognitive

function in athletes who had recently sustained a concussion and had symptoms and those who had recently sustained a concussion but had no symptoms. The population for this study was Australian male athletes who were then split into three groups-concussed with symptoms, concussed without symptoms, and healthy (control). The researchers found that the concussed athletes with symptoms scored significantly lower on neurocognitive tests than the other two groups and that the non-symptomatic group showed a much larger improvement at the time of reassessment than the symptomatic group. The main conclusion of this study is that athletes must have no symptoms and be back to baseline scores before any return to play decisions can be made.²³

The researchers in the next study were Covassin et al.¹⁸ They wanted to determine if there is an association between concussion history and the presence of neurocognitive deficits after sustaining a concussion. The population used was collegiate student athletes with a history of concussions. The researchers of this study found that collegiate athletes who had sustained a concussion and had a previous history of two or more concussions took longer to recover verbal memory and reaction time (as tested on ImPACT) than those athletes with no previous history. Therefore the study concludes that any medical

professional making a decision on an athlete's return to play decision should use neurocognitive testing and make sure it is back to baseline even after symptoms have disappeared before allowing an athlete to resume play.¹⁸

Fazio et al²⁴ conducted a study to determine the correlation between neurocognitive performance and concussed athletes with symptoms, concussed athletes without self-reported symptoms, and a control group of non-concussed athletes. The participants of this study included 192 athletes: 78 concussed with symptoms, 44 concussed without symptoms, and 70 non-concussed (control). The results were that the concussed athletes without reported symptoms scored lower on at least four categories of the ImpACT test than the control group, but scored higher than the concussed with symptoms group. The conclusion from this data is that even if athletes report no symptoms, they can still be concussed. The researchers stress the importance of neurocognitive testing in return to play decisions because it can detect changes or deficits that cannot be felt or seen through signs or symptoms.²⁴

Long Term Effects

In sections above, it has been suggested that a multi-faceted approach to concussion recognition, diagnosis, assessment, treatment, and return to play criteria. If this does not happen and athletes return to play sooner than recommended, long term effects and other complications, such as post-concussion syndrome and second impact syndrome, can arise.

Disregarding recommended treatment methods can lead to long term deficits. In a cohort study performed by Majerske et al,⁴ the researchers wanted to determine the effect that post-concussive activity levels have on symptoms and performance on neurocognitive tests in student athletes. This was a regression analysis that tested the athletes up to 33 days after concussion. The population was 95 high school student athletes. The researchers found those athletes engaging in high activity levels demonstrated worse neurocognitive performance (tested through ImPACT). Therefore, they came to the conclusion that activity level after sustaining a concussion does affect the occurrence of symptoms, neurocognitive deficits, and return time. Medical professionals need to monitor the level of activity

of a concussed athlete and modify it, if need be, to ensure the optimal treatment of a concussion.⁴

The purpose of this next article written by Garden et al²⁵ was to determine the relationship between personality traits and post-concussion symptoms. The population for this study was 93 healthy participants. All participants took a personality test and a post-concussion symptom inventory. The results showed a positive significant correlation between the two tests for a majority of participants. For those who did not have a strong correlation, there was a significant increase in the negative personality traits such as depression, anxiety, etc. The conclusion of the researchers was that personality traits can attribute to some self-reported post-concussion symptoms.²⁵

Multiple concussions can have serious long term effects. Iverson et al²⁶ wanted to determine if there is a cumulative effect of multiple concussions in athletes. The population consisted of athletes with a history of three or more concussions and athletes with no history of concussions. All participants completed the ImpACT computerized test before their season and again within 5 days of injury if they sustained a concussion. The results included the following: the athletes with a history of

concussions reported more symptoms at the time of baseline testing than those with no history, the athletes with a history of concussions also scored significantly lower on ImPACT two days post-injury, and athletes with a history of concussions were 7.7 times more likely to have a severe drop in memory than those with no history. The conclusion from this evidence is that athletes with multiple concussions could have cumulative effects from them.²⁶

Sigurdardottir et al²⁷ wanted to identify post-concussion symptoms and determine any predicting factors of the symptoms through their research. The participants of this study included 115 people who had sustained a mild or severe concussion. The results found by the researchers were 27.8% of all cases developed post-concussion syndrome three months after injury and 23.6% at 12 months. They also found that those subjects with mild to moderate concussions had a steady decline in post-concussion symptoms over time while the severe group did not. The researchers overall conclusion based on their results was that the greater the severity of concussion, the greater the post-concussion symptoms will be and how long they last. There were no differences in post-concussion symptoms regardless of severity of concussion at the 12 month mark.²⁷

The purpose of a prospective study conducted by Yang et al²⁸ was to determine if there are any clinical signs in patients with concussions that would be an indicator of post-concussion symptoms. There were 180 patients who had sustained a concussion that participated in this study. The results were the following: less than 10% of all participants reported any post-concussion symptoms at two months post injury and those patients who complained of physical symptoms at one- and two-weeks post injury were significantly more likely to develop post-concussion syndrome. The researchers concluded that more severe and persistent physical symptoms can be a predictor of negative long-term effects and post-concussion syndrome.²⁸

Post concussion syndrome (PCS) needs to be recognized and treated appropriately. Logan²⁹ published an article to inform readers about the recognition and treatment of post-concussion syndrome in athletes. The article stated that the diagnosis of PCS can be very complex and difficult because the vast amount of signs and symptoms can be associated with many other disorders. The author also stressed the importance of cognitive and physical rest in the treatment of PCS. The conclusion of this article was that medical professionals need to make sure that athletes

with concussions are being monitored closely to ensure correct recovery.²⁹

Lovell et al³⁰ conducted a study with the purpose of being able to present sample data regarding a commonly used concussion symptom list called Post-Concussion Scale (PCS). The population of this study was young males and females. The researchers found that the internal validity of the PCS is very high in healthy and concussed high school and college-aged persons. They also found that there was no significant difference in baseline and post-concussive scores between high school and college participants but there was a difference between genders with females tending to report more symptoms. The conclusion of the researchers is that the PCS is a reliable and valid method of obtaining symptoms from healthy and concussed high school and college males and females.³⁰

Return to Play

As stated numerous times in the sections above, many factors must go into return to play decisions. This section will include why this approach is necessary, what average return to play times are, compliance of return to

play guidelines, and what return to play guidelines are currently being used.

In a study by Broglio et al,³¹ the objective was to determine if any neurocognitive impairment is still present in athletes who have sustained a concussion but no longer have signs and symptoms. The participants for this study included 21 NCAA Division I athletes with a history of one concussion within five to seven days of the study. The results found that three days post-concussion, 81% of athletes had a deficit in at least one area that ImpACT tests and they also found that once the athletes were non-symptomatic, 38% still had at least one deficit. Based on their findings, the researchers concluded that basing return to play decisions purely on the athlete's self-reported symptoms is not practical.³¹ Neurocognitive testing should be an essential part of the return to play decision making and is a main reason why using a many different methods of determining if an athlete is ready to return to play is needed.

The main objective of a study conducted McClincy et al³² was to determine the time it took for return to play in concussed high school and collegiate athletes. The participants in this study consisted of 104 high school and collegiate athletes who had sustained a concussion during a

sport-related event. The results were the following: significant differences were found between baseline scores and two days post injuries in all five areas of ImpACT test, significant deficits were found at day seven in four of the content areas, and significant deficits were still found in the verbal memory content area at day 14 post injury. Therefore, the conclusion is that neurocognitive deficits can occur up to seven days and even to 14 days post injury which stresses the importance of neurocognitive tests such as ImpACT in return to play decisions.³²

The primary objective of a cohort study conducted by Yard and Comstock³³ was to determine if concussed high school athletes complied with recommended return to play guidelines. One hundred high schools in the United States participated in this study. Certified Athletic Trainer's submitted injury reports for boy's and girl's sports and the researchers determined if the athletes followed return to play guidelines set by the American Academy of Neurology or Prague. The study found that of the 1308 concussions reported, 40.5% of athletes following the AAM guidelines and 15% of athletes following Prague guidelines returned to play to early. Also, it was found that in football, 15.8% of athletes who sustained a concussion and a loss of consciousness returned to play in less than one day, and

males were much more likely to return to play within one to two days after sustaining a concussion than females were. The researchers concluded that too many high school athletes are not complying with return to play guidelines and that it is up to coaches, athletic trainers, parents, etc to see that these athletes follow the guidelines.³³

APPENDIX B

The Problem

STATEMENT OF THE PROBLEM

It is estimated that there are up to 3.8 million sports-related concussions each year. Concussions have become a hot topic in sports and medical communities. Most research thus far has focused on educating allied health and medical professionals such as athletic trainers and team physicians in how to effectively recognize, diagnose, and treat concussions with an emphasis on return to play criteria. However, the many factors that affect athletes knowledge of concussions, most specifically the causes, signs and symptoms, serious long-term effects, and the return to play criteria, as well as the role of the athlete throughout the entire process has not been identified. The purpose of the study was to examine factors that affect concussion knowledge in collegiate varsity athletes. Factors that were examined include participation in a concussion education training session, sport, number of years of experience as a college varsity athlete, and personal history of concussions. It is important to examine this because it showed which factors affect concussion knowledge in athletes, and therefore allow Team Physicians and Certified Athletic Trainers to address these factors before the sports season.

Definition of Terms

The following definitions of terms will be defined for this study:

- 1) Concussion - is a mild Traumatic Brain Injury (mTBI) in which the brain undergoes a physiological disruption produced by a trauma.
- 2) Sports-related concussion - is a concussion sustained during an athletic event, most often resulting from a quick acceleration and deceleration mechanism, either in a linear or rotational plane when the head hits a stationary object or is hit by moving object.
- 3) Neurocognitive testing - is a computerized or traditional test measuring verbal and visual memory, complex attention, reaction time, and processing speed.
- 4) Return to play - is the term referred to when an athlete is evaluated and cleared to return to athletic participation by a physician.
- 5) Varsity athlete - is a student-athlete who is participating in a NCAA recognized varsity sport.

Basic Assumptions

The following are basic assumptions of this study:

- 1) The subjects will be honest when they complete their demographic sheets.
- 2) The subjects will answer to the best of their ability on the survey.
- 3) The subjects will have access to a computer and internet in order to complete the online survey.
- 4) The sample obtained will be representative of the population.

Limitations of the Study

The following are possible limitations of the study:

- 1) The survey was completed online and without any supervision by investigators.
- 2) There were many steps that occurred before the athletes were sent the email with a link to the survey.
- 3) Only varsity athletes with a valid email address were surveyed.
- 4) Athletic Directors and coaches were responsible for forwarding the email to their athletes.

Significance of the Study

The results of this study will inform health care professionals who deal within the athletic population, more

specifically team physicians and Certified Athletic Trainers, if conducting a concussion education session for athletes is an effective way of increasing the athletes' knowledge in the subject, especially athletes with factors that cause decreased knowledge. If it is an effective method and athletes' knowledge of concussions is increased, it will aid in the recognition of signs and symptoms, the compliance of the athletes, and the prevention of negative long term effects.

APPENDIX C

Additional Methods

APPENDIX C1

Concussion Knowledge Survey and Answer Key

Concussion Knowledge Survey 2011

Varsity athletes from NCAA Division I, NCAA Division II, NCAA Division III, and NAIA institutions are being asked to participate in this research; however, your participation is voluntary and you do have the right to choose not to participate. You must be 18 years or older to participate in this survey. You also have the right to discontinue participation at any time during the survey completion process at which time your data will be discarded. The California University of Pennsylvania Institutional Review Board has reviewed and approved this project. The approval is effective 03/02/2012 and expires 12/31/2012.

All survey responses are anonymous and will be kept confidential, and informed consent to use the data collected will be assumed upon return of the survey. Aggregate survey responses will be housed in a password protected file on the CalU campus. Minimal risk is posed by participating as a subject in this study. I ask that you please take this survey at your earliest convenience as it will take approximately 20 minutes to complete. If you have any questions regarding this project, please feel free to contact the primary researcher, Angela Boyle at boy8603@calu.edu. You can also contact the faculty advisor for this research (Dr. Jamie Weary, DPT, ATC at 724-938-5708 or weary@calu.edu). By clicking the NEXT button, you are agreeing to participate. Thanks in advance for your participation.

Concussion Knowledge Survey 2011

1. How old are you?

- 18 years old or older
- 17 years or younger

Concussion Knowledge Survey 2011

2. Sex:

- Male
- Female

Concussion Knowledge Survey 2011

9. If yes, what was the profession of the person who diagnosed the concussion? (ex: MD, DO, ATC, PhD...)

Concussion Knowledge Survey 2011

Recognition

Answer all questions to the best of your knowledge.

10. How long does an athlete have to be knocked out to have a sports-related concussion?

- Athletes do not have to be knocked out
- Less than 30 seconds
- 30 seconds to 2 minutes
- More than 2 minutes

11. How important is it to recognize a sports-related concussion?

- It's not very important.
- It's a minor injury, so it is kind of important.
- It's a normal injury, so it is fairly important.
- It's a serious injury, so it is very important.

12. Which injury is the most severe?

- Concussion
- Traumatic Brain Injury
- They both are equally severe
- I don't know

13. An athlete can get a concussion in which of the following sports/activities?

- Sports where a ball is being thrown or hit
- Sports where collisions are common
- Sports where protective equipment is required
- Any sport

14. Which one of the following symptoms might make an athlete suspect he/she has a concussion?

- Excitement or happiness
- Feeling "in the zone"
- Headache or dizziness
- Hunger or thirst

Concussion Knowledge Survey 2011

15. Which one of the following signs may indicate that an athlete's concussion is getting worse?

- Acting extremely hyper
- Developing a rash around the head and neck
- Fading in and out of consciousness
- Clammy skin

16. By definition, a concussion is:

- A spinal cord injury
- A brain injury
- A laceration
- I don't know

17. An athlete can get a concussion from:

- A direct force or hit to his/her head
- A force or hit to his/her jaw
- Hitting his/her head on a stationary object (ground, wall, pole, etc.)
- All of the above

18. It is possible to have a concussion with no visible signs and symptoms.

- True
- False

19. An athlete who reports having a headache after a concussion will likely have other symptoms.

- True
- False

20. A concussion only occurs when the athlete blacks out or loses consciousness.

- True
- False

21. Concussions can sometimes lead to emotional disturbances.

- True
- False

Concussion Knowledge Survey 2011

Management

Answer all questions to the best of your knowledge.

22. An athlete must be removed from activity right away if suspected of having a concussion.

- True
- False

23. What activities should an athlete NOT participate in if they are still showing symptoms of a sport-related concussion? (select one)

- Practice
- Warm-up
- Any level of sport activity
- Games

24. What is the most effective treatment for an athlete with a concussion?

- Exercise without contact to the head
- Medicine from a doctor
- Total rest
- X-rays and diagnostic imaging performed by doctors

25. If an athlete is still feeling the effects of a concussion, is it okay to return to play?

- Yes, as long as the player is careful
- Yes, but only for games
- No, the athlete shouldn't play
- I don't know

26. What should an athlete do if he/she hits his/her head during a game?

- Keep playing
- Not tell anyone
- Stop playing and tell the coach or athletic trainer
- Tell the coach or athletic trainer after the game

Concussion Knowledge Survey 2011

27. Who can diagnose a concussion? (check all that apply)

- Medical Doctor
- Certified Athletic Trainer
- Head Coach
- Parents

Concussion Knowledge Survey 2011

Long Term Effects

Answer all questions to the best of your knowledge.

28. People who have had one concussion are more likely to sustain another.

- True
- False

29. A concussion can cause brain damage even if the person is not knocked out.

- True
- False

30. A concussion is harmless and never results in long- term problems or brain damage.

- True
- False

31. There is a possible risk of death if a second concussion occurs before the first one has healed.

- True
- False

32. Symptoms of a concussion can last for several weeks or longer.

- True
- False

33. Negative effects on long-term health and well-being are rare from multiple concussions.

- True
- False

Concussion Knowledge Survey 2011

Return to Play

Answer all questions to the best of your knowledge.

34. An athlete can return to play after a concussion:

- When cleared by a medical doctor
- When the athlete feels 90% better
- When the athlete only has a mild headache
- For the next game, as long as it has been at least 2 days later

35. Based on NCAA guidelines, what is the least amount of time a collegiate athlete must stay out of athletics after being diagnosed with a sport-related concussion by a Certified Athletic Trainer or Team Doctor?

- 12 hours
- 1 day
- 7 days
- 14 days

36. What level of participation takes longer to return to play after sustaining a concussion?

- All athletes recover at the same rate
- Collegiate athletes take longer to return than other athletes
- High school athletes take longer to return than other athletes
- Professional athletes take longer to return than other athletes

37. An athlete should not be allowed to return to play if he/she show any signs or symptoms of concussion.

- True
- False

38. If an athlete has been hit in the head and his/her signs and symptoms resolve ("go away") after 15 minutes, he/she has not sustained a concussion and can return to play.

- True
- False

Concussion Knowledge Survey 2011

39. An athlete has to meet which of the following criteria before being cleared to return to play? (check all that apply)

- Able to pass a classroom test
- Free of symptoms during rest and physical activity
- Cleared by a medical professional
- Able to pass a neurocognitive test (ImPACT)

40. Who can legally make return to play decisions? (check all that apply)

- Parents
- Certified Athletic Trainer (ATC)
- Medical Doctor
- Coaches
- Athletes

Concussion Knowledge Survey 2011

Symptoms Checklist

Answer all questions to the best of your knowledge.

41. Check all signs and symptoms that you think occur from a sports-related concussion

- Feeling in a "fog"
- Headache
- Feeling slowed down
- Arthritis
- Reduced breathing rate
- Sensitivity to light
- Excessive studying
- Difficulty remembering
- Difficulty concentrating
- Dizziness
- Drowsiness
- Hair loss
- Emotional/ Irritable
- Loss of memory
- Blurred vision
- Chest pain
- Confusion
- Feeling sick
- Trouble sleeping
- Problems studying or doing class work

Concussion Knowledge Survey 2011

Scenarios

Answer yes, no, or unsure for the following questions to the best of your knowledge.

42. If an athlete exhibits disorientation and dizziness but the symptoms clear up within 15 minutes, should the athlete consult a healthcare professional before returning to play?

- Yes
- No
- Unsure

43. If an athlete loses consciousness for less than 1 minute yet exhibits no symptoms after 15 minutes, is this still considered a concussion?

- Yes
- No
- Unsure

44. If an athlete forgets his/her positional assignment following a collision involving the athlete's head, should he/she tell the coach or certified athletic trainer?

- Yes
- No
- Unsure

45. If an athlete appears to move clumsily following a collision involving his/her head, should he/she stop playing?

- Yes
- No
- Unsure

46. An athlete receives a direct force to the side of his/her head from another player and falls to the ground. As he/she gets up, he/she experiences mild dizziness and has a headache. Should the athlete finish the game in this situation?

- Yes
- No
- Unsure

Concussion Knowledge Survey 2011

47. An athlete receives a hit to the head during a practice. As he/she is looked at on the sideline, it is found that he/she is awake, has no loss of memory, feels fine at rest and when is asked to jog around the track, only has a mild headache. Should the player return to play?

- Yes
- No
- Unsure

ANSWER KEY

Recognition

- 10.A
- 11.D
- 12.D
- 13.C
- 14.C
- 15.B
- 16.D
- 17.C
- 18.A
- 19.A
- 20.B
- 21.A

Management

- 21.A
- 22.A
- 23.C
- 24.C
- 25.C
- 26.C
- 27.A,B

Long Term Effects

- 28.A
- 29.A
- 30.B
- 31.A
- 32.A
- 33.B

Return to Play

- 34.B
- 35.B
- 36.C
- 37.A
- 38.B
- 39.B
- 40.B, C

41. Symptom Checklist

- ✓ Feeling in a "Fog"
- ✓ Headache
- ✓ Feeling Slowed Down
 - Arthritis
 - Reduced Breathing Rate
- ✓ Sensitivity to Light
 - Excessive Studying
- ✓ Difficulty Remembering
- ✓ Difficulty Concentrating
- ✓ Dizziness
- ✓ Drowsiness
 - Hair Loss
- ✓ Emotional/Irritable
- ✓ Loss of memory
- ✓ Blurred vision
 - Chest pain
- ✓ Confusion
- ✓ Feeling sick
- ✓ Trouble sleeping
- ✓ Problems studying or doing class work

Scenarios

- 42. Yes
- 43. Yes
- 44. Yes
- 45. Yes
- 46. No
- 47. No

APPENDIX C2

Institutional Review Board -
California University of Pennsylvania



California University
of Pennsylvania

Proposal Number

Date Received

**PROTOCOL for Research Involving
Human Subjects**

Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects

(Reference IRB Policies and Procedures for clarification)

Project Title Factors That Influence Collegiate Varsity Athletes Knowledge of Concussions

Researcher/Project Director Angela Boyle

Phone # (574) 274-7518

E-mail Address boy8603@calu.edu

Faculty Sponsor (if required) Jamie Weary (724-938-5708 or weary@calu.edu)

Department Health Science

Project Dates March 2, 2012 to December 31, 2012

Sponsoring Agent (if applicable) N/A

Project to be Conducted at California University of PA (via internet)

Project Purpose: *Thesis* *Research* *Class Project* *Other*

Keep a copy of this form for your records.

Please attach a typed, detailed summary of your project AND complete items 2 through 6.

1. *Provide an overview of your project-proposal describing what you plan to do and how you will go about doing it. Include any hypothesis(es) or research questions that might be involved and explain how the information you gather will be analyzed. For a complete list of what should be included in your summary, please refer to Appendix B of the IRB Policies and Procedures Manual.*

The purpose of the study is to examine factors that affect concussion knowledge in collegiate varsity athletes. Factors that will be examined include participation in a concussion education training session, type of education training session, sport, number of years of experience as a college varsity athlete, division of college or university, and personal history of concussions.

A survey (Appendix C3) developed by the researcher and reviewed by a Panel of Experts will be sent electronically to NCAA varsity athletes from participating Division I, Division II, Division III, and NAIA institutions. The researcher will utilize SurveyMonkey.com to create a direct link to the electronic survey. A cover letter (Appendix C1) will be sent with the survey explaining the purpose of the study to the participants. An email list will be created through athletic rosters at the ten participating NCAA institutions. An email will be sent to the subjects with the cover letter explaining the purpose and significance of the study. A link on the cover letter will provide the NCAA varsity athletes with direct access to begin the survey. Additional emails will be sent until the desired response rate is reached. There is no obligation of the subjects to participate. All subjects who complete the survey will be anonymous with no way to trace answers back to one subject. Gathered data will be analyzed in terms of the hypotheses.

Hypotheses

1. Varsity athletes with concussion education training will score higher on concussion knowledge test than varsity athletes without training.
2. Concussion knowledge will increase with greater years of collegiate experience as a varsity athlete.
3. Athletes with a history of concussions will score higher than on concussion knowledge test than athletes with no history of concussions.
4. Football players will score the highest on concussion knowledge test among all sports.

An ANOVA will be used within each factor to determine if they significantly affect concussion knowledge. A multiple regression will then be used over all data to determine how much each factor contributes to concussion knowledge.

2. *Section 46.11 of the Federal Regulations state that research proposals involving human subjects must satisfy certain requirements before the IRB can grant approval. You should describe in detail how the following requirements will be satisfied. Be sure to address each area separately.*
 - a. *How will you insure that any risks to subjects are minimized? If there are potential risks, describe what will be done to minimize these risks. If there are risks, describe why the risks to participants are reasonable in relation to the anticipated benefits.*

No research will be conducted until approval is granted by the IRB. Although the risk is minimal in this study, the possible risk of harm associated with knowledge research is psychological and dignitary in nature. Since the responses of each individual are confidential, the risk posed is small.

- b. *How will you insure that the selection of subjects is equitable? Take into account your purpose(s). Be sure you address research problems involving vulnerable populations such as children, prisoners, pregnant women, mentally disabled persons, and economically or educationally disadvantaged persons. If this is an in-class project describe how you will minimize the possibility that students will feel coerced.*

The survey will be sent to the Athletic Directors of the participating NCAA Division I (Indiana University), Division II (CalU), Division III (PSU Fayette), or NAIA institutions. Written permission from Athletic Directors of participating schools is attached. They will then forward the email to all current student-athletes. If any participant is under the age of 18, the electronic survey will automatically end the survey, ending their participation.

- c. *How will you obtain informed consent from each participant or the subject's legally authorized representative and ensure that all consent forms are appropriately documented? Be sure to attach a copy of your consent form to the project summary.*

Informed consent is implied upon completing and returning the survey. Subjects have the right to choose to not participate. This is stated in the cover letter that will be attached to the front (first page) of the survey.

- d. *Show that the research plan makes provisions to monitor the data collected to insure the safety of all subjects. This includes the privacy of subjects' responses and provisions for maintaining the security and confidentiality of the data.*

This is an anonymous questionnaire and upon submissions electronically, neither the name of the subject nor the email address will be attached to their answers. The information will kept strictly confidential. The data will be kept in a password protected electronic file on University servers where only the researcher and advisor will have access to this file.

3. *Check the appropriate box(es) that describe the subjects you plan to use.*

<input checked="" type="checkbox"/> <i>Adult volunteers</i>	<input type="checkbox"/> <i>Mentally Disabled People</i>
<input checked="" type="checkbox"/> <i>CAL University Students</i>	<input type="checkbox"/> <i>Economically Disadvantaged People</i>
<input checked="" type="checkbox"/> <i>Other Students</i>	<input type="checkbox"/> <i>Educationally Disadvantaged People</i>
<input type="checkbox"/> <i>Prisoners</i>	<input type="checkbox"/> <i>Fetuses or fetal material</i>
<input type="checkbox"/> <i>Pregnant Women</i>	<input type="checkbox"/> <i>Children Under 18</i>
<input type="checkbox"/> <i>Physically Handicapped People</i>	<input type="checkbox"/> <i>Neonates</i>

4. *Is remuneration involved in your project?* *Yes* or *No*. *If yes, Explain here.*

5. *Is this project part of a grant?* *Yes* or *No* *If yes, provide the following information:*

Title of the Grant Proposal _____

Name of the Funding Agency _____

Dates of the Project Period _____

6. *Does your project involve the debriefing of those who participated?* *Yes* or *No*

If Yes, explain the debriefing process here.

7. *If your project involves a questionnaire interview, ensure that it meets the requirements of Appendix ___ in the Policies and Procedures Manual.*

California University of Pennsylvania Institutional Review Board
Survey/Interview/Questionnaire Consent Checklist (v021209)

This form **MUST** accompany all IRB review requests

Does your research involve **ONLY** a survey, interview or questionnaire?

YES—Complete this form

NO—You **MUST** complete the “Informed Consent Checklist”—skip the remainder of this form

Does your survey/interview/questionnaire cover letter or explanatory statement include:

- (1) Statement about the general nature of the survey and how the data will be used?
- (2) Statement as to who the primary researcher is, including name, phone, and email address?
- (3) **FOR ALL STUDENTS:** Is the faculty advisor’s name and contact information provided?
- (4) Statement that participation is voluntary?
- (5) Statement that participation may be discontinued at any time without penalty and all data discarded?
- (6) Statement that the results are confidential?
- (7) Statement that results are anonymous?
- (8) Statement as to level of risk anticipated or that minimal risk is anticipated? (NOTE: If more than minimal risk is anticipated, a full consent form is required—and the Informed Consent Checklist must be completed)
- (9) Statement that returning the survey is an indication of consent to use the data?
- (10) Who to contact regarding the project and how to contact this person?
- (11) Statement as to where the results will be housed and how maintained? (unless otherwise approved by the IRB, must be a secure location on University premises)
- (12) Is there text equivalent to: “Approved by the California University of Pennsylvania Institutional Review Board. This approval is effective nn/nn/nn and expires mm/mm/mm”? (the actual dates will be specified in the approval notice from the IRB)?
- (13) **FOR ELECTRONIC/WEBSITE SURVEYS:** Does the text of the cover letter or explanatory statement appear before any data is requested from the participant?
- (14) **FOR ELECTONIC/WEBSITE SURVEYS:** Can the participant discontinue participation at any point in the process and all data is immediately discarded?

**California University of Pennsylvania Institutional Review Board
Informed Consent Checklist (v021209)**

This form MUST accompany all IRB review requests

Does your research involve ONLY a survey, interview, or questionnaire?

YES—DO NOT complete this form. You MUST complete the “Survey/Interview/Questionnaire Consent Checklist” instead.

NO—Complete the remainder of this form.

1. Introduction (check each)

(1.1) Is there a statement that the study involves research?

(1.2) Is there an explanation of the purpose of the research?

2. Is the participant. (check each)

(2.1) Given an invitation to participate?

(2.2) Told why he/she was selected.

(2.3) Told the expected duration of the participation.

(2.4) Informed that participation is voluntary?

(2.5) Informed that all records are confidential?

(2.6) Told that he/she may withdraw from the research at any time without penalty or loss of benefits?

(2.7) 18 years of age or older? (if not, see Section #9, Special Considerations below)

3. Procedures (check each).

(3.1) Are the procedures identified and explained?

(3.2) Are the procedures that are being investigated clearly identified?

(3.3) Are treatment conditions identified?

4. Risks and discomforts. (check each)

(4.1) Are foreseeable risks or discomforts identified?

(4.2) Is the likelihood of any risks or discomforts identified?

(4.3) Is there a description of the steps that will be taken to minimize any risks or discomforts?

(4.4) Is there an acknowledgement of potentially unforeseeable risks?

(4.5) Is the participant informed about what treatment or follow up courses of action are available should there be some physical, emotional, or psychological harm?

(4.6) Is there a description of the benefits, if any, to the participant or to others that may be reasonably expected from the research and an estimate of the likelihood of these benefits?

(4.7) Is there a disclosure of any appropriate alternative procedures or courses of treatment that might be advantageous to the participant?

5. Records and documentation. (check each)

(5.1) Is there a statement describing how records will be kept confidential?

(5.2) Is there a statement as to where the records will be kept and that this is a secure location?

(5.3) Is there a statement as to who will have access to the records?

California University of Pennsylvania Institutional Review Board
Review Request Checklist (v021209)

This form **MUST** accompany all IRB review requests.
 Unless otherwise specified, **ALL** items must be present in your review request.

Have you:

(1.0) **FOR ALL STUDIES:** Completed ALL items on the Review Request Form?

Pay particular attention to:

(1.1) Names and email addresses of all investigators

(1.1.1) **FOR ALL STUDENTS:** use only your CalU email address)

(1.1.2) **FOR ALL STUDENTS:** Name and email address of your faculty research advisor

(1.2) Project dates (must be in the future—no studies will be approved which have already begun or scheduled to begin before final IRB approval—**NO EXCEPTIONS**)

(1.3) Answered completely and in detail, the questions in items 2a through 2d?

2a: **NOTE:** No studies can have zero risk, the lowest risk is “minimal risk”. If more than minimal risk is involved you **MUST**:

i. Delineate all anticipated risks in detail;

ii. Explain in detail how these risks will be minimized;

iii. Detail the procedures for dealing with adverse outcomes due to these risks.

iv. Cite peer reviewed references in support of your explanation.

2b. Complete all items.

2c. Describe informed consent procedures in detail.

2d. **NOTE:** to maintain security and confidentiality of data, all study records must be housed in a secure (locked) location **ON UNIVERSITY PREMISES**. The actual location (department, office, etc.) must be specified in your explanation and be listed on any consent forms or cover letters.

(1.4) Checked all appropriate boxes in Section 3? If participants under the age of 18 years are to be included (regardless of what the study involves) you **MUST**:

(1.4.1) Obtain informed consent from the parent or guardian—consent forms must be written so that it is clear that the parent/guardian is giving permission for their child to participate.

(1.4.2) Document how you will obtain assent from the child—This must be done in an age-appropriate manner. Regardless of whether the parent/guardian has given permission, a child is completely free to refuse to participate, so the investigator must document how the child indicated agreement to participate (“assent”).

(1.5) Included all grant information in section 5?

(1.6) Included ALL signatures?

(2.0) **FOR STUDIES INVOLVING MORE THAN JUST SURVEYS, INTERVIEWS, OR QUESTIONNAIRES:**

(2.1) Attached a copy of all consent form(s)?

(2.2) **FOR STUDIES INVOLVING INDIVIDUALS LESS THAN 18 YEARS OF AGE:** attached a copy of all assent forms (if such a form is used)?

(2.3) Completed and attached a copy of the Consent Form Checklist? (as appropriate—see that checklist for instructions)

(3.0) FOR STUDIES INVOLVING ONLY SURVEYS, INTERVIEWS, OR QUESTIONNAIRES:

- (3.1) Attached a copy of the cover letter/information sheet?
- (3.2) Completed and attached a copy of the Survey/Interview/Questionnaire Consent Checklist? (see that checklist for instructions)
- (3.3) Attached a copy of the actual survey, interview, or questionnaire questions in their final form?

(4.0) FOR ALL STUDENTS: Has your faculty research advisor:

- (4.1) Thoroughly reviewed and approved your study?
- (4.2) Thoroughly reviewed and approved your IRB paperwork? including:
 - (4.2.1) Review request form,
 - (4.2.2) All consent forms, (if used)
 - (4.2.3) All assent forms (if used)
 - (4.2.4) All Survey/Interview/Questionnaire cover letters (if used)
 - (4.2.5) All checklists
- (4.3) IMPORTANT NOTE: Your advisor's signature on the review request form indicates that they have thoroughly reviewed your proposal and verified that it meets all IRB and University requirements.
- (5.0) Have you retained a copy of all submitted documentation for your records?

Project Director's Certification Program Involving HUMAN SUBJECTS

The proposed investigation involves the use of human subjects and I am submitting the complete application form and project description to the Institutional Review Board for Research Involving Human Subjects.

I understand that Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects. If the Board grants approval of this application, I agree to:

1. Abide by any conditions or changes in the project required by the Board.
2. Report to the Board any change in the research plan that affects the method of using human subjects before such change is instituted.
3. Report to the Board any problems that arise in connection with the use of human subjects.
4. Seek advice of the Board whenever I believe such advice is necessary or would be helpful.
5. Secure the informed, written consent of all human subjects participating in the project.
6. Cooperate with the Board in its effort to provide a continuing review after investigations have been initiated.

I have reviewed the Federal and State regulations concerning the use of human subjects in research and training programs and the guidelines. I agree to abide by the regulations and guidelines aforementioned and will adhere to policies and procedures described in my application. I understand that changes to the research must be approved by the IRB before they are implemented.

Professional Research

Project Director's Signature

Department Chairperson's Signature

Student or Class Research

Angela Bayle

Student Researcher's Signature

Jamie Alley

Supervising Faculty Member's
Signature if required

[Signature]

Department Chairperson's Signature

ACTION OF REVIEW BOARD (IRB use only)

The Institutional Review Board for Research Involving Human Subjects has reviewed this application to ascertain whether or not the proposed project:

1. provides adequate safeguards of the rights and welfare of human subjects involved in the investigations;
2. uses appropriate methods to obtain informed, written consent;
3. indicates that the potential benefits of the investigation substantially outweigh the risk involved.
4. provides adequate debriefing of human participants.
5. provides adequate follow-up services to participants who may have incurred physical, mental, or emotional harm.

Approved [_____]

Disapproved

Chairperson, Institutional Review Board

Date

From: Athletics Director
Sent: Monday, February 06, 2012 9:30 PM
To: BOY8603 - BOYLE, ANGELA LYNN [<mailto:BOY8603@calu.edu>]
Subject: Angela Boyle - Athletes participation in survey

Angela,
You have my permission to contact the student athletes.

You will need to send the letter directly to the coaches to distribute to their student-athletes on their team.

Karen

Karen Hjerpe, PhD

Interim Athletic Director/SWA
California University of PA
250 University Ave., Box #34
California, PA 15419
Phone: 724-938-4167
Fax: 724-938-5421
E-mail: Hjerpe@calu.edu

From: "BOY8603 - BOYLE, ANGELA LYNN" <BOY8603@calu.edu>
Sent: Friday, February 03, 2012 4:35 PM
To: Athletics Director
Subject: Angela Boyle - Athletes participation in survey

Dear Ms. Hjerpe,

My name is Angela Boyle, and I am currently enrolled in the Graduate Athletic Training Education Program at California University of PA. I am currently working as a Graduate Athletic Trainer for Penn State Fayette and am conducting a research study as part of my Master's degree requirement. The title of my study is: "Factors That Influence Collegiate Varsity Athletes Knowledge of Concussions." I am writing seeking approval to include California University of PA's athletes in my research study. Participation includes completion of an electronic survey with all responses submitted anonymously. With your agreement, I will send an email to you with a cover letter explaining further details of the study and a link to the survey. To protect personal information and email account distribution, I would ask if you could forward the email to all of your current student-athletes. By replying to this email with a "yes," you are agreeing to allow your student athletes to participate in my study and to distribute the

email to them.

Thank you very much for your time, cooperation, and consideration with this matter. I hope to hear from you soon.

Sincerely,

Angela Boyle, ATC

Email: boy8603@calu.edu

Cell phone: (574) 274-7518

From: tdemant@goshen.edu
To: "BOY8603 - BOYLE, ANGELA LYNN" <BOY8603@calu.edu>
Sent: Monday, March 5, 2012 8:48:42 AM
Subject: Angela Boyle - Survey Research

Angela,
As a current doctoral student myself, I see the value in participation rates so I would gladly forward your survey on to our student athletes.

Tim Demant
Athletic Director
Goshen College
Office: 574-535-7491
Cell: 574-238-3585
Fax: 574-535-7531
tdemant@goshen.edu
www.GoLeafs.net

From: "BOY8603 - BOYLE, ANGELA LYNN" <BOY8603@calu.edu>
To: tdemant@goshen.edu
Sent: Thursday, February 23, 2012 11:30:42 AM
Subject: Angela Boyle - Survey Research

Dear Mr. Demant,

My name is Angela Boyle, and I am currently enrolled in the Graduate Athletic Training Education Program at California University of PA. I am currently working as a Graduate Athletic Trainer for Penn State Fayette and am conducting a research study as part of my Master's degree requirement. The title of my study is: "Factors That Influence Collegiate Varsity Athletes Knowledge of Concussions." I am writing seeking approval to include Goshen College's athletes in my research study. Participation includes completion of an electronic survey with all responses submitted anonymously. With your agreement, I will send an email to you with a cover letter explaining further details of the study and a link to the survey. To protect personal information and email account distribution, I would ask if you could forward the email to all of your current student-athletes. By replying to this email with a "yes," you are agreeing to allow your student athletes to participate in my study and to distribute the email to them.

Thank you very much for your time, cooperation, and consideration with this matter. I hope to hear from you soon.

Sincerely,

Angela Boyle, ATC

Email: boy8603@calu.edu

Cell phone: (574) 274-7518

From: Vince Capozzi<vac12@psu.edu>
Sent: Tuesday, February 07, 2012 10:43 AM
To: "BOY8603 - BOYLE, ANGELA LYNN" <BOY8603@calu.edu>
Subject: Angela Boyle - Athletes participation in survey

Angela,
I am fine with our athletes participating in the survey should they choose to do so.
Vince

Vince Capozzi
Athletic Director
Assistant Women's Basketball Coach
Penn State Fayette, The Eberly Campus
724-430-4100, Ext. 4515

"(athletics are) a great deal like life in that they teach that work, sacrifice, perseverance, competitive drive, selflessness and respect for authority is the price that each and every one of us must pay to achieve any goal that is worthwhile." --- Vince Lombardi

From: "BOY8603 - BOYLE, ANGELA LYNN" <BOY8603@calu.edu>
Sent: Friday, February 03, 2012 4:35 PM
To: Athletics Director
Subject: Angela Boyle - Athletes participation in survey

Dear Mr. Capozzi,

My name is Angela Boyle, and I am currently enrolled in the Graduate Athletic Training Education Program at California University of PA. I am currently working as a Graduate Athletic Trainer for Penn State Fayette and am conducting a research study as part of my Master's degree requirement. The title of my study is: "Factors That Influence Collegiate Varsity Athletes Knowledge of Concussions." I am writing seeking approval to include PSU Fayette's athletes in my research study. Participation includes completion of an electronic survey with all responses submitted anonymously. With your agreement, I will send an email to

you with a cover letter explaining further details of the study and a link to the survey. To protect personal information and email account distribution, I would ask if you could forward the email to all of your current student-athletes. By replying to this email with a "yes," you are agreeing to allow your student athletes to participate in my study and to distribute the email to them.

Thank you very much for your time, cooperation, and consideration with this matter. I hope to hear from you soon.

Sincerely,

Angela Boyle, ATC
Email: boy8603@calu.edu
Cell phone: (574) 274-7518



Institutional Review Board
California University of Pennsylvania
Morgan Hall, Room 310
250 University Avenue
California, PA 15419
instreviewboard@calu.edu
Robert Skwarecki, Ph.D., CCC-SLP, Chair

Dear Angela Boyle:

Please consider this email as official notification that your proposal titled "Factors That Influence Collegiate Varsity Athletes Knowledge of Concussions" (Proposal #11-057) has been approved by the California University of Pennsylvania Institutional Review Board as amended, with the following stipulations:

--The consent form/cover information specifies that individuals must be 18 years of age or older. The first question of the survey asks age, but there is no evidence that the survey then terminates or that the participant is redirected if they answer that they are 17 or younger (or other action). Prior to beginning data collection, you must provide the Board with a statement of what will occur if an individual answers that they are under 18.

-At various points in the proposal , NCAA and NAIA athletes are inconsistently listed. Your consent form/cover letter must explicitly state your target population. You must provide the IRB with a copy of the consent form/cover letter with the correct target population listed.

Please provide the information requested prior to beginning data collection. After this information has been provided for our records, you may immediately begin data collection.

You do not need to wait for further IRB approval once the requested information has been submitted.

The effective date of the approval is 4/3/2012 and the expiration date is 4/2/2013. These dates must appear on the consent form.

Please note that Federal Policy requires that you notify the IRB promptly regarding any of the following:

(1) Any additions or changes in procedures you might wish for your study (additions or changes must be approved by the IRB before they are implemented)

(2) Any events that affect the safety or well-being of subjects

(3) Any modifications of your study or other responses that are necessitated by any events reported in (2).

(4) To continue your research beyond the approval expiration date of 4/2/2013 you must file additional information to be considered for continuing review. Please contact instreviewboard@cup.edu

Please notify the Board when data collection is complete.

Regards,
Robert Skwarecki, Ph.D., CCC-SLP
Chair, Institutional Review Board

Appendix C3
Cover Letter



California University of Pennsylvania

4/4/2012

Dear Student Athlete:

My name is Angela Boyle and I am currently a graduate student at California University of Pennsylvania pursuing a Master of Science in Athletic Training. Part of the graduate study curriculum is to complete a research thesis through conducting research. I am conducting survey research to determine what factors influence collegiate varsity athlete's knowledge of concussions. This data will determine collegiate athlete's knowledge of concussions or lack thereof, what factors that potentially influence that knowledge, and who to focus concussion education on the most.

The target population is varsity athletes from NCAA Division I, NCAA Division II, NCAA Division III, and NAIA institutions; however, your participation is voluntary and you do have the right to choose not to participate. All participants must be 18 years or older. You also have the right to discontinue participation at any time during the survey completion process at which time your data will be discarded. The California University of Pennsylvania Institutional Review Board has reviewed and approved this project. The approval is effective 04/03/2012 and expires 04/03/2013.

All survey responses are anonymous and will be kept confidential, and informed consent to use the data collected will be assumed upon return of the survey. Aggregate survey responses will be housed in a password protected file on the CalU campus. Minimal risk is posed by participating as a subject in this study. I ask that you please take this survey at your earliest convenience as it will take approximately 20 minutes to complete. If you have any questions regarding this project, please feel free to contact the primary researcher, Angela Boyle at boy8603@calu.edu. You can also contact the faculty advisor for this research (Dr. Jamie Weary, DPT, ATC at 724-938-5708 or weary@calu.edu). Thanks in advance for your participation. Please click the following link to access the survey <https://www.surveymonkey.com/s/VD2HNZR>.

Thank you for taking the time to take part in my thesis research. I greatly appreciate your time and effort put into this task.

Sincerely,

Angela Boyle
Primary Researcher
California University of Pennsylvania
250 University Ave
California, PA 15419
(574) 274-7518
Boy8603@calu.edu

REFERENCES

1. Guskiewicz KM, Bruce SL, Cantu RC, et al. National Athletic Trainers' Association Position Statement: Management of Sport Related Concussion. *J. Athletic Training* [serial online]. 2004;39(3):280-297. Available at: www.journalofathletictraining.org.
2. Reddy C, Collins M. Sports Concussion: Management and Predictors of Outcome. *Current Sports Medicine Reports* [serial online]. January 2009;8(1):10-15. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed September 29, 2011.
3. McCrory P, Meeuwisse W, Cantu R, et al. Consensus Statement on Concussion in Sport: The 3rd International Conference on Concussion in Sport Held in Zurich, November 2008. *J. Athletic Training* [serial online]. July 2009;44(4):434-444. Available from: SPORTDiscus with Full Text, Ipswich, MA. Accessed September 29, 2011.
4. Majerske CW, Mihalik JP, Ren D, et al. Concussion in sports: postconcussive activity levels, symptoms, and neurocognitive performance. *J. Athletic Training* [serial online]. 2008;43(3):265-274. Available at: www.nata.org/jat.
5. Mansell JL, Tierney RT, Higgins M, McDevitt J, Toone N, Glutting J. Concussive signs and symptoms following head impacts in collegiate athletes. *Brain Injury*. 2010;24(9):1070-1074. Available from: PsycINFO, Ipswich, MA.
6. Meehan WM, Hemecourt P, Comstock RD. High school concussions in the 2008-2009 academic year mechanism, symptoms, and management. *American J. Sports Medicine* [serial online]. December 2010;38(12):2405-2409.
7. Crisco JJ, Fiore R, Beckwith JG, et al. Frequency and location of head impact exposures in individual collegiate football players. *J. Athletic Training* [serial online]. 2010;45(6):549-559. Available at: www.nata.org/jat

8. Sports-Related concussions: background and significance. *Brain Trauma Research Center*. University of Pittsburgh, Department of Neurological Surgery. 2011. Available from: <http://www.neurosurgery.pitt.edu/trauma/concussion.html>
9. Gessel LM, Fields SK, Collins CL, Dick RW, Comstock RD. Concussions among United States high school and collegiate athletes. *J. Athletic Training* [serial online]. 2007;42(4):495-503. Available at: www.journalofathletictraining.org.
10. Tommasone BA, Valovich McLeod TC. Contact sport concussion incidence. *J. Athletic Training* [serial online]. December 2006;41(4):470-472. Available at: www.journalofathletictraining.org.
11. Bloom GA, Loughhead TM, Shapcott EJ, Johnston KM, Delaney JS. The prevalence and recovery of concussed male and female collegiate athletes. *European J. Sport Science*. 2008;8(5):295-303.
12. Frommer LJ, Gurka KK, Cross KM, Ingersoll CD, Comstock RD, Saliba SA. Sex differences in concussion symptoms of high school athletes. *J. Athletic Training*. [serial online]. 2011;46(1):76-84. Available at: www.journalofathletictraining.org.
13. Catena RD, Van Donkelaar P, Chou LS. The effects of attention capacity on dynamic balance control following concussion. *J. NeuroEngineering and Rehab*. 2011;8(8):1-8. Available at <http://www.jneuroengrehab.com/content/8/1/8>.
14. Notebaert AJ, Guskiewicz KM. Current trends in athletic training practice for concussion assessment and management. *J. Athletic Training* [serial online]. 2005;40(4):320-325. Available at: www.journalofathletictraining.org.
15. Covassin T, Elbin R, Stiller-Ostrowski JL. Current sport-related concussion teaching and clinical practices of sports medicine professionals. *J. Athletic Training* [serial online]. 2009;44(4):400-404. Available at: www.journalofathletictraining.org.

16. Guilmette TJ, Malia LA, Mcquiggan MD. Concussion Understanding and Management Among New England High School Football Coaches. *Brain Injury*. [serial online]. September 2007;21(10):1039-1047. Available from: PsychInfo, Ipswich, MA.
17. McGrath N. Supporting the student-athlete's return to the classroom after a sport-related concussion. *J. Athletic Training* [serial online]. 2010;45(5):492-498. Available at: www.journalofathletictraining.org.
18. Covassin T, Stearne D, Elbin R. Concussion history and postconcussion neurocognitive performance and symptoms in collegiate athletes. *J. Athletic Training* [serial online]. 2008;43(2):119-124. Available at: www.nata.org/jat.
19. Broglio S, Ferrara M, Macciocchi S, Baumgartner T, Elliott R. Test-Retest Reliability of Computerized Concussion Assessment Programs. *J. Athletic Training* [serial online]. October 2007;42(4):509-514. Available from: Academic Search Premier, Ipswich, MA.
20. Piland SG, Ferrara MS, Macciocchi SN, Broglio SP, Gould TE. Investigation of baseline self-report concussion symptom scores. *J. Athletic Training* [serial online]. 2010;45(3):273-27. Available at: www.journalofathletictraining.org.
21. Broglio SP, Ferrara MS, Piland SG, Anderson RB. Concussion history is not a predictor of computerized neurocognitive performance. *British J. Sports Med.* 2006;40:802-805. Available at www.bjsportmed.com.
22. Covassin T, Elbin R, Stiller-Ostrowski JL, Kontos AP. Immediate post-concussion assessment and cognitive testing (ImPACT) practices of sports medicine professionals. *J. Athletic Training* [serial online]. 2009;44(6):639-644.
23. Collie A, Makdissi M, Maruff P, Bennell K, McCrory P. Cognition in the days following concussion: comparison of symptomatic versus asymptomatic athletes. *J. Neuro and Neurosurg Psych.* 2006;77:241-245. Available at www.jnnp.com.

24. Fazio V, Lovell M, Pardini J, Collins M. The relation between post concussion symptoms and neurocognitive performance in concussed athletes. *NeuroRehabilitation* [serial online]. June 2007;22(3):207-216. Available from: PsycINFO, Ipswich, MA.
25. Garden N, Sullivan KA, Lange RT. The relationship between personality characteristics and post-concussion symptoms in a nonclinical sample. *Neuropsychology* [serial online]. March 2010;24(2):168-175. Available from PsycINFO, Ipswich, MA
26. Iverson GL, Gaetz M, Lovell MR, Collins MW. Cumulative effects of concussion in amateur athletes. *Brain Injury* [serial online]. 2004;18(5):433-443. Available at: <http://www.tandf.co.uk/journals>.
27. Sigurdardottir S, Andelic N, Roe C, Jerstad T, Schanke AK. Post-concussion symptoms after traumatic brain injury at 3 and 12 months post-injury: A prospective study. *Brain Injury* [serial online]. June 2009;23(6):489-497. Available from: PsychInfo, Ipswich, MA.
28. Yang CC, Hua MS, Tu YK, Huang SJ. Early clinical characteristics of patients with persistent post-concussion symptoms: A prospective study. *Brain Injury* [serial online]. April 2009;23(4):299-306. Available from: PsychInfo, Ipswich, MA.
29. Logan K. Recognition and management of post-concussion syndrome. *American Medical Society for Sports Medicine*. May 2010;15(3):4-7. Available from: SPORTDiscus.
30. Lovell MR, Iverson GL, Collins MW, et al. Measurement of symptoms following sports-related concussion: reliability and normative data for the post-concussion scale. *Applied Neuropsychology* [serial online]. 2006;13(3):166-174. Available from: PsychInfo, Ipswich, MA.
31. Broglio SP, Macciocchi SN, Ferrara MS. Neurocognitive performance of concussed athletes when symptom free. *J. Athletic Training* [serial online]. 2007;42(4):504-508. Available at: www.journalofathletictraining.org.

32. McClincy MP, Lovell MR, Pardini J, Collins MW, Spore MK. Recovery from sports concussion in high school and collegiate athletes. *Brain Injury* [serial online] January 2006;20(1):33-39. Available at PsycINFO, Ipswich, MA
33. Yard E, Comstock R. Compliance with return to play guidelines following concussion in US high school athletes, 2005-2008. *Brain Injury* [serial online]. October 2009;23(11):888-898. Available from: Academic Search Premier, Ipswich, MA.

ABSTRACT

TITLE: FACTORS THAT INFLUENCE COLLEGIATE VARSITY ATHLETES' KNOWLEDGE OF CONCUSSIONS

RESEARCHER: Angela Boyle, ATC, PES

ADVISOR: Dr. Jamie Weary

DATE: May 2012

PURPOSE: The primary purpose of this study was to determine what factors affect concussion knowledge in collegiate varsity athletes.

Design: Descriptive Survey

Settings: Population-Based Survey

Participants: 500 collegiate varsity athletes at the four participating college institutions. The final response rate was 67.

INTERVENTIONS: The independent variables were concussion education training, experience in a varsity sport, sport, and personal history of concussions. The dependent variable was the score on the concussion knowledge test.

RESULTS: There was significance found in one of the four hypotheses which indicates that a previous history of concussions was the only factor that affected concussion knowledge. In addition, participating in a concussion education training session, having greater years of experience as a collegiate varsity athlete, and being a collegiate football player does not significantly impact concussion knowledge.

CONCLUSIONS: Based on the results of this study, we can conclude that concussion education training is not effective in increasing concussion knowledge and needs to be improved before every sports season begins.