DISSERTATION

# THE IMPACT OF AN EDUCATIONAL INTERVENTION ON COLLEGE ATHLETES' KNOWLEDGE OF SPORTS RELATED CONCUSSIONS

Submitted by

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# ABSTRACT

## THE IMPACT OF AN EDUCATIONAL INTERVENTION ON COLLEGE ATHLETES' KNOWLEDGE OF SPORTS RELATED CONCUSSIONS

**Objective:** To determine if a lecture on sports-related concussions would improve college athletes' knowledge, and to determine common misnomers college athletes have regarding sports-related concussions.

**Design:** Mixed Methods, Validating Quantitative Data Model

**Setting:** Metropolitan State College of Denver

**Participants:** Fifty collegiate men/women's soccer players and men/women's basketball players.

**Intervention:** Participants were asked to listen to a twenty minute educational intervention on sports-related concussions, followed by a questions/answer session.

**Results:** Athletes significantly improved their concussion knowledge from the pre-season survey assessment to the post-season survey assessment ($p = .000$). There was not a significant difference between the four teams ($p = .815$), gender ($p = .788$), or age ($p = .922$) on the survey assessments.

**Conclusion:** An educational intervention given to athletes prior to the beginning of the athletic season significantly improved their knowledge, and they were able to retain that knowledge through the entire athletic season.

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# DEDICATION

This dissertation is dedicated to my incredibly understanding and supportive family. Without their encouragement and support, I would not have been able to complete my doctoral degree. Thank you to my mother and father for supporting me through every step of my life. Thank you to my understanding husband for his patience, support, and encouragement while I went back to school to complete my dream. To my daughter, Alexis, for whom I want to set the best example.

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# CHAPTER 1: INTRODUCTION

Since the inception of athletic competition, sports-related concussions have impacted athletes and their well being. Sports are second only to automobile accidents as a leading cause of concussions in the United States, affecting 1.6-3.8 million athletes per year (Broglio, Ferrara, Macciocchi, Baumgartner, & Elliot, 2007). The cost of treating concussions within the United States has increased to almost $17 billion per year (Report to Congress on Mild Traumatic Brain Injury in the United States: Steps to Prevent a Serious Public Health Problem, 2003). Due to the severity and potentially catastrophic side effects of this head injury, research has been on the rise.

Concussions can occur within any sport, but the most commonly afflicted athletes are football and soccer players. A study evaluating the prevalence of concussions within different high school athletics (425 schools, 9 teams) revealed that 40.5% of concussions occurred in football players, 21.5% occurred in female soccer players, and 15.4% occurred in male soccer players. In regards to the total number of high school athletes who reported a concussion, 16.8% reported having a previous concussion injury (Gessel, Fields, Collins, Dick, & Comstock, 2007).

Research studies have focused on the side effects of multiple concussions and have revealed several potential conditions. Side effects range from temporary to permanent and may include Post-Concussive Syndrome (Sterr, Herron, Hayward, & Montaldi, 2006), Amyotrophic Lateral Sclerosis (ALS) (Chen, Richard, Sandler, Umbach, & Kamel, 2007), clinical depression (Guskiewicz, et al., 2007), and Attention Deficit Disorder (Van Donkelaar, et al., 2005). Athletes with a history of concussions are 4-6 times more likely to sustain another concussion during their athletic careers, and are 3 times more likely to sustain a concussion within the same season. When a study evaluated the age at which athletes sustained their first concussions, the findings revealed a startlingly young age, with athletes reporting their first concussion between the ages of 10.8-14.8 (Valovich, Bay, Heil, & McVeigh, 2008).

Knowing the side effects of multiple concussions, and that athletes are suffering their first concussion at younger ages, researchers have attempted to determine if athletes know when they have sustained a concussion. The rationale was if athletes do not know they have a concussion, they will return to play too soon, and possibly sustain a subsequent head injury. Studies have been conducted on high school athletes and their knowledge of sports-related concussions was shown to be very poor. One survey study revealed that 8.5% of the high school athletes reported having a concussion, while 25% reported having their "bell rung". This same study revealed that a majority of the athletes (n = 566) believed that a loss of consciousness is the most common symptom associated with a concussion. In fact, the most common symptom is a headache, occurring in 86% of all cases (Valovich et al., 2008).

A lack of knowledge among athletes regarding the signs and symptoms of a concussion has resulted in what is believed to be a dramatic underreporting of concussions (McCrea, Olsen, Leo, & Guskiewicz, 2004). This has the potential to lead to an increase in subsequent head injuries and side effects associated with multiple concussions. In addition to the side effects mentioned above, a rare but serious sequelae associated with multiple concussions within the same season is Second Impact Syndrome (SIS). This syndrome occurs after an initial concussion when the athlete returns to play too soon, and sustains a subsequent concussion before the brain has had time to heal. Due to the secondary injury, the brain swells quickly and the athlete may enter into a coma within minutes of an injury. SIS has a 50% mortality rate and almost a 100% morbidity rate (Marineau, Kingma, Bank, & Valovich, 2007).

Another concern regarding athletes and sports related concussions was the reporting, or lack thereof, of this injury to proper medical personal. A study evaluated the rationale behind high school athletes' failure to report concussions, and 66.4% of these athletes (n = 1532) stated they did not believe their injury was serious enough to necessitate medical attention (McCrea, et al., 2004). These findings demonstrate the need for an educational intervention on behalf of these athletes. This educational intervention could potentially lead athletes to promptly seek appropriate medical treatment.

Educational interventions have shown to increase students' knowledge when compared to pre-intervention levels. A study investigating the impact of an educational intervention on college students' knowledge of food safety, for example, reported that food safety practices showed a significant increase after the implementation of an intervention (Yarrow, Remig, & Higgins, 2009). If athletes received formalized education regarding sports-related concussions, they would have the information needed to identify the injury and seek appropriate treatment.

Based on current research of complications associated with multiple concussions, the goal should be prevention. Preventing this injury from ever occurring on the athletic field is not possible, but reducing the number of secondary concussions sustained and improving recognition and management may be feasible by educating athletes on the basics. To do this, athletes at all levels must be informed of the definition of a concussion, the signs/symptoms, potential side effects, and proper concussion management.

**Statement of the Research Problem**

Inherent in the problem is the need to have athletes report concussions so that the proper medical personnel can accurately diagnosis the head injury and provide appropriate medical care. If athletes receive proper care for their initial concussion, there is potential for a decreased likelihood of them sustaining multiple concussions. Following an initial head injury the body enters into a healing response. During this period the brain is susceptible to secondary trauma, and the amount of force needed to inflict additional damage decreases (Wetjen, Pichelmann, & Atkinson, 2010).

The purpose of this research was threefold: (1) determine collegiate athletes' knowledge of a definition, signs and symptoms, management, and detrimental side effects of sports-related concussions, (2) determine how an educational intervention will impact the college athletes' knowledge of sports-related concussions, and (3) determine if athletes change their behavior regarding concussion management.

**Research Questions**

The research hypothesis states that college athletes are not knowledgeable regarding sports-related concussions, but their knowledge will improve following an educational intervention. Aims of this project include educating athletes on the signs/symptoms, appropriate reporting, time held out of play, long-term side effects, and suitable treatments for sports-related concussions

The research questions for this study are: How knowledgeable are collegiate athletes in regards to sports-related concussions? How will an educational intervention impact the college athletes' knowledge of a sports-related concussion? These questions will be answered through a survey questionnaire given to athletes before their season begins (pre-season) and a survey questionnaire given to the athletes at the completion of their entire season (post-season).

Assessment of baseline knowledge will be conducted by analyzing responses to the pre-season survey questions include. Specific questions include: (1) what is the most common concussion symptom? (2) What is the appropriate length of time to be held out of play after a concussion? (3) Have you experienced a concussion and did you report it? (4) Have you experienced a concussion and not report it? (5) If you did report your concussion, who did you report it to? (6) If you did not report your concussion, what was your rationale? (7) If you did sustain their concussion how did you feel immediately after and in the days following the injury? (8) Are side effects from multiple concussions, and what are the side effects?

The change in knowledge in response to the educational intervention will be measured by comparing answers to the preseason survey with those recorded in the postseason survey. In addition to the questions listed above, queries specific to the postseason survey include: (1) Did you experience a concussion this season? (2) Did you report your concussion concussion? (3) To whom did you report your concussion? (4) Did the educational intervention at the beginning of the season impact your decision to report your concussions, and why/why not?

**Significance of the Study**

The rate of concussion injuries is higher at the collegiate level when compared to high school level athletics (Gessel, et al., 2007). Research has demonstrated a poor understanding of sports-related concussions by athletes at the high school level, but the knowledge at the collegiate level has yet to be determined.

This research study focused on the knowledge of college athletes regarding sports-related concussions, and how an educational intervention impacted this knowledge. The purpose of the educational intervention was to inform college athletes of the basic signs and symptoms of a concussion, the management protocols, and the long-term side effects that occur from multiple concussion injuries. By improving knowledge, we hoped to demonstrate the potential for improved injury management by the athletes.

**Definition of Terms**

Concussion: According to McCrory, et al. (2005) the definition of a concussion has been recently redefined to be “a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces” (p. 48).

Concussion Management: For the purpose of this paper, concussion management refers to the appropriate treatment protocols that should be followed for an athlete who has sustained a concussion. These protocols have been put in place by the National Athletic Training Associate (NATA) and the International Summary and Agreement Statement Regarding Concussion in Sports (McCrory, et al., 2005).

Educational Intervention: For the purposes of this paper, an educational intervention was a lecture regarding sports-related concussions presented by the researcher to a group of athletes. This lecture included information regarding the definition of a concussion, signs/symptoms, potential side effects, and concussion management. The format of this intervention was a PowerPoint based lecture with a duration of approximately 20 minutes. At the completion of the lecture, time was allowed for a question and answer session.

**Delimitations**

This research study included NCAA Division II men's and women's soccer players and men's and women's basketball players at Metropolitan State College at Denver, Colorado.

**Researcher's Perspective**

My perspective is based upon my years working as an ATC. I have seen athletes sustain concussive injuries, and have been made aware of the knowledge deficit on the part of athletes, coaches, and parents regarding injury severity, and the potential side effects. The level of knowledge must improve and I believe an educational intervention will accomplish this.

It is my opinion that unless athletes fully understand an injury and its consequences, they will not treat it appropriately. Specifically, athletes have to be educated on what a concussion is, the signs and symptoms, and the detrimental long-term side effects from suffering multiple concussions. Athletes have to be made aware that suffering multiple concussions can lead to a number of different pathologies including depression, ALS, and Alzheimer's. However, to understand fully the complications of this nature, they first need to understand what a concussion is, and recognize when they have sustained this injury.

For too long the athletic mentality has been one of stoicism, and it has been this mentality that has often led to a negative impact on their lives. I am not proposing that athletes become overly cautious concerning every injury. Instead, I hope to improve outcomes associated with potentially life threatening injuries. There are a few injuries that could lead to athletic death, and concussions are one of them. This is an injury we cannot afford to ignore.

**Assumptions**

All athletes will answer honestly on both the pre-season survey and post-season survey. During the educational intervention, the athletes will remain focused on the topic at hand. The educational intervention will contain the most up-to-date information regarding sports-related concussions. Athletes will not receive information regarding concussions from outside sources (physician, teammate, etc.).

# CHAPTER 2: LITERATURE REVIEW

## History of Concussion Injury

Over the years the definition of a concussion has evolved to encompass current research findings. The Committee on Head Injury Nomenclature (1964) originally defined a concussion as "a clinical syndrome characterized by immediate and transient impairment of neural functions due to brain stem involvement" (p. 386). Previous studies and textbooks stated that brain activity would return to normalcy when neuronal function returned (Henze, 2000).

The concern with the previous definition was the word "transient". Research has shown that permanent side effects occur due to concussions, and therefore the medical community re-evaluated the data and produced a revised definition. McCrory, et al. (2005) defines a concussion as "a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces" (p. 48). It is this definition that is currently utilized by most medical professionals.

Concussions management has also greatly evolved with time. The old grading scales defined when an athlete should be allowed to return to play. Within the management criteria, there was no inclusion of symptom duration in the decision-making process. The American Academy of Neurology's report stated that if symptoms resolved, the athlete should be allowed to return to play that day. Further, if the injury constituted the athlete's second concussion he/she should be restricted from play for one week. This scale promotes an aggressive return to play strategy that has been found to be detrimental to the athlete's well-being (Whiteside, 2006).

With regards to concussion severity, original guidelines graded the injury depending on lost consciousness. Loss of consciousness may range from seconds to hours. It was previously believed that if athletes experienced any loss of consciousness, they experienced a more severe injury (Henze, 2000). Currently LOC is considered a symptom not to be used to determine injury severity. LOC is not associated to worsening neurological damage when compared to other concussion symptoms (Makdissi, Darby, Maruff, Ugoni, Brukner, & McCrory, 2010).

The most recent change regarding the grading of concussion severity occurred in 2008 at the International Conference on Concussion in Sport held in Zurich. At this meeting the committee decided to discontinue the "Simple" vs. "Complex" concussion definition. With "simple" concussions, symptoms progressively resolve within 7 days of the injury. A "complex" concussion occurs when the symptoms persist for longer than 7 days, and most commonly occur in athletes suffering from multiple concussions. Based on this scale, concussions are graded retrospectively, because the duration of symptoms will determine the grade (McCrory, et al., 2009). This grading system has been abandoned in the most recent consensus statement because the panel could not agree to the terminology. Currently if an athlete sustains a concussion, he/she is diagnosed as such and the level of severity is not determined.

**Concussion Pathophysiology**

The mechanism of injury for sustaining a concussion is a direct blow to the head, or a blow to the body where the force is transmitted superiorly through the kinetic chain, (i.e. spinal column), resulting in acceleration/deceleration forces being transmitted to the brain (McCrory, et al., 2005). The trauma occurring within the brain itself is not completely understood. The leading theories include negative pressure, positive pressure, and rotational/sheering forces (Hardy, et al., 2007). Understanding the exact mechanism of injury within the brain may lead to further understanding of concussion symptoms and the resultant side effects.

Hardy and associates evaluated how a cadaver brain responded to impact, and noted that the brain had an elastic response, returning to its normal shape and size following stress. It was noted, however, that rotational movement of the brain occurred after the impact on the skull (Hardy, et al., 2007). This movement led to the theory that shearing forces within the brainstem may contribute to the majority of symptoms seen with concussions. Shearing forces were concentrated at the brainstem, and are associated with neuronal and vascular damage (Zhang, Yang, & King, 2004). The brainstem is responsible for controlling respiration, heart rate, and blood pressure. All of these functions, when altered, may lead to physical symptoms associated with concussions such as a headaches or dizzy spells. Also contained within the brainstem are a majority of the 12 cranial nerves, and shearing forces can lead to damage of these nerves, thereby creating additional symptoms. Symptoms associated with cranial nerve damage include deficits in smell, vision, eye movement, face sensation, hearing, balance, swallowing, and tongue movement.

Following a concussion, the body attempts to achieve homeostasis and control the neurological and vascular damage. Immediately following a concussion the brain enters into a state of metabolic depression due to a decrease in cerebral blood flow. It is believed that cerebral blood flow can decrease by 50% immediately following a concussion and last for at least 30 minutes, but it may take up to 10 days to return to baseline. Although there is a decrease in cerebral blood flow, there is an increase in glucose metabolism within the brain. The simultaneous decrease in blood flow and increase in glucose metabolism creates an energy crisis due to the lack of oxygen and nutrients necessary to meet increased demand.

The decrease in the cerebral blood flow is linked to cerebral edema and increased intracranial pressure. The inflammatory response associated with head injuries includes the development of cerebral edema and vasoconstriction of blood vessels, which will further decrease the cerebral blood flow (DeWitt & Prough, 2003). The cerebral edema develops from a combination of increased vascular permeability (allowing fluids to exit vessels into the injured tissue), and increased blood viscosity (which reduces blood flow). The vasoconstriction of vessels is a protective mechanism of the body to isolate all debris/injuring agents to the traumatized site. The amount of inflammation and change in intracranial pressure seen in concussed individuals is not of great significance, and is seen more commonly in individuals who have sustained a traumatic brain injury. Traumatic brain injuries include, but are not limited to, subdural and epidural hematomas and have the potential to present with severe symptoms. These injuries will be diagnosed via imaging techniques. A concussion is defined as a mild traumatic brain injury. This type of injury will present with varying degrees of symptom severity, but will not be evident using traditional imaging techniques.

In addition to the inflammatory process, there is an increased rate of glycolysis, in an attempt to create energy (Nilsson & Ponten, 1977). This leads to an increase in lactate production within the brain, and can contribute to neuronal dysfunction and cerebral edema. Neuronal dysfunction and cerebral edema leaves the brain susceptible to secondary injury, commonly referred to as Second Impact Syndrome (Becker & Jenkins, 1987). The damage will lead to a breakdown in the communication among neurons in the brain, and create neurocognitive dysfunctions. These may include decreased reaction time and impaired memory.

The increase in glucose metabolism occurs due to the increased demand for adenosine triphosphate (ATP). The increased need for ATP is partly due to the sodium-potassium pump attempting to achieve normal neuronal membrane potential. When an individual sustains a concussion, ionic shifts occur, resulting in an influx of calcium with an efflux of potassium. The accumulation of calcium intracellularly can contribute to cellular death and impairment of neural communication. The increase in extracellular potassium creates neuronal depolarization and a release of excitatory amino acids. Following this excitatory change, the neurons become suppressed due to the decrease in the firing of synapses (Somjen & Giacchino, 1985). This suppression has been linked to loss of consciousness, amnesia, and cognitive dysfunction commonly seen in concussed athletes (Nicholson & Kraig, 1981).

The increase in intracellular calcium that occurs following a concussion may result in energy failure due to impaired oxidative metabolism (Verweij, Muizelaar, Vinas, Peterson, Xiong, & Lee, 1997). The additional calcium is stored within the mitochondria, leading to mitochondrial dysfunction and a decrease in oxidative metabolism. The excessive accumulation of calcium will also lead to free radical production and ultimately cellular death (Siesjo, 1992). Free radicals generated under conditions of ischemia (reduced blood supply) are primarily produced within mitochondria, and the mitochondrial dysfunction associated with calcium accumulation leads to the enhanced release of free radicals (Frantseva, Carlen, & Velazquez, 2001).

In addition to altered levels of potassium and calcium within the injured portion of the brain, a decrease in cellular magnesium is also present. Low levels of magnesium may lead to neuronal dysfunction and ultimately decreased motor performance commonly seen in individuals who have sustained a concussion (McIntosh, Faden, Yamakami, & Vink, 1988). It is believed that this may occur because magnesium is required for normal afferent neural activity (Drescher & Drescher, 1987).

Use of specialized imaging techniques that are not commonly used in clinical practice revealed deficits in the brains of individuals with a concussion history. Specifically noted was a decrease in the activation of the dorsolateral prefrontal cortex of the brain and deactivation within the medial frontal and temporal lobes of the brain. The dorsolateral prefrontal cortex of the brain is responsible for working memory, the medial frontal lobe is responsible for memory and emotions, and the temporal lobe is responsible for memory and behavior. The faults seen in the activation patterns within the brain are associated with a loss of gray matter within those specific regions of the brain (Chen, Johnston, Petrides, & Ptito, 2008). These deficits have been linked to depression symptoms, and ultimately the diagnosis of clinical depression in these individuals.

Research using transcranial magnetic stimulation (TMS) revealed intracortical inhibition in concussed athletes, and that the amount of inhibition was directly related to the number of concussions an athlete sustained in their lifetime. Intracortical inhibitions may occur due to lesions within the motor cortex or a decrease in stimulation from subcortical structures (Berardelli, Kaji, & Curra, 2004). This research further promotes the theory that concussions have a cumulative and long term effect on the motor system (De Beaumont, Lassonde, Leclerc, & Theoret, 2007). Research using TMS also showed auditory and visual processing impairments in concussed athletes when the athletes stated they were no longer symptomatic. This suggests that although the athlete feels completely recovered, the brain is still healing from the injury (Dupuis, Johnston, Lavoie, Lepore, & Lassonde, 2000).

Brain metabolites have also been investigated to determine the presence and severity of concussions. Using magnetic resonance spectroscopy, researchers were able to determine that individuals who sustained a concussion had significantly lowered levels of *N*-acetylaspartate (NAA), a metabolite that determines the integrity of neurons within the brain. Decreased levels of NAA are linked to neuronal damage (Cecil, Lenkinski, Meaney, McIntosh, & Smith, 1998). Vagnozzi and associates noted that the NAA imbalance returns to normal levels within 30 days of injury, regardless of the athlete reporting being asymptomatic (Vagnozzi, et al., 2008).

Evaluation of individuals with a history of multiple concussions revealed impairment within their neurocognitive capabilities 30 years following their last concussion. Subjects had deficits in memory and response time, and these deficits were linked to a prolonged cortical silent period (Beaumont, et al., 2009). A cortical silent period is silence in EMG activity following a contraction, and if prolonged is linked to neurocognitive dysfunction. Research has also revealed the impact of multiple concussions on the cortical silent period. A study using TMS revealed that athletes who have sustained multiple concussions experience a significantly longer cortical silent period and that the cortical silent period is directly related to the severity of the concussions sustained. During a cortical silent period motor function is inhibited, and a prolonged silent period will greatly impact an athlete's level of play (De Beaumont, Lassonde, Leclerc, & Theoret, 2007).

Immediate neurocognitive deficits were reported in athletes who sustained concussions when compared to an un-injured counterpart. The most common cognitive deficits reported were visual-motor reaction time, information processing, memory, and attention. Athletes who sustain concussions experience significantly impaired motor function and attention (Collie, Makdissi, Maruff, Bennell, & McCrory, 2006).

**Concussion Severity and Assessment Tools**

A majority of athletic injuries are graded depending on the severity of the injury, with a Grade 1 classified as the least severe and a Grade 3 the most severe. Concussions once fell into this numerical grading system, however there was a push to abandon these scales in favor of a more simplistic diagnostic approach: concussion. The recommendation to abandon the numerical grading scale occurred due to the disagreement among the scales (McCrory, et al., 2005). There were numerous concussion grading scales; however the 3 grading scales most commonly used in the sports medicine arena by allied health professionals are described in Table 2.1 (Arnheim & Prentice, 2009).

*Table 2.1*
*Concussion Grading Scales*

| **Concussion Grade** | **Cantu** | **Colorado Medical Society** | **American Academy of Neurology** |
|---|---|---|---|
| 1 | No loss of consciousness (LOC), confusion, signs and symptoms (s/s) lasting less than 24 hours | No LOC, confusion, s/s last less than 20 minutes | No LOC, s/s last less than 15 minutes |
| 2 | LOC lasting less than 1 minute, s/s last longer than 24 hours but less than 7 days | No LOC, confusion, amnesia | No LOC, s/s last longer than 15 minutes |
| 3 | LOC lasting more than 1 minute, s/s last longer than 7 days | LOC, have to be transported to an emergency medical facility | LOC |

Note. From *Principles of Athletic Training* (p. 924), by D. Arnheim and W. Prentice, 2009, New York: McGraw-Hill. Copyright 2009 by McGraw-Hill.

As noted in Table 2.1, the common link between the 3 scales regarding the grade of concussion is LOC. Research has now shown that LOC does not determine injury severity (McCrea, Kelly, & Randolph, 2002). For this reason, concussions are no longer being graded.

The new method of classifying a concussion and lack of a grading scale has the potential to make communication between the ATC, athletes, parents and coaches difficult. Currently concussions are not graded on severity and athletes are simply diagnosed as having a concussion. The athlete will not be able to be told immediately how severe their injury is, when the symptoms should go away, and when they will be allowed to return to activity. This lack of information also places a strain on coaches, because they cannot be told when their athletes can return back to practices and games.

To further assess the severity of a concussion there are numerous tests that can be employed. It is encouraged that ATCs test their athletes at the beginning of the season to establish a baseline, using the same test(s) that will be used during the athletic season. Commonly employed tests include the Standardized Assessment of Concussions (SAC), Balance Error Scoring System (BESS), Graded Symptom Checklist, and numerous computer-based neurocognitive testing software. All of the tests provide an end score for the athlete, with a low score indicating poor results. When an athlete has sustained a concussion, the post-injury score is compared to the baseline score. The athlete is not allowed to return to play until he/she achieves baseline function or higher.

Computer-based neurocognitive tests have the capability to record the number and severity of each concussion symptom an athlete may be experiencing. These are subjective measurements, and therefore are dependent on each athlete's honesty. Computer-based tests also may be used to assess an athlete's memory, reaction time, ability to orient, and information processing. This approach is preferred, as variables provide an objective measure. The variables that have been shown to be most accurate in assessing neurocognitive function are attention and memory function (McCrory, et al., 2009). Makdissi and associates noted that there was a 2 to 3 day delay between cognitive deficits noted on computer based neurocognitive tests and athletes' self reported symptoms (Makdissi, Darby, Maruff, Ugoni, Brukner, & McCrory, 2010). It is important to note that symptoms may be delayed following the initial concussion injury by several hours (McCrory, et al., 2009). This research supports the notion that athletes' self-reported symptoms are unreliable and should not be a sole determining factor in return-to-play decisions (Makdissi, et al., 2010). Table 2.2 identifies the popular computer-based tests and the cognitive domain they each assess (Prentice and Arnheim, 2009).

*Table 2.2*
*Computer-Based Neurocognitive Tests*

| Computerized Test | Cognitive Domain Assessed |
|---|---|
| Automated Neuropsychological Assessment Matrix (ANAM) | Reaction Time<br>Memory<br>Math Processing<br>Continuous Performance<br>Matching<br>Spatial Processing<br>Code Substitution |
| CogSport | Reaction Time<br>Continuous Learning<br>One-Back |
| Concussion Resolution Index | Reaction Time<br>Visual Recognition<br>Animal Decoding<br>Symbol Scanning |
| ImPACT | Verbal Memory<br>Visual Memory<br>Information Processing Speed |

Reaction Time
Impulse Control

Note. From *Principles of Athletic Training* (p. 922), by D. Arnheim and W. Prentice, 2009, New York: McGraw-Hill. Copyright 2009 by McGraw-Hill.

Signs and symptoms of a concussion can range in type and severity. The most common symptom is a headache, occurring in 86% of all cases (Valovich, et al., 2008). Other symptoms include confusion, amnesia, balance problems, dizziness, nausea, visual difficulties, hearing problems, irritability or other emotional changes, fatigue, poor coordination, seizures, unsteady gait, delayed verbal response, distraction, vomiting, vacant stare, slurred speech, and/or decrease in playing ability (McCrory, et al., 2005).

Headaches are commonly experienced by the healthy population, and therefore the importance of this symptom may be minimized by the athlete. It is important to distinguish headache as a concussion symptom versus a headache from another condition (Register-Mihalik, Guskiewicz, & Mann, 2007). Headaches are commonly experienced with dehydration, which occurs frequently among athletes. Research conducted on dehydrated athletes who did not sustain a concussion showed no significant decrease in concussion assessment scores when compared to their baseline levels. If the etiology of a headache is unknown, medical personnel are encouraged to err on the side of caution. This indicates the importance of baseline assessment, because a concussion will be able to be ruled out or diagnosed based upon assessment scores (Patel, Mihalik, Notebaert, Guskiewicz, & Prentice, 2007). In addition to headaches, deficits present in athletes who have sustained a concussion include: visual-motor reaction time, information processing, memory, and attention (Collie, et al., 2006).

As noted there are a variety of different tests currently in use.  The most common sideline tests are the SAC and the BESS.  The SAC test assesses anterograde and retrograde amnesia and symptom severity.  The BESS test assesses postural control.  If, while assessing the athlete on the side-line, their symptoms begin to worsen, they are to be immediately transported to a hospital because there is a concern for hemorrhaging or edema within the brain.  Even if the athlete remains stable or improves, it is strongly recommended that the athlete not be allowed to return to activity that day.

If the institution has the capability to use any of the previously mentioned objective concussion assessment tools, it is recommended that the athletes' scores return to baseline levels prior to being cleared for activity.  It is not recommended that individuals are tested while symptomatic, because of the increased learning effect it may have on the athlete (Marineau, et al., 2007).

Research by Piland, Motl, Guskiewicz, and McCrea (2006) has investigated the reliability and validity of concussion assessment tests to determine if they are useful to assess concussions.  An ideal assessment tool should be objective, reliable, valid, user-friendly, and efficient.  Originally concussions were assessed using the Graded Symptom Checklist.  This test relied solely upon self-reported symptoms by an athlete.  Athletes would state their symptoms and the severity of each symptom on a scale of 0 to 6, with 6 being the most severe.  This test was shown to be too subjective and therefore not valid. Further, if athletes have a desire to return to play quickly, they may minimize the number and severity of their symptoms.  There is presently no test to objectively assess concussion symptoms.  It is for these reasons that medical personnel are discouraged from utilizing this method of assessing concussions, but rather encouraged to select a test that will assess physical and mental functions (Arnheim & Prentice, 2009).

The BESS test is utilized to assess postural control when an athlete has sustained a concussion. Cavanaugh et al. (2006) describes postural control as “the ability to maintain a desired postural orientation in response to perturbations generated from either internal or external sources” (p. 305). Athletes who sustain concussions and claim to be symptom-free were shown to have a significant decrease in their postural control compared to baseline levels. These findings help medical personnel when making return-to-play decisions, as they provide objective information indicating that the brain has not fully healed (Cavanaugh, Guskiewicz, Giuliani, Marshall, Mercer, & Stergiou, 2006). Neuranal damage caused from concussions leads to a somatosensory deficits. Any somatosensory deficit will cause an alteration in one’s equilibrium and sense of balance (Guskiewicz, 2004).

Despite the advantages, there is a concern with the BESS test. When baseline testing, it is very common for medical staff to perform these tests inside in a quiet room. When athletes sustain a concussion, however, they are usually on a field or court. There is a concern that a change in the environment may cause the baseline score to be unreliable. A study was conducted on baseball players who did not have a concussion and were baseline tested in a quiet environment. When they tested in an environment with distractions their scores did not significantly decrease (Onate, Beck, & Van Lunen, 2007). Although this study did not reveal an environmental effect, it may be prudent to perform baseline assessments in an athlete’s athletic environment.

Computer-based neurocognitive testing has increased in popularity over the last few years because it provides an objective measure of neurocognitive function. As previously noted, Table 2.2 indicates popular computer-based tests and the cognitive domains assessed by each test. These tests have the potential to provide allied health professionals with valuable data, once they are validated (Arnheim & Prentice, 2009). Preliminary research using the most popular computer-based neurocognitive test, ImPACT, demonstrates a correlation between test scores following a concussion and recovery time. Iverson showed a 94% chance that if athletes have 3 low scores on the ImPACT test, they are more likely to have a slower recovery (Iverson, 2007).

In summary, sports medicine professionals have acknowledged the need for a more valid and reliable method to successfully diagnose concussions and make safe RTP decisions. The tools currently used to diagnose the injury and guide management have improved detection of deficits and provided more guide for RTP decisions. Effective RTP decisions may reduce the number of concussions athletes sustain within their lifetimes, thereby reducing the sequelae associated with multiple concussions. The most effective assessment tool, however, will not improve concussion management if athletes do not have the knowledge and awareness to report their injury to a member of the sports medicine team.

**Concussions and Athletes**

For the age group of 15-24 year olds, sports are the second leading cause of traumatic brain injuries. Concussions make up approximately 9% of all high school athletic injuries and 6% of all college athletic injuries. The most common sport associated with concussions is football, constituting 40% of all concussion injuries. Football is followed by men's and women's soccer (Gessel, et al., 2007).

Concussions are different from other injuries in that a majority of the symptoms are reported by the athletes, leaving a potential that athletes will not identify or reveal their injuries. One study revealed that 47% of high school football players reported their concussions to either their coach or athletic trainer, and 53% did not report their concussion to anyone. The reasons athletes did not report their concussion have been investigated. An anonymous survey evaluating high school football players revealed that 66% of these athletes did not report their concussions because they did not believe it was serious enough to warrant medical attention. Other reasons athletes fail to report include an aversion to being held out of play and/or lack of awareness of the injury (McCrea, et al., 2004).

**Multiple Concussions**

An athlete who has sustained a concussion is more likely to receive an additional concussive injury. Athletes are 4 to 6 times more likely to sustain an additional concussion in their athletic career, and are 3 times more likely to sustain an additional concussion within the same season when compared to an athlete with no history of concussions (Valovich, et al., 2008). Moreover, athletes with subsequent concussions will experience more severe symptoms, and are more likely to have a prolonged recovery (Iverson, 2007).

An increase in the number and severity of symptoms has been linked to 3 or more concussions. Athletes with this concussion history were significantly more likely to experience LOC (p = .005), anterograde amnesia (p = .019), and confusion (p = .024). Research has shown that 9.4% of athletes (n = 72) who sustained a concussion and had no previous concussion history experienced prolonged post injury mental status changes. In contrast, 31.6% of athletes (n = 72), who sustained a concussion and had a previous concussion history, experienced prolonged post injury mental status changes (Collins, Lovell, Iverson, Cantu, Maroon, & Field, 2002).

Studies of sequelae to multiple concussions have also revealed motor system dysfunction due to intracortical inhibitory system anomalies. A study using a TMS revealed that athletes who sustained multiple concussions experienced a significantly longer cortical silent period and that the cortical silent period was directly related to the severity of the injury. During a cortical silent period motor function is inhibited, and a prolonged silent period greatly impacts an athlete's level of play and predispose him/her to subsequent injury (De Beaumont, et al., 2007).

One of the larger concerns of multiple concussions is SIS. This syndrome occurs when an athlete who sustained a concussion receives an additional head injury. The brain, not fully healed after the first injury, will swell quickly. The second head injury is usually minor and may not be a result of a direct blow to the head, but rather to the trunk. A blow to the trunk can elicit acceleration/deceleration forces and compromise the brain's autoregulatory system controlling blood flow. Rapid swelling of the brain leads to a dramatic increase in intracranial pressure. Signs and symptoms of SIS include dilated pupils, LOC, coma, and respiratory failure. These symptoms occur quickly, usually within minutes of the injury (Arnheim & Prentice, 2009). SIS is a rare but life-threatening condition with a mortality rate of approximately 50% and a morbidity rate of almost 100%. SIS occurs mainly in athletes under 20 years of age (Marineau, et al., 2007).

Additional medical conditions have been linked to athletes who sustain multiple concussions. While 2 or fewer concussions have no cumulative effect, 3 or more concussions confer an increased risk of suffering from a variety of medical conditions, (Iverson, Brooks, Lovell, & Collins, 2006) including PCS (Sterr, et al., 2006), ALS (Chen, et al., 2007), clinical depression (Guskiewicz, et al., 2007), and Attention Deficit Disorder (Van Donkelaar, et al., 2005).

Post-Concussive Syndrome is a collection of symptoms that do not resolve in a timely manner and have a recovery time of approximately 1 to 3 months. The most common symptoms associated with PCS are anxiety, irritability, and deficits in attention, memory, judgment, and concentration (Henze, 2000). It is a poorly understood syndrome, but currently is believed to be temporary and fully reversible with time (Arnheim & Prentice, 2009). Despite this, approximately 15% of athletes with PCS continue to see their family physician due to persistent symptoms. Current research suggests that 29% of athletes who sustain a concussion will suffer from PCS (Sterr, Herron, Hayward, & Montaldi, 2006).

Athletes with a history of multiple concussions within a 10 year span increased their risk for ALS by 11 times (Chen, et al., 2007). Guskiewicz, et al. evaluated retired professional football players who sustained recurrent concussions and were identified as having an increased risk for clinical depression. Professional football players who sustained 3 or more concussions were shown to be 3 times more likely to be diagnosed with lifelong depression. The risk of depression increased as the number of concussions increased (Guskiewicz, et al., 2007).

Three specific aspects of attention deficits have been evaluated in athletes who sustained multiple concussions. These are alerting, orienting, and the executive component of attention. Alerting is defined as the capability to maintain vigilance during tasks. Orienting is the ability to visually detect targets and move attention span, and the executive component of attention is the ability to switch among different tasks quickly and efficiently. Studies revealed that athletes with multiple concussions had a significantly slower reaction time and were slower to move attention among targets (Van Donkelaar, et al., 2005). Given the nature of the athletic environment, both reaction time and orienting are vital components. A decrease in either aspect will lead to an increased risk for athletic injuries.

**Concussion Management**

Concussion management addresses the proper protocol that should be followed/implemented after an athlete sustains a concussion. Ideally all athletic programs have an ATC on staff that will be first on the injury scene to evaluate the athlete. If this does not/cannot occur, the coach will be responsible for the wellbeing of the athlete. The coach is to understand his/her knowledge scope and duties in regards to caring for the athlete, and refer the athlete to the appropriate medical personnel. When in doubt, it is always recommended to err on the side of caution. All programs should have a list of the medical personnel, contact information, and physical addresses with them at all times.

An accurate medical history identifies 75% of the issues plaguing athletes. Medical histories should be updated prior to the start of every season. All pre-season questionnaires should address whether and when the athlete has sustained a concussion, how many they have sustained, and the severity of the injury (Valovich, et al., 2008). These questionnaires rely on the athlete to accurately and honestly report their injury history. The pre-season questionnaires allow medical personnel to determine if athletes are at an increased risk for sustaining further head trauma, and whether or not the athlete should be allowed to participate in certain sports. It should be noted, however, that self documentation of concussion history has been shown to be unreliable. Medical histories are obtained to provide proper and accurate treatment to athletes, as well as to reduce potential legal reprocautions (McCrory, et al., 2005).

With an acute concussion, management is very conservative. An athlete exhibiting any symptom is to be removed from play and not allowed to return that day (McCrory, et al., 2005). Certain factors should be evaluated by the medical personnel to rule out a more serious injury. These factors include a cervical spine fracture and cranial hematomas. If there are any indications of these potentially life-threatening injuries, the Emergency Medical System (EMS) is to be activated immediately (Arnheim & Prentice, 2009).

After immediate, potentially life-threatening, injuries have been ruled out, the medical staff should perform concussion assessment tests. The same assessment tool used at the beginning of the season to determine the baseline score should be used to test the athlete following their concussion. If the athletes are not baseline tested it is appropriate to perform an objective test, which will allow the medical staff to subsequently monitor the athlete and determine if the athlete is improving, maintaining, or deteriorating (Arnheim & Prentice, 2009).

Following a concussion, athletes should not be alone for the remainder of the day and evening in case their condition deteriorates and the EMS has to be activated. A take-home guide should be given to the individual staying with the athlete (Figure 2.1). The affected athlete should report to the medical staff on a daily basis for re-evaluation, at which time the medical staff will assess symptom severity, development of new symptoms, and neurocognitive function (Arnheim & Prentice, 2009). If an athlete reports being asymptomatic, the medical staff should also perform the concussion assessment testing that was performed at the beginning of the season in order to verify return to baseline status (McCrory, et al., 2009).

After sustaining a concussion, athletes should be informed that they are not allowed to take any medications that could exacerbate their injury or hide their symptoms. For example, the athlete should not take analgesics because they may decrease the severity of the symptoms and possibly mask worsening symptoms. Aspirin and non-steroidal anti-inflammatories (NSAIDs) are not recommended because they may increase intracranial bleeding. It is recommended that athletes wait 3 weeks before taking any medications (Marineau, et al., 2007).

I believe that ___________________________________ has sustained a concussion.
He/She is currently experiencing the following symptoms:

| | | | |
|---|---|---|---|
| __ Headache | __ Dizziness | __ Blurry Vision | __ Ringing in the ears |
| __ Confusion | __ Nausea | __ Fatigue | __ Poor balance |
| __ Unsteady walk | __ Vomiting | __ Vacant Stare | __ Poor coordination |
| __ Slurred speech | __ Slow to respond | | |

If he/she is experiencing an increase in the severity of their current symptoms, or begins to experience new symptoms, contact the local Emergency Medical System.

| It is *ok* to: | There is *no* need to: | Do *NOT*: |
|---|---|---|
| -use an ice pack on head and/or neck | -check their eyes with a flashlight | -drink alcohol<br>-take any medication |
| -eat a light meal | -wake them up every hour | -eat/drink spicy food/ beverages |
| -return to school<br>-rest | -test reflexes | |

Special Recommendations:
____________________________________________________________
Contact ___________________ at ________________________ with any questions or concerns.

*Figure 2.1.* Take home guide for injured athletes.

Return-to-play criteria have changed greatly over the years based upon research findings. Currently, it is recommended that the medical staff implement a graduated RTP protocol. Within this graduated protocol, initiated when the athlete is asymptomatic, athletes can proceed to the next stage if they remain asymptomatic for 24 hours. The entire protocol should take approximately 1 week to complete. If athletes experience any symptoms while progressing through the protocol, they drop to the previous asymptomatic stage and remain there for 24 hours. Once free of symptoms, athletes can begin to immediately perform light aerobic exercises. If they are able to progress to the next stage, the athletes can begin to perform sport-specific exercises. The next stage includes non-contact drills, with a progression to full contact practice. At the completion of a full contact practice and after remaining asymptomatic for 24 hours, the athlete is allowed to return to play.

**Educational Interventions**

Educational interventions are used in a variety of different disciplines, all with the same goal of improving an individual's knowledge of a specific subject matter. To determine if an educational intervention will be effective, the individual will have to be assessed prior to the intervention to establish baseline knowledge, and subsequently determine if the intervention improved their knowledge. The studies discussed below were selected because the assessed populations are similar to the population included in the present study, and because they demonstrate how an educational intervention can improve baseline knowledge. If one is properly educated on a subject matter, common misconceptions may be dispelled and behavior may subsequently be improved.

A study was conducted in first year college students (n = 1345) to determine if an educational intervention would improve their comprehensive knowledge on the subject matter of reproductive health. This study revealed that students significantly improved their knowledge score by 10.2% following the intervention (Mevsim, Guldl, Gunvar, Saygin, & Kuruogln, 2009). Educational interventions have also shown to decrease medication errors in neonatal units. A study investigated the impact of an educational intervention on neonatal hospital staff regarding prescription drug errors and correct identification of the prescribing physician. Following the intervention, prescription drug errors were reduced from 20.7% to 3%, and correct identification of the prescribing physician increased from 1.3% to 78% (Campino, Lopez-Herrara, Lopez-de-Heredia, & Vallis-i-Soler, 2009). A study investigating the impact of an educational intervention on college students' beliefs, attitudes, and knowledge of food safety resulted in an increase in all variable scores when compared to pre-intervention levels. These students reported an improvement in eating behavior, which resulted in eating fewer high-risk foods and therefore reducing the risk of food borne illnesses (Yarrow, et al., 2009).

For this research study a PowerPoint presentation was given to the athletes. The presentation included 10 slides and a short video regarding SIS that aired on ESPN's "Outside The Lines". The use of PowerPoint has been a widely debated means for providing education. Tufte (2003) argued that this teaching methodology creates a flawed thinking process because of the limited template options, forcing students to focus more on the background than on the content (Tufte, 2003). He believed students would concentrate their focus on the physical appearance of the slide instead of the material attempting to be conveyed. However, Showm (2003) argued that the presentation does not impact the thinking process, but rather the student does (Showm, 2003). If it is a clear presentation with applicable graphics and designs, this medium will convey the desired content to an audience. If slides contain few words, creating an outline, it opens the line of communication and the potential for a discussion to begin (Eliot, 2007). For this research project the slides contained bulleted words, not complete sentences. This allowed the researcher to expand on each slide via discussion and ask if the student-athletes had any questions.

# CHAPTER 3: METHODS

## Research Approach and Rationale

To effectively answer the research questions, a Quantitative approach was utilized. Open-ended qualitative questions are designed to enhance and validate the quantitative findings (Creswell & Plano Clark, 2007).

The rationale for selecting this research design includes the capability to effectively answer the research question and the ease with which data can be collected. With only one researcher collecting data from a group of college athletes, it is more efficient to collect both quantitative and qualitative data at the same time, within the same survey.

To select one specific paradigm in regards to one's worldview is difficult as a researcher's stance can change. In this study the worldview was pragmatic, so that the researcher collects data with any procedure necessary to answer the research questions (Creswell & Plano Clark, 2007). There are several reasons as to why this perspective was considered the most appropriate for this study, but the primary rationale was rooted in epistemological and methodology elements: the capability to apply a mixed methods approach and combine two forms of data (i.e. quantitative and qualitative) to better address the research questions.

There are many elements that determine one's worldview. In regards to the axiological element, this researcher has both biased and unbiased perspectives; a biased view on the topic of concussions but an unbiased viewpoint in regards to data collection, analysis, and interpretation of the data. The reason for the biased view is due to the number of athletic concussions witnessed, and the lack of knowledge within this population regarding concussion management.

## Research Aims and Questions

Table 3.1 summarizes the aims, research questions associated with each aim, the survey questions that answered each question, and the data analysis that was conducted to answer each of the questions.

*Table 3.1.*
*Research Aims, Questions, Data Points, and the Analysis Conducted*

| Aims | Research Questions | Data Points | Analysis |
|---|---|---|---|
| Determine athletes' knowledge of sports-related concussions | -Is there a deficit in college athletes' knowledge of sports-related concussions? | Pre-season Q 4-13 | Descriptive T-Test Qualitative |
| | -Is there an underreporting of concussions among college athletes? | Pre-season Q1-3 | Descriptive T-Test |
| Determine the impact of an educational intervention on college athletes' knowledge of sports-related concussions. | -Will there be improvement in post-season assessment scores, compared to pre-season scores following the educational intervention? | Post-season Q9-14 | Descriptive T-Test |
| | -Did the educational intervention impact how athletes managed and/or will manage their concussions? | Post-season Q1-3, 7-8 | Descriptive Qualitative |

## Participants

All research participants signed an informed consent form approved by Colorado State University and Metropolitan State College's (MSCD) Human Subjects Review Committee prior to participating in this study. Athletes participating in men's/women's soccer and men's/women's basketball at MSCD were asked to participate in this study. The rationale for the selection of these teams was based upon concussion ratings within various NCAA athletics. MSCD does not have a football team, and therefore the teams most likely to sustain concussions within a season were selected as participants in this study (Hootman, Dick, & Agel, 2007).

Seventy MSCD student-athletes participated in pre-season data collection and 50 of the 70 MSCD student-athletes completed the post-season survey. The reason for the drop in participants included athletes not making the team, athletes quitting, and seniors graduating. Sample sizes are indicated in Table 3.2.

*Table 3.2.*
*Student-Athlete Breakdown*

| Teams | # of Athletes | |
|---|---|---|
| Men's Soccer | 24 pre | 16 post |
| Women's Soccer | 23 pre | 15 post |
| Men's Basketball | 11 pre | 11 post |
| Women's Basketball | 12 pre | 8 post |

## Measures

The instrumentation used in this study consisted of 2 customized surveys (Appendix 3 and 4). The surveys included both quantitative questions and open-ended qualitative questions. The purpose of the pre-season survey was to obtain a concussion history and a baseline measurement of knowledge of sports-related concussions. The post-season survey assessed the athletes' history of concussions during the previous season and included the same questions from the pre-season survey regarding the athletes' knowledge of concussion management. The purpose of the second survey was to determine whether the educational intervention changed the athletes' knowledge of sports-related concussions, and determine if the intervention impacted their decisions regarding the management of concussions that did occur during that season.

The athletes placed their names on the surveys strictly for data input purposes. The surveys were shredded immediately after the data was input into the computer. The data was coded electronically on an Excel document, with the master copy of the code remaining in a locked cabinet within a locked office to ensure the privacy of all the subjects.

**Collection of Quantitative Data.** The quantitative questions within the surveys were either multiple choice or true/false. Answers were combined to give a concussion knowledge score to the athlete. The athletes answered these questions during the pre-season and post-season surveys, to determine the benefit of the educational intervention on the athletes' knowledge of concussion management and enactment of appropriate treatment strategies. These questions were also individually analyzed to determine specific knowledge deficits. Identifying common misnomers among athletes would allow for targeting of future educational interventions.

**Collection of Qualitative Data.** The 5 qualitative questions within the pre-season survey evaluated how the athlete felt immediately after sustaining a concussion and during the days following the injury. It was expected that identifying an individual's personal experience may provide insights into responses to the quantitative questions. For example, if an athlete sustained a concussion and experienced dizziness, that personal experience may have led to the belief that dizziness is the most common symptom associated with concussions.

During the post-season survey, an additional question regarding the impact of the educational intervention on the athlete was added to the original set of qualitative questions. Doing so allowed the researcher to determine whether and how the intervention altered reporting and management.

## Validity and Reliability

The validity and reliability of the instrument were determined during the pilot-testing phase of this study. More specifically three types of instrument validity were sought, namely: face, content, and construct. Face validity refers to the survey truly testing what it states it is testing. Content validity refers to the survey's inclusion of all necessary information to accurately assess the research questions. Construct validity infers that a group of individuals with proper education will score significantly higher on the survey when compared to a group with no formalized education. How these validities were obtained and determined is briefly explained below.

**Content validity.** Although there is no statistical support for face validity, the instrument has to truly evaluate what it states to evaluate. Twenty ATCs were asked to evaluate the survey and determined if questions were assessing knowledge of concussion management. The survey was presented to the ATCs at a state conference for athletic trainers, and all provided feedback regarding the questions included in the surveys. All ATCs agreed that the survey thoroughly and appropriately assessed concussion knowledge at the level of the collegiate athlete.

**Construct validity.** To determine the construct validity of this instrument, 2 groups that should score differently were asked to complete the survey. The first group included 7 senior athletic training students who have been formally educated on sports-related concussion management. The second group included 24 students in a health and human performance introductory level class, who had not yet received formal education on sports-related concussion management. Construct validity would dictate that the formally educated students would score significantly higher on the survey than the introductory level students.

The survey scores were compared between the 2 groups via a Mann-Whitney test. The 7 senior level students had significantly higher mean ranks (28.00) than the 24 introductory level students (12.50), $U = .000$, $p < .000$, $r = .729$, (Figure 3.1) which according to Cohen (1988) is a larger than typical effect size. The effect size assists in determining the strength of the relationship between variables, and a large effect size indicates a strong relationship.

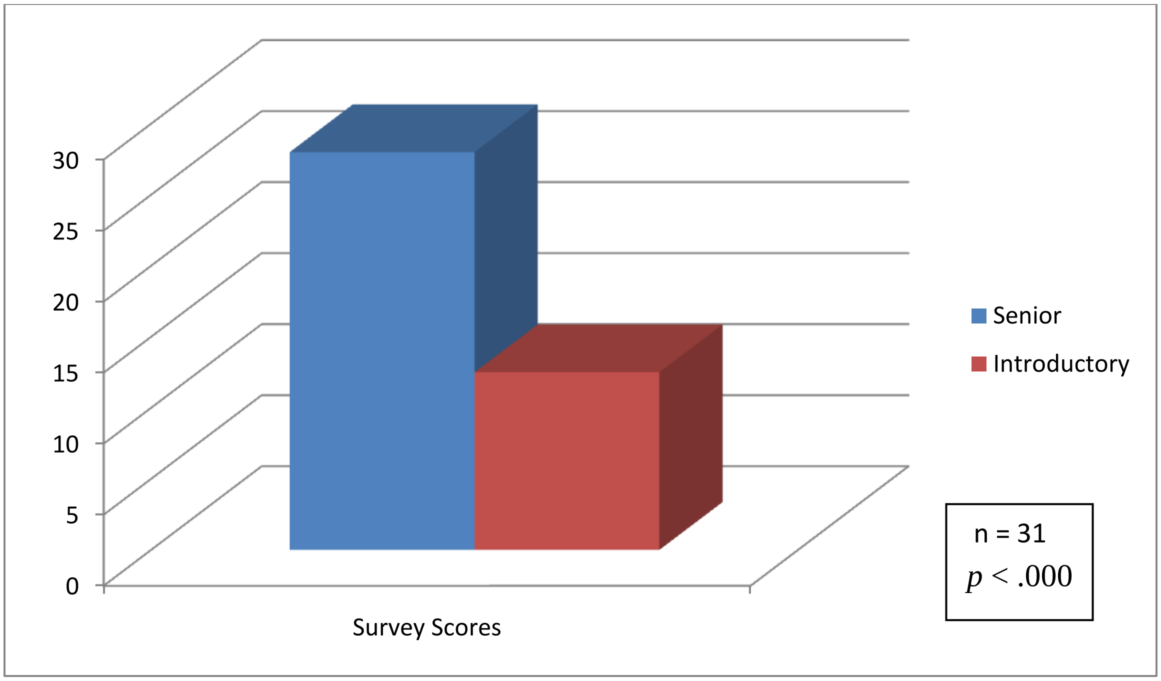



*Figure 3.1.*Validity test comparing senior level students and introductory level students.

**Reliability.** The reliability of this instrument was assessed using a test-retest Pearson correlation coefficient, *r*. A group of 18 college level students participating in an introductory health and human performance course were asked to complete the quantitative portion of the survey, and 10 days later the same group of students completed the same portion of the survey. The educational intervention was not given to this group of students. The scores of the surveys were compared to determine the strength of the relationship between the pre and post test scores, and therefore the reliability of the instrument.

The survey scores where compared within the group via paired samples t-test. The 18 students scored slightly higher on the post-test (3.78) when compared to the pre-test (3.44), but there was still a high correlation between testing dates (Figure 3.2). The higher scores on the post-test may be linked to students looking up the information or inquiring about the information tested. The $r = .734$, which according to Cohen (1988) is a larger than typical effect size. This data provides the necessary information to prove the reliability of the instrument.

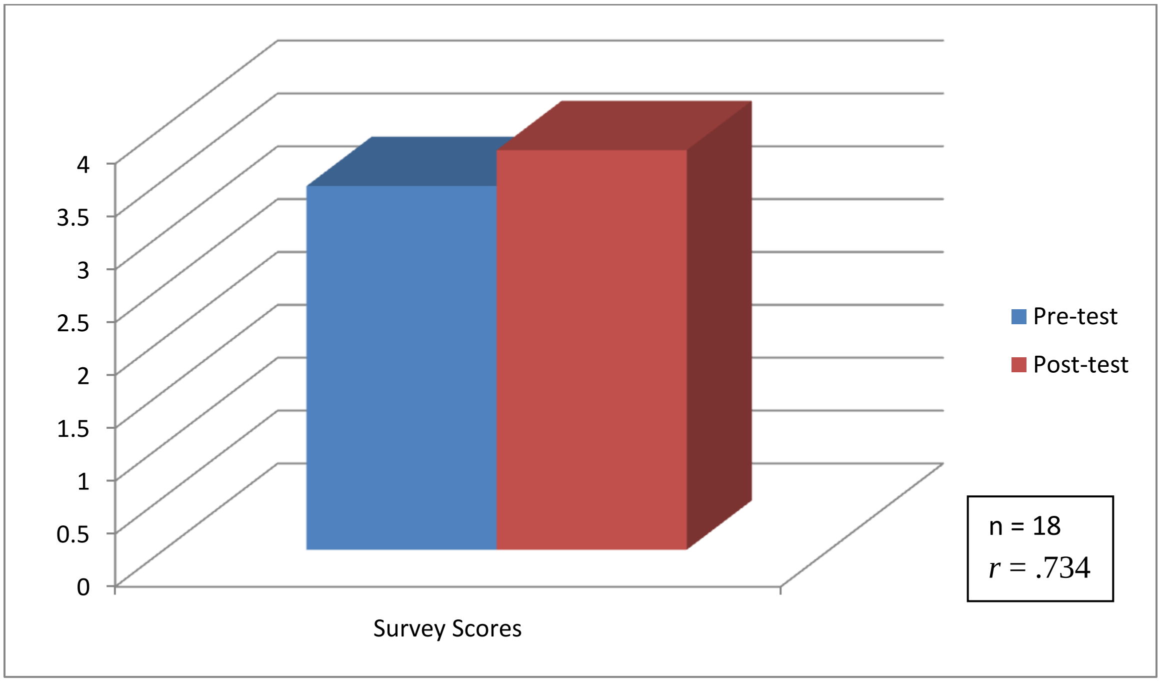



*Figure 3.2.* Reliability test comparing pre-test and post-test scores.

**Procedure**

**Pilot testing.** This study contained 2 phases of pilot testing. During the first phase of the pilot test the following was determined: the validity of the instrument (discussed in the section above), the time it took to complete the survey, and the readability of the survey. The survey was given to a group of 7 senior athletic training students and 24 introductory level human performance and sport students. It was determined that the survey took between 2 and 5 minutes to complete. Students understood the content of all questions. The exercise revealed that directions would be necessary to clarify the first question, as students were unsure how to proceed following this question. Accordingly, explanatory instructions were given to all participants in the principle study. Once all subjects had the survey in their possession, question one was read aloud and the researcher informed the participants where to proceed to based upon their answer. If the participant did not sustain a concussion, they were instructed to turn to page 3 of the survey to finish answering the questions. If participants did sustain a concussion, they were instructed to continue directly to question number 2.

**Data collection.** All research participants signed an informed consent form (Appendix 2) approved by Colorado State University and Metropolitan State College's (MSCD) Human Subjects Review Committee prior to participating in this study (Appendix 1).

Over a 2 day span, in August of 2009, athletes met with their respective teams and were asked to complete the pre-season survey with the primary researcher. After the athletes completed the pre-season survey, the educational intervention was conducted by the researcher.

At the completion of each team's season, end of the season meetings were held. Men's/women's soccer teams held their meetings in January of 2010, and men's/women's basketball held their meetings in March of 2010. During these meetings the athletes completed the post-season survey with the primary researcher.

**Educational Intervention.** The educational intervention was communicated using a PowerPoint lecture given to all the athletes during the pre-season meetings, after completion of the pre-season survey. The lecture was 20 minutes in length, and included time at the end for a question and answer session. The identical educational intervention was given by the same researcher to all subjects. The content of the lecture was derived from the Athletic Training Education courses taught by the researcher and aimed at undergraduate Athletic Training Education students. A general outline of the intervention content is illustrated in Figure 3.3.

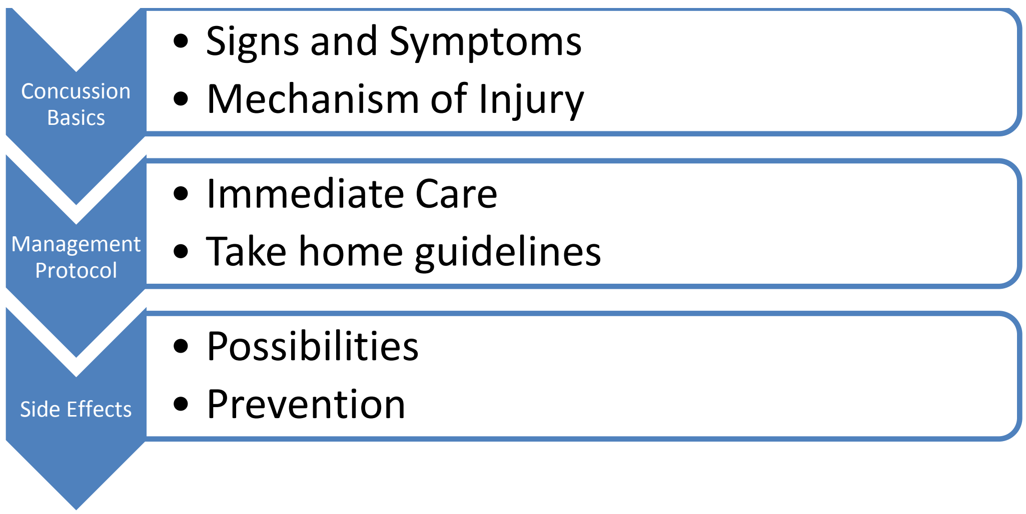



*Figure 3.3.* Educational intervention outline.

**Data Analyses**

The quantitative data were analyzed using SPSS 14.0 statistical software, and the qualitative questions were analyzed individually to determine themes across the student-athletes. Data were analyzed both immediately following the pre-season survey and the post-season survey.

Quantitative questions were scored and compared to scores earned on the post-season survey, but prior to comparing the two survey scores the questions on the pre-season survey were individually analyzed to determine common misnomers by college athletes in regards to sports related concussions.

Descriptive statistics and Paired Samples T-Tests were utilized to analyze quantitative data. Descriptive statistics were used to determine the most common responses, and Paired Samples T-Tests were used to determine any effects gender, age and sports on survey responses, and the effect of the educational intervention on pre-season and post-season survey scores.

The qualitative questions on the pre-season survey were also analyzed in an attempt to determine the athletes' mindset following a concussion in regards to symptoms experienced, concussion treatments, and possible long-term side effects of multiple concussions. The answers to these questions were compared to the athletes' responses to quantitative questions to determine if a personal history of concussions impacted their answers to the quantitative questions.

The qualitative questions within the post-season survey assisted in answering the question of the athletes' perceived benefit of the educational intervention. The answers to these questions will assist in the development of beneficial educational interventions for college athletes, and focus on areas that the athletes perceive to be the most beneficial and as having the greatest impact on themselves.

# CHAPTER 4: RESULTS

During the pre-season survey, 40 out of 70 athletes reported never having sustained a concussion in their lifetime. Of the 40 athletes who indicated they never sustained a concussion, 24 reported having their "bell rung" in their lifetime. Having one's "bell rung" is a common term used in the athletic community meaning one sustained a head injury and is having symptoms-usually ringing in the ears or a "foggy" feeling. It is associated with having a head injury that is not as serious as a concussion. Therefore 60% of these athletes sustained a concussion and were unaware they had done so.

A majority of the athletes that did have a previous history of concussions reported their injury (n=27). The 3 athletes that did have a history of concussions, but did not report their injury, indicated that the reason they did not report their injury was because they felt it was not serious enough to warrant medical attention. Of the 27 athletes who did report their concussion, 59% (n=16) reported their injury to their ATC, 26% (n=7) reported their injury to their coach, and 15 % (n=4) reported their injury to their parents (Figure 4.1). There was a significant difference in reporting behavior, $p < .000$, $d = 2.06$. The difference is both statistically significant and is larger than typical using Cohen's (1988) guidelines.

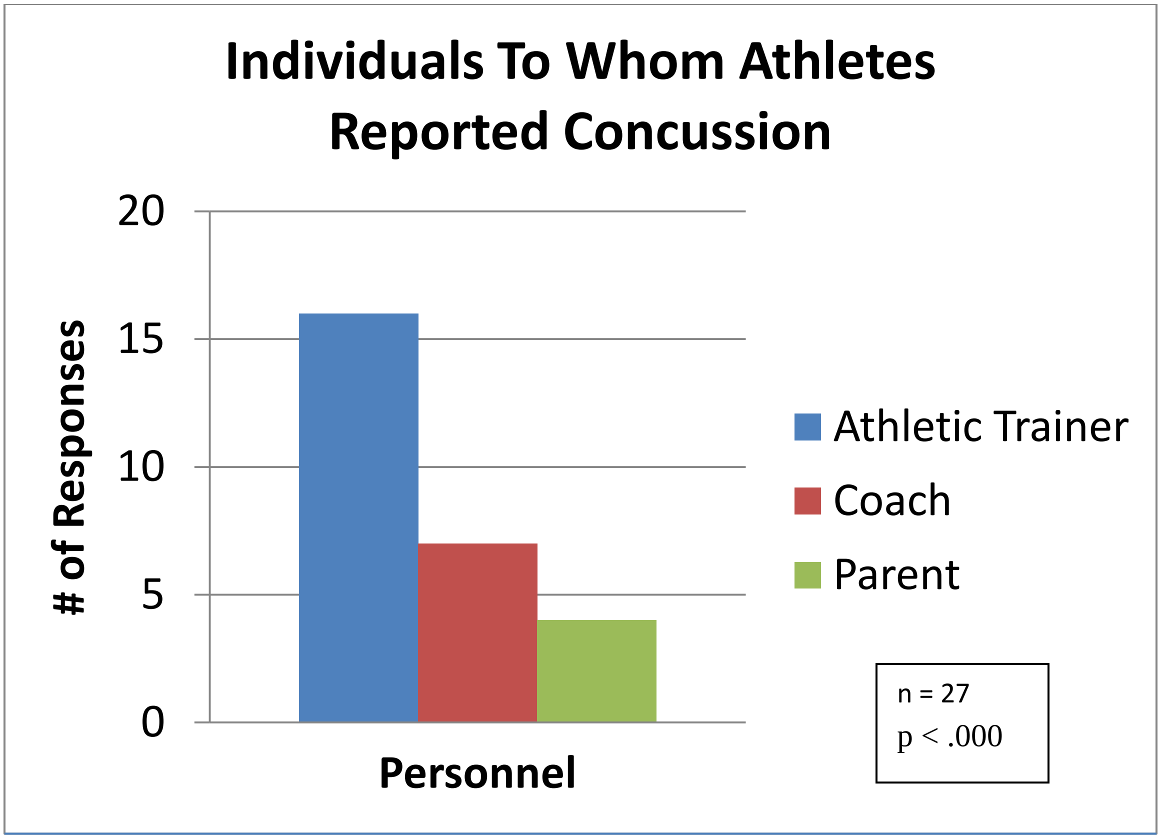



*Figure 4.1.* Individuals whom athletes reported their previous concussions.

Regarding cause of concussion injury, the most commonly reported mechanism of injury was getting hit in the head (n=18). The majority (12/18) of athletes reported having reported having sustained a concussion by hitting their head on the ground. Other objects contacting the head varied among sports, and included players' elbow, knee or head.

Qualitative data revealed the symptoms athletes experienced immediately following their injury and during the following 3 days. The most commonly reported symptoms occurring immediately following a concussion were: dizziness (n=18), headache (n=8), nausea (n=7), visual disturbances (n=5) and amnesia (n=5).  There was a significant difference between the reported symptoms, $p < .000$, $d = 1.79$ (Figure 4-2).

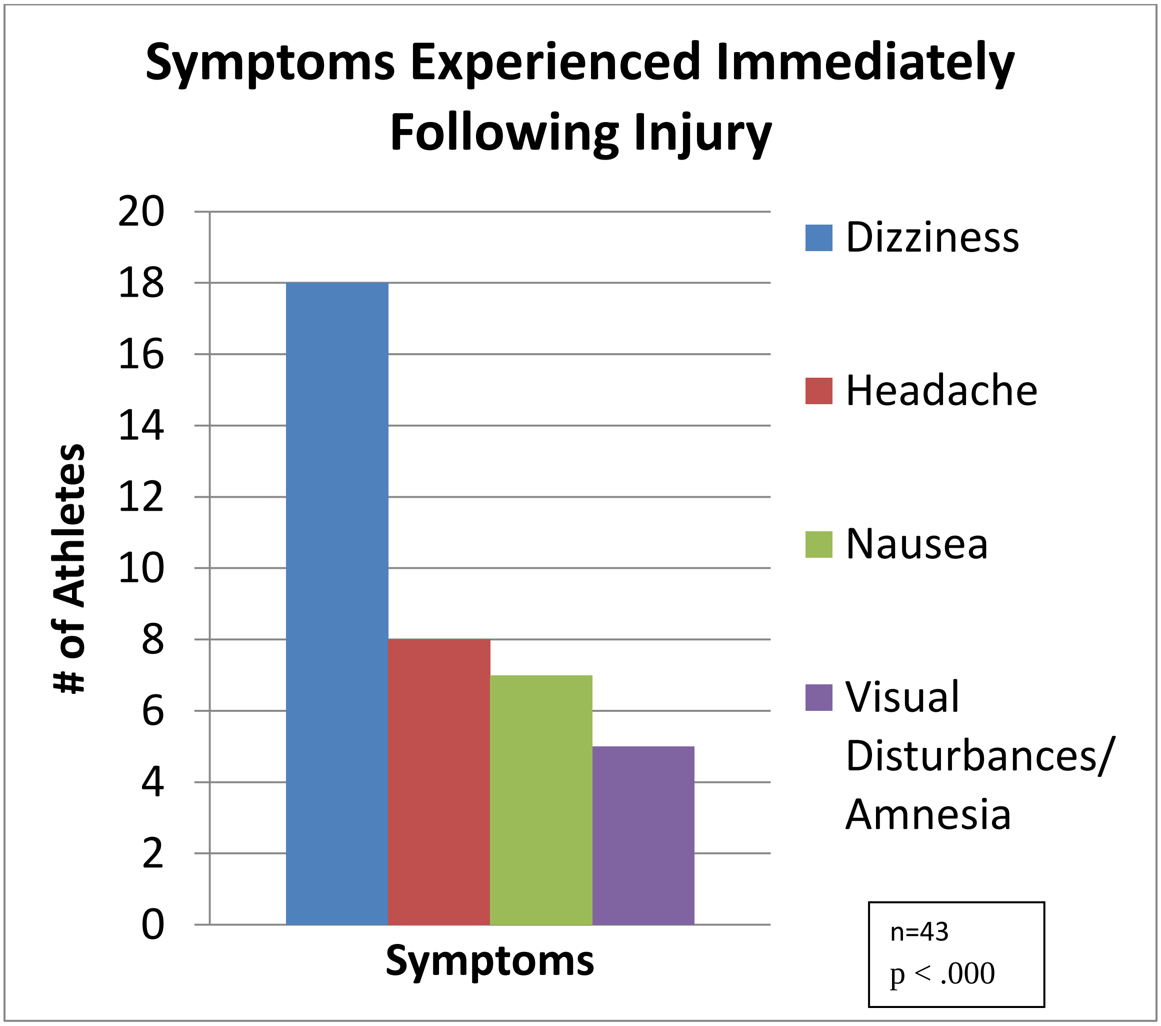



*Figure 4.2.* Symptoms athletes experienced immediately following a concussion.

The most frequently reported symptoms occurring during the 3 days following a concussion were: headache (n=17), fatigue (n=6), and dizziness (n=4) (Figure 4.3). There was a significant difference between these reported symptoms, $p < .000$, $d = 2.03$. Of the 30 athletes that reported having a previous history of a concussion injury, 10% (n=3) were asymptomatic within 24 hours of their injury.

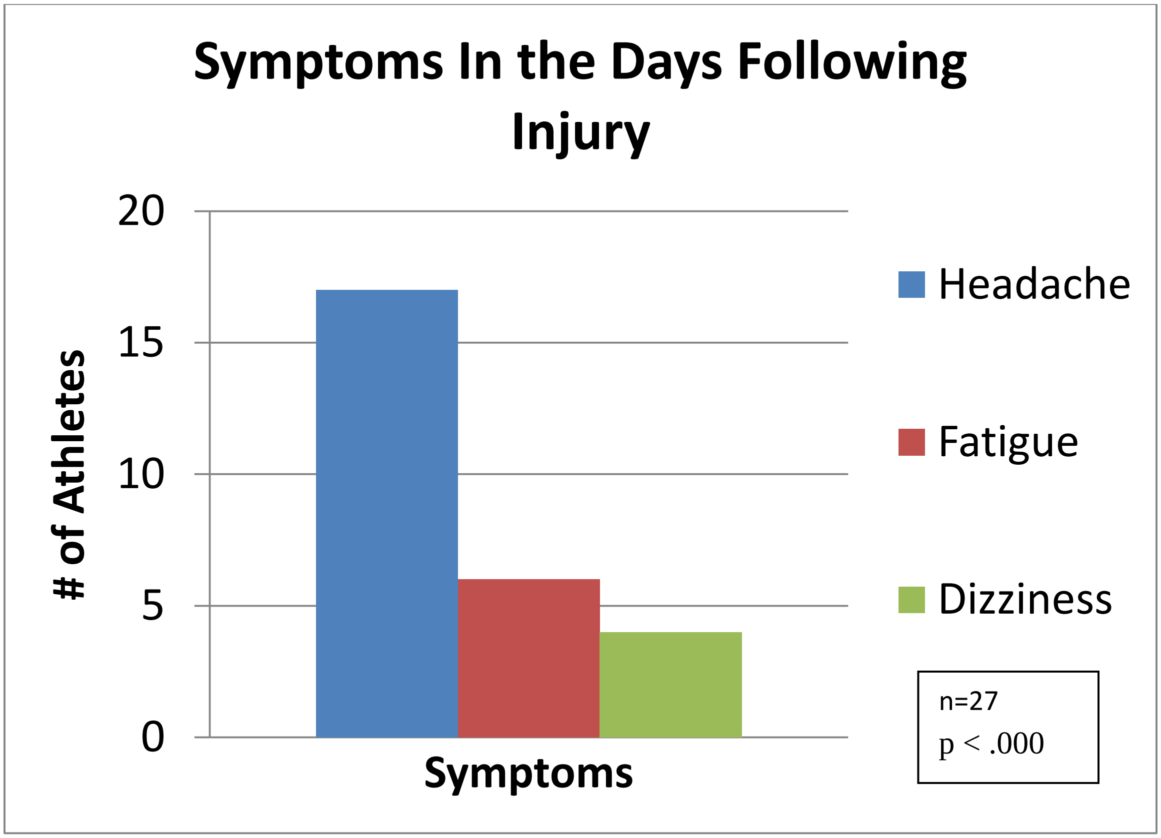



*Figure 4.3.* Symptoms athletes experienced in the 3 days following their concussion.

Evaluation of the individual questions within the pre-season concussion knowledge assessment revealed what athletes knew about concussions prior to the educational intervention. A majority of athletes 44%, (n=31), mistakenly identified dizziness as the most common symptom experienced with a concussion injury, but 66%, (n = 33) correctly identified headache on the post-season survey (Figure 4.4). This coincides with the most commonly reported symptom noted in the qualitative portion of this survey. The Pearson chi-square results indicate a significant difference between the number of correct responses on the pre-season survey versus the post-season survey ($\chi^2$ = 21.942, *df* = 1, *N* = 50). Phi indicates the strength of the association between the variables, and is .662. This indicates a larger than typical effect size according to Cohen's (1988) guidelines.

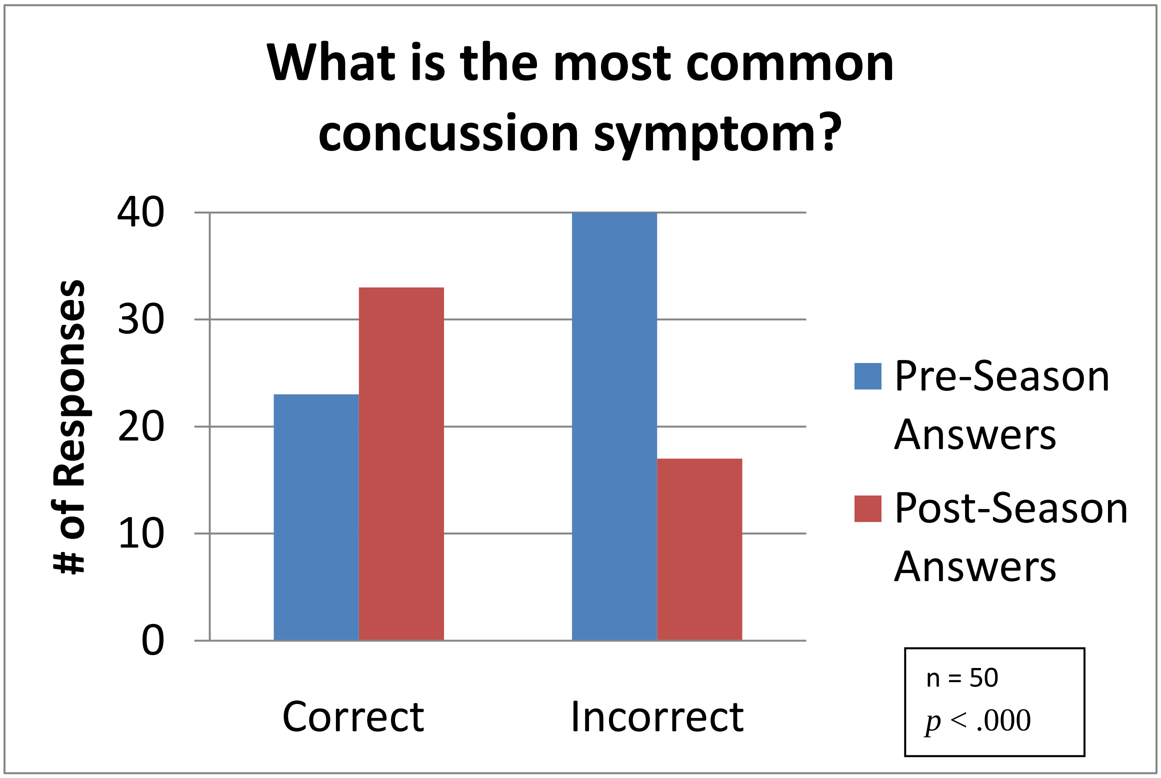



*Figure 4.4.* Pre-season and post-season responses to the question regarding concussion symptoms.

When asked to whom an athlete should report their concussion, 93% of the athletes (n=65) stated that they would report their concussion to their ATC on the pre-season survey and 96% (n = 48) correctly answered ATC on the post-season survey (Figure 4.5). The Pearson chi-square results indicate a significant difference between the number of correct responses on the pre-season survey versus the post-season survey ($\chi^2 = 18.750$, $df = 1$, $N = 50$, $p < .000$). The phi of 0.612 indicates a larger than typical effect size.

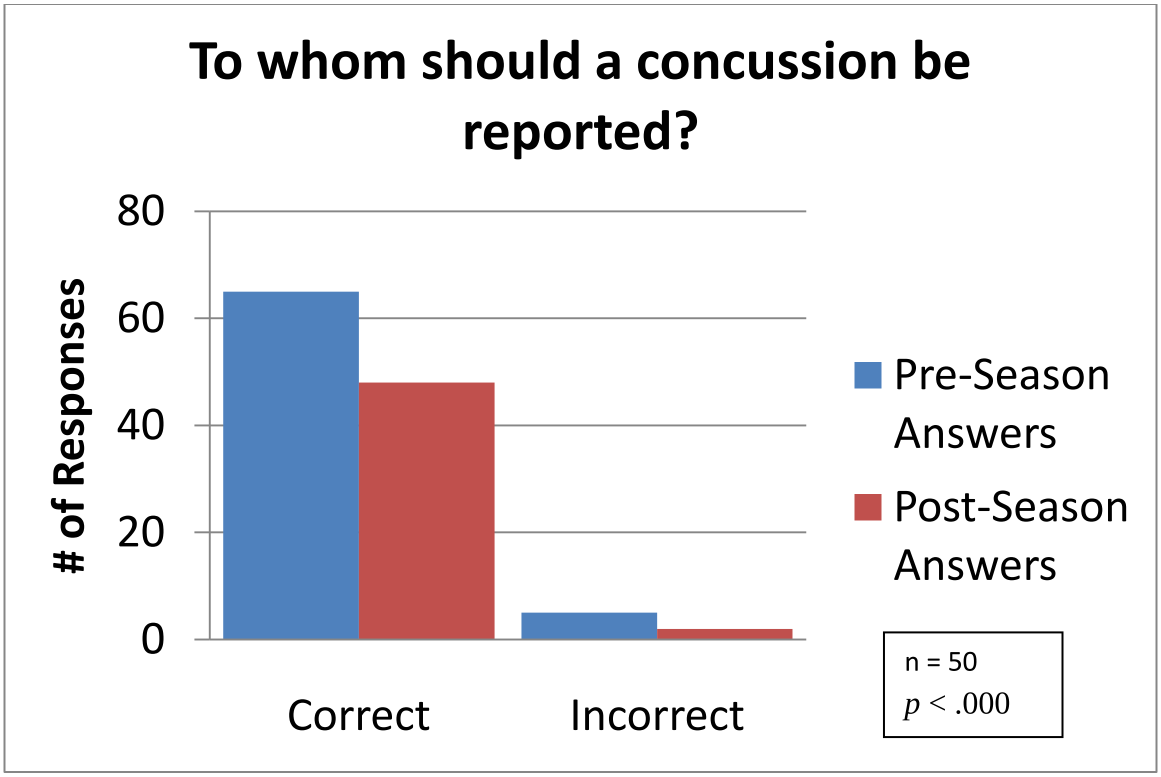



*Figure 4.5.* Pre-season and post-season responses regarding reporting of concussions.

Concerning return to play guidelines, a majority of the athletes, 51% (n=36), believed that they would RTP after 7 days following their injury (Figure 4.6). Correct RTP guidelines states that an athlete may return after 7 days of being asymptomatic. A majority of athletes, 74% (n = 37), correctly indicated 7 days on the post-season survey. The Pearson chi-square results indicates there was not a significant difference between the number of correct responses on the pre-season survey versus the post-season survey ($\chi^2 = 3.172$, $df = 1$, $N = 50$, $p = .075$). Phi is .252 and this indicates a smaller than typical effect size.

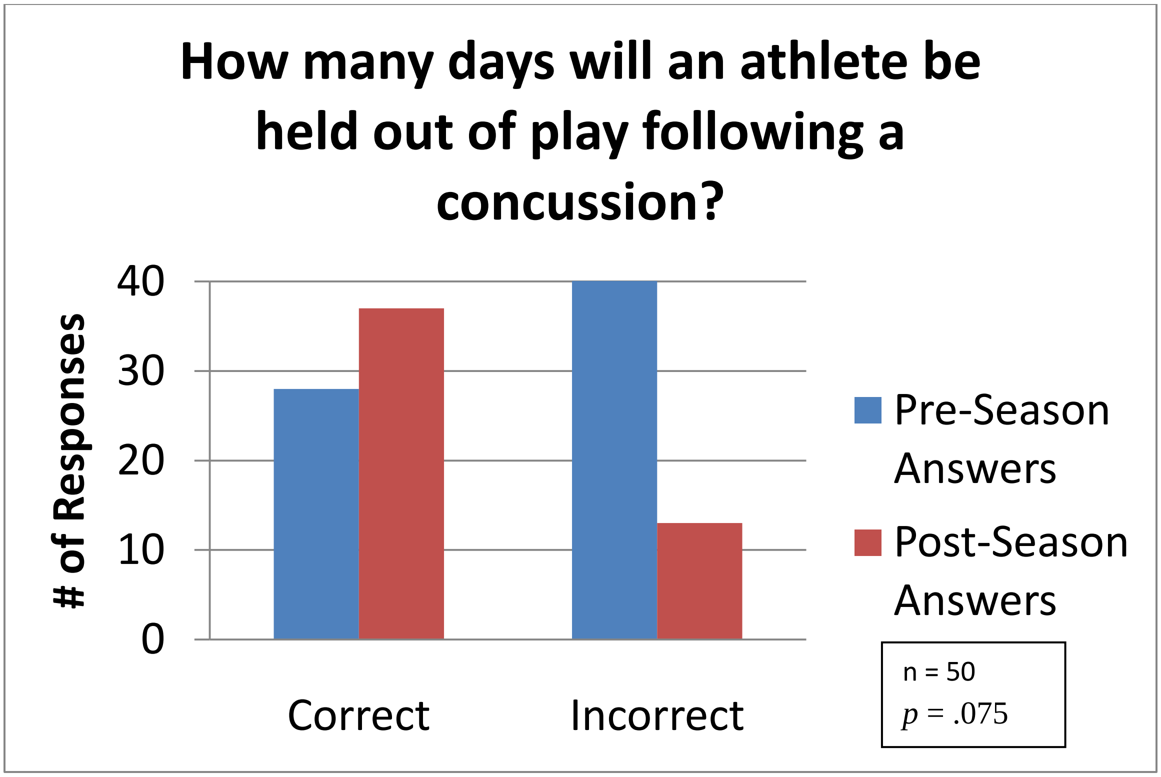



*Figure 4.6.* Pre-season and post-season responses to the question regarding the amount of time a player should be held out of play following a concussion.

Regarding what medications were safe to take while recovering from a concussion, 48% (n=34) of the athletes correctly stated that no medications were safe to take, 33 % (n=23) felt that ibuprofen was safe, 12% (n=8) felt that Tylenol was safe, and 7% (n=5) believed aspirin to be safe (Figure 4.7). A slight majority of athletes, 58% (n = 29) correctly answered on the post-season survey that no medication was appropriate for use. The Pearson chi-square results indicate a significant difference between the number of correct responses on the pre-season survey versus the post-season survey ($\chi^2 = 13.286$, $df = 1$, $N = 50$, $p < .000$). Phi is .515 and this indicates a larger than typical effect size.

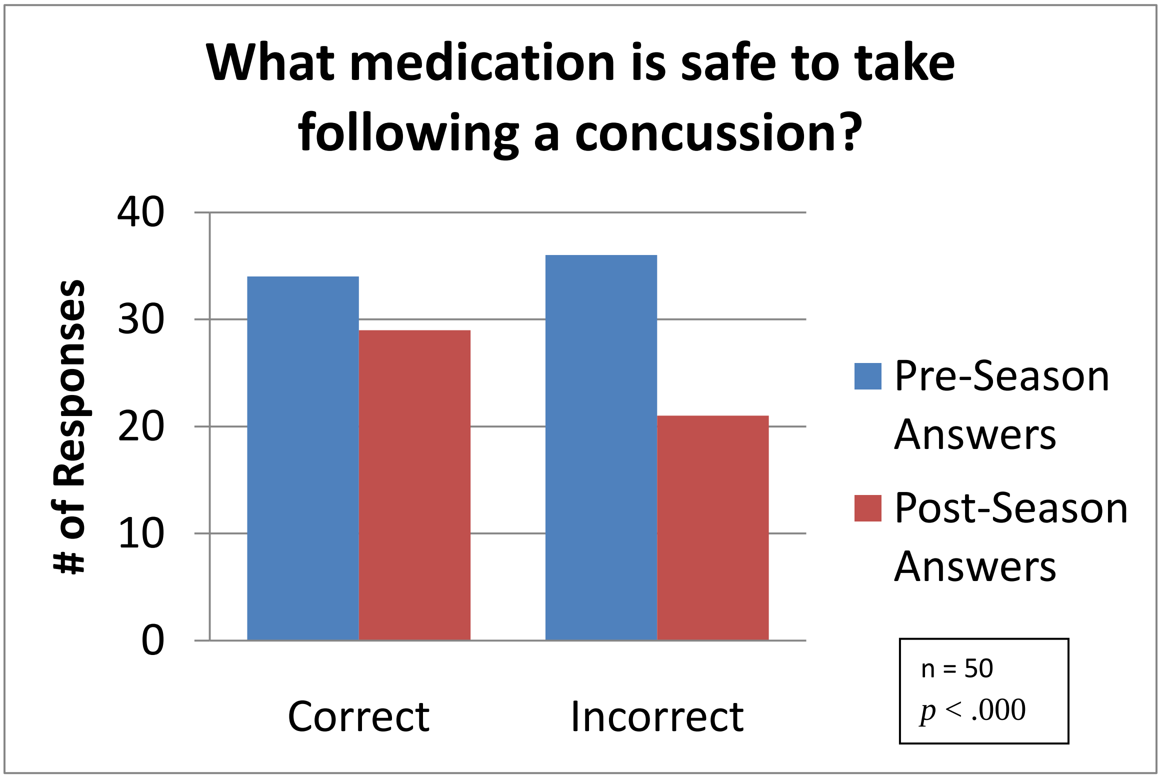



*Figure 4.7.* Pre-season and post-season responses regarding safe medications to take following a concussion.

Analysis of the pre-season survey revealed that 89% (n=62) of athletes know that there are long-term side effects to sustaining multiple concussions, and 98% (n = 49) of athletes answered correctly on the post-season survey (Figure 4.8). These athletes reported death, memory loss, loss of motor function, loss of vision, and permanent headaches as possible long term sequelae. The Pearson chi-square results indicate a significant difference between the number of correct responses on the pre-season survey versus the post-season survey ($\chi^2 = 6.125$, $df = 1$, $N = 50$, $p < .013$). Phi is .354 and this indicates a medium effect size.

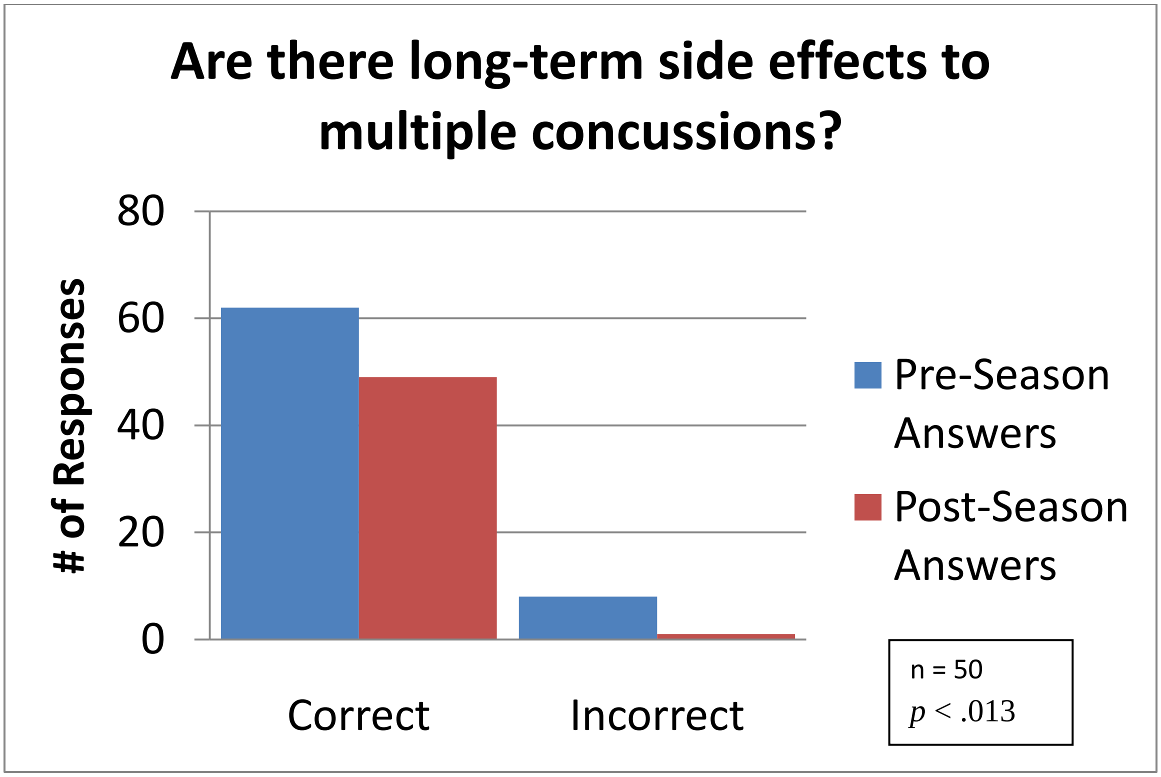



*Figure 4.8.* Pre-season and post-season responses regarding long-term side effects due to multiple concussions.

A majority of athletes, 77% (n=54), correctly indicated that there are no medical treatments for concussions on the pre-season survey, and 86% (n = 43) answered correctly on the post-season survey (Figure 4.9). The athletes who reported potential medical treatments included rest and pharmacological agents. The Pearson chi-square results indicate a significant difference between the number of correct responses on the pre-season survey versus the post-season survey ($\chi^2 = 6.785$, $df = 1$, $N = 50$, $p = .009$). Phi is .372 and this indicates a medium effect size.

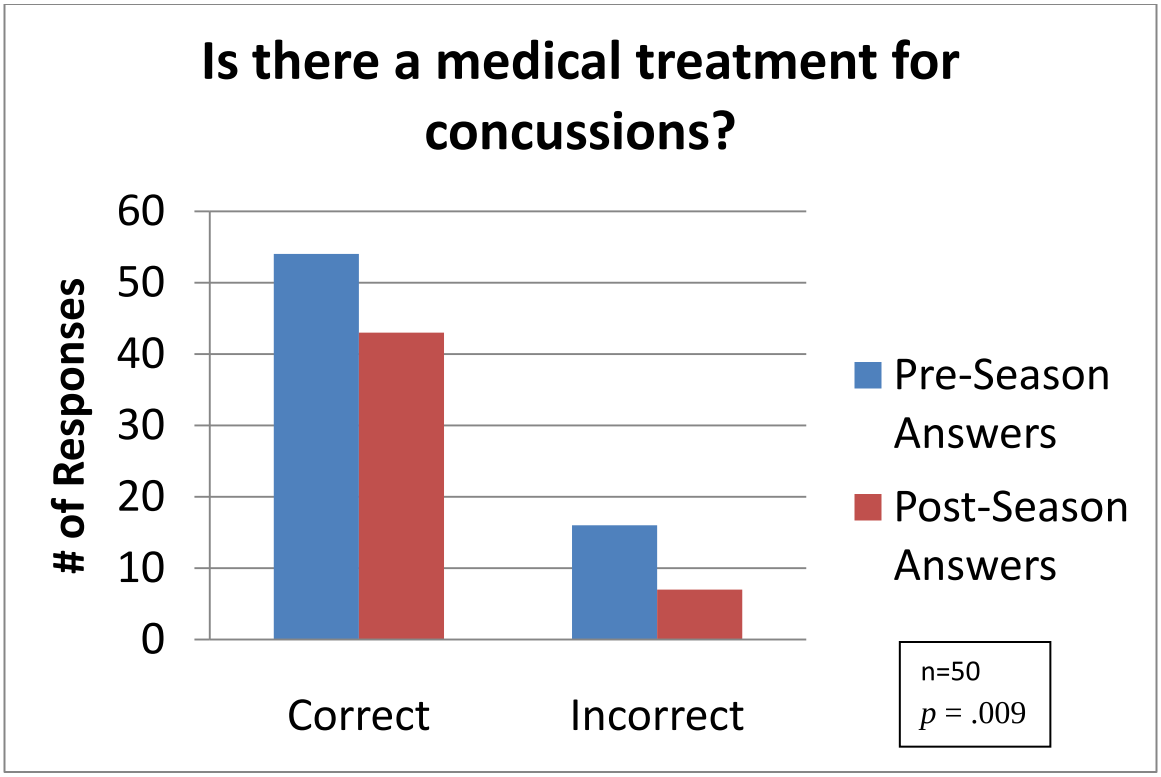
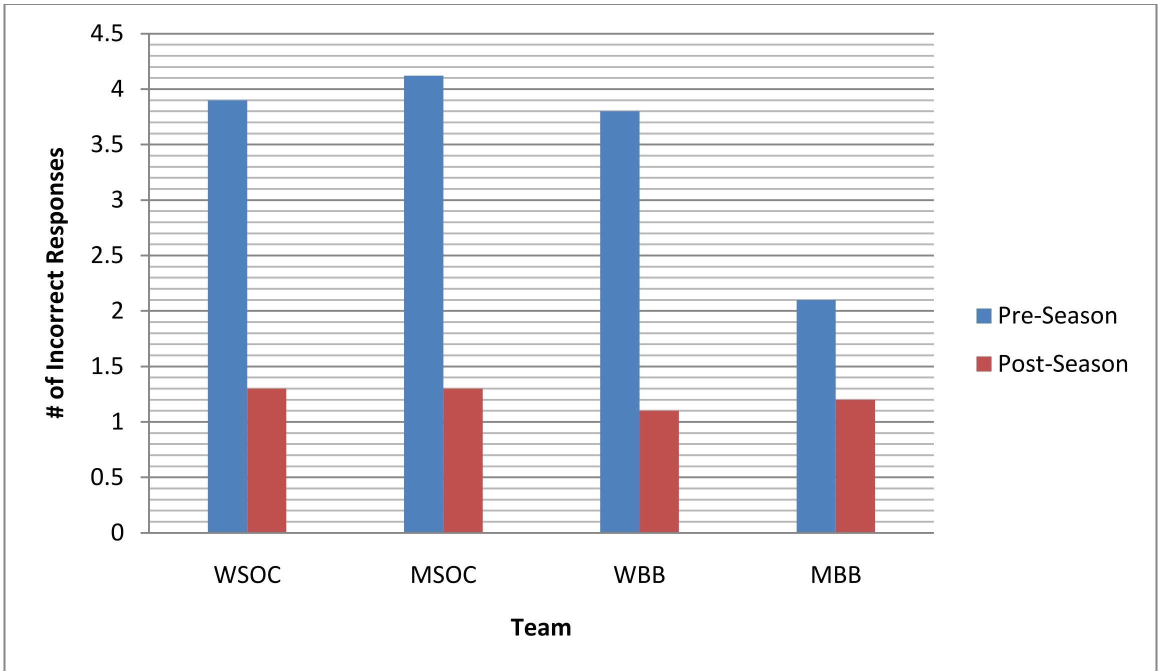



*Figure 4.9. P*re-season and post-season responses regarding medical treatments following a concussion.

A statistically significant difference was found between the 4 sports on the pre-season concussion knowledge assessment, F (3,66) = 3.637, p = .017. A post hoc tukey pairwise comparison revealed a significant difference between the Women's Soccer and Men's Basketball scores (p = .036), and the Men's Soccer and Men's Basketball scores (p = .011) (Figure 4.10). The effect size was determined for both the relationship between the Men's Basketball team and Women's soccer team (d = 1.71) and Men's Basketball team and Men's Soccer team (d = 1.77). According to Cohen's (1998) guidelines, this indicates a larger then typical strength of relationship.

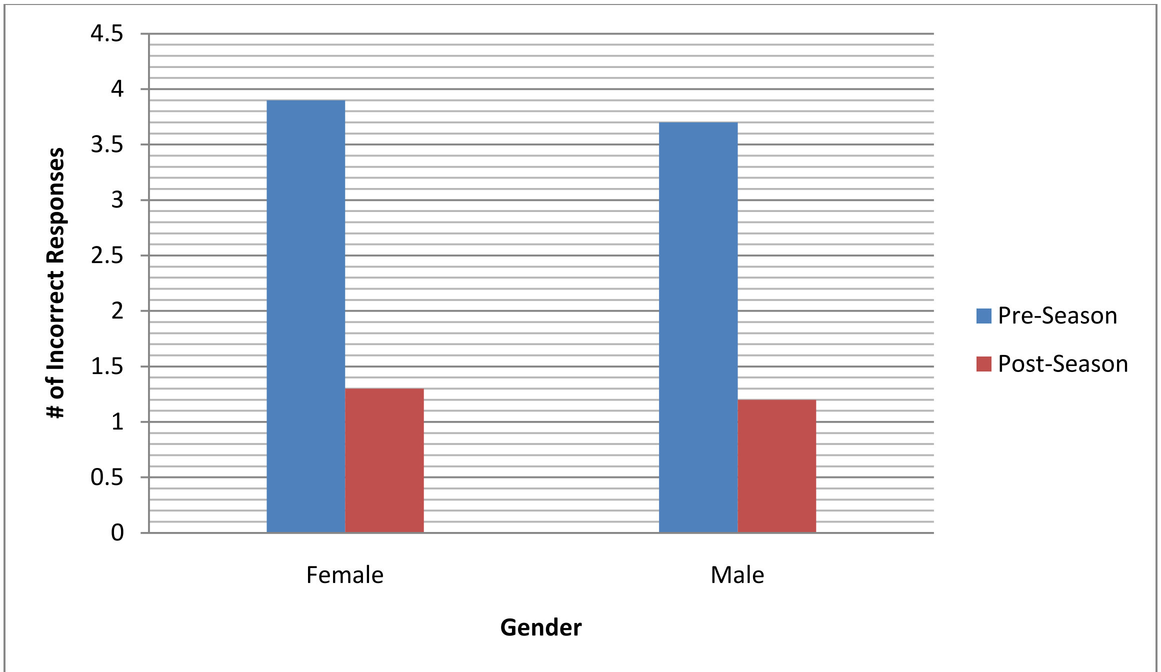



| TEAM | n | Pre-Season Mean | Post-Season Mean | SD Pre | SD Post |
|---|---|---|---|---|---|
| WSOC | 23 | 3.957* | 1.333 | 1.186 | .899 |
| MSOC | 24 | 4.125+ | 1.313 | 1.262 | 1.195 |
| WBB | 12 | 3.833 | 1.125 | 1.029 | .632 |
| MBB | 11 | 2.18*+ | 1.22 | .603 | .975 |

*Figure 4.10.* The number of pre-season and post-season incorrect responses by team. *Indicates p = .036, + indicates p = .011

There was not a statistically significant difference between the 4 sports on the post-season concussion knowledge assessment, $F(3,46) = .314$, $p = .815$, $d = 1.348$ (Figure 4.10).

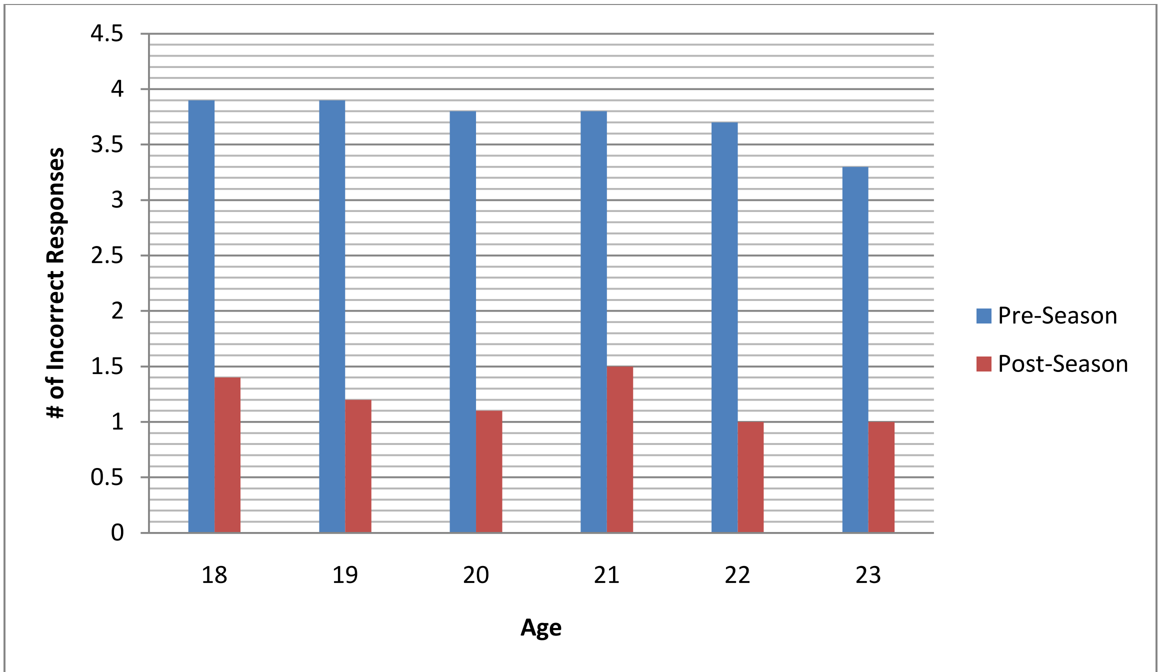
There was not a difference between genders on the pre-season concussion knowledge assessment ($F(1, 68) = .496$, $p = .483$); or on the post-season concussion knowledge assessment ($F(1, 48) = .073$, $p = .788$) (Figure 4.11).




| GENDER | n | Pre-Season Mean | Post-Season Mean | SD Pre | SD Post |
|---|---|---|---|---|---|
| Women | 35 | 3.914 | 1.261 | 1.121 | .964 |
| Men | 35 | 3.714 | 1.185 | 1.250 | 1.001 |

*Figure 4.11.* Number of pre-season and post-season incorrect responses by gender.

There was not a difference between ages on the pre-season concussion knowledge assessment (F(5,64) = .144, p = .981); or on the post-season concussion knowledge assessment (F(5,44) = .279, p = .922) (Figure 4.12).




| AGE | n | Pre-Season Mean | Post-Season Mean | SD Pre | SD Post |
|---|---|---|---|---|---|
| 18 | 13 | 3.923 | 1.400 | 1.188 | 1.265 |
| 19 | 17 | 3.882 | 1.231 | 1.166 | .927 |
| 20 | 19 | 3.789 | 1.059 | 1.357 | .899 |
| 21 | 12 | 3.833 | 1.500 | 1.267 | 1.049 |
| 22 | 6 | 3.667 | 1.000 | 1.033 | 1.000 |
| 23 | 3 | 3.333 | 1.000 | .577 | |

*Figure 4.12.* Number of pre-season and post-season incorrect responses by age.

While completing the Post-Season survey, 6 athletes reported they had sustained a concussion during the previous season of competition. Regarding the impact the educational intervention had on reporting and treatment of their concussion, 50% (n=3) stated that the educational intervention had a positive impact on the management of their concussion. These 3 athletes indicated that the educational intervention made them more aware of the dangers of a concussion, increased their awareness of the recovery time necessary, and the RTP guidelines the medical staff must follow. The most commonly reported symptom reported by the 6 injured athletes both immediately after and in the days following their concussion was dizziness (n=5).

A paired sample t-test indicated that the athletes scored better on the post-season concussion knowledge assessment (t(49) = 10.34, p < .000, d = 1.47). The difference is larger than typical (Figure 4-13). This suggests that the educational intervention given to the athletes at the beginning of the season had a strong positive impact on the athletes' knowledge retention regarding sports related concussions.

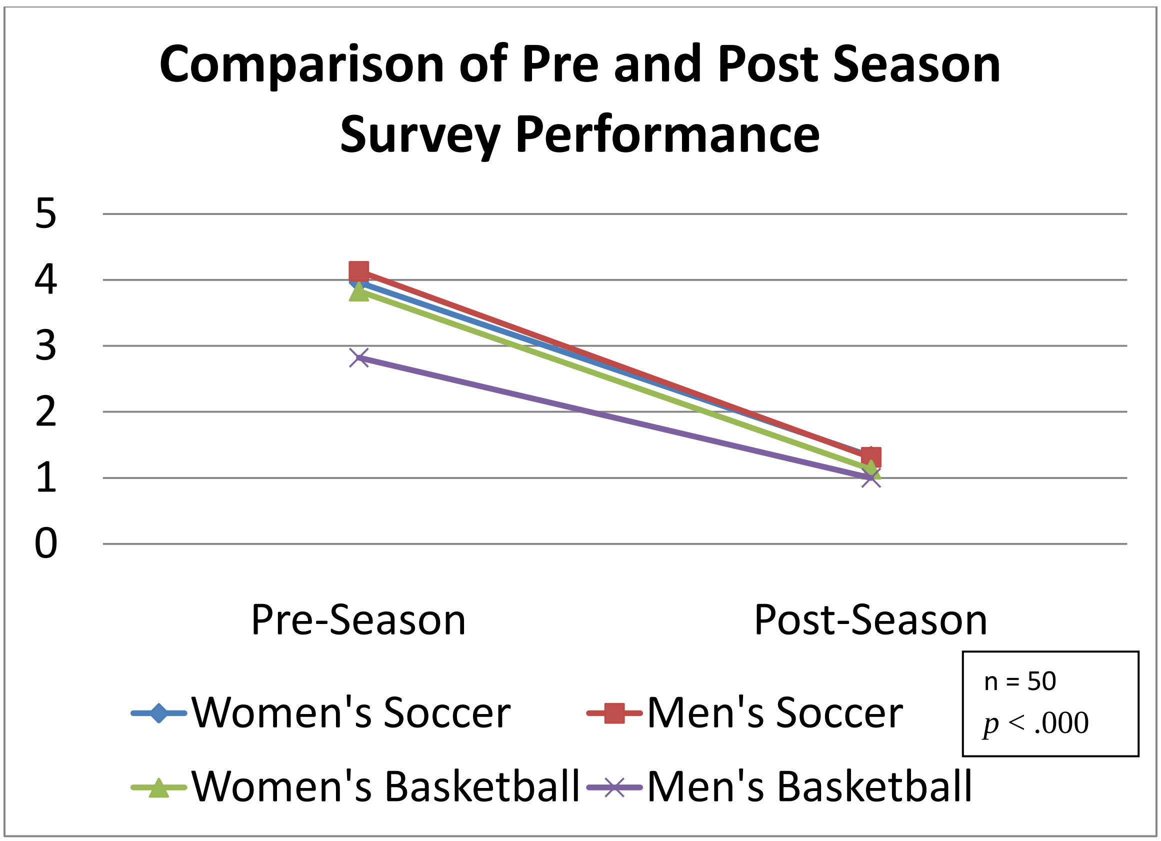



*Figure 4.13.* Number of incorrect responses on pre-season and post-season assessments by sport.

# CHAPTER 5: CONCLUSIONS/IMPLICATIONS

## Summary of Findings/Implications

The primary goal of this research study was to determine if athletes at MSCD demonstrated an improvement in their knowledge of sports-related concussions following an educational intervention. Specifically, this study was designed to provide information to athletes during the pre-season to assist in the reduction of sports-related concussions, and to improve reporting and management.

At the completion of this study it was noted that athletes' post-season scores, compared to pre-season scores, significantly improved following the intervention. On average, athletes answered 3.6 questions incorrectly on the pre-season test, and only 1.22 questions incorrectly on the post-season test. These results coincide with the aforementioned literature review, which, in general, affirms that an educational intervention improves knowledge. The purpose of providing education to a sample population is to provide information with the goal of changing behavior (Campino et al., 2009; Mevism et al., 2009).

The men's basketball team scored significantly higher than the men's and women's soccer teams on the pre-season survey, but there was not a significant difference noted on the post-season scores between the 4 teams. The reasons that the men's basketball team may have scored higher on the pre-season survey include the possibility that these participants may have taken an introductory sports medicine course, received information from medical staff during their athletic career, sustained a concussion previously, or had a family member/friend sustain a concussion. Although the men's basketball team did score significantly better on the pre-season survey when compared to the 2 soccer teams, there was still a significant improvement in the men's basketball post-season survey assessment scores, therefore demonstrating an enhancement in knowledge.

It was hypothesized that the men's and women's basketball teams would not score as well as the men's and women's soccer teams on the post-season survey, because of the increased length of time between the educational intervention and the post-season survey. All teams completed the pre-season survey and educational intervention in August. The soccer teams completed the post-season survey 5 months following the pre-season survey, and the basketball teams completed the post-season survey 7 months after the pre-season survey. The post-season survey assessment scores, however, were similar among the four teams with a mean score of 1.22 incorrect responses.

The ability of the men's and women's basketball teams to retain the information taught to them in August for an entire athletic season suggests that medical personnel can implement educational seminars at the beginning of the school year for the entire athletic department. It is common for medical personnel to conduct pre-participation physicals for all athletes in August, prior to classes beginning. While all athletes are together it would provide a convenient opportunity to educate them on sports-related concussions and other applicable topics.

With the exception of the men's basketball team's pre-season scores, gender or age did not have an impact on concussion assessment scores. It was hypothesized that older athletes would earn a better score because of their increased length of time participating in athletics. An athlete with a longer athletic career has an increased likelihood of sustaining a concussion or witnessing a teammate's injury, and learning about the injury from the medical staff. A potential reason that a difference was not noted between older and younger athletes may be due to the lack of concussion injuries sustained by older athletes that participated in this study. If the older participants did not sustain more concussive injuries than younger athletes, they would not have had an opportunity to learn about concussions from medical personnel. There has also been a push in the media to educate the general population about concussions, and younger athletes have been exposed to this explosion of coverage. There is also the possibility that older athletes feel they need to exhibit a stoic attitude towards injury. These older athletes may believe they have to provide the example to younger athletes that playing injured is the norm and is expected.

The majority of athletes inaccurately defined a concussion prior to the educational intervention. Athletes were asked if they had ever sustained a concussion, and 40 responded no, but later 24 of those 40 athletes reported previously having their "bell rung". It is a common belief among athletes and coaching staffs that having one's "bell rung" falls short of a true concussive injury. However, if an injury results in concussion symptoms, it is diagnosed as a concussion. These findings also coincide with the literature, in that many athletes, coaches, and parents do not know exactly what a concussion is and when they have sustained one (McCrea, et al., 2004). These findings further support the need for educational interventions regarding sports-related concussions aimed at all levels of athletes.

A majority (53%) of athletes who did sustain a concussion in their athletic career appropriately reported their injury to an ATC, and 93% of those individuals correctly identified their ATC as the person to whom the injury should be reported. The minority (36%) reported their concussion to their coach or parents first, which may be attributed to unavailability of an ATC. In the state of Colorado, it is not mandatory to have an ATC present at all high school athletic events. If these athletes sustained a concussion during their high school athletic career, there may not have been an ATC on site.

The 11% of athletes (n=3) who indicated in the pre-season survey that they did not report their concussion did so because they believed their injury was not serious enough to warrant medical attention. These findings correspond to published studies, which indicate that a majority of athletes who do not report their concussion feel that their symptoms are not serious (McCrea, et al., 2004). Sefton (2003) found that college athletes believed that it was acceptable to wait to report their concussion at the end of a practice/game. Providing information regarding the seriousness of concussion injuries to athletes may encourage them to immediately report their injury to the appropriate medical personnel.

The most common mechanism of concussion injury reported in this study was a direct blow to the head. Athletes who did sustain a concussion reported hitting their heads on the ground, or being hit in the head by another player or object. The sport played a major role in determining the exact mechanism of injury. Basketball players were more likely to report hitting their heads on the ground, while soccer players reported having been hit in the head by the ball or another player's head (Gessel, Fields, Collins, Dick, & Comstock, 2007). The mechanism of injury reported by MSCD college athletes for sustaining a concussion is similar to the mechanisms reported by athletes in a previous study.

Immediately following a concussion, the symptom most commonly reported by MSCD athletes was dizziness, which was also identified as the most common concussion symptom. If a majority of athletes experience dizziness following a concussion, it is reasonable to expect that they will select dizziness as the most common symptom. During the days following a concussion, the most commonly reported symptom was headache. Headache is in fact the most common concussion symptom immediately following an injury, occurring in 86% of all cases (Valovich, et al., 2008). A study by Makdissi and associates also found headaches to be the most commonly reported symptom 48 hours post concussion injury, and headaches were the longest lasting symptom. This study found that dizziness was reported in 40% of all cases compared with the 87.5% of cases where a headache was reported (Makdissi, et al., 2010). Headaches are frequently ignored as a concussion symptom, because they are a common condition that may result from a number of different etiologies. The MSCD athletes may have downplayed the seriousness of their headache immediately following their concussion, and therefore did not report headache as a symptom until it persisted for over 48 hours.

Three of the 30 athletes that reported a previous concussion indicated that their symptoms resolved within the first 24 hours. Although physical symptoms may have resolved, neurological function does not return to baseline until approximately 7 days after physical symptoms have dissipated (McCrory, et al., 2009). When physical symptoms resolve, athletes believe they should be allowed to resume activity. If athletes are unaware that their brain has not fully healed, they will resume activity and increase their risk for complications and/or re-injury.

The pre-season questionnaire revealed common misconceptions regarding management of sports-related concussions. While 51% of athletes knew they would be held out of play for at least seven days, 49% believed they could return to play following their concussion within 1 to 5 days. Returning to play too soon following a concussion increases the brain's susceptibility to further injury. Researchers have shown that the brain requires time to reduce inflammation and restore homeostasis. With a concussive injury, cerebral blood flow is decreased by 50%, and may require 10 days to achieve a state of normalcy. The decrease in cerebral blood flow is linked to an increase in cerebral edema and intracranial pressure. During this time, there is a increased risk of SIS which may be fatal (Arnheim & Prentice, 2009; Marineau et al., 2007).

A large challenge for medical personnel is the varying presentations among athletes. A concussion will present differently from case to case, and medical personnel have to develop an individualized approach to concussion management (Eckner & Kutcher, 2010). Athletes return to play at varying times and symptoms will differ in duration, severity, and number. Neurocognitive deficits may be delayed 2-3 days behind subjective symptom reports, and subjective symptoms may persist for 24 hours to 1 week

(Makdissi, et al., 2010). Unknown symptom duration and restriction from play are discouraging factors for many athletes. In response to the majority of injuries seen in athletics, the body follows a standard healing response within a known time frame. This allows athletes to anticipate when they will return to play following their injury.

Long-term side effects are seen in athletes who have sustained 3 or more concussions (De Beaumont et al., 2007; Iverson et al., 2006), and 89% of the subjects knew that there were possible side effects associated with multiple concussions. The reported potential long-term side effects of multiple concussions included death, memory loss, loss of motor function, loss of vision, and permanent headaches. Although a majority of the side effects reported by these athletes were not completely accurate, the important aspect was that these athletes knew they could sustain long-term effects.

During an athlete's symptomatic period, the medical staff will manage the concussion by removing the athlete from all forms of physical activity. Any form of physical activity will increase the body's blood pressure, including intracranial pressure. The increase in intracranial pressure may worsen cerebral edema and damage, causing the symptoms to increase in severity. It has also been suggested that medical personnel remain in close contact with the athlete's teachers to determine if their school work becomes affected by neurocognitive deficits. Teachers are encouraged to allow student-athletes that have sustained a concussion additional time on assignments and permission to reschedule tests.

Taking medication immediately after a concussion is not advised, because of the possible adverse side effects and the potential to diminish the severity of symptoms.

Adverse side effects include coagulopathies, which may increase the severity of cerebral edema (Arnheim & Prentice, 2009). Medications also have the potential to mask the severity of present and developing symptoms. If athletes are unaware of increasing symptom severity, they may fail to recognize a worsening condition. It is recommended that athletes do not take medicine to treat concussion symptoms for 3 weeks post injury.

Slightly more than half (52%) of the athletes incorrectly indicated that using medications immediately post injury period was appropriate. If athletes are not properly educated regarding the complications of medications following a concussion, they may worsen their injury or the severity of the injury may be underestimated (McCrory, et al., 2009).

There is currently no accepted medical treatment for concussions in generally, then, besides rest. Appropriate treatments reported by 23 % of the athletes in this study included medication to reduce pain and minimize swelling within the brain. The athletes who indicated a pharmacologic treatment was appropriate for concussion management also stated that medication was safe to take following a concussion to reduce symptom severity.

An exception to the general avoidance of pharmacologic intervention is the use of anti-depressants to treat PCS specifically, due to the persistent nature of the symptoms. There is the concern for the potential increased suicidal risk associated with anti-depressant medications, therefore, it is important that athletes prescribed this medication remain in close communication with the prescribing physician. Symptoms of PCS may linger for 6 months, and medications are prescribed to assist the athlete in coping. There is a debate as to whether PCS is a psychological or physiological condition, because of the number of emotional symptoms experienced. These emotional symptoms include lowered frustration tolerance, irritability, and depression (Jotwani & Harmon, 2010).

The post-season survey assessment asked athletes who sustained a concussion during the previous season if the educational intervention had an impact regarding their concussion management. All of the athletes who sustained a concussion reported their injury to their athletic trainer. Half of the athletes reported that the intervention had a positive impact regarding how they managed their injury and how they will manage future injuries. These athletes reported an increase in knowledge regarding RTP protocols and possible detrimental side effects of a premature RTP decision. The other half indicated that the intervention did not influence how they managed their concussion, because they always knew to report their injury immediately to their ATC. Although these athletes stated that the educational intervention did not have an impact on their management of the injury, there is the possibility that they retained information regarding the presentation of concussions. If they were made more aware of the symptoms and mechanism of injury, they may have been more diligent in the proper reporting of their injury. Studies have focused on increasing the effectiveness of concussion management, but few have focused on education and the attitudes of athletes regarding concussions. It is believed that athletes possess an unsafe attitude regarding concussions, and this attitude may be linked to a lack of knowledge (Rosenbaum & Arnett, 2010).

There is a challenge associated with educating this generation's college students. These students have demonstrated high scores on the Narcissistic Personality Inventory, implying that they are overconfident (Twenge, 2009). This overconfident and selfcentered attitude may lead these athletes to believe that they know everything there is to know about concussions, and that they are immune to suffering from a concussive injury.

This generation of college students also has a significant shorter attention span, and it may be crucial to change lesson plan format throughout 1 educational session to maintain their interest. For example, the educational intervention that was given to the subjects in this study saw a short video clip on SIS to break up the PowerPoint information that was being provided. It may also prove beneficial to bring in a survivor of SIS or a retired athlete suffering from the long-term side effects associated with multiple concussions to talk with the athletes. For the purpose of this study, the educational intervention was very organized and methodical. It may be beneficial in future educational pieces to have a round-table discussion of the topic. This will further engage the student-athlete and potentially keep their attention on the subject being discussed.

**Limitations of the Findings**

A limitation of this study was the composition of the sample population. Only MSCD athletes participated in this study, and only the soccer and basketball teams were asked to participate. MSCD does not have a football team, so the population most susceptible to sustaining a concussion was not included. Soccer teams, however, rank second and third according to the NCAA in the number of concussions sustained each season (NCAA Injury Surveillance System Data Summary, 2007).

A third second of this study is the potential for outside/additional sources of information. Following the educational intervention athletes may have learned more about concussions from teammates, coaches, family, friends, media, etc. If these athletes received this additional information prior to the post-season assessment, their scores may have been influenced by recent information provided to them.

One weakness of this study was the decrease in number of participants from pre-season to post-season. While this was unavoidable due to normal attrition, the number of participants for the post-season assessment decreased by 20.

Another weakness of this study may have been the athletes' perception of the educational intervention. They may have not taken it seriously, and discounted what was said. There will always be the potential for a group receiving an educational intervention to dismiss the information. This should not prevent the implementation of these programs, because it is likely that some of the athletes will listen, retain the information, and practice what was taught.

An additional weakness of this study is the small number of athletes, n = 6, who sustained a concussion over the season data was collected. It is difficult to generalize outcomes to a greater population when 50%, n = 3, of the athletes reported the educational intervention was beneficial and improved the management of their concussion.

**Implications for Practice**

The results of this study support incorporating educational interventions prior to the start of athletic seasons. Athletes demonstrated an increase in knowledge and retention of information taught during the pre-season. These educational interventions can cover a plethora of information, but interventions directly related to athletes' health and safety should be considered a priority.

Concussions can have a detrimental impact on an athlete's lifestyle. Kuehl and associates found that college athletes' perception of pain, vitality, social functioning, and headaches are negatively affected following a concussion (Kuehl, Snyder, Erickson, McLeod, 2010). With the exception of headache, these are not commonly reported concussion symptoms. Athletes experiencing these symptoms may have difficulty coping, and lack the awareness to link the symptoms to their concussion injury and ask for help.

Athletes should also be made aware of PCS, diagnosed in 5-20% of athletes (Iverson, 2005). Symptoms of PCS include cognitive, physical, and emotional symptoms that persist for longer than would be expected (Jotwani & Harmon, 2010). Although only a small number of athletes suffer from PCS, all athletes should be made aware of the condition and associated symptoms. The awareness will allow athletes to continually assess themselves and teammates following a concussion. The emotional symptoms experienced with PCS are commonly identified by teammates and friends first because of the observed behavioral changes.

Although this study was conducted in college athletes, it is likely that incorporating educational interventions at all levels of athletic participation would have a positive impact on the athletes' knowledge. Athletes who begin to learn about sports-related concussions at a younger age may sustain a fewer number of concussions in their career, and therefore decrease the probability of suffering from the long-term side effects associated with multiple concussions. Studies conducted on high school athletes have noted a significant deficiency in their knowledge and attitude regarding sports-related concussions.

Studies of high school athletes suggest that approximately 50-75% of concussions are not reported. When athletes were asked why they did not report their injury they indicated that they experienced difficulty detecting their injury, they felt it was not serious enough to require medical attention, and/or they did not want to be held out of play (McCrea, et al., 2004). Sye and associates found that approximately 50% of high school athletes returned to play without medical clearance or against medical advice following a concussion. Over one quarter of these athletes stated they believed the importance of an athletic event should have an impact on RTP decisions (Sye, Sullivan, McCrory, 2006).

High school aged student learn by connecting information with previous personal experience or fitting the new information into their current world of knowledge (King, 1994). To resonate with this population it may be important to incorporate their personal experience with concussions into any learning exercise. Sharing stories about their concussion history and associated complications may elicit a greater impact on future concussion management. This may best be implemented with a round table discussion with a facilitator to lead/direct the topic and ensure that correct information is learned.

**Recommendations for Research**

This project could be expanded to include institutions that support high-impact, high-velocity sports programs (football, ice hockey, and men's lacrosse). These schools will see a greater number of concussed athletes each year and therefore will have additional data. The inclusion of these programs would also provide information regarding athletes' knowledge of the seriousness of sports-related concussions. Individuals who engage in these sports often have a stoic mentality regarding injuries. Many coaches continue to encourage athletes to ignore the symptoms associated with a concussion, or associate the symptoms with a less severe injury. These sports involve aggressive tackles and hard hits that can place a player at risk throughout play, and this may contribute to the belief that concussions are a natural consequence of these games. If athletes who participate in these high risk sports receive a pre-season educational intervention, as described in this study, they too may increase their knowledge and subsequently treat future concussions with the seriousness they deserve. In addition to the educational intervention, this population may benefit from being addressed by a former athlete who is suffering from complications associated with multiple concussions. Connecting a person with the reality of the potential sequelae of concussions may resonate with stoic individuals when compared with a lecture.

An additional avenue for continued research is to assess younger athletes' knowledge of sports-related concussions, and evaluate the impact of an educational intervention on their knowledge. If younger athletes are educated in their athletic career, they may retain and implement the information regarding appropriate management.

**Conclusion**

The purpose of this study was to determine athletes' knowledge of sports-related concussions and determine the impact of an educational intervention on their knowledge.

This study was successful in determining that athletes have common knowledge deficit areas, but following the educational intervention they significantly improved their knowledge of sports-related concussions following the intervention.

This study encourages the implementation of annual educational interventions to promote the retention of knowledge of concussion injury. Sports-related concussions may lead to detrimental side effects and negatively impact an athlete's livelihood. If the athletes are properly educated, they may properly manage their injury and prevent the cumulative trauma seen with multiple concussions.

Following the completion of this study, MSCD has implemented an annual educational intervention for all athletes prior to athletic competition beginning. Based upon further literature review, the intervention will include additional information regarding the potential emotional symptoms experienced with PCS and the impact that concussions may have on an athlete's quality of life. The survey assessments will continue to be conducted to determine retention of information, and assess the potential improvement in educating high school athletes.

A few of the high school districts in the Denver Metro area have incorporated a concussion program, and this researcher is implementing a program into the Douglas County School District. As previously stated, the education of younger athletes may reduce the number of concussions an athlete will sustain in their lifetime.

This study assessed college athletes' knowledge of sports-related concussions and found that they have many misconceptions. An educational intervention was given and analysis of the post-season survey found that college athletes had an improvement in their knowledge assessment scores. Future interventions may be improved by providing a guest lecturer, an athlete suffering from the sequelae associated with multiple concussions, or utilizing a clicker presentation to make it more interactive. Regardless of the method of delivery, however, one core aspect that should continue and become implemented on a wide scale is the education of athletes regarding the importance of proper concussion management.

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e-protocol

## NOTICE OF APPROVAL FOR HUMAN RESEARCH

**DATE:** August 05, 2009
**TO:** Timpson, William, PhD, Education
Delano, Theresa, Gilley, Jerry, Frye, Melinda, Biomedical Sciences
**FROM:** Barker, Janell, CSU IRB 1
**PROTOCOL TITLE:** The Impact of an Educational Intervention on College Athletes'Knowledge of Sports-Related Concussions
**FUNDING SOURCE:** NONE
**PROTOCOL NUMBER:** 09-1268H
**APPROVAL PERIOD:** Approval Date: August 05, 2009 Expiration Date: July 31, 2010

The CSU Institutional Review Board (IRB) for the protection of human subjects has reviewed the protocol entitled: The Impact of an Educational Intervention on College Athletes'Knowledge of Sports-Related Concussions. The project has been approved for the procedures and subjects described in the protocol. This protocol must be reviewed for renewal on a yearly basis for as long as the research remains active. Should the protocol not be renewed before expiration, all activities must cease until the protocol has been re-reviewed.

If approval did not accompany a proposal when it was submitted to a sponsor, it is the PI's responsibility to provide the sponsor with the approval notice.

This approval is issued under Colorado State University's Federal Wide Assurance 00000647 with the Office for Human Research Protections (OHRP). If you have any questions regarding your obligations under CSU's Assurance, please do not hesitate to contact us.

Please direct any questions about the IRB's actions on this project to:

Janell Barker, Senior IRB Coordinator - (970) 491-1655 Janell.Barker@Research.Colostate.edu
Evelyn Swiss, IRB Coordinator - (970) 491-1381 Evelyn.Swiss@Research.Colostate.edu

Barker, Janell

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**Approval Period:** August 05, 2009 through July 31, 2010
**Review Type:** EXPEDITED
**IRB Number:** 00000202
**Research Integrity & Compliance Review Office**
**Office of the Vice President for Research**
**321 General Services Building - Campus Delivery 2011**
**Fort Collins, CO**
**TEL:#(970) 491-1553**
**FAX:#(970) 491-2293**

**Consent to Participate in a Research Study**

**Colorado State University**

**TITLE OF STUDY: The Impact of an Educational Intervention on Collegiate Athletes' Knowledge of Sports-Related Concussions**

**PRINCIPAL INVESTIGATOR:** William Timpson, Department of Education at Colorado State University, (970) 491-7630, William.Timpson@ColoState.edu

**CO-PRINCIPAL INVESTIGATOR:** Theresa Delano, PhD student at Colorado State University in the Department of Education, (303) 556-3228, tdelano@mscd.edu

## WHY AM I BEING INVITED TO TAKE PART IN THIS RESEARCH?

You are being asked to participate in this study because you are an athlete at Metropolitan State College of Denver, playing on the soccer or basketball teams.

## WHO IS DOING THE STUDY?

Any athlete participating in Metropolitan State College of Denver's soccer or basketball teams will be asked to participate in this study.

## WHAT IS THE PURPOSE OF THIS STUDY?

This study will determine the knowledge base student-athletes have regarding sports-related concussions. The results of the survey will assist in determining if athletes' have common errors regarding sports-related concussions and if an educational intervention will benefit the student-athlete.

This study is also being done to fulfill the requirements of a doctoral program at Colorado State University. The co-principal investigator, Theresa Delano, is using this research as part of her dissertation.

## WHERE IS THE STUDY GOING TO TAKE PLACE AND HOW LONG WILL IT LAST?

The study will take place in the Physical Education Building at Metropolitan State College of Denver. The study will involve completing two ten minute surveys and one twenty minute educational lecture regarding sports-related concussions. The first survey and lecture will be completed on the same day in August. The second survey will be completed at the end of the season.

## WHAT WILL I BE ASKED TO DO?

You will be asked to honestly complete a ten minute pre-season survey, before team practices beginning. Following this survey, you will be asked to listen to a twenty minute lecture regarding sports-related concussions. The lecture will be given by Theresa Delano, MA, ATC, a faculty member at Metro State who teaches about concussions. At the end of the season, you will be asked to complete a ten minute post-season survey.

Page 1 of 3 Participant's initials _______ Date _______

**ARE THERE REASONS WHY I SHOULD NOT TAKE PART IN THIS STUDY?**
You should not participate in this study if you are under the age of 18.

**WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS?**
There are no risks or discomforts for participating in this study.

**ARE THERE ANY BENEFITS FROM TAKING PART IN THIS STUDY?**

Benefits of this study will include the ability of the Metro State medical staff to properly educate student-athletes on the risks of sports-related concussions, and hopefully decrease the number of concussions sustained by the student-athlete population.

**DO I HAVE TO TAKE PART IN THE STUDY?**

Your participation in this research is voluntary. If you decide to participate in the study, you may withdraw your consent and stop participating at any time without penalty or loss of benefits to which you are otherwise entitled.

**WHO WILL SEE THE INFORMATION THAT I GIVE?**
We will keep private all research records that identify you, to the extent allowed by law.

Your information will be put together with information from other people taking part in the study. When we write about the study to share it with other researchers, we will write about the combined information we have gathered. You will not be identified in these written materials. We may publish the results of this study; however, we will keep you name and other identifying information private.

We will make every effort to prevent anyone who is not on the research team from knowing that you gave us information, or what that information is. For example, your name will be kept separate from your research records and these two things will be stored in different places under lock and key. The coaching and medical staff at Metro State will not be provided with any information you have given.

**WILL I RECEIVE ANY COMPENSATION FOR TAKING PART IN THIS STUDY?**
There is no compensation for participating in this study.

**WHAT HAPPENS IF I AM INJURED BECAUSE OF THE RESEARCH?**

The Colorado Governmental Immunity Act determines and may limit Colorado State University's legal responsibility if an injury happens because of this study. Claims against the University must be filed within 180 days of the injury.

**WHAT IF I HAVE QUESTIONS?**

Before you decide whether to accept this invitation to take part in the study, please ask any questions that might come to mind now. Later, if you have questions about the study, you can contact the investigator, Theresa Delano at tdelano@mscd.edu. If you have any questions about your rights as a volunteer in this research, contact Janell Barker, Human Research Administrator at 970-491-1655. We will give you a copy of this consent form to take with you.

This consent form was approved by the CSU Institutional Review Board for the protection of human subjects in research on August 5, 2009.

**WHAT ELSE DO I NEED TO KNOW?**

In addition to completing two surveys and actively listening to an educational lecture, you are asked to participate in a one-on-one interview at the end of your season. This interview will assist us in determining the impact of the educational intervention lecture. Please check and initial next to each portion of the study you are willing to participate in.

□ Surveys _______

□ Interview_______

Your signature acknowledges that you have read the information stated and willingly sign this consent form. Your signature also acknowledges that you have received, on the date signed, a copy of this document containing 3 pages.

_________________________________________ _____________________

Signature of person agreeing to take part in the study Date

_________________________________________

Printed name of person agreeing to take part in the study

_________________________________________ _____________________

Name of person providing information to participant Date

_________________________________________

Signature of Research Staff

**Pre-Season Concussion Survey**

Name: ____________________________________________

Please circle the letter or number that is your best response.

Athlete History

Age: 18 19 20 21 22 23 or older

1. Have you ever sustained a concussion?
   - A. Yes, and I did report my concussion
   - B. Yes, and I did not report my concussion
   - C. No, I have never sustained a concussion

**If you selected answer C, please proceed to PAGE 3**

2. If yes, I reported my concussion to my:
   - A. Athletic Trainer
   - B. Coach
   - C. Parent
   - D. Teammate
   - E. Other: ____________________________

3. If no, I did not report my concussion because I:
   - A. Felt it was not serious enough to warrant medical attention
   - B. Thought I could tough it out
   - C. Did not want to lose playing time/spot on team
   - D. Thought coach would be mad at me
   - E. For another reason: ____________________________________________

Whether or not you reported your concussion, we would like a brief response to the following 3 questions.

4. How did you sustain your concussion?

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

5. How did you feel immediately after your concussion?

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

6. How did you feel in the days following your concussion?

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

Concussion Knowledge Assessment

Please circle only **1** response.

7. Have you ever had your "bell rung"? YES NO

8. What is the most common concussion symptom?
   - A. Dizziness
   - B. Headache
   - C. Loss of consciousness
   - D. Unequal pupils

9. Who should an athlete report his/her concussion to?
   - A. Coach
   - B. Parent
   - C. Athletic Trainer
   - D. Teammate

10. How long should an athlete be held out of play after his/her symptoms have gone away?
   - A. 1 day
   - B. 5 days
   - C. 7 days
   - D. 10 days

11. What medication is safe to take immediately after an athlete sustained a concussion?
   - A. Ibuprofen (Advil)
   - B. Tylenol
   - C. Aspirin
   - D. None

12. There are long-term side effects from multiple concussions

A. False

B. True

If you selected true, what do you believe the side effects are?

_______________________________________________________________

13. There is medical treatment for concussions.

A. False

B. True

If you selected true, what is the treatment?

_______________________________________________________________

**THANK YOU FOR YOUR TIME!!**

**<u>Post-Season Concussion Survey</u>**

Name: ________________________________________

Please circle the letter or number that is your best response.

<u>Athlete History</u>

Age: 18 19 20 21 22 23 or older

1. Did you sustain a concussion **<u>this past season (Fall 2009)</u>**?
    - A. Yes, and I did report my concussion
    - B. Yes, and I did not report my concussion
    - C. No, I have never sustained a concussion

**If you selected answer C, please proceed to <u>PAGE 4</u>**

2. If yes, I reported my concussion to my:
    - A. Athletic Trainer
    - B. Coach
    - C. Parent
    - D. Teammate
    - E. Other: ______________________________

3. If no, I did not report my concussion because I:
    - A. Felt it was not serious enough to warrant medical attention
    - B. Thought I could tough it out
    - C. Did not want to lose playing time/spot on team
    - D. Thought coach would be mad at me
    - E. For another reason: ______________________________________________

Whether or not you reported your concussion, we would like a brief response to the following 5 questions.

4. How did you sustain your concussion?

________________________________________________________________

________________________________________________________________

________________________________________________________________

________________________________________________________________

5. How did you feel immediately after your concussion?

________________________________________________________________

________________________________________________________________

________________________________________________________________

________________________________________________________________

6. How did you feel in the days following your concussion?

________________________________________________________________

________________________________________________________________

________________________________________________________________

________________________________________________________________

7. Did the pre-season educational intervention have an impact on how you took care of your concussion?

A. Yes

B. No

8. How did the educational intervention have an impact on how you took care of your concussion?

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

Concussion Knowledge Assessment

Please circle only **1** response.

9. What is the most common concussion symptom?
    A. Dizziness
    B. Headache
    C. Loss of consciousness
    D. Unequal pupils

10. Who should an athlete report his/her concussion to?
    A. Coach
    B. Parent
    C. Athletic Trainer
    D. Teammate

11. How long should an athlete be held out of play after his/her symptoms have gone away?
    A. 1 day
    B. 5 days
    C. 7 days
    D. 10 days

12. What medication is safe to take immediately after an athlete sustained a concussion?
    A. Ibuprofen (Advil)
    B. Tylenol
    C. Aspirin
    D. None

13. There are long-term side effects from multiple concussions

A. False

B. True

If you selected true, what do you believe the side effects are?

________________________________________________________________

14. There is medical treatment for concussions.

A. False

B. True

If you selected true, what is the treatment?

________________________________________________________________

**If you are willing to participate in a 1 on 1 confidential interview, please include your contact information. Your help will be greatly appreciated.**

**Contact phone #: _______________________________________**

**Email address: _________________________________________**

**THANK YOU FOR YOUR TIME!**