5-2015

Concussion Education and the Self-Reporting Rate of Concussion Symptoms among College Athletes

Brian J. Hyma
Olivet Nazarene University, bhyma@olivet.edu

CONCUSSION EDUCATION AND THE SELF-REPORTING RATE OF CONCUSSION SYMPTOMS AMONG COLLEGE ATHLETES

by

Brian J. Hyma

Dissertation

Submitted to the Faculty of

Olivet Nazarene University

School of Graduate and Continuing Studies

in Partial Fulfillment of the Requirements for

the Degree of

Doctor of Education

in

Ethical Leadership

May 2015

CONCUSSION EDUCATION AND THE SELF-REPORTING RATE OF CONCUSSION SYMPTOMS AMONG COLLEGE ATHLETES

by

Brian J. Hyma

Dissertation

Dissertation Adviser	18 April 2015 Date
Dissertation Reader	4/18/15 Date
Dissertation Coordinator	4/18/15 Date
Program Director	4-18-15 Date
Vice President for Academic Affairs	4-18-15 Date

ACKNOWLEDGEMENTS

I would first like to thank my Lord and Savior Jesus Christ for the strength and stamina to complete such a project. Most important, he has been faithful to me from the very beginning. I am honored to be known as a child of the King.

Accomplishing such a task would have been impossible if not for my editor in chief, my biggest supporter, my best friend, my wife, Melissa Hyma. I thank you for your love, kindness, compassion, belief, and an occasional kick in the rear. You now get your husband back.

Next, I would like to share my deep gratitude to my advisor, Dr. Rebecca Taylor, for her excellent guidance and amazing encouragement every time we met. Also, I want to thank my reader, Dr. Stan Tuttle, for his patience and commitment towards helping me become a better writer. The multiple documents with *review, revise, and resubmit* were well worth it in the end.

I truly appreciate all of the certified athletic trainers, especially BJ Geasa and April Kamba, who supported my efforts through sacrificing their time to help me administer surveys to their athletes and who also picked up the slack I may have left at work.

I want to thank my parents, Marvin and Jackie Hyma, who modeled and encouraged the importance of education and continue to show their support of their child. Lastly, I want to thank my children, Nora and Titus, for making it through many evenings and days without dad. I am ready to make up time, with interest.

ABSTRACT

This study addressed the effectiveness of a structured concussion education tool in order to increase the knowledge of concussion symptoms among college athletes. Also, efforts were made to determine if the gained knowledge from the education tool would lead to an increase in the self-reporting of acquired concussion symptoms. For the study, pre and postseason surveys were administered to athletes among six universities. Athletes representing the experimental group received pre-season concussion education while the control group did not receive the education. Data concerning the athlete's history of structured concussion education, retained knowledge of concussion symptoms, along with the rate of self-reported concussion symptoms was gathered and analyzed for significance. The study reported that over 73% of the surveyed athletes received some form of concussion education in college or high school. Also, analyzed data revealed a much greater rate of retained knowledge of concussion symptoms among the experimental group compared to the control group. Finally, there was no significant difference between the experimental group compared to the control group when studying the effect a structured education had on the self-reporting of concussion symptoms. The quantitative study demonstrated that a large majority of college athletes have received formal concussion education training. Also, a formal concussion education program does not affect the self-reporting rate of concussion symptoms but does positively affect the athlete's recall of symptoms of concussion injuries.

TABLE OF CONTENTS

LIST OF TABLES

Table Page

LIST OF FIGURES

Figure Page

CHAPTER 1

INTRODUCTION

The American Medical Society has determined that sport-related head injuries, including Traumatic Brain Injury, have become a major public health concern. The term Traumatic Brain Injury (TBI) encompasses a number of specific brain injuries. Harmon et al. (2013) reported that a concussion is generally considered self-limiting and at the less-severe end of the brain injury spectrum. The concern over TBI has prompted some states to consider and in many cases, pass legislation to help reduce the potential of injuries secondary to concussions (Adler & Herring, 2011).

For many years, medical experts' distinguished concussions as either simple or complex based on whether or not the athlete lost consciousness (McCrory et al., 2009). A concussion is considered to be a transient disturbance of the brain caused by a complex pathophysiological process, typically from a traumatic event (Harmon et al., 2013). Concussion injuries with loss of consciousness were previously classified as complex and all others received a mild classification. McCrory et al. noted that medical experts have abandoned the simple versus complex concussion terminology based on loss of consciousness and have based the severity of the concussion on the amount, severity, and duration of lasting effects of a number of symptoms and outward signs. Signs and symptoms such as headache, pressure in the head, dizziness, blurred vision, balance

problems, difficulty concentrating, and 12 other criteria were noted by experts in the field of concussion management as common signs and symptoms of a concussion injury (McCrory et al., 2009).

Through advancements in equipment technology, rule changes, advanced assessment practices, and increased social awareness of concussions, the fatality rate of concussion injuries has steadily decreased over the years (Guskiewicz et al., 2005). Reports of serious medical conditions linked with concussions, however, continued to rise (Harmon et al., 2013), despite the decreased fatality rate. Researchers have associated conditions such as early-onset of Alzheimer's disease (Beaumont et al., 2009), chronic depression (Guskiewicz et al.), and chronic traumatic encephalopathy (CTE) (Gavett, Stern, & McKee, 2011; McKee et al., 2009; Omalu, Hamilton, Kamboh, DeKosky, & Bailes, 2010; Stern et al., 2011) among individuals sustaining multiple concussion injuries.

Cantu and Gean (2010) reported that a subdural hematoma posed the most common cause of death from head injury in sports. Cantu and Gean further reported that in 28 researched cases of head injury fatalities during sports-related activities, 18 victims presented with symptoms of concussion yet continued to participate.

McCrea, Hammeke, Olsen, Leo, and Guskiewicz (2004) hypothesized that athletes have limited knowledge to recognize signs and symptoms of a concussion. Consequently, athletes continued to compete while experiencing head injury symptoms, such as loss of consciousness. McCrea et al. surveyed athletes and determined that the primary reason that athletes did not report a concussion episode to medical personnel was that they did not believe the presenting symptoms constituted a concussion. They also

determined that fewer than 47% or 109 out of 229 high school football players who sustained a concussion reported such an event. Broglio et al. (2010) further reported that a lack of knowledge concerning the severity of concussions ranked as the most common factor for not reporting concussion injuries among adolescent soccer players.

Kaut, DePompe, Kerr, and Congeni (2003) reported that over 28% or 127 of 451surveyed college football athletes failed to report a concussion injury and continued to participate in activity while symptomatic. Further, Kaut et al. concluded that the apparent disregard of concussion symptoms by college athletes raised concern among medical professionals regarding an athlete's knowledge of increased effects and potential catastrophic results of competing while symptomatic. As a result of these findings, the current study was designed to address the effects of concussion education on the self-reporting of concussion symptoms by college athletes.

Statement of the Problem

Medical professionals continue to rely on reported symptoms of a concussion injury as a primary indicator of the concussion injury (McCrory et al., 2009). Consequently, the self-reporting of these symptoms by the athlete is essential for proper diagnosis and subsequent management of the athlete. As reported in previous studies, athletes have failed to report such symptoms for a variety of reasons, primarily due to lack of education concerning the symptoms of concussions (Broglio et al., 2010; Kaut et al., 2003; McCrea et al., 2004). The purpose of this study was to determine the effectiveness of a structured concussion education tool in order to increase the knowledge of concussion symptoms among college athletes. The secondary purpose of the study was

to determine if the gained knowledge would lead to an increase in the self-reporting of acquired concussion symptoms.

Background

An estimated 3.8 million concussions occur each year in the United States during sport competition and recreational activities; however, as many as 50% or 1.4 milllion of these concussions go unreported (Harmon et al., 2013). If lack of knowledge concerning concussions contributed to the low percentage of reported concussion injuries in athletes, then addressing the lack of knowledge is vital in preventing further concussive injury (McCrea et al. 2004).

Schatz, Moser, Covassin, and Karpf (2011) raised concern that athletes who sustain multiple concussions may suffer long-term cognitive effects, along with psychological impairments. Furthermore, they reported that athletes who had sustained two or more concussions suffered a greater number of overall concussion symptoms when compared to those athletes with a history of one or no concussions. Schatz et al. indicated the need for further longitudinal studies concerning any emotional impairments in high school athletes with and without a history of concussion. They also recommended that athletes with a history of concussion participate in activities with caution and reported the need for more substantial education regarding concussion awareness.

Players who sustained three or more concussions had a greater rate of diagnosed mild cognitive impairment and a greater rate of substantial memory loss when compared to players without a history of concussion, according to Guskiewicz et al. (2005). Additionally, Guskiewicz et al. determined that professional football athletes sustaining multiple concussions had an increased risk of future memory impairment disorders.

Additional researchers, including Castile, Collins, McIlvain, & Comstock, (2012) indicated that athletes sustaining a recurrent concussion exhibited a larger number of symptoms, an extended time before resolution of symptoms, and a higher prevalence of loss of consciousness, compared to athletes sustaining a first concussion.

When further evaluating the dangers of multiple concussions, Iverson, Gaetz, Lovell, and Collins (2004) reported that football players with a prior history of concussion had a greater risk of sustaining a subsequent concussion. They also reported a larger number of concussion symptoms, along with a decline in memory function, during baseline testing in athletes with a history of multiple concussions when compared with athletes with no history of concussions. At the time of the concussion injury, athletes with a history of multiple concussions presented with greater severity of on-field symptoms associated with their concussion compared to the group having no history of concussions. Also, athletes with a history of concussions reported a substantial decrease in memory performance after the concussion injury compared to athletes sustaining a first concussion (Collins, Lovell, Iverson, Ide, & Maroon, 2006).

Athletes with a history of three or more concussions sustained loss of consciousness seven times more often than athletes who had no previous history of concussion (Collins et al., 2002). Also, these researchers concluded that athletes with a history of concussion sustained three or four serious concussion markers nine times more often than those with no history of concussion. Serious concussion markers, such as confusion, anterograde amnesia, retrograde amnesia, and loss of consciousness were identified in these participant athletes by Collins et al.

Researchers have utilized Electroencephalogram (EEG) testing in determining the severity of concussion injuries. Slobounov, Cao, and Sebastianelli (2009) conducted a study to determine the EEG Information Quality (EEG-IQ) in athletes who had suffered a sport-related concussion and to determine differences in the EEG-IQ between first and second concussion episodes. The EEG-IQ diagnostic test measures the quality of neurological activity in the brain. Slobounov et al. concluded that athletes who suffer a second concussion soon after their first will have a greater reduction of neurologic activity and will require a greater amount of time before return to baseline compared to athletes with a single concussion. If athletes continue to limit the reporting of acquired concussion symptoms and return to activity while symptomatic, a subsequent concussion injury may prolong decreased brain activity (Slobounov et al.).

In a study concerning the prolonged effects of first-time concussions, Ellemberg, Leclerc, Couture, and Daigle (2007) noted a statistically significant difference in planning and response time between athletes with a first concussion and athletes with no history of concussion. When studying cognitive functions, concussed athletes responded more slowly during the planning and response phases compared to the non-concussed group. The evidence from Ellemberg et al. further strengthens the need to allow an athlete the proper time to recover from symptoms before he or she returns to athletic play.

As noted earlier, rate of concussion injuries continues to rise among athletes in the United States. In the early 1990s, an estimated 300,000 sports-related concussions occurred (Sosin, Sniezek, & Thurman, 1996). In a more recent study, Harmon et al. (2013) reported that the rate of sports-related concussions has increased to an estimated 3.8 million. Gessel, Fields, Collins, Dick, & Comstock (2007) found that a higher rate of

concussions were incurred by collegiate athletes, but noted that concussions accounted for a greater percentage of total injuries in high school athletes.

Athletes often present with a spectrum of outward signs of concussion that a medical professional may visually observe and determine as a concussion; however, a concussion is primarily diagnosed by symptoms that the athlete expresses to an evaluator (McCrory et al., 2009). An athlete's lack of knowledge about concussion symptoms and attitudes towards reporting such symptoms continues to be of great concern to medical professionals. Broglio et al. (2010) reported that lack of knowledge concerning the severity of the concussion led to decreased reporting of injuries by an athlete. Also, athletes recognized concussions as common within sports and did not note a concern towards symptoms that may have represented a concussion injury. Broglio et al. concluded that this lack of concern towards concussion symptoms as another potential cause for the decreased reporting of concussion injuries.

In a study conducted by Bramley, Patrick, Lehman, and Silvis (2012), 72% or 43 of the 60 surveyed athletes who received concussion awareness training reported that they would inform the coach or athletic trainer compared to 36% who had no prior education. Bramley et al. reported that high school soccer players who received concussion education from any source were more likely to notify their coach or medical professional of a concussion injury compared to those with no concussion education. Bramley et al. concluded that education is likely the cornerstone of early identification of concussion symptoms, because accurate diagnosis of a concussion can only occur after an athlete reports symptoms.

Sefton (2003) found that the lack of self-reporting and subsequent proper care of concussion injuries sustained by college athletes posed a subtantial problem within college football. Sefton hypothesized that certain predicators may influence athletes toward the under-reporting of concussion injuries. From completed surveys, Sefton determined an athlete's limited knowledge regarding concussion severity as the most common factor for failure to self-report concussion injuries. This study provided further evidence for concussion injury education at the college level.

Athletes have received concussion education utilizing a number of different approaches over the past several years. Educational materials, for example, consisted of video and published material (Covassin, Elbin, & Sarmiento, 2012), online education (Glang, Koester, Beaver, Clay, & McLaughlin, 2010), and social networks such as Twitter and Facebook (Provvidenza et al., 2013). Although researchers have reported positive results when coaches gained knowledge concerning concussion management (Covassin et al.; Glang et. al.), very little research exists concerning the effects of these forms of education on the increased knowledge of symptoms and self-reporting rate from the athletes themselves. Glang et al. reported the need for researchers to conduct further studies to assess the effectiveness of online education, specifically, on maintained knowledge and attitude of coaches, athletes, medical providers, and parents concerning concussion management over time.

Research Questions

The research was guided by the following questions:

1. To what extent have college athletes been educated in the area of concussion management?

2. What impact does a formal education program related to concussion management have on the accurate identification of concussion symptoms?

3. What is the effect of formal pre-season concussion education on self-reporting of concussion symptoms in collegiate football, male soccer, and female soccer athletes?

Description of Terms

Anterograde Amnesia. The loss of memory concerning events that occur after the concussion event (Collins et al., 2002).

Complex Concussion. A concussion that results in symptoms taking longer than 10 days to resolve (McCrory et al., 2009).

Mild Cognitive Impairment. Mild memory loss in a person that displays normal cognitive functions (Palmer, Fratiglioni, & Winbald, 2003).

Retrograde Amnesia. The loss of memory concerning events that occurred before the concussion occurred (Collins et al., 2002).

Simple Concussion. A concussion that results in symptoms that resolve in a short, seven-to-ten day period (McCrory et al., 2009).

Traumatic Brain Injury (TBI). Trauma to the brain from an outside force causing an impairment of the person's physical and cognitive function (Kaut et al., 2003).

Significance of the Study

Athletes may sustain serious and potentially life-threatening injuries while continuing to participate in sports while presenting with symptoms of concussion (Cantu & Gean, 2010; Stern et al., 2011). McCrory et al. (2009) reported that a headache after contact to the head is a symptom of a concussion. Many athletes continue to participate

while symptomatic, posing a serious health concern (Sefton, 2003). Medical professionals rely on the athlete to self-report these symptoms in order to make an accurate diagnosis. Researchers concluded that athletes have withheld this information because of lack of knowledge concerning concussion signs and symptoms (McCrea et al., 2004). Provision of education materials to athletes will prepare them to recognize the symptoms of concussion, as well as the potential long-term effects of continuing to participate while symptomatic. This increased awareness may encourage them to report such symptoms, thus linking an increased rate of reporting concussion symptoms. Exposure of athletes to a structured educational presentation could also prove beneficial to athletic trainers. If education is found to increase substantially the rate of reporting, medical providers across the country could administer concussion reporting education with confidence that the rate of increasing harm will decrease. Education that aids athletes in the recognition of concussion symptoms, and in the understanding of consequential long-term effects of participating in athletic activities while symptomatic, could potentially provide them the knowledge of the importance to report concussion symptoms, thus protecting them from a potentially life-altering injury. This study may identify educational materials to prepare athletic trainers and coaches better as they educate athletes concerning concussion recognition and management of the injury.

Process to Accomplish

Introduction

The purpose of this study was to determine the effectiveness of a structured concussion education tool in order to increase the knowledge of concussion symptoms among college athletes. The secondary purpose of the study was to determine if the

gained knowledge would lead to an increase in the self-reporting of acquired concussion symptoms. Will athletes who received preseason concussion education have a higher rate of self-reported concussion symptoms compared to athletes with no preseason training? The following process to accomplish was utilized for the stated purpose of this study.

Participants

The population utilized for this study consisted of collegiate athletes from four universities. Purposive sampling was used to reach out to all of the athletes participating in football and in men's and women's soccer. The groups were separated based on specific sport and gender, similar to previous studies. The potential total number of student athletes from the three different sports was approximately 180 from each school. Two university groups were randomly assigned to receive the education and two would not receive the education, based on the willingness of the university's athletic director to participate in the study.

In addition to selecting universities to participate through purposive sampling, a convenience sampling was conducted (Salkind, 2012) for athletes willing to participate. Athletes from the selected colleges participating in football and men's and women's soccer were sampled. Athletes from the two chosen universities who volunteered to participate in the preseason concussion education program formed the experimental group while the athletes who volunteered from the two universities chosen not to receive the concussion education represented the control group.

Measures

The symptom of concussion (SOC) pre and postseason questionnaire was utilized to measure the knowledge of common symptoms of a concussion. The instrument was

utilized to measure the pre and postseason knowledge of concussion symptoms for both the experimental and control group. In constructing the instrument, a list of 22 concussion symptoms agreed upon by a panel of neurologists and experts in the field of head trauma from the International Summit in Prague were included (McCrory et al., 2009). The group of symptoms demonstrated strong content validity as experts in the field created the list of symptoms. Symptoms other than those of concussion were included to act as distractors. Echemendia, Ellis, and Geasa (personal communication, March 15, 2013), considered experts in the field of concussion evaluation and management, provided distractor symptoms. Each of these contributors has extensive background in the area of concussion signs and symptoms. The 22 concussion symptoms and distractors were compiled into one instrument and the instrument was administered to a group of medical experts. This group of medical experts consisted of medical doctors, physician's assistants, and certified athletic trainers who were all well-educated concerning the signs and symptoms of concussion injuries. The experts completed the instrument by selecting all of the symptoms associated with a concussion injury. Any symptom not endorsed by 50% of the four experts used was eliminated from the questionnaire. Any one of the distractors endorsed by the experts was also dropped. The remaining symptoms and distractors were compiled to create the instrument. This process of constructing the SOC identification instrument ensured content validity of the instrument.

Included as part of the concussion symptom questionnaire was a question added concerning the extent of any previous concussion structured information received by the participant concerning concussion signs, symptoms, and management. Athletes were

requested to choose from a time they received this structured information and by what mode they received the information. When selecting the time athletes received information, they could choose from high school, college, or other. When choosing how the information was provided, athletes could choose from coach or medical provider, through a video, through written material, or through internet or television. This information was used to determine whether the athlete had received any concussion information along with the extent of when and how the athlete received the information.

A pilot study was conducted to determine the knowledge of concussion symptoms and extent of concussion education instrument to a group of college athletes not involved with the current study. During the pilot study, open ended questions were added to assess the quality and clarity of the instrument. Information was gathered from the athletes concerning their ability to understand the questions, clarity of directions, and ease of completing the instrument.

To obtain data concerning the effect of concussion education on the self-reporting of symptoms, the McCrea concussion reporting survey instrument, created by McCrea et al. (2004) was utilized. During the study by McCrea et al., researchers desired to determine the rate at which high school football players reported concussion injuries that occurred during the season along with reasons for not reporting such symptoms. The survey was administered to both the research and control group after the season had concluded. The survey included a definition of a concussion injury and four categorical variables: one, did they have a concussion prior to the season; two, did they suffer a concussion during the season; three, if the athlete did suffer a concussion, did he or she report the concussion to supervisory personnel; and four, if they did not report the

concussion injury, what was the reason? The instrument was created by a group of experts in the field of traumatic brain injury and sport-related concussion, which enhanced the content validity of the instrument (McCrea et al.).

Procedure

Athletic department consent was received through written verification from the director of athletics of each participating university. Because this study examined individual behavior and involved minimal manipulation of behavior, the researcher determined that this study posed no more than minimal risk to the participants. As such, informed consent was obtained via a cover letter. This signed statement stipulated that the participants granted consent throughout the pre and postseason survey. Athletes were notified that participation was completely voluntary and that all questionnaire responses would be kept confidential. Additionally, signed informed consent was the only name record linking the participant to the research or data.

To gain data concerning each athlete's knowledge of concussion symptoms, athletes completed the SOC. Through the SOC, participants were asked to select as many symptoms as they believed occurred due to a concussion injury. Athletes participating in the education group viewed an online concussion education course produced by the National Collegiate Athletic Association (2013). The experimental group also viewed a PowerPoint presentation about the prolonged effects of repeated concussions. The control group did not receive the education. Both the experimental and control groups completed the SOC questionnaire during a preseason meeting prior to the online educational presentation to the experimental group. A postseason SOC questionnaire was

administered to both the experimental and control group within one week after their final game.

Data was gathered concerning the effect of preseason education on the self-reporting of concussion symptoms through the McCrea Concussion Reporting Survey (McCrea et al., 2004). At a postseason meeting within one week of the final season game, the researcher administered the instrument to the experimental and control groups. In the instrument, the researcher included the definition of a concussion injury. Through the survey, athletes were asked if they had experienced a concussion during the past season. If the athlete did suffer a concussion during the season, did they report this incident and to whom did they report it to? Reporting personnel the athlete could choose included an athletic trainer, coach, parent, and other. Also, the athlete was asked to report why they did not report the concussion injury during the season. A similar instrument was used in an earlier study by McCrea et al. to gain similar information from high school athletes.

Research Question One

To what extent have college athletes been educated in the area of concussion management?

Data.

Through the previously described instrument, the researcher proposed to determine whether the athlete had received any concussion information along with descriptive data of when and how the athlete received the information. Categorical data of a yes or no answer was collected to determine whether they had received any previous formal concussion information.

Analysis.

The researcher proposed to determine the percentage of college athletes who received any formal concussion information. Of the athletes who had received some form of information, formal information was gathered to determine when they received the formal information and by what method the athlete received it. Athletes could choose between high school, college or other as the timeframe of their education. Regarding the extent of formal information, athletes could choose between in person through coaches or medical provider, through video presentation, through written material, or through an online media source. A descriptive analysis was used when analyzing the percentage of athletes who received formal concussion information and the particular mode of formal concussion information.

Research Question Two

What impact does a formal education program related to concussion management have on the accurate identification of concussion symptoms?

Data.

The study was created to determine the athlete's retained knowledge of the common symptoms of a concussion injury after viewing the formal educational tool. Data was gathered from pre and postseason tests, from which the percentage of correct concussion symptoms recognized by the athletes was calculated. The percentage of correct answers was compared between the pre and posttest responses concerning the knowledge of concussion symptoms across the groups.

Analysis.

Data received was used to determine the retained knowledge of the symptoms of a concussion injury among formally educated college athletes and those athletes not

receiving formal education. When analyzing the data comparing pre and postseason percentages of correctly recognized symptoms within the experimental and control group, a mixed factorial analysis of variance (ANOVA) was used to analyze data between participants and the experimental and control groups concerning the athlete's knowledge of concussion symptoms.

Research Question Three

What is the effect of pre-season education on self-reporting of concussion symptoms in collegiate football and male and female soccer athletes?

Data.

Athletes were educated using an online Concussion in Sport education course published by the National Collegiate Athletic Association (2013) not previously seen by either of the groups. The online course described the etiology of a concussion injury and common signs and symptoms, along with proper recommendations concerning reporting such injuries (National Collegiate Athletic Association). The experimental group also viewed a PowerPoint presentation describing the prolonged effects of multiple concussions. The total number of concussion injuries self-reported to a medical professional or supervising agent was then collected during the postseason meeting through the McCrea Concussion Reporting Survey (McCrea et al., 2004). The researcher secured permission from McCrea to utilize the instrument. Concerning the question of the McCrea survey, "if you suffered a concussion during the season did you report it" the researcher collected categorical data of yes or no answers.

Analysis.

Data collected focused on the connection between concussion education and the reporting of concussion injuries compared to athletes receiving no concussion education. When analyzing the categorical data from the question "if you suffered a concussion during the season did you report it," a Chi-square (X^2) analysis was performed to determine the observed frequencies of reported concussion among the experimental and control group.

Summary

The purpose of this study was to determine the effectiveness of a structured concussion education tool in order to increase the knowledge of concussion symptoms among college athletes. The secondary purpose of the study was to determine if the gained knowledge would lead to an increase in the self-reporting of acquired concussion symptoms. According to previous research, there is a low self-reporting rate of concussion injuries among athletes (Broglio et al., 2010; Kaut et al., 2003; McCrea et al., 2004; Sefton, 2003). This lack of self-reporting increases the risk that athletes will continue participate while symptomatic. If a repeated head injury is sustained, a potentially fatal head injury may result. The next chapter will provide a review of current research concerning concussion injuries and concussion education among athletes.

CHAPTER II

REVIEW OF LITERATURE

Introduction

In 2011, the Centers for Disease Control estimated that up to 3.8 million concussion injuries occur in recreational activity each year (Daneshvar, Nowinski, McKee, & Cantu). Concussion injuries rank as one of the most complex and difficult injuries to care for in the athletic arena (Broglio et al., 2010; McCrory et al., 2013). Most often, concussions do not present observable signs or symptoms to medical professionals. Medical professionals make a diagnosis of a concussion injury through self-reported symptoms by the injured athlete. Commonly, medical professionals see symptoms or assess self-report information immediately after the injury. Some symptoms, however, may not present themselves for hours or days post injury (McCrory et al., 2013).

Adding to the challenge of properly diagnosing concussions, researchers have found a common theme of underreporting concussion injuries by high school and college athletes (Broglio et al., 2010; McCrea et al., 2004; Sefton, 2003; Sye, Sullivan, McCrory, 2006). Lack of knowledge concerning the signs and symptoms of concussion injuries was a commonly cited reason for the lack of reporting (McCrea et al.). A concussion diagnosis primarily occurs through athlete self-awareness of symptoms and then proper reporting of such symptoms to a medical professional. Education and understanding regarding this injury is imperative among high school and college athletes in order to provide them the necessary information to properly manage this injury.

This study reviewed the research related to the history and definition of concussions, the epidemiology of concussion injuries, the common signs and symptoms of concussions, athletes' knowledge and attitudes concerning concussions, the prolonged effects of concussion injuries, and current modes of education for athletes concerning concussion injuries.

Concussion Defined

Historically, medical professionals have viewed concussions as a low-velocity injury to the brain resulting in neurological disturbances that resolve quickly. The term *concussion* began in European countries from the term brain commotion or commoti cerebri (McCrory, et al., 2013). Upon review of historical writings, Johnson, McCrory, Mohtadi, and Meeuwissw (2001) determined no definitive definition of the term *concussion*. Medical professionals have recognized the effect of acute head injuries for years but no specific definition of a concussion injury existed. To begin the process of providing a working definition, Russell and Smith (1961) defined a concussion as "a low-velocity injury leading to temporary disturbance of function" (p. 5). Upon further research on the subject, Johnson et al. revealed that previous researchers focused on the mechanics of the brain within the skull during the accelerated injury rather than its pathology and subsequent clinical symptoms.

According to McCrory et al. (2013), members of the 1964 Congress of Neurological Surgeons defined a concussion injury as "a clinical syndrome characterized by immediate and transient impairment of neural function, such as alteration of consciousness, disturbance of vision and equilibrium due to mechanical forces" (p. 37). Medical professionals accepted this definition for many years; however, in 2002, a group

of neurological experts gathered to discuss a number of components regarding concussion injuries including revisiting the existing definition (Aubry et al., 2002). The panel identified the existing definition as useful but too simplistic and in need of further attention. They worked together to create an agreed-upon working definition of the term concussion.

Aubry et al. (2002) reported that the panel further described a number of features that assist in defining the nature of a concussive head injury. First, a concussion could be caused by either a direct hit to the face, head, neck, or any other part of the body that causes an impulse force to the head. Second, those who suffer such a force could experience short-term neurological deficiencies but these deficiencies tend to resolve themselves over a short period of time. Third, concussions generally reflected a neurological functional deficit rather than a structural injury. Fourth, clinicians would determine a concussion injury based on a number of graded symptoms that may or may not include loss of consciousness. Fifth, structural neuroimaging would reveal no structural abnormalities. Any head injury resulting in structural abnormalities would re-categorize the injury to a moderate or severe traumatic brain injury.

Epidemiology of Concussions

An estimated 170 million people participate in an organized sport or recreational activity in the United States annually, with concussion injuries accounting for 5% to 9% of all sport-related injuries (Daneshvar et al., 2011; Harmon et al., 2013). Gessel et al. (2007) reported sport-related brain injuries as the second leading cause of traumatic brain injury in younger people aged 15 to 24. Marar, McIlvain, Fields, and Comstock (2012) estimated that over 300,000 cases of sport-related concussions occurred annually among

individuals in the 15 to 24 year range. These researchers did conclude, however, that these numbers may be underestimated because of individuals' failing to report concussions (Daneshvar et al., 2011; McCrea et al., 2004).

Guskiewicz et al. (2009) reported that as sport participation in society has become more popular and a greater number of adolescents participate in sports, concussions will increase in number. Coaches, parents, health care providers, and the athletes themselves share the responsibility of recognizing, educating, and managing these injuries. Guskiewicz et al. also noted that the number of catastrophic concussion injuries has steadily declined. In 1968, 36 fatalities occurred in high school and college sports as a result of head and neck injuries. In 1990, no recorded fatalities occurred due to a neck or head injury in high school or college sports. Since 1990, an average of five fatalities per year resulted from neck or head injuries. Although these numbers have dropped since 1968, even a single fatality is one too many (Mueller & Cantu, 2002). Researchers attribute the decrease of fatalities to a number of reasons, including rule changes, player education regarding rule changes, required and improved equipment standards, reduced amount of physical contact during practice, and athlete education on the life-altering dangers of reckless play (Guskiewicz et al.).

Guskiewicz et al. (2009) reported that health care professionals need to continue providing education to athletes concerning head injuries such as concussions. Furthermore, they concluded that athletes who have a better understanding of the signs and symptoms of a concussion injury and the potential negative effects while playing while symptomatic may better understand the necessity of reporting a concussion injury.

Between 1989 and 2002, Boden, Tacchetti, Cantu, Knowles, and Mueller (2007) investigated 92 athletes who suffered a subdural hematoma due to a sport-related head injury. A subdural hematoma is a direct damage to the brain that causes bleeding within the brain, resulting in life-altering conditions or even death (Boden et al.). Of the 92 subdural hematoma injuries, eight ended in death and 46 ended in permanent neurological injury. Boden et al. further reported that 39%, or 40 of the 92, catastrophically injured athletes continued to play while suffering with residual neurological symptoms.

Although the number of fatalities due to concussion injuries has decreased, the actual number of reported concussion injuries has risen steadily over the years. Several researchers concluded that the numbers of reported concussion injuries have increased each year primarily because of the greater focus on concussion awareness and state legislation. (Adler & Herring, 2011; Hootman, Dick, & Agel, 2007; McLeod, Bay, Heil, & McVeigh, 2008). They commended the efforts concerning the increase in concussion awareness but continued to recommend an increase in concussion education.

When reviewing the rate of concussion injuries among high school and collegiate athletes, researchers determined that athletes participating in football sustained the highest percentage rate of concussion, followed by boys' ice hockey, boys' lacrosse, and girls' soccer. Both high school and college level athletics share similar rankings (Gessel et al., 2007; Guskiewicz, Weaver, Padua, & Garrett, 2000; Marar et al., 2012). Furthermore, researchers noted that as the popularity of soccer increased within the United States, the percentage of concussions within soccer would likely continue to increase (Daneshvar et al., 2011).

Rechel, Yard, & Comstock (2008) recognized that American football receives the most attention concerning the subject of concussion injuries. Football has the highest total number of concussion injuries each year, primarily because the total number of football players on a team is greater than most all other high school or college sports teams. Rechel et al. proposed to determine the percentage rate of concussion injuries among high school athletes from different sports.

Through a structured selection process, these researchers recruited 100 high schools from across the country to participate in their study. Certified athletic trainers representing the selected high schools reported each injury through an internet-based injury surveillance system during the academic year. The researchers formulated the injury rate based on athletic injuries per 1000 athlete-exposures. An athlete-exposure is defined as one athlete participating in one practice or competition.

Rechel et al. (2008) reported that the greater rate of injury per 1000 athlete-exposures occurred during competition compared to practice. Furthermore, when reporting concussion percentage rates of practice and competition, they determined that boys' and girls' soccer both had a higher rate of concussion per 1000 athlete-exposures than football. When comparing practice to competition, boys' soccer had the greatest statistically significant difference. Rechel et al. reported a concussion rate of 2.3% per 1000 athlete-exposures in boys' soccer during practice while the rate increased to 15.6% per 1000 athlete-exposures during competition. Girls' soccer also had a large difference, with 9.7% per 1000 athlete-exposure concussion injuries occurring in practice and 18.8% per 1000 athlete-exposures occurring during competition.

Gessel et al. (2007) utilized an online reporting information system and gained information from a nationally representative sample of 100 high schools. The surveyed athletic trainers reported injuries from nine sports over a study period of one school year. The authors concluded that the highest number of sport-related concussions resulted from football, followed by girls' soccer and boys' soccer. Also, Gessel et al. found that a higher number of concussions occurred to collegiate athletes but noted that concussions accounted for a greater percentage of total injuries in high school athletes.

The majority of researchers reviewing injury rates among athletics focused on high school athletics. However, Hootman et al. (2007) reviewed 16 years of college athletic injury reports among multiple divisions of university athletics. Upon review, Hootman et al. reported that athletes participating in football, girls' soccer, and boys' soccer suffered the greatest percentage of concussion injuries among the 15 sports reviewed. They concluded that collegiate athletes participating in girls' soccer had a higher percentage rate of concussions than athletes participating in football.

Researchers have also studied the effects of age and concussion injuries. Field, Collins, Lovell, and Maroon (2003) sought to determine whether age played a role in the recovery rate of concussion injuries. They collected data from 393 male and female college athletes and 183 high school athletes concerning the rate of recovery after a concussion injury. They found that after a concussion with no loss of consciousness, high school athletes reported symptoms, including memory loss, on an average of seven days after the injury while college athletes reported the reduction of symptoms on average within 24 hours. Field et al. further reported that the practice of clearing an athlete to

return to activity within 24 hours of a concussion injury may in fact prove detrimental and even catastrophic to an athlete.

Boden et al. (2007) concluded a number of possibilities concerning the severity and recovery times between concussion injuries among high school and college athletes. They believed that the brain of younger athletes may still be developing, and that the skull is thinner, thus providing less protection to the brain. Younger athletes may utilize poor tackling techniques or be unable to control their bodies because of underdeveloped musculature, also increasing the chance of a head collision. Additionally, younger athletes may have weaker necks, leading to an inability to control a whiplash mechanism of concussion.

When considering prior history of concussion injuries, researchers have determined that athletes who have sustained prior concussion injuries have a two-to-five times greater risk to sustain another concussion than an athlete with no prior history of concussions (Schatz et al. 2011). When considering the effects of a prior history of concussions on the time of recovery, researchers reported conflicting results. Lau, Lovell, Collins, and Pardini (2009) reported no difference in time of concussion recovery among athletes with a history of concussion, while Slobounov, Slobounov, Sebastianelli, Cao, and Newell (2007) found that athletes suffering two or more concussions demonstrated a substantially slower recovery rate compared to athletes with no history of concussion.

A further danger of a concussion injury is the likelihood of the recurrence of the injury. Of the sport-related concussions in the United States between 2005 and 2011, Castile et al. (2012) estimated that 13% of concussion injuries were recurrent. Guskiewicz et al. (2000) reported that athletes who sustained a previous concussion had a

three times higher recurrence rate when compared to an athlete who had never been concussed. Guskiewicz et al. noted the relationship of the high rate of recurrence to the fact that up to one-third of the athletes surveyed returned to activity on the same day, after only 13 minutes of rest, on average. Such a short time period out of participation placed the athlete in a highly vulnerable position for re-injury. Schatz et al. (2011) concluded that athletes who sustained two or more concussions displayed more cognitive and physical symptoms, such as sleep difficulties, compared to athletes sustaining a first-time concussion. These results led Schatz et al. to conclude that athletes sustaining multiple concussions will exhibit a greater number of and more severe post concussion symptoms. Athletes who sustained recurrent concussions took longer for their symptoms to resolve and reported a greater occurrence of loss of consciousness than athletes sustaining first-time concussions. Schatz et al. also concluded that early detection, proper care, and proper healing time may reduce the rate of recurrent concussion injuries.

Concussion Signs and Symptoms

Kelly (2000) reported that the recognition of a concussion may prove difficult, due to the large number of concussion injuries that exhibit only mild symptoms, such as headache and momentary confusion. Kelly believed that the lack of knowledge concerning concussion symptoms among college athletes added to the potential of an attempt by the athlete to mask or underreport any symptoms of the injury. Additional research confirmed Kelly's notion that athletes lacked the knowledge of concussion signs and symptoms, which led to the under-reporting of such injuries (McCrea et. al., 2004). Kelly further reported that an athlete's understanding of the common signs and symptoms

would provide them the beginning knowledge towards the prevention of consequential or life-altering injuries due to a concussion.

During the first International Conference on Concussion in Sports in 2001, a panel of brain injury experts agreed to abandon the traditional grading system of concussion injuries and begin to categorize concussions as simple or complex, based on the number and severity of symptoms present. They also agreed on 22 signs and symptoms commonly present after a mild head injury, such as a concussion, occurred (Aubry et al., 2002). In 2010, the Centers for Disease Control organized this list of signs and symptoms of concussions into one of four categories: physical, cognitive, emotional, and sleep-related (Norton, Feltz, Brocker, & Granitto, 2013).

During the third International Conference on Concussion in Sport held in 2009, McCrory et al. (2009) reported that a panel of experts in the field of brain injuries unanimously agreed to abandon the earlier terminology of simple vs. complex when describing the severity of a concussion. They determined that the terminology did not take into account the number of components present when determining the severity of a concussion. The panel agreed that a medical professional should consider components, such as clinical symptoms, physical signs, behavior, sleep patterns, cognition, and history of prior concussion injuries when determining the severity of the concussion. Thus, a diagnosis of the concussion severity may not happen until the symptoms exacerbate themselves.

According to McCrory et al. (2009), signs and symptoms, such as headache, feeling as if one were in a fog, emotional issues, loss of consciousness, amnesia, irritability, confusion, slowed reaction time, and drowsiness, all represented the effects of

damage to the brain. If any one of these components were evident, a concussion should be suspected.

Researchers further explained that 80% to 90% of concussions resolve in less than 10 days and that less than 10% of athletes who suffered a concussion actually lost consciousness (Harmon et al., 2013; McCrory et al., 2009). The multiple categories, neurocognitive effects, and length of time for a concussion to resolve, combine to make it difficult for an evaluator to apply a statement such as complex or severe. So, experts have suggested discontinuing the practice of grading or placing a name on the severity (McCrory, et al.).

When studying the common signs and symptoms after a concussion injury, researchers rendered similar results. In 260 high school and university level athletes who suffered a concussion, Lovell et al. (2006) determined the most frequent symptoms reported by concussed athletes as headache, fatigue, sluggishness, drowsiness, difficulty concentrating, feeling as though they were in a fog, and dizziness. The researchers reported a greater number of symptoms in high school and university female athletes when compared to males, but identified no statistically significant differences in the severity of the symptoms between the two genders. They did, however, discover a difference in the total number of concussion symptoms, when comparing high school and university athletes. Other researchers (Guskiewicz et al., 2000; Lau, Kontos, Collins, Mucha, & Lovell, 2011) concluded that headache represented the most common symptom suffered by an individual after a concussion injury, in some cases up to as high as 80%.

Most often athletes begin to experience symptoms of a concussion injury soon after the event. At times, however, symptoms present themselves at a later time. According to Lovell, Collins, Iverson, Johnson, and Bradley (2004), concussion signs or symptoms not presented by athletes at the time of the initial evaluation may evolve over a period of time. These researchers also investigated the recovery rate following concussion in high school athletes sustaining a commonly categorized grade 1 concussion injury. They studied 43 high school athletes from different sports who sustained grade 1 concussions. Lovell et al. defined a grade 1 concussion as "an injury that produces transient confusion, no loss of consciousness, and any other concussion signs or symptoms that resolve within 15 minutes of initial injury" (p. 47).

Lovell et al. (2004) evaluated all participants within 36 hours of injury and performed a second evaluation six days post-injury. They reported that athletes sustaining a classic grade 1 concussion presented with a substantially decreased memory processing ability 36 hours post-injury. Athletes also exhibited greater overall post-concussion symptoms at the 36-hour evaluation compared to the initial evaluation at time of injury. They concluded that athletes sustaining simple concussions could present with new or prolonged symptoms up to 36 hours post-injury.

At times, athletes may continue to have neurocognitive deficits that may not produce noticeable signs or symptoms. Broglio, Macciocchi, and Ferrara (2007) determined that medical professionals who rely solely on symptom-based concussion assessments may allow athletes to return to activity before complete recovery. Broglio et al. conducted a study to determine the presence of neurocognitive impairments in athletes who sustained a prior concussion but presented as asymptomatic. They administered a

baseline test to university high-risk sport athletes utilizing the ImPACT test, a computer-based assessment of cognitive function. Broglio et al. included athletes who had sustained a diagnosed concussion during the athletic season. They assessed the athletes' symptoms each day post-concussion. On the day the athletes reported as asymptomatic, the researchers re-administered the ImPACT test to assess the neurocognitive function of the injured athletes.

Broglio et al. (2007) reported substantial cognitive impairments in specific variables, including verbal and visual memory, visual-motor speed, and reaction time after the asymptomatic athletes completed the ImPACT test. They concluded that cognitive impairments may extend long after symptoms subside. Because cognitive deficits still remained in some asymptomatic athletes, athletes who return to activity before normalization of neurocognitive function may assume the risk of life threatening injury. The researchers also concluded that all concussed athletes should complete neurocognitive assessment before return to activity.

Lau et al. (2011) stated that minimal research existed surounding the common on-field signs and symptoms of concussions as predictors for long-term recovery of concussions. The researchers sought to determine which on-field signs and symptoms predicted prolonged recovery rates after concussions in high school athletes. They conducted a five-year prospective cohort study with high school football players who had sustained a concussion during practice or competition. Athletes who recovered in less than seven days were categorized as rapid recovery while athletes who took longer than 21 days to recover were categorized as prolonged recovery. The researchers did not categorize the group of athletes that recovered between eight and 21 days. Of the 176

concussed athletes, 98 participants met the criteria for either rapid or prolonged recovery. Of the remaining 78 participants, 69 did not return to play, were lost to follow-up, did not return to football, or recovered within the eight and 21 day time period.

Among these 107 participants, Lau et al. (2011) reported 13 common signs and symptoms of concussion. They identified headache as the most common symptom at the time of injury in both the rapid and prolonged recovery rate participants. Within the prolonged recovery group, dizziness was the most common symptom after headache. This result led the researchers to conclude that an athlete experiencing dizziness after a concussion injury may potentially experience a prolonged recovery time. Researchers can measure dizziness using a postural/balance test, but more often, dizziness is an experienced symptom reported by the athlete. Because of the commonality of dizziness and prolonged recovery time, athletes' realization of this potentially consequential symptom is vital for proper recovery time, according to Lau et al.

Attitudes and Knowledge of Concussions

Equipment safety has progressed and officials have instituted rules to prevent excessive head contact in an attempt to prevent concussions (Collins, Lovell, Iverson, Ide, & Maroon, 2006). Yet, McCrea et al. (2004) concluded the primary responsibility for preventing the potential of prolonged or life-altering effects of concussions rests on the athlete's knowledge and willingness to report their symptoms. They further concluded that the knowledge level and greater proactive attitudes of athletes towards concussion injuries will help medical professionals treat and possibly prevent long-term effects of concussions.

High School Level

In a seminal work, McCrea et al. (2004) hypothesized that athletes had limited knowledge about recognizing signs and symptoms of a concussion. Consequently, athletes continued to compete while experiencing head injury symptoms. McCrea et al. proposed to determine the rate of unreported concussion injuries in high school football players. In addition to the reporting rate, these researchers also desired to determine the primary reasons that athletes did not report such injuries. McCrea et al. administered a pre and postseason survey to 1,532 football players representing 20 high schools. Athletes completed a pre-season survey on the history and frequency of concussions injuries and a postseason survey to determine the rate of self-reported concussion injuries and, if applicable, the reasons for not reporting such injuries.

From the pre-season survey results, McCrea et al. (2004) determined that 459 out of 1,532 surveyed athletes had sustained a concussion injury prior to the football season. From postseason surveys, the researchers indicated a total of 229 out of 1,532 surveyed athletes stated that they had sustained a concussion injury during the football season. From the 229 athletes reporting that they did receive a concussion injury during the season, 107 athletes indicated that they self-reported the event, leaving 122 of the 229 athletes admitting that they did not report a potential concussion injury. The survey administered to the athletes included the following options for why a concussion was not reported: did not think it was serious enough, did not know it was a concussion, did not want to be pulled from the game, did not want to let the team down, and other reasons. A total of 79 out of 122 athletes reported that they did not think the concussion was serious enough, while 49 out of 122 shared that they did not want to leave the game. Forty-three

out of 121 reported that they did not know they had sustained a concussion, and 26 out of 122 reported that they did not want to let their teammates down.

McCrea et al. (2004) determined that the primary reason for an athlete's failure to self-report concussion injuries was the lack of knowledge concerning the severity of concussive symptoms. McCrea et al. further stated that the importance of education regarding the severity of concussions and description of potential life threatening circumstances that could occur due to repeated concussion events was lacking. They reported that athletes who possessed a greater knowledge of the signs and symptoms and the negative effects of playing while suffering concussion symptoms would more readily report such symptoms to a medical professional.

American football receives the largest majority of attention concerning the subject of concussions but researchers have conducted studies on other sports as well. Utilizing tools and methods from previous studies (McCrea et al., 2004), Broglio et al. (2010) investigated high school-aged Italian soccer athletes' knowledge of concussion injuries and what were the reporting habits of the athletes. Also, Broglio et al. desired to elicit knowledge concerning the medical practices of coaches. They reviewed 303 returned surveys from high school-level Italian soccer athletes. The researchers formulated questions concerning previous the athletes' histories of concussions, along with whether the athletes suffered any concussions during the past season. If an athlete had suffered a concussion, did he or she report it to proper personnel, and if not, for what reasons. The researchers also surveyed coaches concerning the coaches' knowledge about concussion symptoms and assessment and concussion recovery practices.

Of the 650 athletes surveyed, 29 reported that they had suffered a concussion injury during the past season. Of the 29 indicating they had suffered a concussion, 18, or 62%, indicated that they did not report their injury. Broglio et al. (2010) reported even higher rates of athletes underreporting concussion injuries than the earlier studies conducted by McCrea et al. (2004). Regarding the reasons for not reporting their injury, Broglio et al. identified three leading causes: One, athletes stated they did not think the injury was serious; two, they did not know their symptoms indicated a concussion; and three, they believed concussions were just part of the game. Broglio et al. indicated that soccer athletes shared the same reporting habits as American football players. They concluded that further education about concussion injuries was clearly needed among soccer and football athletes.

In another group of athletes, Sye et al. (2006) surveyed 477 adolescent rugby athletes and reported their attitudes and practices concerning concussion injuries. Of the 477 athletes, 128 agreed that a player should play in an important game, even with a suspected concussion. Also, 363 of 477 athletes believed that a teammate had previously played or practiced while concussed. Concerning their knowledge of concussion symptoms, researchers reported a noticeable lack of knowledge concerning the injury with 121 of 477, or approximately 25%, reporting a loss of consciousness as the primary indicator of a concussion. Such responses led Sye et al. to conclude that athletes continue to participate while suffering from what athletes believed to be less serious symptoms. These results remained consistent with prior researchers, who reported that only 10% of concussion cases involve loss of consciousness (Guskiewicz et al., 2000; Lovell, Iverson, Collins, McKeag, & Maroon, 1999).

Register-Mihalik et al. (2013) proposed to determine the effects of outside influences on the individual athlete's potential to report a concussion injury. Researchers provided a survey to 167 high school athletes. The survey was constructed utilizing concepts of the Theory of Reasoned Action and Planned Behavior, a theory that assists understanding the relationship between attitude and behavior. The theory focuses on outside influences that effect behavior. Register-Mihalik et al. sought to determine attitudes towards reporting concussion injuries and whether an association between intention to report and actual concussion reporting behaviors existed. Athletes reported that media and outside sources played a part in influencing their decisions to report a concussion injury but positive support from coaches, parents and fellow players provided the greatest influence. Register-Mihalik et al. further reported that athletes stated that they would be more likely to report a concussion injury if they sensed a favorable attitude from coaches concerning concussion injuries.

Register-Mihalik et al. (2013) further questioned athletes to recall any concussion injuries during the past year. When asked to recall the concussion events, 89 of the 167 surveyed high school athletes reported a concussion event at some point during their playing career. Only 15 of the 89 athletes stated that they reported all recalled concussion events to a medical professional or coach. Although Register-Mihalik et al. reported a more favorable attitude towards reporting concussion injuries among high school athletes, athletes continued to underreport concussion events. They concluded that although high school athletes intended to report a concussion event, such intent may not result in actual reporting habits.

In a similar study conducted by Bramley et al. (2012), 43 of 60 soccer athletes receiving concussion awareness training reported that they would inform the coach or athletic trainer compared to 17 of 60 who had no prior education. Bramley et al. concluded that high school soccer players who received concussion education from any source may more likely notify their coach or trainer of a suspected concussion compared with athletes with no such education. These results are similar to research conducted by Register-Mihalik et al. (2013), but results from Bramley et al. only indicated athletes' potential to act, not their actual reporting practices.

Participation in sports requires risk, especially in sports that have a high rate of serious and potentially life-altering risks. Athletes take great risks when deciding to continue to participate in sports while experiencing symptoms of a concussion injury. Researchers have utilized a number of theories to determine the prevalence of the risk-taking attitude among developing adolescents.

The sensation-seeking model attributes the desire for improper and risky behavior to the excitement that the behavior brings the adolescent. Arnett (1992) discovered that adolescents have no perspective of the negative effects of reckless behavior when compared to adults' perspectives. Another adolescent developmental characteristic that addresses the prevalence of risky behavior is the problem-solving behavior theory (Jessor, 1987). Jessor reported that, according to the problem-solving behavior theory, adolescents tend to participate in risky behavior to gain acceptance from peers or to promote self-esteem. According to Gibbons and Gerrard (1995), individuals who ascribe to the prototype model of risk-seeking behaviors maintain that adolescents have an image of risky behavior performed by adults that they desire to model. Additionally, according

to Gibbons and Gerrard, adolescents view and romanticize adult-like risky behavior on TV or movies and desire to replicate such actions.

The understanding of these theories concerning adolescent development may assist medical professionals in understanding the propensity of adolescents to continue participation in practices or games while suffering from symptoms of a concussion. Because of the lack of properly trained medical professionals at every athletic practice and competition, coaches share the responsibility to detect and properly manage concussion injuries. According to McLeod, Schwartz, and Bay (2007), youth football coaches exhibit a deficiency in first-aid knowledge; further research revealed that the majority of surveyed coaches could not pass a basic first aid exam (Ransone & Dunn-Bennett, 1999).

McLeod et al. (2007) determined that youth football coaches lacked the knowledge to recognize concussion symptoms and therefore may allow a player to return to activity while suffering from a concussion. McLeod et al. surveyed youth football coaches, with coaches responding to questions concerning their coaching experience, medical training, and recognition skills about the common signs and symptoms of concussion. The researchers also questioned whether or not coaches used a sign and symptom checklist when responding to an athlete who had sustained a head injury. McLeod et al. reported a high rate of knowledge regarding the recognizing of serious signs and symptoms of concussion, but they determined that nearly half of the coaches identified loss of consciousness as a requirement for a concussion and that a quarter of the responding coaches would let symptomatic athletes return to play. Based on this

deficit in concussion awareness, coaches, athletes, and parents could benefit from concussion education.

When comparing knowledge of concussion symptoms between high school coaches and the general public, Guilmette, Malia, and McQuiggan (2007) concluded that coaches demonstrated a moderately better knowledge about concussions than the general public and a moderate percentage of coaches reported taking a conservative approach to concussion management. These authors found that coaches with a better knowledge of concussion symptoms may potentially remove a player from activity as long as the athlete informed the coach of his symptoms.

Colligate Level

The majority of the current literature on the attitudes towards and knowledge of concussion injuries have focused on high school athletes. Some researchers have gathered information concerning the habits and knowledge of concussion injuries among college athletes. Their research has revealed a lack of concussion knowledge and poor habits when considering participation while symptomatic (Kaut et al., 2003; Sefton, 2003).

Kaut et al. (2003) reported that incoming college athletes had limited knowledge concerning concussion injuries. After surveying 461 athletes entering college athletics between the years of 1995 and 2001, Kaut et al. concluded that 125 reported playing in a game or practice despite experiencing dizziness, and 280 football players surveyed reported playing while suffering from a headache after a hit. The authors further reported that 241of the 461 surveyed athletes expressed limited knowledge of the possible consequences due to participation while symptomatic.

Sefton (2003) stated that the lack of self-reporting and subsequent proper care of concussion injuries sustained by college athletes posed a serious problem within college football. Sefton hypothesized that certain predicators may influence athletes toward the under-reporting of concussion injuries. She conducted the study to examine the knowledge athletes had of head injuries, the amount of unreported head injuries, and potential factors that may affect the self-reporting of head injuries by college athletes. Sefton administered a postseason survey to 503 participants, including 547 football players, 38 coaches, and eight athletic trainers from various college football programs across the country. She gathered information regarding athletes' awareness of head injury, their past history, their knowledge of common signs and symptoms of concussion, injuries that occurred during the previous season, and potential reasons for not reporting a head injury. Sefton further surveyed coaches and athletic trainers concerning their knowledge of head injuries, attitudes about head injuries, and any formal education provided to the athletes.

From the data obtained via the postseason surveys, Sefton (2003) reported that, during the season, 391 head injuries occurred. Of the 391 head injuries, 282 went unreported, with limited knowledge held by the athlete regarding concussion severity given as the most common factor for failure to self-report concussion injuries. Also, 35 of the 39 coaches surveyed believed that head injuries with mild symptoms, categorized as "bellringers/dingers," (Sefton, p. 10) and concussions represented different injuries. Sefton's findings further substantiate the need for athlete education regarding the self-reporting of symptoms.

Prolonged Effects of Concussion Injuries

For medical professionals to notice an improvement in the practice of self-reporting of concussion symptoms among athletes, presenting the potential long-term effects of concussions to athletes may prove beneficial. Researchers have thoroughly investigated the common early signs and symptoms that they associate with a concussion injury (Lau et al., 2009; McCrory et al., 2009; Slobounov et al., 2009). Along with research regarding common signs and symptoms, researchers have also completed studies concerning the prolonged effects of concussion injuries.

Most concussion symptoms resolve within seven to 10 days. Lovell et al. (2003) reported that common neurological symptoms such as headache, dizziness, and nausea resolve by day four and all symptoms typically resolve within seven days. In another study, McCrea et al. (2012) surveyed over 18,000 athletes during a 10-year time-period in order to determine the recovery rate of athletes with no history of concussion who suffered a first-time concussion. A total of 570 athletes reported suffering a first-time concussion during their athletic season. Of first-time concussed athletes, only 10% reported effects lasting longer than one week, while 90% reporting a resolution of effects in less than one week. This research supported earlier work by Iverson, Brooks, Lovell, and Collins (2006) that reported no measurable long-term effects of concussion injuries in athletes suffering two or fewer concussions.

Although concussion symptoms may commonly resolve within seven to 10 days, researchers desired to probe the evidence of long-term effects of concussion injuries among athletes. Ellemberg et al. (2007) conducted a study to determine the possible chronic cognitive impairments after a first-time concussion injury in female soccer

players six months post-injury. The researchers recruited 22 college-aged female soccer players as participants. The first groups consisted of 12 athletes who had no history of a concussion injury and completed the season without concussion while the second group consisted of 10 athletes who had sustained a single concussion during the season. The researchers tested athletes six months postseason to determine potential chronic cognitive effects. Participants completed a 10-question neuropsychological test constructed by researchers to measure athlete planning, attention, memory, visual skills, and learning. Ellemberg et al. noted a statistically significant difference in planning and response time between the two groups. Concussed athletes responded more slowly during the planning and response phases compared to the non-concussed group. Ellemberg et al. concluded that athletes could sustain chronic cognitive deficits after one concussion.

While researchers may have conflicting results concerning the prolonged effects in athletes after a first-time concussion, multiple researchers supported the consistent results of increased severity of acute symptoms, prolonged time of symptom recovery, and potentially long-term cognitive and motor effects after suffering multiple concussion injuries (Collins et al., 2002; Guskiewicz et al., 2005; Iverson et al., 2004; Moser, Schatz, & Jordan, 2005). Besides the potential risk of prolonged recovery time, researchers have reported that college and high school athletes who suffer a first-time concussion have an increased likelihood of sustaining a second concussion after the first (Gessel et al., 2007; Zemper, 2003). When studying high school athletes, Collins et al. concluded that athletes who suffered a first-time concussion were up to three times more likely to sustain another concussion than athletes with no history of concussions.

Iverson et al. (2004) found that football players with a prior history of concussion had a substantially greater risk of sustaining a subsequent concussion. They also connected long-term neurocognitive deficits with a history of multiple concussions. Iverson et al. conducted their study in order to determine concussion symptoms between athletes with multiple concussions and those with no history of concussions at pre-season baseline testing and five days after concussion symptons presented. Additionally, the researchers examined the post-injury symptom severity and the post-injury neurocognitive deficits between the two groups.

Iverson et al. (2004) recruited 38 athletes who had sustained a concussion during the athletic season. The researchers divided the athletes into two groups, consisting of 19 athletes with no prior concussions and 19 athletes with a history of three or more concussions. The athletes had completed a pre-season baseline ImPACT computer-based neurocognitive exam to determine neurocognitive deficits and any current concussion symptoms. Also, each athlete performed the same ImPACT test within five days of the concussion injury. The authors reported a greater number of concussion symptoms along with a decline in memory function at baseline testing in athletes with a history of multiple concussions compared with athletes with no history of concussions. At the time of the concussion injury, athletes with a history of multiple concussions presented with greater severity of on-field symptoms associated with their concussion compared to the group having no history of concussions. Also, athletes with a history of concussions reported a substantial decrease in memory performance after the concussion injury compared to athletes sustaining a first concussion.

In another study conducted by Collins et al. (2002), researchers recruited 173 high school athletes with known concussion histories to complete a questionnaire concerning the number of previous concussions and concussion symptoms. When comparing results among athletes with a known history of concussion with those who had no history of concussion prior to initiation of the study, Collins et al. reported that athletes with a history of three or more concussions sustained loss of consciousness seven times more often than athletes who had no previous history of concussion. Also, the Collins et al. concluded that athletes with a history of concussion sustained three or four serious concussion markers such as dizziness, amnesia, and loss of consciousness nine times more often than those with no history of concussion.

Schatz et al. (2011) raised concern that athletes who had sustained multiple concussions may suffer long-term cognitive effects along with psychological impairments. They sought to determine whether high school athletes with a history of multiple concussions would possess a greater number of emotional and behavioral symptoms when compared to those with no previous history of concussions. Schatz et al. reported that athletes with a history of two or more concussions indicated more episodes of headache, balance problems, dizziness, nausea, and fatigue compared to the other group. Conversely, Schatz et al. determined no statistically significant differences for the symptoms in the emotional and sleep categories.

When considering another assessment after concussion injuries, Slobounov et al. (2009) studied Electroencephalogram (EEG) results when determining the effects of sport-related concussions. Slobounov et al. conducted the study to determine the EEG Information Quality (EEG-IQ) in athletes who had suffered a sport-related concussion

and to determine differences in the EEG-IQ between first and second concussion episodes. The EEG-IQ diagnostic test measures the quality of neurological activity in the brain. Slobounov et al. recruited 265 male and female athletes between the ages of 18 and 25 and with no prior history of concussion injuries for the study. A total of 21 participants met the five inclusion criteria. The athletes completed an EEG-IQ examination at baseline, and at seven, 14, and 21 days post-injury.

Slobounov et al. (2009) reported decreased EEG-IG values for each participant suffering a first and second concussion during the season. They concluded that athletes who suffer a second concussion soon after their first will have a greater reduction of neurologic activity. They also found that these athletes will exhibit a greater amount of time before return to baseline compared to athletes with a single concussion.

Along with cognitive effects, athletes may suffer a prolonged decrease in postural stability up to three years post injury (Catena, van Donkelaar, & Chou, 2007) and affected gait as well (Guskiewicz, Ross, & Marshall, 2001; Martini et al., 2011). Martini et al. proposed to evaluate gait patterns of patients with and without a history of concussion. Volunteers recruited from a university setting were divided into two groups based on concussion history. Martini et al. involved both men and women, with 28 participants reporting a history of concussion and 40 participants reporting no previous history of concussion. The researchers determined a concussion occurred based on a physician diagnosis, but required no documentation of the grade of severity.

Each volunteer completed four tasks under varying conditions. The four tasks included walking with no cognitive task or obstacles, walking with no obstacles while completing a cognitive task, walking with obstacles but no cognitive task, and walking

with obstacles and a cognitive task. The researchers constructed an 8.3 meters-long walkway embedded with pressure sensors and placed two 29.5 cm-tall foam blocks as the obstacles for volunteers to step over. For the cognitive task, participants verbally repeated from memory the location of eight numbers on a 4x4 grid. The researchers timed the volunteers as they progressed through the walkway and then analyzed velocity, step length, cognitive task accuracy, and the time spent in the double leg stance and single leg stance phases of gait.

Martini et al. (2011) determined a difference in walking speed between the control group and those having a history of concussion, during the no obstacle, no cognitive task condition. The control group walked a pace of 1.46 seconds per meter, while those with a history of concussion walked at a pace of 1.56 seconds. In all other walking tests, the researchers determined no statistically significant differences in velocity. They did identify a statistically significant difference in balance in all conditions as participants with a concussion history spent less time in the single leg stance phase of gait. When reviewing a correlational analysis, Martini et al. noted that time spent in the single leg stance phase was further decreased in individuals with history of greater than one concussion. Martini et al. recognized that their data set was small but noted this finding was consistent with previous evidence by Catena et al. (2007) and Guskiewicz et al. (2001), who reported a correlation between the number of concussions and chronic cognitive deficit.

Until recently, little research existed concerning long-term effects of concussion injuries among athletes that occurred over 30 years after athletes have finished their playing careers. In a seminal study, Guskiewicz et al. (2005) examined the evidence of

mild cognitive impairments and Alzheimer's disease in retired professional football players who had sustained concussions during their playing time. Guskiewicz et al., distributed a health questionnaire comprised of questions concerning current musculoskeletal, cardiovascular, and neurological conditions to 3683 retired National Football League players. Guskiewicz et al. also included questions concerning the number of concussions sustained during the athletes' playing careers and any current diagnosed neurological diseases.

Guskiewicz et al. (2005) reported that players who sustained three or more concussions had a greater rate of diagnosed mild cognitive impairment and a greater rate of consequential memory loss when compared to players without a history of concussion. Guskiewicz et al. concluded that professional football athletes sustaining multiple concussions had an increased risk of future memory impairment disorders. They also observed an earlier onset of Alzheimer's disease in the athletes who sustained multiple concussions than in the general population of American males. In a similar study, Guskiewicz et al. reported a correlation between athletes suffering three or more concussions and the prevalence of depression or feelings of depression in former professional football players.

In another study conducted to determine later-life effects of multiple concussion injuries, De Beaumont et al. (2009) sought to determine whether a presence of concussion symptoms existed in athletes who sustained a concussion injury 30 years prior to the study. Researchers compared athletes with no history of concussion injuries between the ages of 50 and 65 and athletes in the same age group who had sustained at

least two concussions during their athletic career. The last sports-related concussion within the concussion group occurred between the ages of 20 and 30.

After conducting tests to measure cognitive and motor skills, De Beaumont et al. (2009) determined that participants within the concussion group exhibited cognitive and motor deficits similar to athletes tested at three years after a concussion injury. When compared to the non-concussed group, the concussed group displayed statistically significant deficits in motor speed tests, response time tests, along with substantially decreased memory. Within the concussion group, De Beaumont et al. also discovered frontal lobe dysfunctions similar to individuals suffering from early-onset Alzheimer's disease. These results led De Beaumont et al. to conclude that athletes who sustain multiple concussions run the risk of possessing significant neurocognitive deficits later in life.

A prevalence of chronic traumatic encephalopathy (CTE) cases has led researchers to study the possible cause of such a disease of the brain. Omalu et al. (2010) defined CTE as "the cumulative long-term neurologic consequences of repetitive concussive and subconcussive blows to the brain" (p. 40). Researchers reported the first two cases of autopsy-confirmed CTE in two former NFL athletes in 2005 and 2006 (Omalu et al., 2005; Omalu et al., 2006). Stern et al. (2011) raised the question concerning the link between CTE and repeated moderate to severe traumatic brain injuries (TBI) suffered in sports such as football, hockey, and boxing. Stern et al. also identified memory disturbances, behavioral and personality changes, Parkinsonism, severe depression, and speech and gait abnormalities as initial clinical observations of CTE. Later clinical observations included worsening memory impairment, language

difficulties, aggressive and irritable behavior, apathy, motor disturbances, and severe dementia. Stern et al. reviewed the 50 documented neuropathological-confirmed cases of CTE. In each case, Stern et al. identified a history of repeated brain trauma. Stern et al. dispute the specific amount of brain trauma exposure needed to develop CTE but they believe that repetitive brain trauma such as concussion injuries may cause a number of progressive neurodegenerative changes that may lead to a more severe condition such as CTE.

Gavett et al. (2011) reported that medical professionals cannot conclusively diagnose CTE until after death, during a brain autopsy. Researchers do not know the exact connection between concussions and CTE, but research by Giza and Hovda (2001) raised concern that repetitive mild traumatic brain injuries such as concussions may trigger the pathological changes that lead to CTE. Gavett et al. reported CTE as the only known neurodegenerative dementia with an identifiable cause of head trauma. They further noted the inability to determine if a single blow to the head could cause the progression of such a neurological degeneration, but they did note that, to the time of their study, 2011, all participants with confirmed CTE cases had a history of repetitive head trauma. This knowledge led Gavett et al. to propose that a valid way to prevent CTE is to prevent repetitive head trauma.

Current Modes of Concussion Education

Previous researchers have reported a lack of basic awareness and recognition of concussion injuries among athletes (Delaney, Lacroix, Leclerc, & Johnston, 2000; Kaut et al., 2003; McCrea et al., 2004; Sefton, 2003; Sye et al., 2006). Furthermore, researchers have reported that this lack of knowledge serves as a prime reason for the

underreporting of such injuries by athletes (Broglio et al., 2010; Kaut et al., 2003; McCrea et al., 2004). Also, researchers have clearly noted the lack of knowledge among coaches, parents and even medical professionals concerning the recognition and management of concussion injuries (Covassin et al., 2012; Guilmette et al., 2007; Notebaert, & Guskiewicz,2005; Ransone, & Dunn-Bennett, 1999).

Although these trends may still exist to a degree, diligent efforts by medical professionals and educators to promote education among athletes, parents, and coaches has led to the creation of numerous concussion education tools (Daneshvar et al., 2011). Over 40 states have laws or pending bills concerning concussion education, with 31 of the 40 states requiring concussion education among high school coaches and athletes (Schatz et al., 2011). Researchers have reported a positive attitude among athletes and coaches concerning concussion education (Bramley et al., 2012; Register-Mihalik et al., 2013; Sye et al., 2006), as well as research conducted by Bramley et al. reporting the likelihood of high school athletes reporting concussion injuries higher among those who have received concussion education training.

The *Heads Up: Concussion in High School Sports* material created by the Centers for Disease Control and Prevention (CDC) has served as the primary educational tool for relaying concussion education among high school coaches since 1988 (Daneshvar et al., 2011). The material included video information, flyers and written material geared towards coaches. The CDC provided this educational tool to all high schools free of charge. The research conducted by Sarmiento, Mitchko, Klein, and Wong (2010) as well as Covassin et al. (2012) reported positive findings concerning the increased knowledge among coaches who viewed the *Heads Up* material. Covassin et al. reported that coaches

who reviewed the educational material viewed concussion injuries more seriously and believed they could identify concussion symptoms more easily after exposure to the educational material.

Mrazik, Bawani, and Krol (2011) reported that of the 178 coaches surveyed, 117 had a limited to moderate knowledge of concussion symptoms while 160 of the 178 coaches rated knowledge of concussions as highly important to their role as a coach. Over half of the coaches stated that they had received concussion information through newspapers and magazines, while they rated the internet as the next leading source of information. The authors identified concerns by the coaches regarding the importance of concussion education, but only a small number of coaches had a confident knowledge of concussion symptoms.

Until recently, most authors of concussion education materials have written their materials to educate coaches and not players (Harmon et al., 2013) Harmon et al. recently reported an increased amount of educational material geared towards athletes as well as coaches. Ahmed, Sullivan, Schneiders, and McCrory (2012) wrote as technology has evolved, educators have supplemented traditional face-to-face and written material information with audio-visual material, websites, and even video games as prominent ways to expose athletes to current concussion education.

Echlin et al. (2010) reviewed the effectiveness of the *Think first* concussion education via DVD and an interactive computer-based education tool provided to junior hockey players between the ages of 16-21. Echlin et al. proposed to measure the retention of the specific information presented through these two modes. They reported an increase in retention knowledge in both educational intervention groups compared to the control

group. The control group demonstrated a decrease in concussion knowledge after 30 days. Echlin et al. determined that athletes receiving concussion education through these two specific educational tools obtained sustained gains in concussion knowledge.

Bagley et al. (2012) reported positive results in knowledge retention among adolescents after the introduction of concussion educational materials. Researchers reviewed the effectiveness of the Sports Legacy Institute Community Educators (*SLICE)* concussion education program provided through the Sports Legacy Institute. The *SLICE* program included PowerPoint slides, video segments, demonstrations, case reports, personal testimonies from previously concussed college athletes, interactive discussions with students, and a question-and-answer period. The total time of the education ranged from 40-60 minutes. Bagley et al. conducted a pretest with the students to determine the baseline knowledge of signs and symptoms along with potential short-term and long-term consequences related to concussion injuries.

Bagley et al. (2012) provided the *SLICE* program prior to the athletic season and then provided a posttest after the completion of the season. Athletes who participated in the *SLICE* program obtained a 34% overall increase in passing rates compared to the pre-education test. These results led Bagley et al. to conclude that the *SLICE* program was effective in the retention of concussion information among student athletes. Although effective in achieving retained knowledge, Bagley et al. questioned the practicality of such a lengthy program among athletic programs.

As web-based and social media outlets such as Facebook have gained popularity, organizations have begun to provide concussion education through these modes of delivery. Researchers have reported the internet as an effective mode in providing

training, education, and promoting a change in behavior (Casebeer et al., 2008; Fordis et al., 2005; Fotheringham, Owies, Leslie, & Owen, 2000), yet little research exists to supporting the effectiveness of concussion education among athletes (Ahmed et al., 2012). One such study, conducted by Glang et al. (2010) reviewed the effectiveness of the *ACTive: Athletic Concussion Training* online training among coaches who supervise athletes between the ages of 11-18.

Glang et al. (2010) selected 75 volunteer coaches to complete the online education; a control group of coaches who did not view the educational tool also participated. Glang et al. noted statistically significant higher measures of knowledge of concussion signs and symptoms, management, and prevention; attitudes concerning the prevention of concussion; and the intention to support athletes who reported signs and symptoms of a concussion injury of those who viewed the education tool compared to those who did not. Such results led Glang et al. to conclude that the *ACTive* concussion education tool served as a valid and effective method for training youth coaches.

As previously noted, the majority of research concerning concussion education has focused on coaches rather than athletes. Researchers have reported that athletes have a positive attitude towards concussion education (Register-Mihalik et al., 2013), as well as the belief that they would more likely report concussion injuries if properly educated (Bramley et al., 2012). Little research, however, exists that demonstrates a definitive change in the behavior of self-reporting concussion symptoms in athletes who received concussion education.

Conclusion

The existent literature concerning the historical background of sports-related concussions, common signs and symptoms, as well as the effects of concussion injuries, has been reviewed. The literature presented the attitudes and behaviors of coaches and athletes towards concussion injuries, along with the effects of concussion education among youth coaches. A review of the literature described an alarming number of student athletes who underreport symptoms of concussion due to lack of education concerning the injury (McCrea et al., 2004). A further review of the literature determined that athletes are often misinformed concerning this injury; coaches and parents also have limited knowledge. Athletes who refuse or neglect to report such symptoms or who continue to play while symptomatic run the risk of serious and potentially long-term consequential cognitive and motor dysfunction.

Further review of the literature noted current educational tools along with specific modes of concussion education. These tools, however, focused primarily on high school coaches rather than the athletes. No information about the effects of concussion education among college athletes regarding a change in behavior concerning the self-reporting of concussion injuries was found in the current review of the literature. This information or lack of information serves to encourage and support further research concerning the effectiveness of concussion education among college athletes.

Summary

The purpose of this study was to determine the effectiveness of a structured concussion education tool in order to increase the knowledge of concussion symptoms

among college athletes. The secondary purpose of the study was to determine if the gained knowledge will lead to an increase in the self-reporting of acquired concussion symptoms. The following chapter includes an in-depth review of the quantitative methodologies used in conducting this study and how these methodologies were used to answer the three research questions previously presented.

CHAPTER III

METHODOLOGY

Introduction

The current literature relevant to concussion injuries among high school and college athletes was reviewed. This review primarily focused on the cognitive effects of concussion injuries among athletes, along with the attitudes, knowledge, and perceptions of athletes concerning these injuries. The current modes of education provided to high school and college athletes were also presented.

Researchers determined that high school athletes who suffer concussion injuries reported their concussions a rate of just below 47%. As reported in previous studies, athletes fail to report such symptoms for a variety of reasons, largely due to lack of education concerning the symptoms of concussions (Broglio et al., 2010; Kaut et al., 2003; McCrea et al., 2004). The majority of the current literature on the attitudes towards and knowledge of concussion injuries has focused on high school athletes. Some information concerning the habits and knowledge of concussion injuries among college athletes has been gathered. This research revealed a lack of concussion knowledge and poor self-care habits when considering participation while symptomatic (Kaut et al.; Sefton, 2003).

The purpose of this study was to determine the effectiveness of a structured concussion education tool in order to increase the knowledge of concussion symptoms

among college athletes. The secondary purpose of the study was to determine if the gained knowledge will lead to an increase in the self-reporting of acquired concussion symptoms. Further, the current study sought to gather information concerning the history of structured concussion education among college athletes as well as the common mode of such education. The research design used to answer each research question will be presented. A detailed review of the population and sample, data collected, analytical measures used, as well as limitations within the study, will be discussed within this chapter.

To gain an understanding of athletes' current knowledge of concussion symptoms and the effects of such knowledge on the self-reporting of concussion injuries, the researcher used the following research questions:

Research Question 1. To what extent have college athletes been educated in the area of concussion management?

Research Question 2. What impact does a formal education program related to concussion management have on the accurate identification of concussion symptoms?

Research Question 3. What is the effect of formal pre-season concussion education on self-reporting of concussion symptoms in collegiate football and male and female soccer athletes?

Research Design

The current study sought to determine the extent of concussion education among college athletes, the effect of a formal preseason concussion education tool on the proper recognition of concussion signs and symptoms, and the effect of a formal concussion education tool on athletes' self-reporting of concussion symptoms. A quantitative, quasi-

experimental, nonequivalent control group design was used in this study (Salkind, 2012). Quantitative data was gathered through a survey administered to athletes from four private universities within the Chicagoland area. The gathered data was analyzed through the use of the Statistical Package for Social Sciences (SPSS) version 16.0. The selection of specific methodology was guided by the following questions:

Research Question 1. To what extent have college athletes been educated in the area of concussion management?

To answer the first research question, use of descriptive statistics determined the occurrence of formal concussion education among college athletes along with the specific mode of the education. Of the 568 athletes who responded, the percentage of those who received formal concussion education training was documented. Athletes were able to choose between 12 different modes of delivery of concussion education. Descriptive statistics were used to determine which mode was chosen at the highest rate by the athletes. Based on the data, the mode was ranked from highest to lowest.

Research Question 2. What impact does a formal education program related to concussion management have on the accurate identification of concussion symptoms?

To answer the second research question, use of a Mixed Factorial ANOVA determined whether changes occurred between pretest and posttest along with the effect that educational status had on the accurate identification of concussion symptoms through the overall scores of the Symptom of Concussion (SOC) questionnaire. An ANOVA is typically used when more than two groups or variables are being tested (Salkind, 2011). For the SOC questionnaire, the researcher asked the participants to select the common symptoms of a concussion injury from a list of 22 symptoms. The total number of correct

symptoms from each participant was analyzed within the participants through the pre and posttest. Also, the pre and posttest scores were evaluated between groups. The two groups represented athletes who received concussion education and athletes who did not receive concussion education. Significance of each independent variable was compared at the confidence level of $p < .05$.

Research Question 3. What is the effect of formal pre-season concussion education on self-reporting of concussion symptoms in collegiate football and male and female soccer athletes?

To answer the third research question, use of a Pearson's Chi-Squared (X^2) analysis determined the effect that a formal pre-season concussion education had on self-reporting of concussion symptoms in collegiate football and male and female soccer athletes. Significance of educational status and the particular sport was compared at the confidence level of $p < .05$. Salkind (2011) stated that when comparing direct variables that were nominal, a Pearson's Chi-Squared analysis was preferred. Athletes completing the McCrea concussion questionnaire were asked if they suffered a concussion injury during the past season. Those who did suffer a concussion were further asked if they reported the injury or not. The nominal data was collected and compared between groups.

Population

The population studied consisted of athletes representing football, men's soccer, and women's soccer from four universities within the greater Chicago area. The selection of the specific universities occurred through convenience sampling (Salkind, 2012). To obtain a similar population, the researcher selected universities with an equivalent student population and athletic association affiliation level. Convenience sampling (Salkind,

2012) was utilized in acquiring athletes willing to participate in the study. Volunteer athletes from the selected colleges participating in football and men's and women's soccer participated. The research and control groups were selected based on the willingness of the institutions' athletic directors to join in the preseason concussion education program. Those who provided immediate willingness formed the experimental group while the remaining two universities represented the control group. The study population consisted of both male and female college athletes with an age range from 17-25 years old.

Volunteer participation resulted in a sample size totaling 653. A total number of 367 athletes represented the experimental group and 286 athletes represented the control group. Male participants totaled 564 from two soccer and two football teams; female participants totaled 89 athletes from four soccer teams.

Data Collection

The McCrea Concussion Reporting Questionnaire and the Symptom of Concussion Questionnaire (SOC) represented the two survey tools utilized within this study. The surveys can be found in Appendix D and E respectively. The McCrea Concussion Reporting Questionnaire was created and used during a study conducted by McCrea et al. (2004). During the McCrea et al. study, the researchers desired to determine the rate at which high school football players reported concussion injuries that occurred during the season along with reasons for not reporting. A group of experts in the field of brain trauma and neurological science created the instrument, ensuring the instrument's content validity. Permission to use to instrument was granted via e-mail. For

the current study, the researcher collected similar data from college athletes as opposed to high school athletes selected by McCrea et al. in their study.

The SOC pre and postseason questionnaire was constructed to measure the extent of any previous concussion education along with the athletes' knowledge of common symptoms of a concussion. The instrument measured the pre and postseason knowledge of concussion symptoms for both the experimental and control group. The instrument included a list of 22 concussion symptoms agreed upon by a panel of neurologists and experts in the field of head trauma from the International Summit in Prague (McCrory et al., 2009). Utilizing this group of symptoms allowed for strong content validity because experts in the field created the list of symptoms. Symptoms other than concussion symptoms acted as distractors. Experts in the field of concussion evaluation and management provided distractor symptoms for the current study. Each contributor has an extensive background in the subject of concussion signs and symptoms. After compilation of both true and distractor symptoms, a group of medical experts reviewed the completed tool. This group of medical experts consisted of medical doctors, physician assistants, and certified athletic trainers, each well-educated and experienced concerning the signs and symptoms of concussion injuries. The experts completed the instrument by selecting all of the symptoms associated with a concussion injury. The researcher eliminated from the questionnaire any symptom not endorsed by 50% of the experts, and excluded any of the distractors as symptoms of concussion chosen by the experts. This process of constructing the SOC identification instrument ensured content validity of the instrument.

Included with the concussion symptom questionnaire, athletes were requested to choose from a time period in which they received this structured information and by what mode they received the information. When selecting the time athletes received information, they could choose from high school, college, or other. When choosing how the information was provided, athletes could choose from coach or medical provider, through a video, through written material, or through internet or television. The researcher proposed to determine whether the athletes had received any concussion information along with the extent of when and how they received the information. A sample questionnaire concerning the knowledge of concussion symptoms and extent of concussion education instrument was presented to a group of college athletes not involved with the study as a pilot test. Within the pilot test, open ended questions were added to assess the quality of the instrument. Information was gathered from the athletes concerning their ability to understand the questions, the clarity of directions, and the ease of completing the instrument.

To protect the rights of each participant, both surveys included an informed consent section on the first page of the survey that explained the respondents' rights during the data collection. Once signed by the participants, this signed statement indicated the participants granted consent to participate in both the pre and postseason survey. Athletes were notified that participation was completely voluntary and researchers ensured the participants' confidentiality. Additionally, signed informed consent represented the only name record linking the participants to the research or data. Athletic department consent was gathered through written verification from the director of athletics of each participating university. A copy of the director of athletics consent is

located in Appendix A. Because this study examined individual behavior and involved minimal manipulation of behavior, it posed no more than minimal risk to the participants.

To investigate the degree to which college athletes received education in the area of concussion management as well as the impact of a formal education program related to concussion management has on the accurate identification of concussion symptoms, the researcher used the SOC questionnaire. Athletes representing football and men's and women's soccer from the four participating universities completed the SOC questionnaire during a preseason team meeting. Athletes participating in the experimental group viewed an online concussion education course produced by the National Collegiate Athletic Association (2013). The experimental group also viewed a PowerPoint presentation on the prolonged effects of repeat concussions. The control group did not receive the education.

To investigate the effect that a structured concussion education presentation had on the self-reporting of concussion symptoms among college athletes, the McCrea Concussion Reporting Questionnaire was used. The researcher desired similar data to the McCrea et al. (2004) study but chose college athletes to represent the participants. Permission to use the tool was granted by McCrea via e-mail. Descriptive questions were added regarding the university each athlete attended, age, gender, and sport played to enhance the researcher's ability to match pre and posttests. To maintain the confidentiality of each athlete the use of uniform number instead of names was used by the researcher as the identifying marker of each athlete was used.

The McCrea Questionnaire was administered to football and men's and women's soccer athletes from both the control group and experimental group during the teams'

postseason meetings. Athletes completed the questionnaire during a team meeting. Providing the questionnaire at a postseason meeting secured a large return rate of questionnaires.

Analytical Methods

As stated previously, the purpose of this study was to determine the effectiveness of a structured concussion education tool in order to increase the knowledge of concussion symptoms among college athletes. The secondary purpose of the study was to determine if the gained knowledge would lead to an increase in the self-reporting of acquired concussion symptoms. The researcher further designed the study to gather information concerning the history of structured concussion education among college athletes as well as the common mode of such education.

Descriptive statistics were employed to answer the first research question, exploring the number of athletes exposed to a formal concussion education program and the most common mode of delivery of the education program. Through the SOC questionnaire, athletes responded whether they had received previous formal concussion education or not. Also, athletes chose among 12 different modes of delivery of the education; they could also select more than one mode if it was applicable

Question two explored the impact that a formal education program related to concussion management had on the accurate identification of concussion symptoms. A Mixed Factorial ANOVA was conducted to determine whether changes occurred between pretest and posttest along with the effect educational status had on the accurate identification of concussion symptoms through the overall scores of the SOC question.

The researcher compared the significance of each independent variable at a confidence level of $p < .05$.

The third question explored the effect of a formal preseason concussion education on the self-reporting of concussion symptoms in collegiate football, and male and female soccer athletes. Through a Pearson's Chi-Squared (X^2) analysis, the researcher compared the significance of educational status and the particular sport to the athlete's self-reporting of concussion injuries at a confidence level of $p < .05$.

Limitations

The samples used within this study came from small, private, Midwestern universities. Great care must be used when generalizing the results and conclusions among all athletes at all university levels. Surveying and educating participants from larger public universities may be warranted during further research. Including athletes from public universities may provide the researcher a broader description of athletes.

A common limitation during survey or questionnaire research is that data is gathered through participants' self-reported information (Leedy & Ormrod, 2013). Athletes who responded to the questionnaire may have felt pressure to respond a certain way to specific questions. Furthermore, athletes were requested to recall injuries that occurred during the previous athletic season. Athletes may have had difficulty recalling previous, specific injuries.

Another limitation of this study centralized around the limited number of concussion injuries that did occur. A total of 72 athletes reported a concussion during the past athletic season. Larger numbers of reported concussions could possibly create a stronger database and increase the power of the results and conclusions. Another

limitation realized that during this study was the inability of the researcher to limit the amount of concussion education or concussion recognition material the control or experimental groups were exposed to between a pre and posttest. The potential for outside concussion education possibly may have skewed the results of the SOC questionnaire posttest outcomes among athletes. Such a limitation may prove extremely difficult to control.

A further limitation noted during the study occurred with the presentation of the SOC questionnaire. Participants found the question concerning the mode of concussion somewhat confusing. A number of participants questioned whether they were to choose one or multiple modes, causing minor confusion among the participants. The researcher noted that written instructions should be included in future research using this tool.

Summary

This chapter has provided the methodology used to explore both the history of concussion education among athletes and the effect that a formal concussion education had on the proper recognition of concussion symptoms. Also, the chapter provided the methodology used to explore the effect that concussion education had on self-reporting of such an injury. The following chapter will discuss the analyzed data collected for this study. Additionally, conclusions will be drawn and a discussion presented concerning the effects of structured concussion education among college athletes.

CHAPTER IV

FINDINGS AND CONCLUSIONS

Introduction

The current study was conducted to determine the extent of concussion education among college athletes, the effect of a formal preseason concussion education tool on the proper recognition of concussion signs and symptoms, and the effect of a formal concussion education tool on the self-reporting of concussion symptoms. Previous studies had presented information concerning the self-reporting practices of concussion symptoms practices of high school football players along with specific reasons for failure to report such injuries (McCrea et al., 2004). Their results indicated that under 50% of high school football players reported a sustained concussion during the previous season and the primary reason for not reporting was lack of knowledge concerning the signs and symptoms of a concussion injury.

College athletes have also reported a limited knowledge concerning the recognition of concussion signs and symptoms (Sefton, 2003). It has also been reported by Cantu and Gean (2010), that failure to report such symptoms of a concussion injury and continuing to participate while symptomatic possesses a potentially immediate health risk, prolonged acquired symptoms, and possible long-term effects. The research on the effects of formal concussion education, the recognition of concussion symptoms, and the effect of such education on the self-reporting of concussion symptoms among college athletes is extremely limited.

Because lack of research concerning college athlete knowledge concerning concussion education was limited, it was important to conduct such research to investigate and answer the questions concerning the effects of a formal concussion education tool on the proper recognition of concussion symptoms and how the formal education affected the self-reporting rate of concussion injuries among college athletes. The researcher used the following research questions to guide the study:

Research Question 1. To what extent have college athletes been educated in the area of concussion management?

Research Question 2. What impact does a formal education program related to concussion management have on the accurate identification of concussion symptoms?

Research Question 3. What is the effect of formal pre season concussion education on self-reporting of concussion symptoms in collegiate football and male and female soccer athletes?

A quantitative, quasi-experimental, nonequivalent group design was used in this study Quantitative data was gathered through a survey administered to four private universities within the Chicagoland area. The gathered data was analyzed through the use of the Statistical Package for Social Sciences (SPSS) version 16.0.

Findings

Research Question One

In order to determine the extent to which college athletes have been educated in the area of concussion management, general descriptive statistics were used. To collect necessary data, the Symptom of Concussion (SOC) survey was administered to college athletes participating in football, men's soccer, and women's soccer from four different

universities. In constructing the SOC survey, a list of 22 concussion symptoms agreed upon by a panel of neurologists and experts in the field of head trauma from the International Summit in Prague were included (McCrory et al., 2009). The group of symptoms demonstrated strong content validity because experts in the field created the list of symptoms.

Symptoms other than concussion symptoms were included in the survey to act as distractors. Experts in the field of concussion evaluation and management provided distractor symptoms. Each contributor possessed extensive background knowledge in the subject of concussion signs and symptoms.

A list of 22 concussion symptoms and distractors were combined into one instrument and administered to a group of medical experts. This group of medical experts consisted of medical doctors, physician assistants, and certified athletic trainers, all well-educated and experienced concerning the signs and symptoms of concussion injuries. The experts completed the instrument by selecting all of the symptoms associated with a concussion injury. Any symptom not endorsed by 50% of the experts was eliminated from the questionnaire. Any one of the distractors endorsed by the experts as a symptom was also dropped. The researcher compiled the remaining symptoms and distractors to create the instrument. This process of constructing the SOC identification instrument ensured content validity of the instrument.

When completing the SOC, athletes reported any history of formal concussion education along with the mode of such education. When reporting the time frame that athletes received concussion education, athletes could choose between college, high school, and other time for when they received specific formal education. When answering

the specific mode of such education, athletes could choose from coach or medical provider, through a video, through written material, or through other modes such as internet or television. Athletes were allowed to choose more than one mode if applicable.

Of the 565 athletes who responded properly, 415, or 73.1%, answered that they had received some sort of formal concussion education, while 150, or 26.4%, stated that they had not received any formal education in the past. Of the 789 responses concerning the specific mode of concussion education, 228 athletes responded that they received education through a coach or medical provider at the high school and college level. This mode represented the largest mode of education. Table 1 displays the descriptive statistics representing the responses to the history of any concussion education along with the distribution of the mode in which athletes received formal concussion education.

Table 1

The Extent of Formal Concussion Education Among College Athletes

Formal Education	Yes - %/N	No - %/N
	73.1%/415	26.4%/150

Mode of Education	Number	Percentage
High school coach or medical provider	228	28.8%
High school video	80	10.1%
High school written	81	10.1%
High school other	49	6.2%
College coach or medical provider	169	24.5%
College video	57	7.2%
College written	54	6.04%
College other	61	8.4%
Other coach or medical provider	5	0.6%
Other video	3	0.3%
Other written	1	0.1%
Other other	1	0.1%

Note. Athletes could choose more than one mode. A total of 789 mode selections were selected from 565 athletes.

Research Question Two

In order to determine the impact of a formal education program related to concussion management on the accurate identification of concussion symptoms, the SOC

survey was utilized. Along with descriptive questions, the SOC included a list of 17 concussion symptoms along with five symptoms that represented distractors. Athletes were asked to mark all of the symptoms they believed to occur due to a concussion injury.

The correct answers were tabulated with a subtraction of one for every distractor chosen. A score of 17 represented the highest score achieved. After completion of the SOC questionnaire, the experimental group viewed a concussion management educational DVD that included the common signs and symptoms of a concussion injury while the control group did not participate in the education. A Mixed Factorial ANOVA was conducted to determine the effect a pre and posttest test as well as prior educational status had on the accurate identification of concussion symptoms through the overall scores of the SOC question. The statistical significance of each independent variable was compared at the $p < .05$ level. A statistically significant interaction between survey administrations would also indicate any improvement between pre and posttest differences between the experimental group and the control group.

Table 2 displays the results of the pre and posttest SOC Questionnaire for the experimental and control groups. Athletes receiving the formal education scored a mean of 11.0 on the pretest of the SOC while athletes within the control group scored a mean of 10.7. After the SOC was administered at the end of the athletic season, the athletes receiving the formal education included as part of the current study scored a mean of 13.0 while the control group scored a mean of 11.3 on the posttest. The results of the Mixed Factorial ANOVA were statistically significant for the pre and posttest comparison ($F(1,379) = 52.96$, $p = .001$, $n^2 = .12$). When comparing the effect that educational status

had on the accurate identification of concussion symptoms, statistically significant difference was found ($F(1,397) = 15.69$, $p = .001$, $n^2 = .04$). These results indicated a statistically significant higher retention rate of concussion symptoms on the postseason SOC survey by athletes from both the experimental and control groups.

Athletes who viewed the preseason education video scored a greater retention rate on the postseason SOC survey compared to athletes who did not view the video. Following Table 2, Figure 1 displays the mean scores and the trend of concussion symptom retention from pretest to posttest differed in the two groups.

Table 2

Athlete scores from Symptom of Concussion Questionnaire (SOC)

Educational Status	*M* – Pretest	*M* – Posttest	Percentage Diff.
Educated	11.0	13.0	15.3%
Non-Educated	10.7	11.3	5.3%

Note. A total of 17 correct responses were possible on the (SOC) Questionnaire.

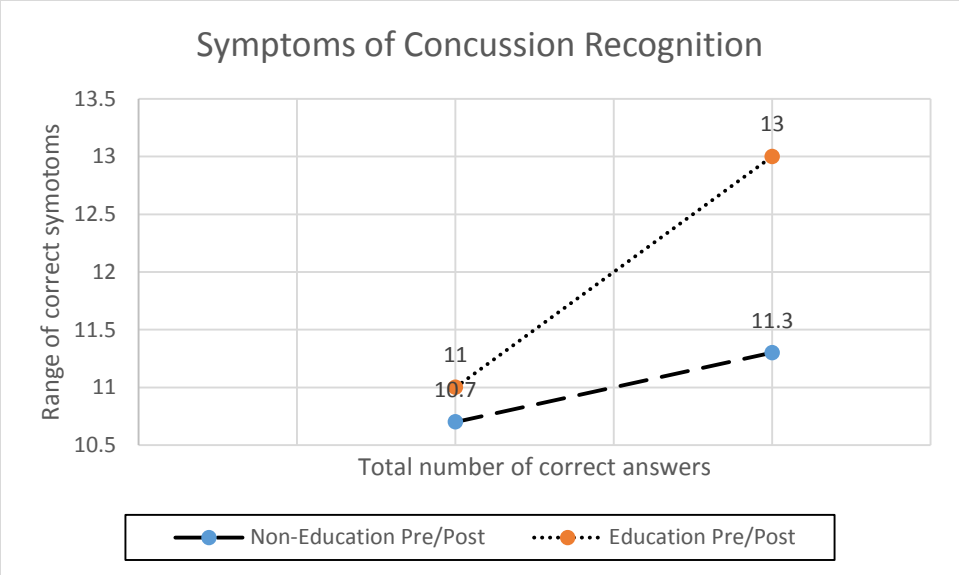

Figure 1. Mean Scores of Symptoms of Concussion Recognition Survey

Note. A total of 17 correct responses were possible on the (SOC) Questionnaire.

Research Question Three

To determine the effect that a formal preseason concussion education had on self-reporting of concussion symptoms in collegiate football and male and female soccer athletes, data was obtained via the McCrea Concussion Questionnaire and was analyzed through a Pearson Chi-Square (X^2) analysis. The significance of educational status and the particular sport was compared at the confidence level of $p < .05$. Table 3 displays the results of the McCrea Concussion Questionnaire for the educational status of athletes in each particular sport.

During a postseason meeting, all athletes from the experimental and control groups completed the McCrea Concussion Questionnaire to determine whether they suffered a concussion during the past athletic season, and if so, if that injury was reported. A total of 72 athletes reported receiving a concussion during the past athletic season. When reviewing the educational status of the respondents, the experimental

group had 27 athletes who reported a concussion injury and 15 who did not. The control group had 24 athletes who reported a concussion injury and six who did not. When differentiating between the educational statuses on the self-reporting rate, no statistically significant difference in the frequency of reporting concussion injuries was found (X^2 (1) = 2.09, p = .148). The data indicated that formal preseason education had minimal effect on increasing the reporting rate of concussion injuries during the year.

When analyzing the effect a particular sport had on the self-reporting rate, football players reported 29 self-report and 17 non-self-reports of a concussion injury. Men's soccer reported 10 self-reports and one non-self-report of a concussion injury and women's soccer reported 12 self-reports and three non-self-reports of a concussion injury. When analyzing the effect that the particular sport had on the self-reporting of concussion injuries, no statistically significant differences in the different sports in relation to reporting rate occurred ($X^2(2) = 4.10$, p = .128). Data indicated that the particular sport had no effect on the self-reporting rate of concussion injuries.

Table 3

McCrea Concussion Questionnaire

Educational Status – Total injuries	Total Reports - %	Total Non-Reports -%
Education - 42	27 - 64.2%	15 - 35.7%
Non-Education - 30	24 - 80%	6 - 20%

Sport – Total injuries	Total Report	Total Non-Reports
Football - 46	29 – 63%	17 – 36%
Men's Soccer - 11	10 – 90%	1 – 9%
Women's Soccer - 15	12 – 80%	3 – 20%

Note. A total of 72 athletes reported a concussion injury during the past year.

Conclusions

As reported in previous studies, athletes have failed to report concussion injuries for a variety of reasons, primarily due to lack of education concerning the symptoms of concussions (Broglio et al., 2010; Kaut et al., 2003; McCrea et al., 2004). The purpose of this study was to determine the effectiveness of a structured concussion education tool in increasing the knowledge of concussion symptoms among college athletes. The secondary purpose of the study was to determine if the gained knowledge would lead to an increase in the self-reporting of acquired concussion symptoms.

Concerning the prevalence of concussion education among college athletes, the current study determined that over 73% or 415 of the 565 reporting athletes received concussion education in some form prior to the study. At the time of the study, no

research had reported numbers concerning the percentage of athletes who had received formal concussion education of any kind. Collected data for the current study indicated that over 50%, or 397 of 798 athletes, received concussion training during high school or college through a coach or medical provider.

Numerous studies have reported the lack of athlete knowledge concerning the signs and symptoms of concussion injuries (Delaney et al., 2000; Kaut et al., 2003; McCrea et al., 2004; Sefton, 2003; Sye et al., 2006). Other researchers have reported positive results concerning the retained knowledge of concussion symptoms after formal education among coaches and parents (Mrazik et al., 2011). Those who received formal education presented with a more positive attitude toward proper treatment of concussion injuries along with a greater knowledge of concussion symptoms. Concerning athletes, some previous studies have reported an increased knowledge among athletes who received a formal concussion education (Bagley et al., 2012; Echlin et al., 2010); however, minimal research existed that had studied the comparison of athletes who received education to those who did not, concerning retained knowledge of concussion symptoms.

The current study reported that the mean score of the SOC posttest compared to the mean score on SOC pretest presented improvement in athlete recognition of concussion symptoms. Athletes who did not receive preseason concussion education presented a mean score of 10.7 for the pretest and a mean of 11.3 on the posttest, resulting in a 5.3% increase in the retained knowledge of concussion symptoms after the athletic season. Such results indicated a statistically significant difference at the $p < .05$ confidence level. Athletes who did receive concussion education presented with a mean

SOC pretest score of 11 and a posttest mean of 13, resulting in a 15.5% increase in their knowledge of concussion symptom after the athletic season. These results also indicated a statistically significant difference at the $p < .05$ confidence level..

These results aligned with previous research conducted by Bagley et al. (2012), which reported the impact of the SLICE program on retained knowledge of concussion symptoms. The current study's results indicated that providing preseason concussion education would benefit athletes by providing them important knowledge that would assist them with the recognition of concussion symptoms which may increase the likelihood of reporting such an injury. Based upon posttest results, athletes retained the knowledge presented to them during preseason education, with a statistically significant increase in knowledge compared to their pretest results. Because previous research indicated that a primary reason for lack of self-reporting of concussion injuries was due to lack of knowledge (Delaney et al., 2000; Kaut et al., 2003; McCrea et al., 2004; Sefton, 2003; Sye et al., 2006), the current study represented a very important aspect in protecting athletes from prolonged complications due to unreported concussion injuries. If athletes know the common symptoms of a concussion, they may be more likely to report such an injury and less likely to continue to participate while symptomatic.

Previous research had determined that fewer than 47% of high school football players who sustained a concussion reported such an event (McCrea, 2004). Little published research has been conducted since 2004 intended to determine the concussion self-reporting rate of high school athletes. There also existed a large research void concerning the actual self-reporting rate of concussion injuries among college athletes, specifically athletes representing football and men's and women's soccer.

Concerning the self-reporting rate among athletes presented with a preseason concussion education compared to those who did not receive concussion education, interesting results occurred. The current study indicated that athletes who received no formal preseason education reported concussion injuries at a 16% higher rate than those who had received formal education. These results indicated no statistically significant differences concerning the effect of a preseason concussion education tool on the increase of the self-reporting rate of concussion injuries. Furthermore, the current study indicated that no statistically significant difference existed concerning the influence that a specific sport had on the self-reporting rate of concussion injuries among athletes. The current study indicated that college athletes self-report concussion injuries at a much greater rate than the previous study indicated by McCrea (2004). Although the current study results indicated that the specific concussion education may not have resulted in a higher self-reporting rate, additional results from the current study indicated that over 73% of the surveyed athletes had received some sort of concussion education prior to the study. This prior education may have positively impacted the athlete's decision regarding their reporting of concussion injuries.

Implications and Recommendations

The purpose of this study was to investigate the effect of a structured concussion education tool on the retention of knowledge concerning concussion symptoms. Also, the study researched the effect such education had on the self-reporting rate of concussion injuries during an athletic season among college athletes. Many researchers recommended that concussion symptom recognition education among athletes be

increased in order to combat the effects of concussion injuries (Bramley et al., 2012; Broglio et al.,2010; Kaut et al., 2003; McCrea et al., 2004).

The current study's finding that over 73% of the surveyed athletes had received concussion education in the past was important because the data provided evidence that institutions have increased their efforts towards concussion education. Extensive efforts have gone into advancing equipment technology as well as competition and practice rule changes intended to lessen the risk of concussion injuries (Guskiewicz et al., 2005). Even with these advancements and rules changes, concussion injuries continue to occur at high rates among adolescents in sports (Marar et al., 2012). As reported earlier, substantial efforts have gone into creating legislation in a number of states requiring some level of concussion education among adolescent athletes (Adler & Herring, 2011). An implication of the current study is that the large majority of athletes are receiving concussion education, providing them with the knowledge of recognizing concussion symptoms. Because it is difficult to prevent concussion injuries from occurring, athletes can continue to be provided with the necessary means of preventing further brain injury through correct recognition, reporting, and early treatment of their injury.

Additionally, the current study added empirical evidence related to the knowledge level of concussion injuries among college athletes as well as their willingness to report such a potentially damaging injury when it occurs. Findings from the current study supported earlier research by Bagley et al. (2012), which reported that a specific concussion education program can positively increase the amount of retained knowledge of concussion signs and symptoms by its learners. Such findings would imply that athletes with a greater knowledge of the symptoms of a concussion injury and the

potential physical results of participating while symptomatic could greatly increase the urgency with which athletes report such injuries to the proper medical personnel.

Based on the findings of the current study, college athletes self-report sustained concussion injures at a much greater rate than past studies indicated (McCrea, 2004; Sefton, 2003). The current study's results would imply that athletes have a greater concern towards concussion injuries and the potential results to their own brains.

A recommendation for further research would be to ask the athlete what led him or her to report their concussion. This knowledge could lead medical professionals to specific action steps toward maintaining and increasing the already-noted high reporting rate among athletes. The current study's data that indicated both the control group and experimental group athletes self-reported at a much higher percentage may be due to the fact that a large majority of the athletes had received some form of concussion education prior to the current study. Further research on the subject may include limiting participants to include only those who have not received previous concussion education when reviewing the preseason concussion education effect on self-reporting rates. To complete such a study would require a much larger sample size. This effort may prove difficult, or maybe unnecessary, because of the increased state legislation efforts mandating required concussion education among all high school athletes.

In conclusion, concussion injuries may never be completely preventable, yet research efforts continue to be made toward increased understanding and proper treatment of this specific Traumatic Brain Injury. Proper recognition, self-reporting, and proper treatment of concussion injuries may prevent future complications for athletes. The evidence from the current study has shown that educational efforts can increase an

athlete's retention rate of their knowledge concerning symptoms of concussion injuries. Understanding these symptoms of concussions and the potential risks of participating while symptomatic may improve the self-reporting rate among athletes and result in a decrease of life-altering conditions among athletes who suffer such an injury.

REFERENCES

Adler, R. H., & Herring, S. A. (2011). Changing the culture of concussion: Education meets legislation. *Physical Medicine and Rehabilitation, 3*(10), S468-S470.

Ahmed, O. H., Sullivan, S. J., Schneiders, A. G., & McCrory, P. R. (2012). Concussion information online: Evaluation of information quality, content and readability of concussion-related websites. *British Journal of Sports Medicine, 46*(9), 675-683.

Arnett, J. (1994). Sensation seeking: A new conceptualization and a new scale. *Personality and Individual Differences, 16*(2), 289-296.

Aubry, M., Cantu, R., Dvorak, J., Graf-Baumann, T., Johnston, K., Kelly, J., . . . Schamasch, P. (2002). Summary and agreement statement of the first International Conference on Concussion in Sport, Vienna 2001. *British Journal of Sports Medicine, 36*(1), 6-7.

Bagley, A. F., Daneshvar, D. H., Schanker, B. D., Zurakowski, D., d'Hemecourt, C. A., Nowinski, C. J., . . . Goulet, K. (2012). Effectiveness of the SLICE program for youth concussion education. *Clinical Journal of Sport Medicine, 22*(5), 385-389.

Beaumont, L., The´oret, H., Mongeon, D., Messier, J., Leclerc, S., Tremblay, S., . . . Lassonde, M. (2009). Brain function decline in healthy retired athletes who sustained their last sports concussion in early adulthood. *Brain; A Journal of Neurology, 132*(3), 695-708. doi:10.1093/brain/awn347

Boden, B. P., Tacchetti, R. L., Cantu, R. C., Knowles, S. B., & Mueller, F. O. (2007). Catastrophic head injuries in high school and college football players. *The American Journal of Sports Medicine, 35*(7), 1075-1081.

Bramley, H., Patrick, K., Lehman, P., & Silvis, M. (2012). High school soccer players with concussion education are more likely to notify their coach of a suspected concussion. *Clinical Pediatrics, 51*(4), 332-336. doi:10.1177/0009922811425233

Broglio, S., Macciocchi, S., & Ferrara, M. (2007). Neurocognitive performance of concussed athletes when symptom free. *Journal of Athletic Training, 42*(4), 504-508.

Broglio, S., Vagnozzi, R., Sabin, M., Signoretti, S., Tavazzi, B., & Lazzarino, G. (2010). Concussion occurrence and knowledge in Italian football (soccer). *Journal of Sports Science and Medicine, 9*(3), 418-430. Retrieved from http://www.jssm.org/vol9/n3/10/v9n3-10pdf.pdf

Catena, R. D., van Donkelaar, P., & Chou, L. S. (2007). Cognitive task effects on gait stability following concussion. *Experimental Brain Research, 176*(1), 23-31.

Cantu, R., & Gean, A. (2010). Second-impact syndrome and a small subdural hematoma: An uncommon catastrophic result of repetitive head injury with a characteristic imaging appearance. *Journal of Neurotrauma, 27*(9), 1557-1564. doi:10.1089/neu.2010.1334

Casebeer, L., Engler, S., Bennett, N., Irvine, M., Sulkes, D., DesLauriers, M., & Zhang, S. (2008). A controlled trial of the effectiveness of internet continuing medical education. *BMC Medicine, 6*(1), 37.

Castile, L., Collins, C., McIlvain, N., & Comstock, R. (2012). The epidemiology of new versus recurrent sports concussions among high school athletes, 2005-2010. *British Journal of Sports Medicine, 46*(8), 603-610. doi:10.1136/bjsports-2011-09011

Collins, M., Lovell, M., Iverson, G., Cantu, R., Maroon, J., & Field, M. (2002). Cumulative effects of concussion in high school athletes. *Neurosurgery, 51*(5), 1175-1181. doi:10.1227/01.NEU.0000031572.99927.93

Collins, M., Lovell, M. R., Iverson, G. L., Ide, T., & Maroon, J. (2006). Examining concussion rates and return to play in high school football players wearing newer helmet technology: A three-year prospective cohort study. *Neurosurgery, 58*(2), 275-286.

Covassin, T., Elbin, R., & Sarmiento, K. (2012). Educating coaches about concussion in sports: Evaluation of the CDC's "Heads up: Concussion in youth sports" initiative. *Journal of School Health, 82*(5), 233-238. doi:10.1111/j.1746-1561.2012.00692.x

Daneshvar, D. H., Nowinski, C. J., McKee, A., & Cantu, R. C. (2011). The epidemiology of sport-related concussion. *Clinics in Sports Medicine, 30*(1), 1-17.

De Beaumont, L., Theoret, H., Mongeon, D., Messier, J., Leclerc, S., Tremblay, S., . . . Lassonde, M. (2009). Brain function decline in healthy retired athletes who sustained their last sports concussion in early adulthood. *Brain, 132(*3), 695-708.

Delaney, J. S., Lacroix, V. J., Leclerc, S., & Johnston, K. M. (2000). Concussions during the 1997 Canadian football league season. *Clinical Journal of Sport Medicine, 10*(1), 9-14.

Echlin, P. S., Johnson, A. M., Riverin, S., Tator, C. H., Cantu, R. C., Cusimano, M. D., . . . Skopelja, E. N. (2010). A prospective study of concussion education in 2 junior ice hockey teams: Implications for sports concussion education. *Neurosurgical Focus, 29*(5), E6.

Ellemberg, D., Leclerc, S., Couture, S., & Daigle, C. (2007). Prolonged neuropsychological impairments following a first concussion in female university soccer athletes. *Clinical Journal of Sports Medicine, 17*(5), 369-374. Retrieved from http://journals.lww.com/cjsportsmed/toc/2007/09000

Field, M., Collins, M. W., Lovell, M. R., & Maroon, J. (2003). Does age play a role in recovery from sports-related concussion? A comparison of high school and collegiate athletes. *The Journal of Pediatrics, 142*(5), 546-553.

Fordis, M., King, J. E., Ballantyne, C. M., Jones, P. H., Schneider, K. H., Spann, S. J., . . . Greisinger, A. J. (2005). Comparison of the instructional efficacy of internet-based CME with live interactive CME workshops. *Journal of the American Medical Association, 294*(9), 1043-1051.

Fotheringham, M. J., Owies, D., Leslie, E., & Owen, N. (2000). Interactive health communication in preventive medicine: Internet-based strategies in teaching and research. *American Journal of Preventive Medicine, 19*(2), 113-120.

Gavett, B., Stern, R., & McKee, A. (2011). Chronic traumatic encephalopathy: A potential late effect of sport-related concussive and subconcussive head trauma.

Journal of Clinical Sports Medicine, 30(1), 179-188. doi:10.1016/j.csm.2010.09.007

Gessel, L., Fields, S., Collins, C., Dick, R., & Comstock, D. (2007). Concussions among high school and college athletes. *Journal of Athletic Training, 42*(4), 495-503. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2140075/pdf/i1062-6050-42-4-495.pdf

Gibbons, F. X., & Gerrard, M. (1995). Predicting young adults' health risk behavior. *Journal of Personality and Social Psychology, 69*(3), 505.

Giza, C., & Hovda, D. (2001). The neurometabolic cascade of concussion. *Journal of Athletic Training, 36*(3), 228-235. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC155411/pdf/attr_36_03_0228.pdf

Glang, A., Koester, M., Beaver, S., Clay, J., & McLaughlin, K. (2010). Online training in sports concussion for youth sport coaches. *International Journal of Sports Science and Coaching, 5*(1), 1-12. doi: 10.1260/1747-9541.5.1.1

Guilmette, T., Malia, L., & McQuiggan, M. (2007). Concussion understanding and management among New England high school football coaches. *Brain Injury, 21*(10), 1039–1047. doi:10.1080/02699050701633080

Guskiewicz, K., Bruce, S., Cantu, R., Ferrara, M., Kelly, J., McCrea, M., . . . McLeod, T. (2009). National athletic trainers association position statement: Management of sport-related concussion. *Journal of Athletic Training, 39*(3), 280-297.

Guskiewicz, K., Marshall, S., Bailes, J., McCrea, M., Cantu, R., Randolph, C., & Jordan, B. (2005). Association between recurrent concussion and late-life cognitive

impairment in retired professional football players. *Neurosurgery, 57*(4), 719-726. doi:10.1227/01.NEU.0000175725.75780.DD

Guskiewicz, K. M., Marshall, S. W., Bailes, J., McCrea, M., Harding, H. P., Matthews, A., . . . Cantu, R. C. (2007). Recurrent concussion and risk of depression in retired professional football players. *Medicine and Science in Sports and Exercise, 39*(6), 903.

Guskiewicz, K. M., Ross, S. E., & Marshall, S. W. (2001). Postural stability and neuropsychological deficits after concussion in collegiate athletes. *Journal of Athletic Training, 36*(3), 263.

Guskiewicz, K. M., Weaver, N. L., Padua, D. A., & Garrett, W. E. (2000). Epidemiology of concussion in collegiate and high school football players. *The American Journal of Sports Medicine, 28*(5), 643-650.

Harmon, K., Drezner, J., Gammons, M., Guskiewicz, M., Halstead, M., Herring, S., . . . Roberts, W. (2013). American medical society of sports medicine position statement: Concussion in sport. *British Journal of Sports Medicine, 47*(1), 15-26. doi:10.1136/bjsports-2012-091941

Hootman, J. M., Dick, R., & Agel, J. (2007). Epidemiology of collegiate injuries for 15 sports: Summary and recommendations for injury prevention initiatives. *Journal of Athletic Training, 42*(2), 311-319.

Iverson, G. L., Brooks, B. L., Lovell, M. R., & Collins, M. W. (2006). No cumulative effects for one or two previous concussions. *British Journal of Sports Medicine, 40*(1), 72-75.

Iverson, G., Gaetz, M., Lovell, M., & Collins, M. (2004). Cumulative effects of concussion in amateur athletes. *Brain Injury, 18*(5), 433-443. doi:10.1080/02699050310001617352

Jessor, R. (1987). Problem-behavior theory, psychosocial development, and adolescent problem drinking. *British Journal of Addiction, 82*(4), 331-342.

Johnson, M., McCroy, P., Mohtadi, N., & Meeuwisse, W. (2001). Evidence-based review of sport-related concussion: Clinical science. *Clinical Journal of Sports Medicine, 11*(3), 150-159.

Kaut, K., DePompe, R., Kerr, J., & Congeni, J. (2003). Reports of head injury and symptom knowledge among college athletes: Implications for assessment and educational intervention. *Clinical Journal of Sports Medicine, 13*(4), 213-221.

Kelly, J. (2000). Concussion in sports and recreation. *Seminars in Neurology, 20*(2), 165-172.

Lau, B., Lovell, M. R., Collins, M. W., & Pardini, J. (2009). Neurocognitive and symptom predictors of recovery in high school athletes. *Clinical Journal of Sport Medicine, 19*(3), 216-221.

Lau, B., Kontos, A., Collins, M., Mucha, A., & Lovell, M. (2011). Which on-field signs/symptoms predict protracted recovery from sport-related concussion among high school football players? *The American Journal of Sports Medicine, 39*(11), 2311-2318. doi:10.1177/0363546511410655

Leedy, P. D., & Ormrod, J. E. (2013). *Practical research* (10th ed.). Columbus, OH: Pearson Merrill Prentice Hall.

Lovell, M., Collins, M,. Iverson, G., Johnston, K., & Bradley, J. (2004). Grade 1 or ding concussions in high school athletes. *The American Journal of Sports Medicine, 32*(1), 47-54. doi:10.1177/0363546503260723

Lovell, M. R., Collins, M. W., Iverson, G. L., Field, M., Maroon, J. C., Cantu, R., . . . Fu, F. H. (2003). Recovery from mild concussion in high school athletes. *Journal of Neurosurgery, 98*(2), 296-301.

Lovell, M. R., Iverson, G. L., Collins, M. W., McKeag, D., & Maroon, J. C. (1999). Does loss of consciousness predict neuropsychological decrements after concussion? *Clinical Journal of Sport Medicine, 9*(4), 193-198.

Lovell, M. R., Iverson, G. L., Collins, M. W., Podell, K., Johnston, K. M., Pardini, D., . . . Maroon, J. C. (2006). Measurement of symptoms following sports-related concussion: Reliability and normative data for the post-concussion scale. *Applied Neuropsychology, 13*(3), 166-174.

Marar, M., McIlvain, N. M., Fields, S. K., & Comstock, R. D. (2012). Epidemiology of concussions among United States high school athletes in 20 sports. *The American Journal of Sports Medicine, 40*(4), 747-755.

Mrazik, M., Bawani, F., & Krol, A. (2011). Sport-related concussion: Knowledge transition among minor hockey coaches. *Clinical Journal of Sports Medicine, 21*(4), 315-319. Retrieved from http://journals.lww.com/cjsportsmed

Martini, D., Sabin, M., DePesa, A., Leal, E., Negrete, T., Sonsnoff, J., & Broglio, S. (2011). The chronic effects of concussions on gait. *Archives of Physical Medicine and Rehabilitation, 92*(4), 585-589. doi:10.1016/j.apmr.2010.11.029

McCrea, M., Guskiewicz, K., Randolph, C., Barr, W. B., Hammeke, T. A., Marshall, S. W., . . . Kelly, J. P. (2012). Incidence, clinical course, and predictors of prolonged recovery time following sport-related concussion in high school and college athletes. *Journal of the International Neuropsychological Society, 19*(1), 22.

McCrea, M., Hammeke, T., Olsen, G., Leo, P., & Guskiewicz, K. (2004). Unreported concussion in high school football players. *Clinical Journal of Sports Medicine, 14*(1), 13-17. Retrieved from http://journals.lww.com/cjsportsmed/toc/2004/01000

McCrory, P., Meeuwisse, W., Echemendia, R., Iverson, G., Dvořák, J., & Kutcher, J. (2013). What is the lowest threshold to make a diagnosis of concussion? *British Journal of Sports Medicine, 47*(5), 268-271.

McCrory, P., Meeuwisse, W., Johnston, K., Dvorak, J., Aubry, M., Molloy, M., & Cantu, R. (2009). Consensus statement on concussion in sport – the 3rd International Conference on Concussion in Sport held in Zurich, November 2008. *South American Journal of Sports Medicine, 21*(2), 36-46. doi:10.3810/psm.2009.06.1721

McKee, A., Cantu, R., Nowinski, C., Hedley-Whyte, T., Gavett, B., Budson, A., Santini, K. . . Stern, R. (2009). Chronic traumatic encephalopathy in athletes: Progressive tauopathy following repetitive head injury. *Journal of Neuropathology & Experimental Neurology, 68*(7), 709-735. doi:10.1097/NEN.0b013e3181a9d503

McLeod, T. C. V., Bay, R. C., Heil, J., & McVeigh, S. D. (2008). Identification of sport and recreational activity concussion history through the preparticipation screening

and a symptom survey in young athletes. *Clinical Journal of Sport Medicine, 18*(3), 235-240.

McLeod, T., Schwartz, C., & Bay, C. (2007). Sport-related concussion misunderstandings among youth coaches. *Clinical Journal of Sports Medicine, 17*(2), 140-142. doi:10.1097/JSM.0b013e31803212ae

Moser, R. S., Schatz, P., & Jordan, B. D. (2005). Prolonged effects of concussion in high school athletes. *Neurosurgery, 57*(2), 300-306.

Mueller, F., & Cantu, R. (2002). *Nineteenth Annual Report Fall 1982-Spring 2001.* National Center for Catastrophic Sport Injury Research, University of North Carolina: Chapel Hill: NC.

National Collegiate Athletic Association. (2013). Don't hide it, report it, take time to recover. Available from http://www.ncaa.org/wps/wcm/connect/public/ncaa/ssi/medical+conditions/concussion+landing+page

Norton, C., Feltz, S. J., Brocker, A., & Granitto, M. (2013). Tackling long-term consequences of concussion. *Nursing 2012, 43*(1), 50-55.

Notebaert, A. J., & Guskiewicz, K. M. (2005). Current trends in athletic training practice for concussion assessment and management. *Journal of Athletic Training, 40*(4), 320.

Omalu, B. I., DeKosky, S. T., Minster, R. L., Kamboh, M. I., Hamilton, R. L., & Wecht, C. H. (2005). Chronic traumatic encephalopathy in a National Football League player. *Neurosurgery, 57*(1), 128-134.

Omalu, B. I., DeKosky, S. T., Hamilton, R. L., Minster, R. L., Kamboh, M. I., Shakir, A. M., & Wecht, C. H. (2006). Chronic traumatic encephalopathy in a National Football League player: Part II. *Neurosurgery, 59*(5), 1086-1093.

Omalu, B., Hamilton, R., Kamboh, I., DeKosky, S., & Bailes, J. (2010). Chronic traumatic encephalopathy (CTE) in a National Football League player: Case report and emerging medicolegal practice questions. *Journal of Forensic Nursing, 6*(1), 40-46. doi:10.111/j.1939-3938.2009.01064.x

Palmer, K., Fratiglioni, L., & Winbald, B. (2003). What is mild cognitive impairment? Variations in definitions and evolution of nondemented persons with cognitive impairment. *Acta Neurologica Scandinavica, 179*(107), 14-20. doi:10.1034/j.1600-0404.107.s179.2.x

Provvidenza, C., Engebretsen, L., Tator, C., Kissick, J., McCrory, P., Sillis, A., & Johnston, K. (2013). From consensus to action: Knowledge transfer, education and influencing policy on sports concussion. *British Journal of Sports Medicine, 47*(5), 1-8. doi:10.1136/bjsports-2012-092099

Ransone, J., & Dunn-Bennett, L. R. (1999). Assessment of first-aid knowledge and decision making of high school athletic coaches. *Journal of Athletic Training, 34*(3), 267.

Rechel, J. A., Yard, E. E., & Comstock, R. D. (2008). An epidemiologic comparison of high school sports injuries sustained in practice and competition. *Journal of Athletic Training, 43*(2), 197-204.

Register-Mihalik, J., Lihnan, L., Marshall, S., McLeod, T., Mueller, F., & Guskiewicz, K. (2013). Using theory to understand high school aged athletes' intentions to report

sport-related concussions: Implications for concussion education initiatives. *Brain Injury, 27*(7), 878-886.

Russell, W., & Smith, A. (1961). Post traumatic head injuries in closed head injuries. *Archives of Neurology, 5*(1), 4-7.

Salkind, N. J. (2011). Statistics for people who think they hate statistics (4th ed.). Thousand Oaks, CA: Sage.

Salkind, N. J. (2012). *Exploring research* (8th ed.). Boston, MA: Pearson.

Sarmiento, K., Mitchko, J., Klein, C., & Wong, S. (2010). Evaluation of the Centers for disease control and prevention's concussion initiative for high school coaches: "Heads up: Concussion in high school sports." *The Journal of School Health, 80*(3), 112-118. doi:10.1111/j.1746-1561.2010.00491.x

Schatz, P., Moser, R., Covassin, T., & Karpf, R. (2011). Early indicators of enduring symptoms in high school athletes with multiple previous concussions. *Neurosurgery, 68*(6), 1562-1567. doi:10.1227/NEU.0b013e31820e382e

Sefton, J. M. (2003). *An examination of factors that influence knowledge of and reporting of head injuries in college football* (unpublished master's thesis). Central Connecticut State University, New Britain, Connecticut. (CCSU Thesis 1709)

Slobounov, S., Cao, C., & Sebastianelli, W. (2009). Differential effects of first versus second concussive episodes on wavelet information quality of EEG. *Clinical Neuropsychology, 102*(5), 862-867. doi:10.1016/j.clinph.2009.03.009

Slobounov, S., Slobounov, E., Sebastianelli, W., Cao, C., & Newell, K. (2007). Differential rate of recovery in athletes after first and second concussion episodes. *Neurosurgery, 61*(2), 338-344.

Sosin, D., Sniezek, J., & Thurman, D. (1996). Incidence of mild and moderate brain injury in the United States, 1991. *Brain Injury, 10*(1), 47-54. doi:10.1080/026990596124719

Stern, R., Riley, D., Daneshvar, D., Nowinski, J., Cantu, R., & McKee, A. (2011). Long-term consequences of repetitive brain trauma: Chronic traumatic encephalopathy. *American Academy of Physical Medicine and Rehabilitation, 3(*10), S460-S467. doi:1097/NEN.0b013e3181a9d503

Sye, G., Sullivan, J., & McCrory, P. (2006). High school rugby players' understanding of concussion and return to play guidelines. *British Journal of Sports Medicine, 409*(12), 1003-1005.

Zemper, E. D. (2003). Two-year prospective study of relative risk of a second cerebral concussion. *American Journal of Physical Medicine & Rehabilitation, 82*(9), 653-659.

Appendix A

McCrea Concussion Questionnaire

McCrea Concussion Questionnaire

Please fill in the following information. Your information will be kept completely private

University _____ Uniform Number _____

Year in School_____ Age _____

Sport – Please place an X by your sport

Football ___ Men's Soccer ___ Women's Soccer ___ Men's B-Ball___ Women' B-Ball_____

USE TO FOLLOWINFG DEFINNITION OF CONCUSSION TO ANSWER THE FOLLOWING QUEATIONS:

- **Definition of Concussion:** *A concussion is a blow to the head followed by a variety of symptoms that may include any of the following: headache, dizziness, loss of balance, blurred vision, "seeing stars", being in a fog, memory problems, poor concentration, nausea or throwing-up. Getting "knocked out" or being unconscious does NOT always occur in a concussion.*

1. **Did you ever have a concussion before this season?**

   _____ Yes → How many concussions before this season?___

   _____ No

2. **How many times before this season have you been "knocked out" or unconscious from a concussion?__**

Tell us about this past season

1. **Did you have a concussion injury this past season?** *(check "yes" if you think you had a concussion even if you did not mention it to anyone.)*

   ____Yes → How many concussions do you think you had this past season?_____ *(go to #2)*

   ___ No → *(If no, stop here; You are done with the questionnaire)*

2. **Did you report you concussion to anyone?**

   _____Yes (go to #2a below)

   _____No (go to #3 below)

2a. To whom did you report you concussion to?

____athletic trainer ____coach ____parent ____teammate

____ other (who) _____

3. **If you did not report your concussion to anyone, why not** *(check all the following that apply)*

   ___ Did not believe my symptoms were that of a concussion

___ My symptoms were not serious enough to report

___ I did not want to let my teammates down

___ I did not want to be removed from the game

Appendix B

Symptom of Concussion Questionnaire

Symptom of Concussion Questionnaire

University _____ Uniform Number _____

Year in School _____ Age _____

Sport – Please place an X by your sport

Football_____ Men's Soccer_____ Women's Soccer_____ Men's B-Ball_____ Women' B-Ball_____

Note: "Formal information" is regarded as structured or published material viewed by you or taught to you concerning the subject of concussion signs and symptoms.

1. Have you ever received formal information concerning the signs, symptoms, management of a concussion injury?

   _____ No

   _____ Yes (please complete the below chart)

   To what extent and when have you received formal information? (Please select 1)

Provided to you:	High School	College	Other Time(please identify)
In Person by: (coach, medical provider)			
Through Video			
Written Material (pamphlet/flyer)			
Online (i.e. internet)			

2. From the following list, please identify the symptoms of concussions (note there are some symptoms that do not occur after a concussion). Place and X by as many as you feel are a symptom of concussion.

_____Headache	_____Pressure in head	_____Nausea or vomiting
_____Dizziness	_____ Blurred vision	_____Color Blindness
_____Balance problems	_____ Sensitivity to light	_____ Feeling slowed down
_____Swollen Tongue	_____"Don't feel right"	_____Difficulty Concentrating
_____Excessive Thirst	_____ Hot/Cold sensitivity	_____Confusion
_____Low Energy	_____Nervous or Anxious	_____Difficulty Remembering
_____Trouble Breathing	_____More Emotional	_____Irritability
_____ Inability to speak	_____Sadness	_____Burning sensation in hand