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Concussion Education in High School Athletes

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CONCUSSION EDUCATION IN HIGH SCHOOL ATHLETES

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ABSTRACT

This paper examines concussion education in high school athletes. Specifically, it examines how educationally beneficial a concussion presentation is for high school athletes. The study examined eighteen-year-old participants from two Minnesota high schools participating in Minnesota State High School League (MSHSL) sanctioned spring sports. A presentation on concussion definitions, signs/symptoms, and adverse effects was presented to the participants. A pre and posttest questionnaire was used to evaluate participants' baseline knowledge on concussion related topics and their knowledge gained after hearing the presentation. Data was analyzed via a comparison of the mean score differences using a paired t-test of within group differences of the pre and posttest scores. The findings from the data analysis demonstrate a statistically significant improvement in mean scores from pre to posttest. Specifically, over 80% of participants improved their scores from pre to posttest after listening to the concussion education presentation. The statistically significant findings of the data suggests that a concussion education presentation is educationally beneficial, as demonstrated by the improvement in answers to the multiple choice questions on the pretest and posttest across the sample size as a whole. While this research only scratches the surface of addressing the overall need and effectiveness of concussion education programs, it serves as a guide for further research into the extent of need and benefits of concussion education in high school athletes.

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Comparison of Mean and Standard Deviation Between Schools

School	n	Pre-test mean (std dev)	Post-test mean (std dev)	P value
1	25	68.6 (17)	92.0 (11.3)	.0000021
2	18	68.3 (15.1)	79.2 (14.2)	.0095
Overall	43	68.4 (16.1)	86.6 (14)	.00000018

Table 2

Percentage of Athletes that Improved and Declined from Pretest to Posttest

School	Improved	Same	Declined
1	84%	8%	8%
2	83.3%	0%	16.7%
Overall	83.7%	4.7%	11.6%

Table 3

Comparison of Responses to Individual Questions

Question	Correct pre	Correct post
1	95.3%	100%
2	90.7%	93.0%
3	46.5%	74.4%
4	100%	100%
5	58.1%	67.4%
6	55.8%	74.4%
7	30.2%	86.1%
8	n/a	97.7%

CHAPTER 1
INTRODUCTION

Background

Concussions and post-concussion syndrome (second impact syndrome) have been the subject of much debate recently. New studies have shown numerous correlations between concussions and adverse, long-term problems, especially in athletes who receive multiple concussions or suffer from second impact syndrome as a result of returning to play too soon following a concussion (Daneshvar et al., 2011). This has led to a national push aimed at protecting student athletes from concussions and post concussion syndrome. With numerous different guidelines on return to play timeframes, there is inconsistent data available for schools, parents, teachers, and coaches on when it is safe for athletes to return to play (Meehan et al., 2011). Furthermore, there is lack of standardized education being provided to parents, players, and coaches on concussions and post concussion syndrome (Meehan et al., 2011). Given the overwhelming amount of information available on concussions, return to play guidelines, second impact syndrome, etc., it can be very confusing to sort through all the information and determine the best approach to prevention and management of concussions in student athletes (Meehan et al., 2011).

A concussion is a traumatic brain injury caused by force transmitted either directly or indirectly to the head, face, or neck (Daneshvar et al., 2011). Clinical signs and symptoms of concussions can include loss of consciousness, amnesia, behavioral changes, cognitive impairment, sleep disturbances, headaches, and emotional disturbances (Daneshvar et al., 2011). While this is one commonly accepted definition, there are multiple definitions out there, only adding to the confusion. Aside from the

adverse effects previously mentioned, the effects of concussions can be exacerbated if athletes return to play too soon after a concussion (Meehan et al., 2011). Returning to play too soon following a concussion can drastically increase the risk of second-impact syndrome, multiple concussions, early onset dementia, and even chronic traumatic encephalopathy (Meehan et al., 2011).

The increase in awareness surrounding concussions has lead to the development and implementation of concussion assessment tools. Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) is the most widely used and scientifically validated computerized concussion evaluation system ("About ImPACT," 2013). ImPACT evaluation includes a pre and post injury assessment. Each assessment evaluates attention, memory, processing speed, and reaction time. Schatz and his associates determined that ImPACT testing is 81.9% sensitive and 89.4% specific (Schatz et al., 2006).

It is common for individuals to suffer from post concussion symptoms following the initial injury, which can include visual, motor, sensory, memory, and mental changes as well as headaches and balance problems (Daneshvar et al., 2011). Many days to weeks can pass before these symptoms truly resolve and the symptoms may be very mild, making it difficult to determine when it is safe to return to play (Daneshvar et al., 2011). When athletes return to play before they are truly symptom free, they greatly increase their chance of second impact syndrome (Meehan et al., 2011). This occurs by receiving a second blow to the head before the symptoms of the first concussion have subsided. Usually these second impacts only need to be very mild in nature to have severe effects on the individual. After being hit, athletes may appear dazed but still conscious. A short

period (usually 15-30 seconds) after the hit, however, they may collapse with rapidly dilated pupils and signs of respiratory failure in severe cases (Daneshvar et al., 2011).

The effects of returning to play too soon have been receiving more research attention lately, as more is being discovered about just how serious the effects on younger athletes can be (Gomez et al., 2013). With that in mind, more development on return to play guidelines has been aimed at decreasing the number of athletes who experience additional adverse effects following a concussion. However, with all the new guidelines comes an increased level of obscurity for many individuals in high school athletics. There is a wide variety of information published using different populations, so it is important when reviewing the literature to focus on the studies that apply best for each athlete.

Aside from the national attention at the high school level, discussion has been increasing at the professional level as well. The interest in sports related concussions and long-term effects have become a hot button issue gaining a lot of attention in both the media and in governing bodies of many sports, including the National Football League, National Hockey League, Big Ten Conference, and Minnesota State High School League. Concussions have come to the forefront following the $765 million settlement between the NFL and its retired players who are suffering from ongoing brain trauma (NFL Labor files). In order to minimize lasting or recurring symptoms, concussion protocols have been implemented by both leagues and schools to any athlete showing signs of a concussion (Gomez et al., 2013). Rule changes, like the head contact penalty that has been implemented in high school hockey, are attempting to make sports safer but may not be enough to avoid head injuries. Studies show that rule changes have not led to a

reduction in the number of hockey players injured from concussions (Donaldson et al., 2013).

A recent study with new technology has shown that there is no correlation between the force of the impact and degree of the injury (Broglio et al., 2011). This shows that the mechanism of a concussion has not been completely defined and therefore it is difficult to determine the best way to prevent an injury.

Problem Statement

With the current surge in concussion-based research, a lot of information has been presented. To a high school student this volume can be overwhelming. Many studies have been done with their own niche, and this can be difficult to navigate for a student who does not have much experience evaluating peer-reviewed literature. Some studies focus on different long-term effects following a concussion between students in different sports, different ages, and even different genders. A concise resource that contains only the pertinent information that can be presented to athletes and personnel is needed in order to maximize their recognition and recovery. Athletes that have been given a formal lecture have shown to have more knowledge of concussions and are more aware of symptoms to report (Myashita, 2013).

Purpose

The purpose of this paper is to outline a method for presenting resources and literature on concussions to athletes in a clear and concise form. This will be accomplished through a presentation that will provide current data on signs and symptoms, long-term effects of head injuries, treatment strategies, and resources available in the community.

Significance of Study

Concussions have been of increasing interest after research has found many long-term problems associated with suffering a concussion. Studies comparing athletes at differing ages, specifically high school and college have shown athletes at younger ages and female athletes report a higher degree of symptoms and more postural stability deficits in both days and weeks following the injury (Covassin, 2012). The prevalence of concussions in high school athletes has been increasing recently, with an estimated 1.6 to 3.8 million concussions occurring each year in children and adolescents participating in organized athletics (Daneshvar et al., 2011).

Research Question

Through the design of the study, the purpose of the research was to answer the following question:

1. How educationally beneficial is a concussion presentation to a high school athlete?

Hypothesis

High school athletes who receive a concussion education presentation will score higher on their individual post-test than their individual pre-test.

CHAPTER 2
LITERATURE REVIEW

Introduction

A concussion has been defined as "a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces" (Aubry et al., 2002). Athletes suffering a concussive injury may report increasing symptoms that include motor and cognitive declines following the injury for a period of time. This review will outline the current literature on topics related to concussions in athletes and provide a basis for comparing and contrasting the different findings.

Overview of Post Concussion Syndrome

Concussion symptoms are better recognized and treated now more than ever. Logan (2010), the author of an article entitled, "Recognition and management of post-concussion syndrome," gives a clear picture of post-concussion syndrome and its management. Logan (2010) states that post-concussion syndrome has been estimated to occur in 10% of concussion cases, while noting that this estimate may be low depending on the population and the definition of post-concussion syndrome. *The Diagnostic and Statistical Manual of Mental Disorder,* 4th Edition (DSM-IV) defines post-concussion syndrome as the presence of three or more concussion symptoms for at least 3 months following the initial trauma. Logan (2010) states that physicians and practitioners who treat large numbers of concussions are recognizing and diagnosing post-concussion syndrome earlier. In cases where the practitioner is unfamiliar with post-concussion syndrome, recognition of symptoms can be as low as 60% (Logan, 2010).

In his research, Logan discussed correct diagnosis of post-concussion syndrome by assessing the entire spectrum of symptoms. Logan described symptoms of post-

concussion syndrome as a continuation of acute concussion symptoms that interact with each other. This description adds complexity to the entire illness picture. For example, sleep difficulties due to prolonged concussion symptoms can lead to sadness and difficulty concentrating (Logan, 2010). Symptoms can be described as physical, cognitive, emotional, and sleep related (Logan, 2010). A complete differential diagnosis including depression and post-traumatic stress disorder can make post-concussion syndrome difficult to isolate (Logan, 2010). Logan discussed how a thorough history that gives a clear picture of the injury and a complete social history that notes dysfunction are key to an accurate diagnosis (Logan, 2010).

In his article, Logan discussed the evaluation of neuropsychological tests to aid in the diagnosis of post-concussion syndrome. Computerized neurocognitive assessment tools are useful in clarifying vague symptoms associated with a concussion (Logan, 2010). Neurocognitive assessment tools are used to identify patients in whom full cognitive recovery has not occurred (Logan, 2010). Neurocognitive assessment tools assess cognition, attention, and psychological status (Logan, 2010). Research surrounding Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) as a neurocognitive assessment tool will be discussed in more detail later in this chapter.

Lastly, there is the important discussion of treatment of post-concussion syndrome. Research has shown that the most effective treatment for post-concussion syndrome is cognitive and physical rest. Logan (2010) discussed that the basic premise of this treatment is that any activity that causes symptoms should be avoided. This treatment is difficult for many patients as it can result in the loss of work or missed time at school.

Symptoms of post-concussion syndrome like headache, sleep disturbances, and neuropsychological problems can be treated as they occur (Logan, 2010).

Classifying Concussion Severity

Symptoms seen in the days to weeks after suffering a concussion are based on the injured athletes ability to recognize and report the signs and symptoms. Due to the subjective nature of this method, research has been done to evaluate the reliability of the process. Lovell, Iverson, Collins, Podell, Johnston, Pardini, and Maroon (2008), the authors of a research article entitled, "Concussion in sports: Post concussive activity levels, symptoms, and neurocognitive performance", aimed to discover what differences exist in reporting of symptoms between different populations. Much of the literature includes a portion of evaluating the injury called measurement of symptoms, so the focus of this study was to find more information on how that is defined and used (Lovell, et al., 2008). Lovell et al looked at groups of both male and female high school and college athletes from a variety of sports for the study. The Post-Concussive Scale was the test used. This scale measures 22 different symptoms on a scale from 0 to 6 in order to find symptoms present in athletes at three intervals following the concussion. The first time interval was within 72 hours of initial injury, the second interval was 4 to 8 days, and the final interval was 7 to 30 days post injury (Lovell et al., 2008). The most commonly reported symptoms were found to be headache, fatigue, feeling slowed down, drowsiness, difficulty concentrating, mentally 'foggy', and dizziness. In regards to gender differences, the study found women to have higher reports of symptoms following a concussion, but this was not statistically significant when compared to women's higher report rates of symptoms at baseline as well. Some symptom reports can depend on comorbidities or in

many cases concussion patients tend to have good and bad days, so their mood can influence how they answer the questions on a certain day (Lovell et al., 2008). The problem with this finding is whether to base the different findings on actual differences in symptoms or differences due to avoidance of reporting because of the fear of missing playing time. The results are based on the athlete's perception of their symptoms and lack a method of standardization. Although the Post-Concussive Scale lacks scientific accuracy, this scale does help give some significance of symptom reporting to clinicians. The key is to use symptom evaluation as one of many tools when evaluating a concussion, with a clinical evaluation giving you more information (Lovell et al., 2008).

Other variables, which are seen in concussions and have also been studied, include age and sport differences. Covassin, Elbin, Harris, Parker and Kontos, who are the authors of "The role of age and sex in symptoms, neurocognitive performance, and postural stability in athletes after concussion", looked to evaluate the effects of a concussion on different populations through different factors. The goal was to compare differences between a large sample of high school and college athletes as well as any gender differences between the groups. The testing was done through evaluations using ImPACT and the Post Concussive Scale at 2 days, 7 days, and 14 days following the initial injury (Covassin et al., 2012). The post-concussion tests revealed female and high school athletes to score lower on verbal and visual memory tests. Females also reported more symptoms, consistent with the results found by Lovell, et al (2008). Covassin, et al. (2012) hypothesized the gender differences may be due to different hormonal effects or simply different mindsets of not recognizing or choosing to report symptoms. The diminished scores seen in high school athletes were especially significant when looking

at the longer time intervals. This study showed neurocognitive impairments in high school athletes lasting for 10-21 days after injury but only 5-7 days on average for college athletes (Covassin et al., 2012). Use of neurocognitive data is supported by this study as a valuable tool for assessment and management. Neurocognitive data is useful for discovering deficits as long as the athletes have a baseline level recorded.

Force Relationship to Injury Degree

A common perception by participants and spectators of contact sports is that the magnitude of impact affects the severity of injury. Broglio, Eckner, Surma, and Kutcher (2011), who are the authors of "Post-Concussion Cognitive Declines and Symptomatology Are Not Related to Concussion Biomechanics in High School Football Players", explored what effects the biomechanics of the force has on the degree of injury. The newest technology was used to measure many factors of the hit including the linear acceleration, location of impact, and rotational acceleration (Broglio et al., 2011). Broglio, et al. (2011) also tracked both the amount of time since the previous impact to the helmet as well as the time elapsed from the start of the event in order to account for the accumulation of hits throughout a game. A helmet that is able to record all this information was used in the study. The athletes were then evaluated for discrepancies from their preseason baseline testing in both concussion-like symptoms as well as cognitive and motor abilities. Of the high school football players studied, the majority of the concussions were caused by initial impact to the front of the helmet while some were also seen with initial impact to the top, back, and side (Broglio et al., 2011). The findings that the majority of concussions were due to impact to the front of the helmet may suggest an enhanced pathophysiological effect but may also be due to the prevalence of

head-on collisions in football. The results showed that there was no significant correlation between impact variables and concussion severity, which are consistent with a previous study on college football players (Guskiewicz et al., 2007). It is difficult to completely evaluate the mechanism of an impact because there are so many factors. The study may have been missing some variables that could influence how to classify the degree of impact. Many of the participants in the study had a history of concussion and this was not taken into account when looking at the results. The lack of evidence relating force and impairment level is a concern and warrants a complete evaluation for athletes who are showing mild or severe impact symptoms, including changes in motor or cognitive abilities (Broglio et al., 2011).

ImPACT Testing

Due to the rise of concussion injuries among high school athletics and the increased availability of neuropsychological testing, a study by Schatz, Pardini, Lovell, Collins, and Podell entitled, "Sensitivity and specificity of the ImPACT test battery for concussion in athletes", evaluated the Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) tool for its specificity and sensitivity. ImPACT evaluates attention, memory, processing speed, and reaction time. The test consists of three parts: demographic data, neuropsychological tests, and the Post-Concussion Symptom Scale (PCSS). The data from these three areas are combined to provide assistance with accurate diagnosis of concussive injuries. Schatz, et al (2006) evaluated 72 high school athletes who had sustained a concussion in the last 72 hours and 66 healthy high school students with the ImPACT tool. All participants had baseline data, which was collected during the off-season before participation in practice or competition. Athletes in the study that were

affected by concussions were participants in primarily football (73%) and the control group participants were involved in primarily non-contact sports (79%). MANOVA and ANOVAS evaluation of the ImPACT data determined that ImPACT testing in these cases was 81.9% sensitive and 89.4% specific. These researchers summarized that ImPACT testing is a very effective tool in helping practitioners assess a high school athlete's status and ability to return to play (Schatz et al., 2006).

Accurately assessing baseline values for athletes is key to accurately using ImPACT for diagnosis. Schatz (2010) recently researched the test-retest reliability of ImPACT baseline assessments. The study looked at 95 collegiate athletes who were tested twice to evaluate any changes in their baseline values. The athletes were tested about 2 years apart and during that time period sustained no concussions. The researchers used two statistical evaluations that helped them determine that baseline data remains stable over a two-year period. The data supports stretching assessments from one year to two years. A potential cost benefit may exist by stretching assessments from one year to two years. In a study by Schatz entitled, "Long-term test-retest reliability of baseline cognitive assessments using ImPACT", it was discussed that annual testing may be indicated for younger athlete, as their brains are still maturing. It should be noted that collegiate football players were not included in this study (Schatz, 2010).

Ultimately ImPACT must be effective in aiding with concussion diagnosis. Iverson, Lovell, and Colins (2005) have worked on research to determine how ImPACT compares to other evaluation methods in measuring processing speed following a concussion. Evidence revealed that athletes with concussion show performance decreases on computerized neuropsychological test in the days following a head injury. ImPACT

testing specifically measures the attention and processing speed in athletes at baseline and post-concussion. The researchers compared ImPACT results with Symbol Digit Modalities Test, which has been used and proven effective in concussion research (Iverson, et al., 2005). Iverson, et al (2005) hypothesized that the Symbol Digit Modalities Test would be more correlated to the processing speed and reaction time composite scores on ImPACT versus the two memory composites. Results determined the hypothesis to be accurate. The results also helped the researchers to conclude that the composite scores from ImPACT are beneficial to practitioners but could use ongoing evaluation (Iverson et al., 2005).

Concussion Prevalence in High School Athletes

A study by McClincy, Lovell, Pardini, Collins, and Spore entitled "Recovery from sports concussion in high school and collegiate athletes", found that high school athletes suffer the majority of concussions seen in American athletes each year. The numbers seen in contact sports are high; with over 62,000 high school football players suffering a concussion each year and 34% of college football players reporting to have suffered one in their career (McClincy, et al., 2006). The degree of concussion did not correlate to the extent of ongoing symptoms. It was found that impairment might still be present in the absence of symptoms, highlighting the importance of neurocognitive testing like ImPACT (McClincy, et al., 2006). The effect of a previous concussion on the current injury was also analyzed. Concussion history was found to be related to ongoing symptomatology in high school athletes (McClincy et al., 2006).

In a recent article by Daneshvar, Nowinski, Mckee, and Cantu, the prevalence of concussions in organized sports was examined. They examined twenty different sports,

looking at both men and women in high school and collegiate athletics. They collected data from the National Center for Catastrophic Injury Research, which included data from 1982-2008. Upon evaluation of each individual sport, looking at participation and injuries sustained, they found that the rate of concussions in organized athletics has been steadily increasing since the 1980's. They credit the rise in concussions partially to improvement in detection techniques and methods, but also speculate that the rise may also be due to more concussive impacts occurring. On a more specific level, the study found that athletes participating in football, women's soccer, men's soccer, and women's basketball are at the highest risk for concussions (Daneshavr et al., 2011). They also found that athletes have a higher risk of concussion during competition as compared with practice. In discussing possible solutions to the rise in concussions, the authors discuss the possibility of mandatory pre-participation examinations, mandatory concussion education, proper strength and conditioning, and proper training of coaches, trainers, and medical staff (Daneshavr et al., 2011). These all aim to reduce the prevalence of concussions and concussion-related injuries in organized athletics (Daneshavr et al., 2011).

Concussion Education Effectiveness

In a recent article by Bramley, Patrick, Lehman, and Silvis, the authors examined the effectiveness of concussion education on athlete symptom reporting. Specifically, they examined the correlation between concussion education in high school soccer players with their willingness or ability to notify coaches about potential concussive symptoms. The authors designed a survey that was distributed to roughly 180 high school soccer players in Ohio and Pennsylvania. The survey included questions such as:

1. What is your grade?

2. Is it okay for an athlete to continue playing in a game in which they have suffered a concussion?

3. You think you have suffered a concussion during a game. Do you tell your coach or trainer, or do you say nothing and continue to play?

4. During a championship game you develop an injury that does not significantly hinder your ability to play, but could result in severe permanent injury if you continue to play. Do you tell your coach or trainer, or do you say nothing and continue to play?

5. Have you been taught about concussions? If yes, from whom or where? Family, Teachers/School, Trainer, Coach, Doctor.

(Bramley, et al., 2012, p. 333)

In order for student-athletes to participate, parental permission was required. The results showed a correlation between student-athletes who had some form of concussion education and informing a coach about concussion-like injuries. Specifically, 72% of student-athletes who had previous concussion education reported they would notify a coach or trainer if they suspected a concussion. This is contrasted by 36% of student-athletes who had no previous concussion education reporting they would notify a coach or trainer if they suspected a concussion. Overall, they found that nearly three-fourths of student athletes who had previous concussion training said they would notify coaches if they were having concussive symptoms during a game, compared to roughly one-third of athletes who had no previous concussion training. The findings from this study suggest that student-athletes who receive some form of concussion education are more likely to

notify a coach or trainer if they suspect they may have sustained a concussion during a game or practice. This supports the notion that high school athletes, coaches, and parents should receive education on the effects and signs and symptoms of concussions in order to limit the adverse effects that may result (Bramley et al., 2012).

Return to Play Guidelines

Following an injury like a concussion, athletes always want to know when they can get back to playing again. Return to play is currently a hot topic of debate and different sports and leagues tend to follow their own protocols, although it is a difficult problem due to the individualization of each case. Some states have been creating legislation that requires a licensed medical professional to evaluate an athlete with a head injury before allowing them to return to the game. The previous attention has been on professional athletes but this new legislation will shift the focus to adolescent players, which will have a direct effect on high school athletics. The current and accepted guidelines require an athlete to go through increasing activity levels while remaining asymptomatic through each step. The return to play testing protocol starts with simple jogging and works toward non-contact practice and eventually full contact practice without any reported symptoms. Any reporting of symptoms would require the athlete to move back a step to a decreased activity level. Sady, Vaughan, and Gioia, who authored a study entitled, “School and the concussed youth: recommendations for concussion education and management”, found academic abilities may be used for a return to play guideline, as this can be a good indicator of where athletes’ cognitive levels are. Other tests analyzing comprehension and memory have shown to have a relevant use for post-concussion evaluation (Sady, et al., 2011). Deficits found in comprehension or memory

would be an appropriate reason to delay their return to play, even if symptoms were absent during activity (Schatz et al., 2011). The key to testing is having a baseline to compare with, so schools have been encouraged to provide preseason testing in order to best manage the athlete (Jamault et al., 2013).

Summary

This literature review outlines the prevalence of concussions among student athletes, as well as provides background information on the effects of post concussion syndrome. Furthermore, this review highlights the effectiveness of concussion education programs on minimizing the adverse effects that can arise due to concussions. It also establishes the uses of ImPACT testing in concussion management in student athletes. With the high occurrence of concussion in high school athletes, it is crucial to know how to recognize symptoms. Research has shown there is much more involved with the physiology of a concussion than just the impact of a hit. The return to play guidelines are changing as new studies are completed, and it will be important to stay current on the latest research and recommendations.

CHAPTER 3
METHODOLOGY

Introduction

The purpose of this study was to educate high school athletes on concussions and the adverse effects they can have. More specifically, the research examined the effectiveness of concussion education programs on improving athletes understanding of concussions and their adverse effects. To facilitate this research the following question was addressed and analyzed:

1. How educationally beneficial is a concussion presentation to a high school athlete?

To expand upon the research ideas, this chapter will address the population, design, methods, data analysis, and validity and reliability, as well as limitations of the study.

Population

The population of interest for this study included high school athletes in Minnesota public schools who were 18 years of age. More specifically, athletes at two high schools: Saint Louis Park High School, Saint Louis Park, MN and Cloquet High School, Cloquet, MN. No contact was made between the researchers and the participants regarding this study prior to the day of the presentation. Confidentiality of the participants was ensured by not collecting names or personal information. In order to maximize the number of participants, the presentation and pre and posttests were given prior to a team practice. Data was gathered from athletes participating in any Minnesota State High School League (MSHSL) sanctioned sports.

Equipment and Instruments

The evaluation tool for this study included a pre-test prior to the presentation as well as a post-test following the presentation. This allowed the researchers to analyze the

effectiveness of the presentation and the athletes' level of education on concussions before and after the education. The questions pertained to prior knowledge of concussions, signs and symptoms, and their understanding following the presentation. The pre and post-test provided a means of analyzing effectiveness of the presentation with respect to providing education on concussion signs, symptoms and management.

The pre-test and post-test were on separate sheets and were numbered to ensure that each participants data was matched in analysis. Participants took the pre-test and it was collected. The presentation was given and then the participants were given the post-test. The pre-test/post-test contained the questions designed by the authors of the study and were multiple choice. The content of the pre-test/post-test was the same with the exception of one additional question on the post-test. Question 8 on the post-test was designed to evaluate overall recognition of potential concussion symptoms. The survey included a demographics section that recorded gender and high school sports the student participates in.

The education of the participants consisted of a PowerPoint slideshow that was narrated by the authors of the study. The presentation aimed to educate and highlight key points about concussions, including symptom recognition, steps to take if suspecting a concussion, and potential long-term consequences. The PowerPoint slideshow and a script were used to ensure consistency in the presentation when it was given to athletes at different schools.

Study Design

This study was a quantitative, non-randomized, experimental design that consisted of a group pretest-posttest study analyzing the effectiveness of an informative,

concussion presentation to high school athletes. The research was conducted through a within group comparison. The dependent variable was the participant's understanding of concussions, while the independent variable was the education on concussions. The data was scored using a paired t-test.

Validity and Reliability

The pre-test/post-test used for this study was created by the researchers performing the study and was designed to obtain the most appropriate and useful data related to the research questions. The survey was evaluated by a pre-study review by the committee chair and reviewed by other faculty members to confirm it was understandable and related directly to the research questions. Reliability was determined through the statistical analysis performed by the authors comparing responses to multiple questions asked on the pre and post-test. Answers received from participants surveyed provided the data used in the statistical analysis. Presenting the research-based presentation on concussion identification and management with a PowerPoint and script ensured validity. Additionally, peers and PA faculty reviewed the presentation.

Procedures

The researchers have developed a script that was followed during the presentation. This ensured consistency throughout each of the presentations. Prior to starting the presentation, all athletes in attendance were given a consent and a pre-test. They were instructed to acknowledge their consent to participate in research and then complete the pre-test. After completion they noted the number on their pre-test and the researchers collected it. The researchers then used the script and slideshow to give the presentation on concussions. Following the presentation the participants received a post-

test matching the numeric identifier on the pre-test. Selecting the sample size consisted of surveying all 18+ year-old athletes at each respective school participating in spring sports. When compiling the data from the survey only complete surveys were included for analysis. The project's independent variable was the presentation, while the dependent variable was the athlete's knowledge of concussions after hearing the presentation. In order to apply controls to the sample, all participants heard the same presentation (via the script and PowerPoint slideshow) and were given the same pre-test/post-test survey.

Statistical Methods

The pre-tests were collected before the presentation and the post-test was given after the presentation. The pre-test/post-test results were analyzed using a computer based statistical program. The sample size was 43 (25 from school one and 18 from school two) high school athletes 18 years of age from MSHSL sanctioned sports. The authors of this study performed the statistical analysis under the guidance of an experienced statistical analysis researcher. A comparison of the mean score differences of knowledge was done using a paired t-test of within group difference of the pre and posttest scores. A quantitative analysis was done using numeric statistical data. The data looked for statistically significant differences in responses from the pretest to the posttest. Descriptive statistics were used to find the mean, standard deviation, and percentages for improvement after the presentation. These differences were assessed using a computer based statistical program, which allowed for conclusions to be drawn on how the presentation influenced the participant's knowledge of concussions. The data analysis allowed the researchers to support or reject the hypothesis.

Limitations

The following are limitations that the researchers believe to be inherent and potential weaknesses of the study:

1. Finding willing participants that will give appropriate feedback and put forth full effort.
2. Finding schools that are in need of concussion information for their athletes, as there has been a recent push towards education.
3. Maintain a consistent presentation, both with clarity of information in the presentation as well as clarity in the directions to the participants for completing the survey. It will be made clear both verbally and in writing what questions to answer before the presentation and which ones to answer after.
4. Finding appropriate survey questions that accurately represent the participant's knowledge of the subject.
5. The participants will be aware that they are being measured and may compensate somewhat to give feedback based on what they think the researchers want to hear.
6. The study does not address long-term retention of the information presented. The participants' immediate understanding of the education will only be evaluated. Following up on the knowledge maintained over time is a potential area of further research.

CHAPTER 4
RESULTS

Technique

The survey data was collected and analyzed using a computer based statistical program under the guidance of an experienced statistical analysis researcher. A comparison of the mean score differences was done using a paired t-test of within group difference of the pre- and post-test scores. A quantitative analysis was done using numeric statistical data. Descriptive statistics were used to find the mean percentage, standard deviation, and p-value of each school individually as well as both schools combined. The p-values were calculated in order to numerically quantify whether the data shows statistically significant results from the pretest to the posttest. The percentages of student athletes who improved, scored the same, or declined on the pretest as compared to the posttest were calculated. Responses to each question in the survey were analyzed and the percentage of correct responses on both the pretest and posttest were calculated in order to determine which individual questions were difficult as well as to determine which questions showed improvement.

Data Analysis

Table 1

Comparison of Mean and Standard Deviation between schools

School	n	Pre-test mean (std dev)	Post-test mean (std dev)	P value
1	25	68.6 (17)	92.0 (11.3)	.0000021
2	18	68.3 (15.1)	79.2 (14.2)	.0095
Overall	43	68.4 (16.1)	86.6 (14)	.00000018

Table 2

Percentage of Athletes that Improved and Declined from Pretest to Posttest

School	Improved	Same	Declined
1	84%	8%	8%
2	83.3%	0%	16.7%
Overall	83.7%	4.7%	11.6%

Table 3

Comparison of Responses to Individual Questions

Question	Correct pre	Correct post
1	95.3%	100%
2	90.7%	93.0%
3	46.5%	74.4%
4	100%	100%
5	58.1%	67.4%
6	55.8%	74.4%
7	30.2%	86.1%
8	n/a	97.7%

CHAPTER 5
DISCUSSION

Overview

The findings from the data analysis demonstrate a statistically significant difference in mean scores from pre to posttest. This is indicated by the p-score value of less than 0.05 on both the individual school scores and the overall combined scores. This supports the hypothesis that student athletes will improve scores on their post-test questionnaire as compared to their pre-test questionnaire after receiving an educational presentation on concussions. The statistically significant findings of the data suggests that a concussion education presentation is educationally beneficial, as demonstrated by the improvement in answers to the multiple choice questions on the pretest and posttest across the sample size as a whole.

Overall, the percentage of participants who improved their score from the pretest to the posttest was high. Over 80% of the student athletes improved their score and similar results were observed at both schools. There were a small percentage of participants who scored lower on the posttest than on the pre-test, showing that there is room for improvement in the educational presentation. It is worth noting that there were a few participants who scored 100% on both the pre- and post-test, showing extensive prior knowledge on the topic.

Looking more specifically at the results, one can see that there was a variation in the scores when looking at the pre and posttest results for individual questions. Questions 3 and 7 showed the biggest improvement in percent correct from pre to posttest, with a 27.9% and 55.9% improvement respectively. Question 6 demonstrated a moderate improvement of 18.6% correct from pre to posttest. Questions 1, 2, and 5 demonstrated

mild improvement in percent correct from pre to posttest, with 4.7%, 2.3%, and 9.3% respectively. With respect to question 4, there was no improvement shown in percent correct as all participants scored 100% on both the pre and post-test. The data for individual questions help to highlight areas of strength in the concussion education presentation. Researchers designed question 8 on the posttest to evaluate the comprehensive ability of the participant to identify a concussion in their own athletic endeavors, in a friend or a teammate. The data identified that 97.7% of participants were able to accurately identify the presentation of a concussion by answering question 8 correctly on the posttest.

Limitations

One barrier to this research and future research is finding schools that are in need of concussion education for their athletes. Recent advances in research and discoveries showing the long term adverse effects of head injuries have led to many schools already instituting concussion education programs for their athletes. Researchers contacted 14 schools inquiring about providing education to their athletes and only two of these schools expressed a need.

Partnering with schools that expressed a need for concussion education created a natural partnership with the coaches and athletic directors. Coaches at both sites were willing to release senior athletes from practice to participate in the concussion education presentation. One variable that could be identified in later research is whether or not athletes were motivated by wanting to learn about concussions or if athletes were motivated by the opportunity to be excused from practice. The majority of student athletes were attentive throughout the presentation and gave appropriate feedback. After

analyzing the surveys, it was determined that all participants put forth ample effort and no surveys needed to be discarded.

The pre-test scores for both schools are very similar. However, the post-test scores at school number 1 are higher than school number 2. This could be explained by chance. Students at school number 2 may have learning styles that learn best when given an oral presentation while school number 1 may benefit from reading the educational material. Despite the researcher's efforts to maintain consistency using a powerpoint slideshow and a script, the two presentations may have differed in clarity and flow of information presented.

Participants taking the pretest and posttest did not verbalize questions regarding formatting, syntax or content of the questions. Regardless, participant understanding of the questions or the presentation may be a limiting factor. Researchers clearly explained that the pretest was designed to evaluate knowledge before the presentation and posttest was used to evaluate knowledge gained, this was further ensured by keeping the pretest and posttest on two separate forms.

The participants were aware that they were being evaluated on their performance and could have intentionally answered pretest questions incorrectly in order to answer them correctly on the posttest. The participant's awareness that they were being evaluated ideally did not have a significant role in the results as the pretest and posttest are designed to minimize the possibility of having participants adjust responses to what they perceive the researchers were hoping to find. Multiple-choice questions were utilized that included answers that were related to concussion education but included only one correct answer.

The consistency of the data between the schools indicates that the participants were answering honestly.

Recommendations

Based on the findings from this study, further research could help develop concussion education programs in high schools by further assessing the need and effectiveness of concussion education provided to high school athletes. The results of this research study showed promising educational benefits from a concussion education program. Further research could be improved by recruiting a larger sample size. A larger sample size will help to improve overall reliability and validity. Including more schools within the research area will help identify if concussion education programs are equally beneficial at all schools.

Further research could compare schools of different socioeconomic backgrounds, number of students, cultural backgrounds and evaluate scores based on rural vs. suburban vs. urban schools. As noted above, one school showed more improvement on the posttest as compared to the other. Further research can be conducted on how location and access to resources at different schools affects student athletes' knowledge of concussions and may help better direct educational programs to different schools based on the need and baseline knowledge.

Researchers noted that while the pretest and posttest were effective in evaluating the participants, some questions on the pre and post-test might benefit from being altered. Evaluating individual questions and analyzing the improvement for each indicates some of the questions were more difficult than others. Future research could focus on formatting a presentation that isolates areas of learning with the most potential benefit

and modify the presentation to better address these areas of deficit. Specifically noting, questions 3, 6, and 7 addressed areas of knowledge deficit in participants that greatly improved after participating in the concussion education. Replacing some of these questions with ones that require more insight into the specifics of concussion signs and symptoms may be beneficial in helping to better assess the need and benefit of concussion education programs.

Conclusion

Overall, the results of this research study suggest that concussion education programs are both needed and beneficial for high school athletes. While there has been much emphasis recently on improving concussion awareness in an attempt to reduce the adverse effects that can come with concussions, it is clear that there are still gaps that need to be closed. This research only scratches the surface of addressing the overall need and effectiveness of concussion education programs. In conducting this research one of the goals was to shed some light on the topic so that others may work to further address this topic. Concussion education has come far in the last decade but there is still a need for further investigation into how improvements can be made to help better educate student athletes on the importance of concussion education and the potential long term effects.

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APPENDICES

Appendix A

IRB Approval

Institutional Review Board
3900 Bethel Drive
PO2322
St. Paul, MN 55112

March 19, 2015

Nathan Birno
Bethel University
St. Paul, MN 55112

Re: Project SP-12-15 Effectiveness of Concussion Education for High School Athletes

Dear Nathan,

On March 19, 2015, the Bethel University Institutional Review Board completed the review of your proposed study and approved the above referenced study.

Please note that this approval is limited to the project as described on the most recent Human Subjects Review Form. Also, please be reminded that it is the responsibility of the investigator(s) to bring to the attention of the IRB any proposed changes in the project or activity plans, and to report to the IRB any unanticipated problems that may affect the welfare of human subjects. Last, the approval is valid until March 18, 2016.

Sincerely,

Peter Jankowski, Ph.D. Chairperson Bethel University IRB

Appendix B

Consent Form

You are invited to participate in a study of concussion education. The purpose of the study is to investigate the effectiveness and the need of concussion education in high school athletes. You were selected as a possible participant in this study because you are a high school athlete participating in a spring sport. The information collected will be used for thesis research in affiliation with Bethel University's Physician Assistant Masters Program.

If you decide to participate, we will provide an educational session regarding knowledge and awareness of concussions. The presentation will last approximately twenty minutes. Before the presentation, participants will be asked to complete a pre-test and following the presentation participants will be asked to complete a post-test. The pretest will consist of demographic questions as well as questions regarding concussions and the information presented in the educational session. The posttest will not include demographic information. Additionally, one multiple-choice question regarding the educational presentation will be included in the post-test. The risks to you as a participant are minimal; it is possible you may misinterpret and/or misuse the information provided about concussions. You may benefit from participating by gaining knowledge about concussions that may potentially help recognize a concussion and know what steps to take in order to receive appropriate treatment. There are no incentives for participation in the study.

Data collection documents you complete will not include your name and will be coded so that you cannot be identified. In any written reports or publications, you will not be identified or identifiable and only aggregate data will be presented.

Your decision whether or not to participate will not affect your future relations with Bethel University in any way. If you decide to participate, you are free to discontinue participation at any time without affecting such relationships.

This research project has been reviewed and approved in accordance with Bethel's Levels of Review for Research with Humans. If you have any questions about the research and/or research participants' rights or wish to report a research-related injury, please call Nathan Birno PA-S, (952) 240-5454. Larson Davick PA-S, (320) 491-6694. Kyle Oostra PA-S, (320) 766-0910. Christina Hanson PA-C (651) 635-8042.

You will be offered a copy of this form to keep.

You are making a decision whether or not to participate. Your acknowledgement indicates that you are 18 years of age and have read the information provided above and decided to participate. You may withdraw at any time without prejudice after signing this form should you choose to discontinue participation in this study.

Appendix C

Questionnaire

PRE-TEST

Gender: **Sports Played Throughout the Year:**

Which of the following is not a sign of a concussion?
A. dizziness
B. arm weakness
C. headache
D. nausea

What criteria must be met to return to game action?
A. symptom free for 24 hours
B. able to practice with full contact symptom free
C. able to attend class and perform homework symptom free
D. all of the above

Concussion symptoms typically resolve within what time period?
A. the same day as injury
B. 24-72 hours
C. 7-14 days
D. 1 month

Who should you inform if you suspect a concussion or other head injury?
A. Parent
B. Coach
C. Athletic trainer
D. All of the above

What potential long-term effects are NOT associated with second impact syndrome or post concussion syndrome?
A. brain swelling leading to death
B. long term headaches
C. paralysis
D. memory loss

What percentage of concussions in student athletes result in post concussion syndrome?
A. 1%
B. 5%
C. 10%
D. 25%

What percentage of student athletes with no prior concussion education believe they would report a potential concussion if they believe they have suffered one?
A. 8%
B. 36%
C. 54%
D. 81%

☐By checking this box I acknowledge that I am 18 years of age and I agree to participate in this study.

POST-TEST

Which of the following is not a sign of a concussion?

A. dizziness
B. arm weakness
C. headache
D. nausea

What criteria must be met to return to game action?

A. symptom free for 24 hours
B. able to practice with full contact symptom free
C. able to attend class and perform homework symptom free
D. all of the above

Concussion symptoms typically resolve within what time period?

A. the same day as injury
B. 24-72 hours
C. 7-14 days
D. 1 month

Who should you inform if you suspect a concussion or other head injury?

A. Parent
B. Coach
C. Athletic trainer
D. All of the above

What potential long-term effects are NOT associated with second impact syndrome or post concussion syndrome?

A. brain swelling leading to death
B. long term headaches
C. paralysis
D. memory loss

What percentage of concussions in student athletes result in post concussion syndrome?

A. 1%
B. 5%
C. 10%
D. 25%

What percentage of student athletes with no prior concussion education believe they would report a potential concussion if they believe they have suffered one?

A. 8%
B. 36%
C. 54%
D. 81%

Which of these athletes likely has a concussion:

A. Johnny is a high school baseball player who was hit in the side of the helmet with a wild pitch while at bat. He reports feeling fine and is not concerned due to fact that the pitch was only a curveball. He does feel nauseous and had one episode of vomiting five minutes after the incident. He never blacked out or lost consciousness, and he does not have any prior history of head injury.

B. Freddy is a high school football player who comes out of the game after a big collision. Freddy says, “I just got my bell rung, I am fine”. Freddy admits to a small headache and being a little dizzy.

C. Walton is a high school hockey player who was skating down the ice when he lost control on his skates and went into the boards head first. He was able to get up under his own power, but was feeling a little dizzy and off balance. He made it back to the bench and told his coach he was fine.

D. All of the above

Appendix D

Confidentially Agreement

Title: The Need for Concussion Education in High School Student Athletes

Local Principal Investigators: Nathan Birno, Larson Davick, Kyle Oostra
Research Advisor: Christina Hanson, PA-C

As a member of this research team I understand that I may have access to confidential information about study sites and participants. By signing this statement, I am indicating my understanding of my responsibilities to maintain confidentiality and agree to the following:

- I understand that any identifying information about study sites and participants are completely confidential.

- I agree not to divulge, publish, or otherwise make known to unauthorized persons or to the public any information obtained in the course of this research project that could identify the persons who participated in the study.

- I understand that all information about study sites or participants obtained or accessed by me in the course of my work is confidential. I agree not to divulge or otherwise make known to unauthorized persons any of this information, unless specifically authorized to do so by approved protocol or by the local principal investigator acting in response to applicable law or court order, or public health or clinical need.

- I understand that I am not to read information about study sites or participants, or any other confidential documents, nor ask questions of study participants for my own personal information but only to the extent and for the purpose of performing my assigned duties on this research project.

- I agree to notify the local principal investigator immediately should I become aware of an actual breach of confidentiality or a situation that could potentially result in a breach, whether this be on my part or on the part of another person.

Nathan Birno (electronic signature)	12/21/2014	Nathan Birno
Signature of local principal investigator	Date	Printed name
Larson Davick (electronic signature)	12/21/2014	Larson Davick
Signature of local principal investigator	Date	Printed name
Kyle Oostra (electronic signature)	12/21/2014	Kyle Oostra
Signature of local principal investigator	Date	Printed name
Christina Hanson (electronic signature)	12/21/2014	Christina Hanson
Signature of research advisor	Date	Printed name