

Potential Impacts of Brain Related Head Injuries on
Secondary and Post-Secondary Student-Athletes

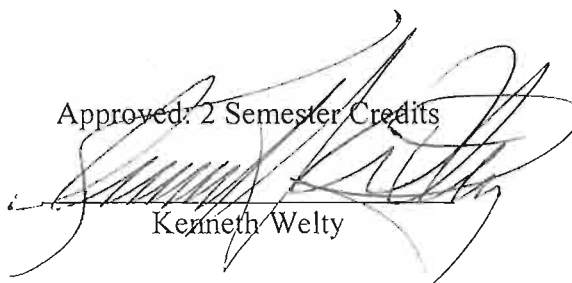
by

Matthew Schroeder

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A large, stylized handwritten signature in black ink, appearing to read 'Kenneth Welty', is written over the text 'Approved: 2 Semester Credits' and 'Kenneth Welty'.

Kenneth Welty

The Graduate School

University of Wisconsin-Stout

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**The Graduate School
University of Wisconsin-Stout
Menomonie, WI**

Author: Schroeder, Matthew J.

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Abstract

The purpose of this research was to determine the effects brain related injuries have on secondary and post-secondary student-athletes. Participant information was gathered from multiple resources and scientific studies in an effort to provide a comprehensive look at information regarding the types of brain related injuries athletes can sustain, the short term and long term effects of those injuries and the periods of recovery and/or rehabilitation student-athletes face if they sustain such an injury. Included in this study is also information about professional athletes who have sustained different levels of brain related injury.

The results of the study found that all levels of competition and sport were not immune to brain related injuries, although sports of more physical contact did produce the highest number of brain related injuries. The research shows that often the most significant impacts did not warrant the greatest amount of injury; instead, it was the repetition of impacts that caused the longest lasting and most harmful effects. It is recommended that additional research on all levels

of competition be conducted to determine at what point athletes should be informed with the hope that the potential injuries/disabilities can be prevented.

**The Graduate School
University of Wisconsin Stout
Menomonie, WI**

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Chapter 1: Introduction

Over the course of the past fifty years, athletics have become commonplace in nearly every public school district and college across the nation. Participant growth among high school sports has been exponential, and college sports have provided many otherwise non-college bound athletes a chance to earn a degree, especially since the advent of Title IX in 1972 (National Federation of State High Schools Association (NFSA), 2009). The increases in participation have had a positive effect on the lives of many former athletes and led to the development of several of today's business and political leaders. Although these positive effects are not uncommon, there are many negative effects that have come from the advancement of athletics during the same period of time. The negative effects of participation in sports are often the unspoken or dark side of what has become a multimillion-dollar a year enterprise at the high school and college level.

Today's youth are inundated with images of professional athletes who are advertising anything and everything, from cars to cereals. These images mislead many young people by suggesting professional athletes have an easy life. The mainstream television channels and media further misconstrue the realities of the life of the professional athlete by providing reality-based shows and in depth coverage while players are in training phases. In both cases, young people are misguided as to the difficulties of ever beginning a career in professional sports; that misconception leads some young people to believe they will make it to the ranks of the professional athlete.

Young athletes are dreamers, and, often, they have dreams that they can one day make it to the professional level. The reality is much grimmer than they can understand or comprehend. More than 7.5 million students competed in athletics last year at the high school level, while only

an approximate 400,000 students played at the college level (NCAA, 2009, NFHS, 2009; Rechel, Yard, & Comstock, 2008). When these numbers are divided by the standard four year university, an estimated 100,000 students will leave college or be replaced each year to make room for incoming students to play. A more staggering statistic is, of the number of college athletes playing in 2007-2008, an approximate 1 percent of college athletes will ever make it to the professional level (NCAA, 2009).

Table 1

Likelihood of Advancement in Sports

	High School Seniors that Move on to Play in College	College Seniors that get Drafted to Play Professionally
Boy's Basketball	1 out of 35 = 3.1%	1 out of 75 = 1.2%
Girl's Basketball	3 out of 100 = 3.4%	1 out of 100 = 0.9%
Football	1 out of 17 = 5.8%	1 out of 50 = 1.8%
Baseball	3 out of 50 = 6.4%	9 out of 100 = 8.9%
Boy's Hockey	11 out of 100 = 10.9%	1 out of 27 = 3.7%
Boy's Soccer	3 out of 50 = 5.5%	1 out of 50 = 1.6%

Note: All numbers are approximates based on 2009 NCAA information

What these statistics show is it is highly unlikely any athlete will ever have a chance to play professionally, but what they do not show is there is a significant number of young athletes who will never reach this level because their lives have been altered by a serious injury.

Approximate 3-11 percent of students participating in high school sports will sustain an injury that requires medical attention each year, depending on the sport they play (Sharma, Luscombe, & Maffulli, 2003). Many of these injuries are brain related head injuries and will have life long effects on the student and can dramatically alter their course life after high school.

Statement of the Problem

Mild, severe, and traumatic brain related head injuries affect the way student-athletes will progress through their lives. In some cases, a role transition from athlete to non-athlete becomes the central point in which the individual's focus is altered due to the severity of the injury. The fallout of this change can result in a variety of outcomes, including an imbalance in emotional state, dependence or addiction to medications or drugs, and uncertainty regarding rehabilitation and recovery times, including the risk of permanent disability.

Purpose of the Study

The purpose of this study is to describe how brain related head injuries that occur during amateur athletics could be detrimental to the lives of student-athletes. This information can then be utilized to determine the scenarios in which the injuries will have occurred, while determining which sports lead to the most overall injuries. Additionally, the research will be used to determine if there is a point in which athletes should be informed of the potential injuries and disabilities. To that end, this study addressed the following research questions.

1. What is the nature and occurrence of brain related head injuries?
2. What impact can brain related head injuries have on future athletic participation?
3. What are the potential psychological impacts of brain related head injuries?
4. What are the potential long-term impacts of brain related head injuries?
5. What are the potential economic impacts of brain related head injuries?

Definition of Terms

The following definitions of key terms and concepts were adopted for the purposes of this investigation.

Ability to Compete after an Injury: The ability of a student-athlete to compete is always effected after a brain injury is sustained, whether it becomes permanent or short term. Some student-athletes learn to play with their injuries and understand their bodies better after the recovery from the injury is complete. Others will struggle through brain related head injuries, never being able to fully recover for a myriad of reasons and never reaching the goals they may have set for themselves.

Alzheimer's Disease: A brain disorder that destroys brain cells, causing memory loss and problems with thinking and behavior severe enough to effect work, lifelong hobbies or social life. Alzheimer's gets worse over time and is fatal, as there is currently no know cure.

Brain Damage: The permanent result of an injury to the brain, which limits the cognitive abilities of individuals throughout the remainder of their lives. Individuals with brain damage are limited in their abilities to perform daily functions and may need assisted living care.

Chronic Traumatic Encephalopathy (CTE): A progressive neurological disorder found only in individuals who have suffered some type of brain injury and is often mistaken for an early onset of Alzheimer's disease

Concussion/Mild Traumatic Brain Injury (MTBI): A mild brain injury, often resulting in temporary loss of normal brain function. Commonly, concussions occur from a blow to the head that can cause temporary disorientation, memory loss, nausea and vomiting, slurred speech, loss of coordination, feelings of anxiousness or being overly tired, and unconsciousness. It may result in permanent scarring and loss of cognitive ability.

Dementia: A usually progressive deterioration of intellectual functions, such as memory, which can occur while other brain functions, such as those controlling movement and the senses, are retained.

Economic Burden: The economic burden a student-athlete must bear is immeasurable at first glance. Some recoveries take a minimal amount of time or money, often requiring rest and noninvasive procedures. Severe brain related head injuries could cost between thousands of dollars and hundreds of thousands of dollars. The costs incurred could alter the lives of student-athletes to the point that they are unable to make a substantial living for themselves, even if they are able to return to their previous sport.

Emotional Effects: Often, emotional effects develop due to a loss of abilities or due to physiological changes within the brain and most commonly are defined by psychologists as depression. These emotional effects can delay student-athletes' return to competition or stop them from competing again. Repeated brain related head injuries, such as concussions, could lead to mental instability and the development of mental disorders.

Long Term Effects: Some of the long-term effects include emotional and/or psychological problems and physiological changes that take place as a result of the brain related head injuries. Long-term effects of brain related head injuries could multiply if the recoverability rate of an injury is low, if the re-injury rate is high or if new injuries to the area occur.

Loss of Identity Due to Inability to Compete: Most schools will honor a scholarship for a student-athlete who is no longer able to play due to injury, but many students struggle when the hyphen is removed from their scholastic title. No longer an athlete, students will be required to live up to certain expectations in the classroom they may not have noticed previously.

Sometimes they are unable to keep up, while other times they simply move beyond the game and into life.

New Injury to Old/Same Area: New injuries to the old/same area of the brain are not uncommon and are often the result of returning to practice or competition too quickly after the initial injury is sustained. These injuries often lead to increased damage and loss of functions.

Physiological Effects: The physiological effects of a brain injury can alter the healing process of other areas of the body that may be connected to the injured area of the brain. Brain related head injuries could also alter the way the body processes such things as liquids or foods and have a lasting effect on general health and well-being.

Post-Concussion Syndrome (PCS): In the period of time following a concussion where individuals may be susceptible to re-injury and feel lingering effects of the initial injury including decreased cognitive ability, as well as an increase in dizziness, headaches, memory loss, nausea, sensitivity to light, and vomiting.

Program/School Completion Rates if Injury Prohibits Further Play: Statistics show injuries which prohibit student-athletes from continuing their playing careers can lead to a depressive state which slows the desire of student-athletes in other areas, including their studies. For a large number of students, the desire to complete school programs or graduate is diminished and can result in a complete life change.

Recoverability Rate of Student-Athlete: The recoverability rate of a student-athlete is the determination of how fast a student-athlete's brain heals compared to the severity of the brain injury. The more severe a brain injury is, the more likely it is that the student-athlete will have a lower recoverability rate.

Re-injury Rate: The re-injury rate is determined by the amount of injuries a student-athlete endures during the course of his/her career and is divided by the amount of time in which the injuries take place. Often, a student-athlete who has a high re-injury rate is considered injury or concussion prone.

Severity of Injury: The severity of a brain injury is determined through medical procedures and can have an overall effect on the recoverability of a student-athlete. The more severe a brain injury is, the longer it will take to heal or the more rehabilitation it may take to regain normal cognitive processes. In worst case scenarios, the student-athlete suffers a permanent brain injury and disability.

Tau: A protein that maintains the stability of the microtubules that serves as a transport system within brain cells. It is also implicated in the formation of masses of fibrous protein in the brains of people with Alzheimer's disease. Also, it is common in research done to identify individuals with CTE.

Traumatic Brain Injury (TBI): The result of a severe impact to the head or brain resulting in loss of nervous system control and bodily functions. Individuals who suffer TBI's have a very low percentage of recovering and leading a normal life, although some have recovered and have been able to remain functioning members of society.

Unforeseen/Immeasurable Effects from Injury: Often unforeseen or immeasurable effects from injuries are the hardest to cope with for student-athletes and/or their families. For some student-athletes, there is a developed dependence on pain killing or steroid-type drugs to aid in the recovery or coping process. There is also abuse of alcohol or other non-prescription drugs that student-athletes may take part in to aid them in coping with the injury. Others may take their own lives because they can no longer be the person they had envisioned themselves

becoming. All of these effects can be linked to depression and the psychological effects of life change.

Chapter 2: Review of Literature

The purpose of this study was to describe how brain related head injuries that occur during amateur athletic activities could impact the lives of student-athletes. More specifically, it sought to portray the nature of brain related head injuries and the conditions under which they occur. The study also tried to depict potential psychological, economic, and long-term impacts that brain related head injuries can have on student athletes. The following review of literature addressed the nature of athletic injuries and their effects on the brain. It also included the effects that these injuries have on the student-athlete's course of life, psyche, future athletic participation, and economic status.

Rationale

The reason for researching the effects on the lives of student-athletes due to severe brain related head injuries comes not only from the number of participants in amateur athletics being at an all time high, but also because the number of overall severe injuries is on the rise (NCAA, 2009, NFHS, 2009, Mueller, 2007). Identifying these injuries, how they occurred and the potential related outcomes will provide insight into both how to prevent the injuries from happening and the approaches that can be used when addressing future occurrences and/or incidences. This information, along with information gathered about life changes, can be used to determine the overall effects of severe injuries on the lives of the student-athletes.

Injuries and Their Effects on the Brain

Brain related head injuries happen across all sports and between both genders. Statistics gathered and analyzed recently reported that 150,000 concussions/mild traumatic brain related head injuries (MTBI) were suffered last year alone in high school sports, which are far more common than other types of brain related head injuries (Simon, 2009). However, these numbers

are thought to be conservative because of a reluctance report such injuries to coaches or athletic trainers (AT) by athletes (Crossman, Jamieson, & Hume, 1990, Knowles, Marshall, & Guskiewicz, 2006, Rechel et al., 2008).

Given that most athletes 13-23 are still growing into their bodies, the research shows an initial brain injury at 13 years old could plague them for years to come. This is because the damage to the prefrontal cortex never heals completely (Franklin Institute, 2004). This type of brain injury is most common and most recurrent during MTBI. Unfortunately, how these injuries slow an athlete, both physically and mentally, can take a great deal of time to determine, but diagnostic evidence being compiled at the University of North Carolina and the University of Pittsburgh has begun to link the amount of trauma athletes sustain to their brain to the progression of several deadly and debilitating diseases (Gladwell, 2009, Gregory, 2010, Simon, 2009). The evidence available shows certain sports or activities are capable of causing greater or less harm to an individual's brain (Darrow, Collins, Yard, & Comstock, 2007, Gladwell, 2009, Mueller, 2007, New York Times, 2010, Rechel et al., 2008). Football has historically been the most detrimental sport to the brains of its participants, yet each year enrollments in football, as well as all sports, go up (Mueller, 2007, NFSA, 2009, Rechel et al., 2008).

There is no way to predict when a brain injury will take place, and, in most cases, when injuries do take place, they are commonly unavoidable. Often the result of two individuals colliding is rarely considered one individual's fault. Regardless of intent, the unfortunate effects on the individual can be initially or eventually catastrophic. Research has provided a wealth of scenarios and information to reinforce the brutal nature some of the sports offer to competition (Mueller, 2007, Rechel et al., 2008).

Unexpected Changes in Life Course

Anytime student-athletes endure a physical injury, it requires that they adapt their lifestyle in some way to accommodate it, even if this change may only affect a person for a short period of time (Franklin Institute, 2004, Mueller, 2007). In the case of brain related head injuries though, a complete shift in the student-athlete's life course, starting immediately after the injury, takes place with the possibility of continuing into adult life. There is evidence to show the slowed development of intelligence and increased development of learning disabilities in youth who have suffered brain related head injuries early in their lives. Additionally, these injuries have been linked to the impairment of emotional control, personality changes, and decreased social acceptability standards (Franklin Institute, 2004).

Many of the changes that will take place in the life course of a student-athlete will not come until after his/her playing days are through. These changes can be small, from changes in diet and exercise, to serious cognitive and psychological ailments which limit the former student-athlete's ability to continue to make a living or function in society (Franklin Institute, 2004, Gladwell, 2009, Gregory, 2010, Nack, 2001). In some cases, the brain related head injuries former student-athletes sustained have been linked to suicide, although specific reasons for suicide have not been determined (CDC, 2007, Gladwell, 2009, Sabo, Miller, Melnick, Farrell, & Barnes, 2005, Zhang, 2000).

Injuries and Their Effects on the Psyche

Research regarding the effects on the confidence and overall psyche of an individual who has suffered a brain injury is difficult to locate because it is often not differentiated from general studies on the psyche of student-athletes. Still it is pertinent to the discussion of the effects of

brain related head injuries as it differs from life course and brain injury, while still being directly related.

Information regarding the benefit of participation in sports, both academically and socially, is wide ranging (Burnett, 2001, Ferris, Finster, & McDonald, 2004, Whitley, 1999). According to an article in the *College Student Journal*, it is stated that experiences gained in athletic participation influence student-athletes in many areas of their future lives, including job satisfaction and life satisfaction (Serbu, 1997). However, what if that opportunity is taken away?

Of the information available, most of it addresses the socio-psychological effects of injuries, both in the immediate and on-going years. Some of this research focuses on the sensation seeking or reclusive behaviors many student and professional athletes undertake because of the absence of competition (Gregory, 2009, Simon, 2009, Smith, Ptacek, & Smoll, 1992). Other research attributes behavioral shifts to the lack of emotional stability the student-athlete is going through (Crossman, Jamieson, & Henderson, 1987, Hildebrand, Johnson, & Bogle, 2001, Quackenbush & Crossman, 1994).

Information regarding injuries that have the most affect on student-athletes is dependent upon the amount of time required to recover or the level of brain trauma the student-athlete has gone through previously. At least one author stated injuries that require six weeks or less to recover from consistently show full recovery physically and partial recovery psychologically (Smith et al., 1992). Information provided in a more recent study by the University of North Carolina, states brain related injuries may not heal properly during a six week period of time and will lead to additional damage being done to the prefrontal cortex and, possibly, other regions of the brain (Franklin Institute, 2004, Gladwell, 2009). Additional research on this information

provides a deeper understanding of the difference between minor and major, or severe, brain related head injuries (Comstock, Knox, Yard, & Gilchrist, 2006).

Further investigation into the effects of a student-athlete's psyche refers back to the discussion of suicide rates. As stated previously, without direct knowledge of the reasoning behind suicide, there can be a great deal of speculative conversation taking place (CDC, 2007, Gladwell, 2009, Sabo et al., 2005, Zhang, 2000). All suicides discussed were associated with some sort of emotional imbalance, although the suicide conversation has been stifled because there has not been a specific association sports related head injuries and suicide rates.

Injuries and the Athlete's Future

The athlete's future is hard to determine. Much of the secondary and post secondary data that does exist provides little to no indication of the individual who is being examined or researched due to privacy laws. Possible outcomes for student-athletes can be generalized based on the location of the brain injuries and its severity, but it is limited because of the lack of a standardized procedure for monitoring brain related head injuries. Much of the research conducted focuses on immediate outcomes, with little reference to long-term (10 years or more) potential outcomes of the student-athletes (Franklin Institute, 2004, Gladwell, 2009). This is because many of the student-athletes' windows for participation is limited by their age, their ability to recover from injuries, which decreases as they get older, and their further participation in sports beyond the collegiate level (Crossman et al., 1990, Kvist, Ek, Sporrstedt, & Good, 2005).

New research is being developed at the University of North Carolina and the University of Michigan Institute for Social Research, with a specific focus on the effects of impacts on the head of a student-athlete takes and the potential for damage based on those impacts. The Boston

University School of Medicine is also doing research on donated brains, some from former professional athletes including boxers, wrestlers, and football players. They hope to grasp the full consequence of each hit by determining the full effects of the trauma these athletes suffered throughout their careers (Gladwell, 2009, Simon, 2009).

In addition to the health aspects of brain related head injuries, the academic performance of the athletes after they have suffered the injury is questioned. The NCAA does provide information on the graduation rates of Division I and II student-athletes, as well as students in general, on their website in documented form. The difficulty of using this information is that it does not differentiate between the students who left or failed out of school, either due to an injury or not, and those who completed school even though they had an injury. What can be deduced though is that both general students and students-athletes who suffer from brain related head injuries are likely to struggle with their coursework and/or miss classes on a regular basis, affecting their overall academic performance (Ferris et al., 2004, Gayman, & Crossman, 2003, Quackenbush & Crossman, 1994, Rishe, 2003, Whitley, 1999). This being said, there is also a solid base of information regarding student-athletes' continuation in athletics beyond their current level after sustaining a severe brain related head injury. Some of the information regarding these cases can be individualized, allowing for further interpretation but not providing an overwhelming amount of generalization based on each injury (Brooks, Schiff, & Rivara, 2009, Crossman et al, 1987, Finch, Little, & Garnham, 2001).

The Economic Effects of Injuries

Overall costs associated with brain related head injuries are not easily determined because they may be specific to each case or are dependent on the athletic trainer, doctor or hospital policy. Policy dictates whether some doctors or hospitals require a CT scan, while others

a MRI or X-Ray. Some require a 24-hour observation, while some brain related head injuries do not require a hospital visit at all. Emergencies and the cost of an ambulance trip are dependent on municipality, region, and/or state. When factoring in the differentiating coverage of insurance policies, numbers can become more varied or skewed. Unfortunately, this is true for almost all types of injuries student-athletes sustain (radiologyinfo.org).

The difficult aspect of trying to factor the costs of a brain related head injury is there is no guarantee one treatment will be enough. It has been determined there is no cure for MTBI or TBI or the potential additional disorders caused by either of these injuries (Franklin Institute, 2004, Gladwell, 2009). This renders the individual incapable of determining the full cost of the injury.

Chapter III: Methodology

The purpose of this study was to describe how brain related head injuries that occur during amateur athletic activities could impact the lives of student-athletes. More specifically, it sought to portray the nature of brain related head injuries and the conditions under which they occur. The study also tried to depict potential psychological, economic, and long-term impacts that brain related head injuries can have on student athletes. The following review of literature addressed the nature of athletic injuries and their effects on the brain. It also included the effects that these injuries have on the student-athlete's course of life, psyche, future athletic participation, and economic status.

Research Design

This inquiry was essential synthesis study that used information gathered from the professional literature to describe how brain related head injuries that occur during amateur athletics are detrimental to the lives of students and how their lives are affected because of the injuries. The information gathered highlighted the type of brain related head injuries being suffered and the occurrence of such injuries. The remaining information gathered addressed a variety of aspects of a student-athletes future, including role transition, the central point by which a student-athlete's life course is altered due to the severity of the brain related head injury; imbalances in a student-athlete's emotional state, which can possibly lead to drug use or psychotic behavior; and, often, the substantial physical damage to the brain itself.

The design of this study focused on the analysis of information gathered with the intent of addressing the key question, "How are brain related head injuries that occur during amateur athletics detrimental to the lives of students-athletes?" More specifically, the study addressed the following research questions.

1. What is the nature and occurrence of brain related head injuries?
2. What impact can brain related head injuries have on future athletic participation?
3. What are the potential psychological impacts of brain related head injuries?
4. What are the potential long-term impacts of brain related head injuries?
5. What are the potential economic impacts of brain related head injuries?

The research questions were used as tools to narrow the scope of the variables in this research and provide a better understanding of the effects of brain related head injuries on the lives of student-athletes. Specific emphasis was placed on the changes student-athletes have made due to their individual brain related head injuries, their recovery from the stated injuries and the likelihood of either re-injuring or developing a new injury to a similar area of their brains. The information was then analyzed to determine potential patterns of brain related head injuries, recovery, re-injury and how the injury has changed a student-athlete's life.

Scope

The subjects who were the center of this study ranged in age from 13-23 years old, with the focus being on secondary and post-secondary student-athletes. The subjects were chosen from the previously gathered information. Although no precise verification of individuals could be provided, these individuals would likely have been chosen previously based on participation in school sponsored athletics with a high level of anonymity or by volunteering themselves or by their families. The student-athletes chosen consisted of both sexes, varying within the given age group and coming from a variety of economic, educational and social backgrounds. Additional information was researched regarding youth participants and former professional athletes' cases and injuries, which was provided through multiple references, either voluntarily or by the

families, respectively. These participants' information was utilized to show early and long-term effects of brain related head injuries.

Information Sources

The research was conducted by reviewing a variety of different case studies, pilot studies, scholarly articles and journals, topic-related books, national media news articles and government information in an attempt to distinguish the similarities between different amateur athletics to brain related head injury ratios and the effects of those injuries on the long term health and life course of student-athletes. This information was used further, after the associated research was completed, to describe sociological, economic and psychological effects of the indentified brain related head injuries and during the analysis of potential outcomes for groups of student-athletes suffering severe brain related head injuries. Unfortunately, due to the absence of an independently conducted study, the research was based solely on the aforementioned resources.

Data Collection

The resources' information was selected based on its relevance to the subject matter and the individual resource's use of multiple participants to gather a compilation of information. Pertinent data was collected from these sources by filtering a series of scenarios and/or situations student-athletes have encountered while suffering and recovering from a mild or severe brain related head injury. This data was then analyzed and applied to other corresponding information to provide a concise representation of the facts and outcomes of each case regarding the effects brain related head injuries have on student-athletes. The steps used to analyze date are as follows:

1. Gather information from a variety of sources.

2. Identify case studies, pilot studies, scholarly articles and journals, topic-related books, national media news articles and government information with applicable information to research project.
3. Collect data from the case studies, pilot studies, scholarly articles and journals, topic-related books, national media news articles and government information that can be used to reinforce the hypothesis and develop and answer to the problem statement.
4. Identify and filter data, breaking information into groups and subsets based on relevance to specific scenarios and/or brain related head injuries.
5. Compile all additional information and apply it to information obtained in case studies, pilot studies, scholarly articles and journals, topic-related books, national media news articles and government information.
6. Create a definitive finale in which pertinent information is developed and described with intent to answer or further describe on the original problem statement.

Data Analysis

Factual and statistical data was gathered from case studies, pilot studies, scholarly articles and journals, topic-related books, national media news articles and government information and presented at the end of the research in the form of statistical tables and explanatory paragraphs to show the information gathered. Each paragraph attempted to completely address the questions raised during the design and instrument section of the methodology. Additional data was added to these paragraphs based on relevance and was used to analyze all the applicable information. This information was further used to define each scenario and the outcomes found to be most common among them. Each piece of applicable evidence was used to create the summary of

facts. The culmination of the data gathered was used to reinforce the summary of facts and develop answers to the questions in the problem statement for review.

Limitations

The lack of individually gathered and/or surveyed local information made the overall information hard to link to regional student-athletes. Even though this was not part of the original task, being able to verify the information with local school athletic departments may have allowed for a greater total understanding of the types of brain related head injuries and how to prevent them. Much of the compiled information comes from a variety of studies that gathered information from schools in California, Illinois, New York, North Carolina, and Texas. Although these states do make up the majority of students competing in athletics, and knowing there are few differences in the rules of the sports nationally, local information would have allowed the research to verify or refute the validity of the results nationally.

Although a great deal of weight was placed on analyzing the primary effects of brain related head injuries, the addition of professionally trained psychological staff would have been a large asset in delineating potential outcomes more efficiently. This is primarily because many of the long-term non-physical effects can only be viewed from an outside perspective until after death, when a brain can be exhumed and examined completely. Practicing psychologists and psychiatrists would have been able to provide a deeper level of insight to the emotional and psychotic tendencies of student-athletes who have suffered brain related head injuries.

Chapter IV: Results

This study tried to determine and describe how brain related head injuries that occur during amateur athletics are detrimental to the lives of students and how their lives are affected because of the injuries. The information gathered highlighted the types of brain related head injuries suffered and the occurrence of such injuries. The remaining information gathered addressed a variety of aspects of a student-athlete's future, including role transition as their life course was altered due to the severity of the brain related head injury, imbalances in a student-athlete's emotional state and psychotic behavior leading to drug and alcohol abuse, as well as the substantial physical damage to the brain itself. Findings were developed after analysis of related case studies, pilot studies, scholarly articles and journals, topic-related books, national media news articles, and government information had been completed and information had been gathered.

The subjects who were the center of this study primarily ranged in age from 13-23 years old, although younger and older individuals were incorporated, and had competed in secondary and post-secondary athletics during the time the research had been completed. The participants were chosen from previous case studies, pilot studies, scholarly articles and journals, topic-related books, national media news articles, government information and information compiled by researchers and would likely have been chosen at random, unless information was volunteered. Additionally, these participants would have been previously chosen from a wide demographic consisting of both sexes, while varying within the given age group, and coming from a diversity of economic, educational and social classes. All information provided by professional athletes was in part due to studies being conducted by members of neuroscience departments at the Boston University School of Medicine, the University of North Carolina and

the University of Michigan Institute for Social Research and in part due to the severe cognitive, psychological and social issues they were having.

Nature and Occurrence of Brain Related Head Injuries

Brain related head injuries can rarely be predicted and, in most cases, are unavoidable and are the result of no one individual's fault. They can occur during a number of activities or exercises and can be caused by varying levels of impact (Gladwell, 2009, Gregory, 2009). For the brain to become injured, it needs to sustain an impact, often caused by a collision or something striking the head such a ball or by being spun unexpectedly and rapidly (Durani, 2007, Franklin Institute, 2004, New York Times, 2010). In contact sports such as football, ice hockey and wrestling, the incident rate of head injuries is predictably higher than other sports (Rechel et al., 2008.) Yet for all sports, mild traumatic brain injuries (MTBI) or concussions are a common side effect of modern day competition.

The Center for Disease Control states children aged 0 to 4 years, older adolescents aged 15 to 19 years and adults aged 65 years and older are most likely to sustain a MTBI, with males being more susceptible across all age groups. According to a 2008 study based on statistics from Reporting Information Online (RIO), MTBI made up the largest portion of competition based head injuries among athletes (Rechel et al., 2008). Additional statistics gathered nationally, place MTBI in secondary and post-secondary athletics at close to 3,000,000 yearly with 150,000 MTBI reported in high school sponsored athletics (Simon, 2009). When it is factored in that an estimated fewer than 50% of MTBI sustained were reported in football alone, that number jumps to well over 300,000 MTBI yearly in high school sports (Crossman et al., 1990, Gregory, 2009, Rechel, 2008).

Mild traumatic brain injuries are only one of several brain related head injuries student-athletes can suffer while participating in their respective sports. Additional injuries include, but are not limited to, cranial fracture, torn or broken blood vessels, blood clots, strokes, the development or rupture of an aneurysm, a severe traumatic brain injury or a catastrophic brain injury resulting in death (Durani, 2007, Finch et al., 2001, Mueller, 2007). Each brain related head injury should be treated with a trip to the doctor to determine the full effects or damage sustained. In some cases, immediate medical attention is easily identifiable and needed (Durani, 2007, Simon, 2009). The Brain Injury Association states the leading cause of disability and death among children and adolescence in the United States as traumatic brain injury (Franklin Institute, 2004).

Research has shown brain related head injuries were more likely to have occurred in individuals who were not in the proper physical shape to compete at the time they were injured (Sharma et al, 2003). This is likely because they had not taken the proper steps to prepare for a specific season and were forced to compensate physically or because they were coming back from other related or unrelated injuries which may not have been evident (Knowles et al., 2006). Further statistical evidence shows (Table 2) that the majority of brain related head injuries in high school sports are sustained during competition, when overall activity and physicality are higher (Rechel, 2008).

Table 2

Head Injuries Sustained in Practice versus Competition

Sport	Percentage of head injuries sustained in practice	Percentage of head injuries sustained in competition	Injury Proportion Ratio
Football	8.7%	12.0%	1.39
Soccer (Boys)	2.3%	15.6%	6.94
Basketball (Boys)	3.4%	3.7%	1.07
Wrestling	4.6%	6.3%	1.37
Baseball	1.8%	2.5%	1.42
Soccer (Girls)	9.7%	18.8%	1.93
Basketball (Girls)	3.3%	19.0%	5.83
Softball	8.9%	0.4%	0.05

Potential Impact on Future Athletic Participation

The recoverability rate of a student-athlete with this type of injury is hard to determine. Although, once the initial brain related head injury is sustained, it will never heal completely (Franklin Institute, 2004, Simon, 2009). If an individual sustains a MTBI, he/she is up to four times more likely to sustain another in his/her lifetime and up to eight times more likely to sustain subsequent brain related head injuries (Franklin Institute, 2004, New York Times, 2010). Each additional MTBI is life threatening. The damage will become worse and worse, even if not originally visible through the images of modern technology, and it can lead to the possibility of several deadly diseases forming within the brain (Franklin Institute, 2004, Gladwell, 2009, Gregory, 2009, Simon, 2009).

The length of time a player is out of competition depends on the medical staff on hand, the doctors and the desire of the player to return to competition. Injuries of all levels require time

to heal, but injuries requiring periods of time away from competition are of the greatest concern. Some brain related head injuries might be visible or have visible physical characteristics but still require time away from competition to heal (Rechel et al, 2008). Generally speaking, MTBI and cranial fractures often allow the student-athlete to return to competition after periods of lay off, but there are a number of cases that have resulted in the end of a student-athlete's career (Mueller, 2007). Brain related head injuries, such as blood clots or torn or broken blood vessels, may allow for an athlete to return to competition after some time, but they may also result in the end of the athlete's career. The more severe a brain related head injury is, the higher the likelihood is a student-athlete will never return to the same level of competition that he/she was capable of before the initial injury (Finch et al., 2001, Kvist et al, 2005). More severe, traumatic and/or catastrophic brain related head injuries often spell the end of a student-athlete's participation in athletics (Finch, 2001, Franklin Institute, 2004, Mueller, 2007).

Participation in amateur athletics by secondary and post-secondary student-athletes who have suffered a severe brain related head injury during the course of their athletic careers remains inconsistent, as it has for the last thirty years (Mueller, 2008, NFSA, 2009). The likelihood that someone would be able to continue to pursue a career in athletics after sustaining such an injury is based primarily on the severity of the initial brain related head injury and on a number of extenuating factors, most importantly being their desire to continue (Crossman et al., 1990, Junge, 2000, Quackenbush & Crossman, 1994, Smith et al., 1992). A student-athlete's continuation in athletics beyond his/her current level after sustaining a severe brain related head injury could rarely be individualized. This allows for little interpretation but does not provide an overwhelming amount of specific or generalized data to correlate with a specific brain related head injury (Brooks et al., 2009, Crossman et al, 1987, Finch et al., 2001). Student-athletes who

suffer from brain related head injuries or psychological disorders associated with brain related head injuries are likely to struggle with their coursework, especially if the effects of their injury are long term. They may also miss classes on regular basis; therefore further affecting their overall academic performance (Ferris et al., 2004, Gayman, & Crossman, 2003, Quackenbush & Crossman, 1994, Rishe, 2003, Whitley, 1999). A severe injury would decrease the likelihood the student-athlete would be able to continue to pursue his/her original goals.

Statistical evidence shows continuation in athletics after initial brain related head injuries has been scarce because information regarding specific athletes is not distinguished, but the NCAA and the National High School Alliance do provide detailed reports on the graduation rates of all student-athletes to show they graduate at a higher rate and have better attendance than regular students. It can be assumed that if a student-athlete who suffered a brain related head injury continued in their athletic or academic pursuits, they would then fall into those statistical categories.

Potential Psychological Impacts

Whether it is willingly or unwillingly, most mild and severe brain related head injuries result in a partial or complete modification of a student-athlete's lifestyle (Smith et al. 1992, Smith & Sparkes, 2008). Traumatic brain injuries (TBI) result in damage to the frontal lobe and prefrontal cortex of the brain, commonly from a single blow or repeated impacts, which took place over time. Typical results of frontal lobe and prefrontal cortex injuries are increased rates of psychological, health and functional problems (Bryant, 2008). This is done by blocking the passageways to the older portions of the brain, prohibiting the transfer of chemicals and slowing the transmission of neurons resulting in an increase in dead tissue, especially if repeated damage is done (Franklin Institute, 2004). This damage has been further shown to cause emotional and

behavioral changes in student-athletes of all ages as well as in professional athletes (Gladwell, 2009, Gregory, 2009, Simon, 2009).

Emotional and behavioral changes can range from minimal to severe with misdiagnosis commonly being administered to student-athletes on all levels (Bryant, 2008). Decreased spontaneity, decreased rate of habit or range of interests and loss of initiative may be early signs of depression or other severe mental disabilities. Other signs of emotional disturbances can be divided into two principle groups: 1) inhibition - apathy, narrowing of interests, flattered affect, withdrawal and 2) disinhibition - euphoria, impulsiveness without self-corrective action, irritability, uncommon anxiety and extreme or excessive use of obscene language (Lang, 2010). They may also be masking some form of other psychological disorder, which has gone undiagnosed due to the student-athlete's lack of desire to admit to the injury, or disorder (Crossman et al., 1990, Junge, 2000, Smith et al., 1992).

Frontal lobe and prefrontal cortex injury from competition have been shown to possibly lead to depression and anxiety a student-athlete did not have previously, which may result in behavior which was not previously expected from the student-athlete (Hildebrand, 2001, Long, 2010, Smith et al., 1992). Injury to this area early in life has also been linked to a decreased association with guilt, moral and social reasoning and an inability to grasp the concept of linear time or plan for the future. It has been found that individuals with this type of injury are more prone to commit violent crimes or act aggressively without regard to consequences (Franklin Institute, 2004, Long, 2010).

The absence of competition may also lead to the use of illegal drugs or to the consumption of alcohol to cope with the changing role and the loss of identity (Gregory, 2009). The student-athlete may also resort to the use of steroids or other performance enhancing drugs

in an attempt to recover and return to competition before he/she has completely healed (Smith et al., 1992). In some cases, the use of steroids and PEDs cause a further fluctuation in the student-athlete's emotional state (Gayman & Crossman 2003, Hildebrand et al, 2001, Quackenbush, 1994). There are a number of confirmed cases in which the use of these drugs, as well as alcohol and illegal drugs, has lead to death, suicide or attempted suicide (CDC, 2007, Sabo, 2005).

Potential Long-term Impacts

One disorder gaining recognition is chronic traumatic encephalopathy (CTE). CTE is a progressive neurological disorder found in people, not just athletes, who have suffered some sort of brain related head injury (Gladwell, 2009, Simon, 2009). The brain related head injury results in the development of tau protein, which systematically destroys brain tissue. It draws comparisons to Alzheimer's disease in that it starts with subtle behavioral, memory and personality changes, followed by the symptoms of disinhibition and extreme irritability. Eventually, the individual begins to fall into dementia and total loss of mental control before dying (Franklin Institute, 2004, Gladwell, 2009, New York Times, 2010).

Researchers believe that many CTE cases have been misdiagnosed as Alzheimer's. Recent evidence has shown an individual as young as 18 years old was suffering from CTE (Gladwell, 2009). Although information is still developing on CTE, slow but substantial progress is being made to determine if it is preventable. Unfortunately, there is no known cure for CTE, and the only way to determine if someone has it is to take cross sections of his/her brain after he/she is deceased (Gregory, 2009, Simon, 2009).

As stated above, another disease that can result from brain related head injuries is Alzheimer's. Alzheimer's, similar to CTE, destroys brain cells, causes memory loss and problems with thinking and gets significantly worse over time. Not to mention, it is fatal, as no

cure is currently known. Yet, a major difference is the existence of beta-amyloid, a protein similar to the tau protein, although, beta-amyloid is thought to be responsible for the onset of dementia. Both are present in the brain of an Alzheimer's patient after death, whereas only tau is present in the brain of a CTE positive individual (Franklin Institute, 2004, Gladwell, 2009, Simon, 2009). Further symptoms include behavioral changes severe enough to affect work, lifelong hobbies or social life. Unlike CTE though, Alzheimer's is not directly linked to brain related head injuries. Today, Alzheimer's is the seventh-leading cause of death in the United States (CDC, 2010, ALZ.org).

Additionally, damage resulting in lesions on the frontal lobe and prefrontal cortex may hinder the cognitive abilities of the individual suffering the injury. Cognitive deficits associated with lesions of the prefrontal cortex can vary in disturbances like in the regulatory role of speech or in visual tracking and scanning, especially on complex tasks or problem solving difficulties associated with disturbances in selective organization of mental activity with minor lesions. As well, it can vary in disturbances like decreased creativity or increased level of distractibility, especially by small noises or events when more severe lesions are present (Franklin Institute, 2004, Lang, 2010). They may also cause an increased intracranial pressure resulting in severe headaches.

Potential Economic Impacts

The economic burdens accompanying the recovery and/or rehabilitation period are unpredictable. Depending on the original costs of treatment, the medical professional providing services and the further determined severity of the brain related head injury; costs could vary greatly (radiologyinfo.org). Other types of physical injuries are often easier to diagnose and could be treated and healed for less than \$10,000, if no surgeries were required and hospital

visits were kept at a minimum (Baylor, 2000, Souryal & Adams, 2009). Severe brain related head injuries, including spinal cord injuries (SCI), may require thousands of hours of physical therapy, special machines or devices and permanent staff members to be assigned to assist in the recovery and daily life events or activities (Simon, 2009, Smith & Sparkes, 2008). Cost to student-athletes or their families is heavily reliant on the socio-economic environment the student-athletes come from, the types of insurance they or their families have and their dependence on others to get around (Baylor, 2000, Souryal & Adams, 2009).

Chapter V: Discussion

The purpose of this study is to describe how brain related head injuries that occur during amateur athletics are detrimental to the lives of students-athletes. A mild, severe or traumatic brain related head injury affects the way student-athletes progress through their lives. Some setbacks are short term or merely financial, but, often, the amount of recovery and rehabilitative time leads to a significant role transition. How the student-athlete's life is altered due to a brain related head injury could cause an imbalance in his/her emotional state, sometimes leading to illegal drug use, alcohol abuse or even emotional, behavioral and/or psychological instability, as well as the possibility of economic hardship.

Summary

The design of the study focused on the effects student-athletes faced due to the brain related head injury they sustained, their recovery from those injuries and the likelihood they could either re-injure or develop a new injury to the same area of their brains. The information was then analyzed to determine if there were distinguishable patterns of injury, recovery, re-injury and how the injury has changed the student-athlete's lifestyle.

The research was conducted by reviewing a variety of different case studies, pilot studies, scholarly articles and journals, topic-related books, national media news articles and government information to show the ratios between different athletic events, the occurrence of brain related head injuries and the effect they had on the lives of student-athletes. Furthermore, the research provided insight to sociological, economic and psychological effects the brain related head injuries had as well as the potential outcomes specific injuries had on the lives of student-athletes.

Because much of the research was based on case studies, pilot studies, scholarly articles and journals, topic-related books, national media news articles and government information, the scope of the variables in the study were easily controlled to provide a better understanding of the effects of brain related head injuries on the lives of student-athletes.

Conclusions

Based on the research conducted and the information gathered in this study, it can be concluded that brain related head injuries are unpredictable events that are almost always unavoidable. Evidence was conclusive that damage from the brain related head injury was permanent and could lead to additional brain health concerns, as well as general health concerns. There was evidence to illustrate more brain related head injuries occurred during competition than practice (Table 1.2). Some of the injuries were more likely to have occurred in individuals who were not in the proper physical shape or who were trying to come back from other injuries to quickly to compete at the time they suffered a brain related head injury. There was also a great deal of evidence to show many of the brain related head injuries that took place were not reported. For individuals who suffered repeated brain related head injuries, there was significant evidence to show future brain disease, including the potential for CTE and advanced Alzheimer's disease. The likelihood that student-athletes would continue to pursue a career in athletics after such an injury is based on a number of extenuating factors, most importantly being the severity of the brain related head injury and their desire to continue competing.

Brain related head injuries were also shown to result in life course changes for individuals who were temporarily unable to continue with athletics. Student-athletes who become connected to their identity will struggle to fill the void without the presence of competition while recovering from their injuries. For individuals who are incapable of returning

to their sport immediately, as well as those that have suffered repeated brain related head injuries, it is common to become more reckless, both physically and mentally, often taking risks and seeking thrills for the enjoyment it brings. Helping these students get through these difficult emotional times is important to the well being of the student in general.

The absence of competition may also lead to the use of illegal drugs, steroids or other PEDs. This is often done in an attempt to recover and return to competition before an injury is healed completely. There are a number of confirmed cases where the use of these drugs, as well as alcohol and other non-prescription types, has lead to suicide or attempted suicide.

The research also determined the economic burden may be great enough to end a student-athlete's pursuit of competition. Bills accumulated during the recovery and/or rehabilitation period may easily accumulate into the thousands of dollars or more, depending on severity. Minor brain related head injuries are often treated for less than \$10,000, primarily because no surgery is required. Other factors affecting the economic burden are the socio-economic environment the student-athletes come from, the type of insurance they have, and their ability to access transportation.

The study also verifies that participation in amateur athletics by secondary and post-secondary student-athletes will continue to grow, as it has done for more than 30 years. In other words, brain related head injuries would continue to occur. Graduation rates among student-athletes are consistently higher than the general student population, but statistics show very few high school seniors go on to play college or pro sports (Table 1.1), which would be the ultimate goal of any athlete. A student-athlete who suffers any such brain related head injury should utilize these statistics and consider turning his/her pursuits elsewhere. Many student-athletes will

struggle with the transition at first, but, if the injury occurs early in their athletic pursuit, they have the best chances of adapting and living a normal life.

Recommendations

Based on the research conducted and the information gathered in this study, it is recommended participants in amateur athletics, both coaches and athletes, need to prepare themselves better for brain related head injury prevention and awareness. Teaching proper techniques and recognition of injuries is something all levels of competition should embrace. Parents should also take a more active role in understanding the potential brain related head injuries their children may suffer.

There should be a greater emphasis on academic performance of student athletes and more accounting of their performances. Although statistics that are compiled by the NCAA and NHSA by sport and as a whole show a higher graduation rate for student-athletes than general students, they do not provide specific break downs for academic programs, positions (by sport) or for individuals who have suffered injuries during the course of their playing career. This information could be used to determine if longer periods of time were taken by a specific program, position or the injured athletes themselves to graduate or if they were able to complete their degrees in an acceptable amount of time.

Research must continue in the advancement of sports medicine to factor in changes in the games being played and the types of brain related head injuries that are being sustained. This includes the development of new, safer equipment to be used by all participants, similar to the Riddell Revolution helmets, with information readily available for view by the public. Specific sports should also factor in rule changes to eliminate potentially hazardous or more consistent exposure to brain related head injuries

An application for grant funding to conduct additional research should be started to develop a greater amount of information on types of head injuries and their effects, both regionally and nationally. Because much of the information is gathered from specific locations, it cannot be assumed it is consistent with all regional areas. Also, the research should be conducted on an individual case study basis to recover first hand experiences from student-athletes with severe injuries to be applied to both regional and national data. Regardless, proper physical preparation and practice are critical to reducing the high rate of brain related head injury occurrence.

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