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Effects of Cumulative Concussions on High School and College Athletes and Concussion Prevention Strategies

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Read and Approved by: Cathy Houston-Wilson

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Accepted by the Department of Kinesiology, Sport Studies, and Physical Education, The College at Brockport, State University of New York, in partial fulfillment of the requirements for the degree Master of Science in Education (Physical Education).

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Abstract

Concussions are a common injury that can occur at almost any time. There are many different causes of these injuries, but athletic participation is one of the most common. There are many different ways in which sustaining multiple concussions can have an impact on your overall health and well being not only immediately after the injury, but also moving well into the future. Although these injuries cannot be completely prevented in athletics, there are steps that we can take that can help to limit the number of these injuries in athletics.

Chapter One – Introduction

Recently, concussions have been an increasingly popular topic of research. In 2002, Chronic Traumatic Encephalopathy (CTE) was introduced to the world by Dr. Bennett Omalu, and made headline news a few years later because of the number of NFL players reporting having symptoms of CTE (Abreu, Cromartie & Spradley, 2016). Since all of the media attention, medical professionals and researchers have been much more curious about brain injuries. Their curiosity has led to many different studies and has helped to produce a vast amount of information on this fascinating topic. It is within the confines of that information that lies the information needed to understand what concussions are, how they effect our health, and how to prevent them as best as possible.

According to the Centers for Disease Control and Prevention (CDC), concussions have often been described as a mild form of traumatic brain injury, although there is nothing mild about concussions (CDC, 2015). Concussions may be caused by a bump, blow, or jolt to the head. They may also be caused by taking a hit to the body, which can lead to the brain moving rapidly back and fourth within the skull. The sudden movement of the brain caused by either a blow, bump, jolt, or hit to the body can cause the brain to bounce and twist within the skull, leading to chemical changes in the brain and also the potential of stretching and damaging brain cells (CDC, 2015).

Concussions can occur at just about any time. Some of the most common causes of concussions are falls, traffic accidents, fights, and participation in athletics. For the purpose of this synthesis, the focus will be on concussions caused by participation in athletics. According to a study done by the NCAA on concussions during the 2009-10

through 2013-14 seasons, the most common sports that produced concussions in collegiate athletics were wrestling, men's ice hockey, women's ice hockey, football, and women's soccer (Zuckerman, Kerr, Yengo-Khan, Wasserman, Covassin, & Solomon, 2015). In a similar study focused on high school athletics, the most common sports to produce concussions were football, boy's ice hockey, girl's soccer, boy's lacrosse, and girl's lacrosse (Broglio, 2017).

Coaches as well as athletes need to be able to recognize the signs and symptoms of concussions. According to the CDC, some signs one might observe in a concussed athlete could be that the athlete can't recall events prior to or after the hit or fall, they appear dazed or stunned, they forget basic information, they move clumsily, they answer questions slowly, they lost consciousness, or they show mood, behavior, or personality changes (CDC, 2015). Some symptoms of concussions in athletes are headaches, nausea, balance issues or dizziness, double vision, sensitivity to light or noise, feeling sluggish, hazy, foggy, or groggy, confusion, concentration, or memory problems, and just not "feeling right," or "feeling down" (CDC, 2015). If the concussion is severe enough, one might notice the concussed athlete has one pupil larger than the other, won't wake up from losing consciousness, headaches that get worse and don't go away, slurred speech, weakness, numbness or decreased coordination, repeated vomiting, convulsions or seizures, and unusual behavior, increased confusion, restlessness, or agitation (CDC, 2015). In the case that any of these signs are present, it is important to take the athlete to a medical professional right away.

The recovery process is extremely important when it comes to healing the brain. There is really no other way to treat a concussion other than rest. Physically, the athlete

needs to rest and not participate in their sport until medically cleared by their physician. They should also try to not participate in cognitive activities, as this may cause symptoms to become worse. When the athlete is feeling better and has been cleared by their doctor, it is important for them to return to play slowly. The athlete should always ease there way back in to their sport. The recovery process usually takes around 7 to 10 days, although it could be longer for young children and adolescents (McCroy et al., 2013). The reasoning behind wanting to return to play slowly and giving the brain the time it needs to heal is because of Second Impact Syndrome (SIS). According to the CDC, SIS occurs when an athlete has a second concussion within a short time frame of their previous concussion. SIS is a serious injury, as it causes rapid brain swelling, leading to coma or in some cases even death (CDC, 1997). For this reason, it is extremely important that athletes report when they think they have a concussion and wait as long as they need to recover. Another issue that athletes need to be aware of is post-concussive syndrome. Athletes who have a history of concussions are the most prone to enduring this syndrome. According to the CDC, post-concussive syndrome is when concussion symptoms tend to last longer than a week or two, and prolong for months or longer (2015).

Statement of the Problem

Concussions are a common, yet severe injury that can occur in multiple different sports. It is safe to assume that athletes participating in high school athletics or collegiate athletics have been participating in sport for a while, and could have had multiple concussions throughout their athletic careers. Sustaining multiple concussions throughout one's career can really have an impact on their health later on in their journey through life. We have seen numerous professional athletes have their careers ended due to

sustaining too many concussions, and some have even ended up passing away due to health complications related to recurrent brain injury. It may not be possible to prevent concussions from occurring in athletics, but it is possible to limit the numbers. If coaches and athletes were more knowledgeable about concussions, if athletes were honest about reporting potential concussion, if rules were always enforced, and if equipment is improved, the amount of concussive injuries can be reduced.

Purpose of the Study

The purpose of this synthesis is two-fold. The first is to review the literature on the effects of recurrent concussions in high school and collegiate athletes, and second to discuss concussion prevention strategies.

Operation Definitions

The following are operational definitions for this synthesis:

1. Concussion: Can be defined as a mild form of traumatic brain injury caused by a bump, blow or jolt of the head or a blow to the body that causes the brain to move back and fourth within the skull (CDC, 2015).
2. Traumatic Brain Injury: Can be defined as a brain injury that causes a disruption to the normal function of the brain caused by a bump, blow, jolt or penetrating injury to the head (CDC, 2015).
3. Chronic Traumatic Encephalopathy: Can be defined as progressive neurodegenerative disease that is caused by trauma to the brain (CDC, 2015).
4. Post-Concussive Syndrome: Can be defined as concussion symptoms that last up to three months or longer (CDC, 2015).

5. Second Impact Syndrome: when an athlete has a second concussion within a short time frame of their previous concussion. Can lead to coma or death (CDC, 1997).

Assumptions

The following can be regarded as assumptions for this synthesis:

1. The literature review was exhaustive and comprehensive.

2. The participants in the studies reviewed were reflective of the population the study was trying to look at.

3. The results reported in the studies reviewed were reflective of the population that the study was looking at.

Delimitations

This synthesis is delimited to:

1. Concussions as opposed to TBI as a whole.

2. Effects of recurrent concussions versus a single concussion.

3. High school and collegiate athletes only.

4. Male and female participants.

5. All sports, not sport specific

Limitations

Limitations of this synthesis are:

1. The available research on concussion prevention strategies.

Chapter Two - Methods

The purpose of this chapter is to review the methods used to find literature on the effects of recurrent concussions in collegiate and high school athletes, as well as ways to prevent these injuries from happening. The studies collected for the critical mass of this synthesis were identified using the EBSCO host database from the College at Brockport's Drake Memorial Library. Within the EBSCO host database, searches were conducted using the SPORTDIscus database, the CINAHL database, and the MEDLINE with Full Text database. From these searches, a total number of 12 articles met the criteria for inclusion as part of the critical mass in this literature review. For an article to be selected to be in this literature review, they needed to meet a certain criteria. To start, the articles needed to be peer-reviewed articles. If an article has been peer reviewed, it will most likely be of higher quality and also be more scientifically valid. Second, the articles needed to have been published between the years of 2000 and 2017. This helped to ensure the most current and up to date information available. Some other basic information used as background information and or supplemental information came from the Centers for Disease Control and Prevention website, www.cdc.gov, as well as through additional searches using the same criteria as articles included within the critical mass, and from the list of references of other related articles.

Many different searches were done to compile the list of 12 articles to be used in this literature review. The first search used the phrase cumulative effects of concussions and high school athletes, and college athletes. Only one hit came from this search, but it was an article that made the selection process. Search two used the phrase concussion effects in college athletes. This search provided 32 hits and one article was pulled to be

used in this literature review. The third search used the phrase reducing concussions in athletics. This search provided 15 hits, and one article was pulled to be used in this literature review. Search four was conducted using the search terms concussion history and effects. This search provided 22 hits, with one articles from those 22 being pulled for use in this literature review. Search five used the phrase multiple concussions and effects on brain. This search provided 25 hits, and one article was selected to be used in this literature review. Search six used the phrase multiple concussions and college athletes. This search provided 25 total hits, and two articles were selected for this literature review. Search seven used the phrase concussion prevention in sports. This landed 364 hits to start. To narrow the selection, college was added to the search to make it say, concussion prevention in college sports. By changing the search, 364 hits turned to 99, and one article was pulled to be used in this literature review. Search eight used the phrase cumulative effects and concussions. This search yielded 16 hits, and two articles were able to be pulled for use in this literature review. Search nine used the phrase NCAA concussion rates. This search provided 21 hits and one article was selected for use in this synthesis. The tenth search used the phrase referee and illegal activity. This provided only two hits, and one of the two articles was selected to be used in this synthesis.

Two other searches were conducted to find articles to be used for this synthesis, but not to be included within the critical mass of articles. The first search used one term, and it was the name Omalu. This provided three hits, and one of the three articles was chosen to be used in this synthesis. The second search used the terms CTE effects, which provided 9 hits and one article was selected for use in this synthesis. One last article that

was used in this synthesis but not included within the critical mass of articles came from the reference list of another article that is also not a part of the critical mass.

There were specific criteria that needed to be met in order for an article to be selected as part of the critical mass for this literature review. First, the article needed to be a peer-reviewed article. This helps to prove that the article is of good quality and it also helps prove the article's validity. The second criteria that needed to be met was that the articles needed to be published between the years 2000 and 2017. This ensured that the articles used in this synthesis provided the most current and up to date information available. The third criteria that needed to be met was that articles needed to be found using the online databases through the College at Brockport's Drake Memorial Library. This is important because this is where most of your scholarly articles are located, and scholarly articles usually hold more validity and reliability than other articles.

Other background information about concussions came from the Centers for Disease Control and Prevention website. With this being a government run webpage, it is safe to assume that the information provided is kept accurate and up to date. Background information was also found using the online databases through the College at Brockport's Drake Memorial Library. These articles were searched using the same criteria as articles included within the critical mass just to keep things consistent. Another article used but not included in the critical mass was taken from the reference list of an another article not included within the critical mass.

After completing 10 different searches and reading through hundreds of potential articles, a total of 12 were selected to be used in the critical mass of articles for this literature review. To find these articles, searches were completed using the EBSCO host

database from the College at Brockport's Drake Memorial Library. Within EBSCO, searches for articles occurred in the SPORTDiscus database as well as the CINAHL database and the MEDLINE with Full Text database. All but one of the articles chosen for this literature review came from the SPORTDiscus database. The other came from the CINAHL database. The specific journals that the articles were selected from were the Health Education & Behavior Journal, the American Journal of Sports Medicine, the Journal of the American Medical Association, Neurosurgery, Brain Injury, the Journal of Athletic Training, Injury Prevention, Athletic Training and Sports Health Care, Coaches PLAN, and the Journal of Clinical Sports Psychology. Each article selected to be in this literature review was carefully read over twice, the first just a run through and the second was where key information was pulled. This information was later put into a grid format. This helps to make it easy to search for similarities between the many different articles. The article grid also includes articles that were not included as part of the critical mass of articles, but are in the synthesis paper.

As the purpose of this synthesis states, the critical mass of subjects in all of the studies are limited to high school and college athletes. The trainers of these athletes were also important subjects throughout a few articles. There were a total number of 9,805 athlete participants across the many studies used in this synthesis. Based on the information provided, it was determined that there were 6,054 high school athletes and 3,751 college athletes included throughout the studies. Also, it could be concluded that there were 8,560 male athletic participants and 178 female. There were many more female participants, but many articles did not specify the exact amount of athletes from each sex. There was also a total of 8,287 athletic trainers involved in these studies. The

ages of the athlete participants ranged from early teens to mid twenties (13-24). The student-athlete subjects in these studies participated in many different sports, as it was not the purpose of this synthesis to look at one sport in particular. Although the purpose of this synthesis is to look at cumulative effects of repeated concussions, the participants in the studies used in this paper included both student-athletes with no prior history of concussions and student-athletes with a prior history of concussions. This allows for comparison with how the brain reacts after receiving your first concussion versus how it may react after receiving your second, third, fourth and so on.

Chapter Three – Review of Literature

The purpose of this chapter was two-fold. The first was to review the literature on the effects of recurrent concussions in high school and college athletes, and the second to review the literature on possible concussion prevention strategies. Specifically, the following topics will be reviewed:

- Longer recovery in athletes with a history of concussions.
- History of concussions can negatively effect an athlete's mental health.
- Athletes with a history of concussions will experience more on field severity markers.
- Athletes with a concussion history are more likely to experience future concussions.
- Reporting suspected concussions.
- Knowing the right time to return to play.
- Concussion education.
- Officials and rule enforcement to help prevent concussions in sports.

Effects of Recurrent Concussions in High School and College Athletes

Recurrent concussions in high school and college athletes can have an effect on an athlete's health later on in life, or presently in the moment. These effects can be anything from having more on field severity markers from a concussion, to still having symptoms months to years later. There were many studies that provided information on different effects that recurrent concussions can have on a high school or college athlete.

Longer Recovery in Athletes With a Concussion History

In a study conducted by Guskiewicz et al., (2003) researchers looked at cumulative effects associated with recurrent concussions in 2,905-college football players across all 3 NCAA divisions. Each athlete was baseline tested at their time of enrollment, and they used a Graded Symptom Checklist (GSC), and an wide-ranging health questionnaire. If an athlete suffered a concussion, these tests would be administered again at the time of the injury, 3 hours after, and then on days 1, 2, 3, 5, and 7 post injury. Their results suggested that athletes with a history of concussions led to a longer recovery process as it related to neurological functioning after receiving another ensuing concussion (Guskiewicz et al., 2003).

Similarly, in another study by Covassin, Stearne & Elbin III (2008), the researchers looked at concussion history and post-concussion neurocognitive performance and symptoms in collegiate athletes. Participants included 57 athletes, both male and female. 36 did not have a concussion history, and 21 had a history of two or more concussions. Each athlete participated in baseline ImPACT testing, and then went through the test again day one post concussion and day 5 post concussion. They found that college athletes who reported a history of concussions might take longer to recover on neurocognitive measures of verbal memory and reaction time as compared to athletes without a history of concussions (Covassin, Stearne, & Elbin III, 2008).

A study by Iverson et al., (2004) looked at cumulative effects of concussion in amateur athletes. There were 38 total athletes in this study. 19 had a history of three or more concussions and the other 19 had no prior concussion history. The athletes completed a baseline ImPACT test and a concussion history questionnaire. They were

retested within 5 days of suffering a concussion during their athletic seasons. The researchers found that athletes with a history of concussions had more unfavorable consequences in the acute recovery period, and scored lower on the memory testing two days after the most recent concussion then the athletes with only one concussion (Iverson et al., 2004). They also found that athletes with a history of concussions reported considerably more lingering of post-concussion symptoms, and that they performed marginally worse on preseason baseline memory testing than athletes without a history of concussions (Iverson et al., 2004).

History of Concussions Can Negatively Effect an Athlete's Mental Health.

In a study by McLeod, Bay & Snyder (2010), researchers looked specifically at how a self-reported history of concussions could affect health related quality of life (HRQOL) in 303 male high school athletes. Each athlete completed a demographic survey, a concussion history questionnaire, a Medical Outcomes Short Form (SF-36), and the Headache Impact Test (HIT-6) as a baseline test. These assessments were then administered again post concussion. They found that adolescent aged athletes with a self-reported history of concussions showed lower HRQOL on several subscales, which included scales related to mental health and a greater impact of headache on their general health. They also found that 66% of their group that had a history of concussions had an affected HRQOL even after a whole year since their last concussive injury (McLeod, Bay & Snyder, 2010).

Similarly, in another by Collins et al., (2002), researchers looked at the cumulative effects of concussion in 173 high school athletes. Baseline ImPACT testing was completed, and the test was administered again within 72 hours of an athlete

receiving a concussion. The researchers found that only 9.4% of the players with no concussion history showed lingering post injury mental status changes at the time of the injury, versus the 31.6% of high school athletes with a history of multiple concussions (Collins et al., 2002).

Athletes With a History of Concussions Will Experience More on Field Severity Markers

Another common effect on high school or college athletes was that athletes with a history of concussions are more likely to experience more on field severity markers than athletes with no prior history. Iverson et al., (2004) found that athletes with a history of concussions were six times more likely to experience post-traumatic amnesia and roughly eight times more likely to experience 5 or more minutes of mental status disturbance. Examples of this mental status disturbance could be post-traumatic amnesia and disorientation (Iverson et al., 2004). Similarly, Collins et al., (2002) found that high school athletes in which have a self-reported concussion history of three or more were more then nine times more likely to show signs of three or four on field abnormal markers of injury after an ensuing injury then students without any prior history. The markers of injury referred to are a loss of consciousness, anterograde amnesia, retrograde amnesia, and puzzlement (Collins et al., 2002). Anterograde amnesia is when a person can't create new memories post concussion, and retrograde amnesia is when a person cannot recall memories or information from before the concussion occurred.

Athletes With a Concussion History Are More Likely to Experience Future Concussions.

One last effect that was found to be a commonality between articles was that high school and college athletes with a history of concussions were more likely to experience potential future concussions. Iverson et al., (2004) found that athletes with a history of concussions seem to be more vulnerable to enduring another, more severe concussion down the road (Iverson et al., 2004). Similarly, Guskiewicz et al., (2003) found that athletes with a history of three or more prior concussions were three times more likely to endure another in game concussion then the athletes with no prior history (Guskiewicz et al., 2003).

Concussion Prevention Strategies

Concussions are an injury that will never be able to be completely prevented in athletics. With that being said, there are actions that one can take to help lower the concussion rates in the future for high school and collegiate athletics. After reading through the literature on the topic, there seems to be a few key factors that can help to aid in the prevention of these injuries.

Reporting Suspected Concussions

In an article by Kroshus & Baugh (2015) that looked at concussion education in U.S collegiate sports, 789 athletic trainers and 325 athletes completed surveys as they related to the current concussion education programs in place. The surveys were compared to see what the athletic trainers and student-athletes' thoughts were in regards to the current concussion education programs. From their research, the authors were able to conclude that the most important safety behavior that an athlete can control is to reveal

symptoms of a suspected concussions to a parent, coach, or medial personnel (Kroshus & Baugh, 2015). With that being said, there is an epidemic of student-athletes who do not report concussion symptoms to anyone.

Davies and Bird (2015) looked at motivations for underreporting suspected concussions in college athletics. 193 NCAA D1 athletes, both male and female, answered survey questions on the topic. They found that during the 2012-2013 athletic season, out of the 193 student-athletes, 45% did not report an assumed concussion to anyone at all (Davies & Bird, 2015). They also found some explanations for this underreporting of suspected injury. They found that the biggest reasons for not reporting were that student-athletes didn't think the concussion was serious enough, that they didn't want to have to leave a practice or game, and that they didn't know that they even sustained a concussion (Davies & Bird, 2015).

Although you can't prevent the original concussion, one can prevent the possibility of enduring an even more severe, and potentially fatal injury. If an athlete does not report a suspected concussion, and the injury hasn't had enough time to heal and they sustain another concussion, they could experience second impact syndrome. Also, less severe but just as important, an athlete may also experience lingering effects of a concussion for a long time. The student-athlete needs to be responsible and either reporting to a coach, parent, or medial professional when they believe that they may be concussed.

Knowing the Right Time to Return to Play

Knowing when to come out of an activity because of a potential concussion is important, but it is equally important to know when it is appropriate to return to play. For

the same reasons as reporting injury, you don't want to return to play too quickly and sustain another concussion before your prior one heals. Again, this is because you could experience the potentially fatal second impact syndrome and or other health related issues. Many different studies in this literature review used Immediate Post-concussion Assessment and Cognitive Testing (ImPACT) to determine if an athlete was ready to return to play.

The ImPACT test is a computer-based program that was created specifically for evaluating sports related concussions (Collins et al., 2002). For the ImPACT testing, each athlete has to do a baseline test so that after a concussion, they can compare the results to the baseline test to help in determining if recovery has occurred or if more time is needed. This test includes six modules and they are word discrimination, design memory, x's and o's, symbol match, color match, and three letters. These tests provide composite scores for verbal memory, visual memory, visual-motor speed, reaction time, and impulse control (Brooks et al., 2016). Also, the test includes a post-concussion symptom scale that is made up of 22 of the most common reported symptoms of concussions (Brooks et al., 2016). These symptoms are rated using a Likert scale ranging from a score of zero to six. A zero means that the athlete is not experiencing the symptom at all, with six being the most severe (Covassin, Stearne & Elbin III, 2008). Lastly, the test includes a concussion history questionnaire (Iverson et al., 2004).

The ImPACT test is a reliable measure of determining when a concussed athlete can return to play. This is because of the extensive validation, test-retest reliability, sensitivity, and specificity through many studies. With that being said, it is no surprise that the ImPACT test is a commonly used concussion assessment in high school, college

and professional sports (Covassin, Moran & Wilhelm, 2013). It is important to note that the recovery process for each athlete is going to differ. In a previously referenced article by Collins et al., they state that return-to-play decisions are difficult in that no two concussions are the same (Collins et al., 2002). With that being said, the ImPACT test is great for determining when an athlete should return to play because it works on an individual basis.

McLeod, Bay & Snyder (2010) assessed a student-athletes health related quality of life (HRQOL) by using three different assessments. They used a concussion history questionnaire, the medical outcomes short form (SF-36) and the headache impact test (HIT-6) (McLeod, Bay & Snyder, 2010). The concussion history questionnaire helps to determine the student-athletes concussion history. The SF-36 assessment is used to figure out information related to a student-athlete's physical functioning, role limitations due to physical health problems, bodily pain, general health perceptions, vitality, social functioning, role limitations due to emotional problems, and mental health. The HIT-6 assessment is a headache specific outcomes scale. It looks at pain, social functioning, role functioning, vitality, cognitive functioning, and psychological distress (McLeod, Bay & Snyder, 2010). In this study, adolescent aged athletes with a history of concussions scored lower on the bodily pain, general health perceptions, vitality, mental health subscales, and the mental composite score, which characterized observed shortages in those domains of HRQOL. This suggests that a concussion evaluation should be multidimensional and must consider all characteristics of an individual's health. It also suggests that being able to assess an athlete's HRQOL after a concussion could

potentially benefit doctors who work with school staff to carefully return student-athletes not only to their sport, but also to the classroom (McLeod, Bay & Snyder, 2010).

Concussion Education

Another prevention method that was a commonality between different articles was concussion education. Concussion education is becoming more popular as we begin to truly understand the severity of concussions. Being educated on the topic can help to reduce the amount of these injuries. Tator (2011) discussed the role of the coaches in regards to concussion education and prevention. He states that in sports, it is crucial to educate many different groups of people to improve recognition, management, and prevention of concussive injuries (Tator, 2011). The groups of people that he suggests receive continued education on the topic include the players, coaches, parents, trainers, referees, the sports organization or league, the media, schoolteachers, and health care professionals (Tator, 2011).

Kroshus & Baugh (2015) compared what college athletes were receiving for concussion education to what those athletes wanted to receive during those educational sessions. The authors found a divide between the current concussion education that athletes are receiving and what these athletes want, as far as content, source, and delivery method (Kroshus & Baugh, 2015). The authors also stated that if athletes take part in concussion education that is done properly, it has the potential to help reduce the public health burden of sport-related concussions (Kroshus & Baugh, 2015).

Similarly, another article by Zuckerman et al., (2015) looked at the epidemiology of sports-related concussions in the NCAA between the 2009-10 and 2013-14 seasons. They used sport related concussion data that came from the NCAA's Injury Surveillance

Program during those seasons. The researchers suggest that continual strengthening of concussion education procedures is necessary to increase a student-athletes' identification of concussion symptoms and their plan to report (Zuckerman et al., 2015).

Davies & Bird (2015) determined that the results of their study showed that student-athletes may lack knowledge of what a concussion is, as well as the potential effects they may have on your overall health and well being. They also suggest that athletic programs need to place a focus on educating their student-athletes on signs and symptoms of concussions, as well as the importance of self-reporting a suspected concussion or reporting a suspected concussion of another teammate (Davies & Bird, 2015).

Concussion education can play a big role in helping to limit the number of sports related concussions. If athletes were more knowledgeable about concussions and their severity, they may try to avoid any kind of play during a game that could result in a concussion. They may also begin to understand the importance of making sure to report a suspected concussion. Education can also help parents, coaches, trainers, officials, league representatives, and more become aware of the symptoms to look out for, how to take care of a concussed athlete, and how to determine when the athlete can return to play.

Officials and Rule Enforcement to Help Prevent Concussions in Sports

One last prevention method that was a commonality across the research was that officials need to be strict and enforce the rules to help in preventing not only concussions in sports, but also all other injuries. Collins, Fields, & Comstock (2008) looked at sports related injuries as they relate to illegal play in high school athletics. They used data from the 2005-06 and 2006-07 National High School Sports Related Injury Surveillance study.

The authors found that highest percentage of sports injuries caused by illegal play was related to head and face injuries at 32.3%. Of those 32.3% of head and face injuries, 25.4% were concussions (Collins, Fields, & Comstock, 2008). The authors' later state that illegal play is a commonly disregarded risk factor associated with sports related injuries. Also, they note that reducing illegal play by enforcing the rules may help to reduce sports injury (Collins, Fields, & Comstock, 2008). Similarly, Tator (2011) states that the rules of the game as well as the enforcement of those rules play a major role in sports injury prevention. He also states that education itself is not enough to generate a major reduction of neurotrauma, and that it must be supplemented by thorough recording of injury data, engineering enhancements, and rules introduction and enforcement (Tator, 2011).

Conclusion

The purpose of this chapter was two-fold. The first was to review the literature on the effects of recurrent concussions in high school and collegiate athletes. The second was to review the literature on concussion prevention strategies that could be used to help limit the amount of concussions in high school and collegiate athletics. After completing research on both purposes, it was discovered that there are many different effects that recurrent concussion can have on a high school or college athlete. Also, although there is no way to completely prevent concussions from occurring, the research shows that there are ways in which we can limit the concussion rates in sports. Although a concussion may be viewed as a mild form of a traumatic brain injury, they are not mild and shouldn't be treated as a mild injury.

Chapter Four – Results and Discussion

The purpose of this chapter is to present the results and discuss on the effects of recurrent concussions on high school and collegiate athletes as well as prevention strategies to help limit the number of these injuries in high school and college athletics. The literature review provided information in regards to effects as well as prevention strategies for these injuries. All of the information was reviewed, and following are the conclusions that were drawn.

Results

Concussions are a common sports injury that should not be taken lightly. They are serious injuries and need to be treated as such. Concussions occur frequently throughout high school and college athletics. It is important to understand how these injuries affect the overall health and wellbeing of the athlete. With that being said, there are some different ways in which concussions can affect the health of an athlete, especially if an athlete has a history of concussions.

First, the research suggests that an athlete who has a history of concussions may take longer to recover from another concussion. Their neurocognitive functioning will take longer to recover then an athlete without a history of concussions. Memory and reaction time are examples of what will tend to take longer to recover in an athlete with a history of concussions (Covassin, Stearne, & Elbin III, 2008).

Another effect of repeated concussions in high school and college athletes is that repeated concussions can have an impact on the HRQOL of an athlete. HRQOL is referring to an athlete's mental health status and impact of headache. Research suggests that athletes with a history of concussions will score worse on the mental health and

impact of headache assessments, even up to a year after their last concussion (McLeod, Bay & Snyder, 2010).

A third effect of repeat concussions is the increased likelihood of experiencing on field severity markers when sustaining another concussion. These markers include loss of consciousness, anterograde amnesia, retrograde amnesia, and puzzlement (Collins et al., 2002). If an athlete experiences any of these severity markers, it is important to get them to a medical professional right away to be evaluated.

The final effect of repeat concussions is that an athlete with a history of concussions is more likely to experience a future concussion than an athlete with no prior history. Research suggests that athletes with a history of concussions are more vulnerable when it comes to receiving a future concussion (Iverson et al., 2004). Athletes with a history of concussions may have an increased risk for future concussions in their sport, but concussions don't always occur in sport.

Concussions can really have an impact of the health of an athlete. Unfortunately, concussions are an injury in sports that will never be able to be fully prevented. The good news is that there are steps that we can take to lower the concussion rates in sports in the future. It is important that these steps be followed to help in the prevention of these serious, yet common injuries.

First off, it is important for a high school or college level athlete to report to someone if they feel that they are experiencing concussion like symptoms. Not coming out of a game and continuing to play can put an athlete at risk of sustaining a more severe, even potentially fatal injury. The athletes need to be responsible and do their part

in keeping themselves safe by reporting their potential concussions (Kroshus & Baugh, 2015).

Another step that can be taken to prevent these injuries is to make sure that the athletes go through an extensive return to play protocol. Returning to play before you have fully healed can have the same negative effects on an athlete as not reporting their potential symptoms to someone. For that reason, coaches, trainers and medical professionals want to make sure that you return to play when you are fully healed. There are many different tests that can be done to determine if an athlete is ready to return to play, but the most popular test seems to be the ImPACT test. This test uses computer modules, as well as a concussion symptoms scale and a concussion history questionnaire to determine when an athlete is ready to return from a concussion (Brooks et al., 2016). Other assessments that could help with this could be related to an athletes' HRQOL, such as the SF-36 and the HIT-6 assessments (McLeod, Bay & Snyder, 2010).

A third step that can be taken revolves around concussion education. If athletes, parents, coaches, trainers, officials and more are more educated on concussions, how they occur, their symptoms, how they actually affect the brain, the importance of reporting, importance of the return to play protocol, and so on, these injuries could be prevented just from knowledge (Tator, 2011). Also, the concussion education we are providing today needs to be revamped. Research suggests that there is a divide between the current concussion education that athletes are receiving and what these athletes want, as far as content, source, and delivery method (Kroshus & Baugh, 2015). The educational materials need to be presented in a way that is beneficial to everyone, and all topics need

to be covered with equal importance in order to be beneficial to all parties in helping to prevent these injuries.

A final step that can be taken to help in preventing concussions in high school and college athletics is for officials to strictly enforce the rules of the game. If the officials are letting the players play, they may be getting away with illegal activity that should be penalized. These plays can lead to not only concussions, but many other kinds of injuries as well. Calling a tight game and being strict when it comes to rule enforcement will show athletes that they aren't going to be able to get away with any illegal play. This in turn, will hopefully lead to less illegal activity, resulting in a safer game (Collins, Fields, & Comstock, 2008).

Discussion

As the research shows, there are many different ways that sustaining repeat concussions can impact your overall health and wellbeing. The research also shows that concussions are a prevalent sports injury in both high school and college athletics. Although we can't completely eliminate concussions from athletics, the research provides us with many different ways to try and limit these injuries and to prevent them from occurring again. It is unfortunate that most prevention methods are things you can do once an injury has already occurred, but that is just the nature of the beast. These injuries can affect not only high school and college athletes, but also many other different groups of people as well.

The findings of this synthesis may also be useful outside of athletics. A physical education teacher could benefit from the findings of this synthesis as well. In the physical education setting, there is an increased risk of concussion because of the participation in

sport or recreational activities. If the physical education teacher is educated on the topic and keeps up to date with the most current information, they can help to limit the number of concussions that may take place their class, and know how to address a concussion situation properly when one occurs. Although that is just one example, these results can be beneficial to multiple different groups of individual

Based on the literature review, education is a key tool in helping to prevent concussions. There were a couple of articles that talked about education, one discussing the importance of education and how it could be beneficial to help prevent these injuries, and another that discussed how in the NCAA, the concussion education program is not beneficial to the athletes who take part in it. Although they are saying that the education is not beneficial, they do suggest that education is important. This article suggests revamping the education program by making sure to hit on all of the content areas as well as delivering the content in a way that the student-athletes will retain the information. Other then this, there were no other real contractions found within the results.

Chapter Five – Recommendations for Future Research

The purpose of this chapter is to present recommendation for future research related to the effects of repeat concussions in high school and college athletes, as well as to prevention strategies used to help limit the number of these injuries. Although brain injuries have been an increased topic of interest for many researchers, there are still areas that are lacking information. These areas should be examined further to help us better understand this fascinating topic.

The first recommendation for future research would be to conduct more longitudinal studies with high school and college athletes with and without a history of concussion. Most longitudinal studies have been done with professional and ex-professional athletes. Although helpful, the majority of the population does not play professional sports and their playing careers ended after either high school or college. Having this information will help to provide more possible long term effects of concussions during high school and college athletics. Also, much of the information found only provided information up to a year post injury.

Another recommendation for future research would be to look more in depth as to when a concussed athlete can return not to play, but to school. An athlete will usually return to school before returning to play. If an athlete returns to school before their brain has had enough time to heal, their schoolwork and the brainpower that it requires could potentially make concussion symptoms worse and potentially postpone the athlete's return to play date.

One last recommendation for future research would be for someone to look into the possible benefits of a universal concussion education curriculum that works like the

current common core curriculum across all K-12 school districts in the United States. It would be ideal to have two separate curriculums for both high school and college to make sure the information is being presented in an age appropriate way. If both levels work together to create this curriculum along with the help of many medical professionals, this could be something that could have the potential to be extremely beneficial in helping to limit the amount of concussions in high school and college athletics.

Appendix

Synthesis Article Grid

Authors (Year)	Title	Source	Purpose & Participants	Methods & Procedures	Analysis	Findings	Discussion
Emily Kroshus & Christine M. Baugh (2015)	Concussion Education in U.S. Collegiate Sports: What is Happening and What do Athletes Want?	Health Education & Behavior 2016, Vol. 43 (2), Pages 182-190	Purpose was to determine the content & delivery modalities of the concussion education currently provided to U.S. collegiate athletes. Also, purpose was to report what a sample of athletes would like the concussion education delivered by their institution to look like in	Surveys were used to collect data from the athletic trainers. They completed questions that characterized the concussion education provided to athletes at their institution. The athletes completed questions starting with the stem "If you were in charge of designing	Data analysis was done through the use of Pearson's χ^2 tests to determine if there are differences in source preferences attributable to individual as opposed to role characteristics.	Based on the answers provided in the survey to both AT's and athletes, percentages were created to represent the findings. There are too many to put in to the grid! Basically what they found was that education is most often provided by the AT but that athletes would like to have coaches	Concussion education for athletes can really help reduce public health burden of these injuries. In the format of the information, there was difference between what athletic trainers reported was being delivered and the expressed preferences of the athletes surveyed

			terms of content, source, and delivery modalities. Participants included 789 athletic trainers from 276 schools & 325 athletes from 4 schools.	concussion education for athletes at your school . . .” They were asked who they would want to deliver the information and how they would want it delivered.		and physicians to be involved in process. Athletes also suggested a preference for content provision across many topics.	.
Tracey Covassin, Ryan Moran & Kristyn Wilhelm (2013)	Concussion Symptoms and Neurocognitive Performance of High School and College Athletes Who Incur Multiple Concussions	The American Journal of Sports Medicine, Vol. 41, No. 12	The purpose of this study was to examine concussed athletes with a history of 0, 1, 2, or □3 concussions on neurocognitive performance and the recently	A prospective cohort design was used to compare baseline concussion symptom clusters and neurocognitive performance. Administered a	The ImPACT test provides composite scores for verbal memory, visual memory, motor processing speed & reaction time. ANCOVA was performed on	The ANCOVA for verbal memory composite scores indicated a significant interaction with concussion group and time (Wilks l = .906; $F_{6,912}$ = 7.83; P \	Findings suggest that athletes with a history of 3 or more concussions are still impaired on cognitive task and concussion symptoms compare

			revised symptom clusters. Participants included A total of 598 (420 male and 178 female; 335 high school and 263 college) athletes from an ongoing sport concussion surveillance study in the mid-Michigan area who sustained a concussion over a 6-year period	baseline ImPACT test before the start of their season. Mid-Michigan Sport Concussion Program protocol is to administer the ImPACT neurocognitive test approximately 2 to 3 days and 1 week after a concussion.	composite scores. ANCOVA also performed on 4 symptom clusters.	.001) The ANCOVA for reaction time was also significant for the interaction between group and time (Wilks l = .927; F6,928 = 5.99; P \ .001). The ANCOVA for migraine-cognitive-fatigue cluster symptoms indicated significant differences in the interaction with time by concussion group (Wilks l = .952; F6,984 = 4.09; P \ .001)	d with their baseline scores. Athletes with 3 or more concussions were impaired on the migraine-cognitive-fatigue cluster at 8 days after injury compared with baseline levels.

Brian L. Brooks, Rebekah Mannix, Bruce Maxwell, Ross Zafonte, Paul D. Berkner, Grant L. Iverson (2016)	Multiple Past Concussions in High School Football Players Are There Differences in Cognitive Functioning and Symptom Reporting?	The American Journal of Sports Medicine, Vol. 44, No. 12	The purpose of this study was to determine if a history of concussions is associated with differences in cognitive functioning or symptom reporting in a very large sample of high school football players. Participants included 6069 high school football players from Maine (18-18 years old).	Each player completed baseline ImPACT testing.	All analyses were completed using SPSS (version 21.0; IBM Corp). ANOVA and MANCOVA used. Kruskal-Wallis and Mann-Whitney also used.	No significant main effects or pairwise differences across the 5 groups (0, 1, 2, 3, or □4 prior concussions) on any of the cognitive test scores when considered individually in univariate analyses. No significant group effect for the cognitive test scores when comparing those with 0 versus multiple	No differences in cognitive test performance associated with concussion history. Greater symptom scores were reported in those with multiple prior concussions compared with those with no or fewer prior injuries not only for total symptom scores but also across the 4 subdomain scores (eg, cognitive-

			Final sample came to 5232 players.			(□3) prior concussions. There was a significant univariate effect for total symptom scores across the groups but there was only a small effect size. Those with 0 prior concussions reported significantly fewer symptoms than those with 3 prior concussion. Those with 1 prior concussion reported fewer	sensory, sleep-arousal, vestibular-somatic, and affective).

						total sympto ms than those with □4 prior concussi ons.	
Kevin M. Guskie wicz, Michael McCrea , Stephen W. Marshal l, Robert C. Cantu, Christo pher Randolp h, William Barr, James A. Omate, James P. Kelly (2003)	Cumulat ive Effects Associat ed With Recurren t Concussi on in Collegiat e Football Players The NCAA Concussi on Study	The Journal of the America n Medical Associat ion Volume 290, Issue 19	The purposes of this study were to examine the associati on between history of previous concussi ons and likelihoo d of experien cing recurrent concussi ons and to compare time to recovery followin g concussi on between athletes with a history of previous concussi	Preseaso n baseline measure s were collected at the time of enrollme nt using a Graded Sympto m Checklis t (GSC) and an extensiv e health question naire. In event of a concussi ve injury, the CAT administ ered the GSC at the followin g assessme nt points (time of injury, 3 hours	For analyses dealing with case series of injured players, X^2 tests of associati on were used to compare proporti ons in tables; the Fisher exact test wasused when 80% of expected countsw ere less than 5. Statistica l analyses were con-ducted using SAS software,	When the concussi ons were retrospec tively graded for severity on the Cantu Evidenc e-Based Grading Scale," most concussi ons (118116 9 [69.8%]) were classifie d as a grade 2, while only a small percenta ge were either grade 1 (25/169 [14.8%]) or grade 3 (26/169	College football players with a history of concussi ons are likely to have future concussi ve injuries. 1 in 15 players with concussi ons may have addition al concussi ons in the same playing season, occur within a short window of time from one another (7-10 days). A history

			on compared with those without a history of previous concussions. Participants include 2905 collegiate football players from 19 division I, 3 division II, and 3 division III schools.	after, 1,2,3,5, &7 days after).	version 8.2 (SAS Institute Inc. Cary, NC). The level of significance was set a priori at $P<.05$ for Xl tests of association.	[15.4%]) concussions. Headache was the most common reported symptom followed by dizziness/balance difficulties and feeling cognitively "slowed down". Sixty-six (35.1%) of 188 injuries were recorded as "repeat injuries" from within the last 7 years; football players with a history of 3 or more previous concussions were 3 times more	of concussions is associated with prolonged recovery following subsequent concussions. Concussions manifest with varying signs and symptoms as well as severity and duration of these symptoms.

						likely to sustain an incident concussion than those with no concussion history; and similar elevations in risk, although less marked, were observed in players with 2 previous. Athletes with history of multiple concussions experienced longer recovery.	
Michael W. Collins, Mark R. Lovell, Grant	Cumulative Effects of Concussion in	Neurosurgery, Volume 51, Number	The purpose of the study was to evaluate	ImPACT tests was method used to collect data on	Concussed HS athletes with no history of	Athletes with a history of multiple concussi	Results suggest that a pronounced history

L. Iverson, Robert C. Cantu, Joseph C. Maroon, Melvin Field (2002)	High School Athletes	5	the relationship between concussion history and on-field presentation of symptoms after subsequent cerebral concussion. Participants included 173 high school athletes who participated in the Sports Medicine Concussion Program at the University of Pittsburgh Medical Center.	concussion history (IV), and on field presentation of symptoms (DV) after the occurrence of an in-study concussion. All athletes had baseline tests done. If concussion received during study, ImPACT done within 72 hours of the injury. Symptoms of the concussion were thoroughly recorded.	concussions compared to HS athletes with a history of 3 or more. Statistical comparisons between the groups were done using X (squared) analysis with on field markers of concussion severity as dependent variables.	ons were significantly more likely to experience an initial on-field LOC, anterograde amnesia, and confusion after a subsequent concussion. Variable representing mental status change for 5 or more minutes of confusion, anterograde amnesia, and or retrograde amnesia. Only 9.4% of players with no history of concussi	of concussion seems to increase the athlete's susceptibility to the acute effects of a subsequent concussive injury. Specifically, HS athletes with a self-reported history of 3 prior concussions were 9 times more likely than those with no prior concussions to exhibit 3 or 4 on-field abnormal markers of injury when they

						on demonstrated prolonged post injury mental status changes at time of injury as compared to 31.6% of players with multiple past concussions.	experienced a subsequent concussion
Grant L. Iverson, Michael Gaetz, Mark R. Lovell, Michael W. Collins (2004)	Cumulative Effects of Concussion in Amateur Athletes	Brain Injury, Volume 18, No. 5 (Pages 433-443)	The purpose of this study was to replicate and extend the results of previous studies that reported increased post-concussion symptoms at baseline for amateur athletes	ImPACT testing was used throughout the study. Athletes were administered a baseline evaluation. Concussion history questionnaire administered also. All athletes were measure	A mixed model 2 X 2 ANova was used to determine if there were between and within group effects on each of the dependent variables (total symptoms, reaction time,	For total symptoms score, there was a significant main effect for time. For reaction time and processing speed composite scores, there were no significant between or within group effects.	Main findings of current study were that young athletes who sustain multiple concussions reported significantly more symptoms and demonstrated a clear trend toward

			who sustained multiple concussions vs. those who had none. Participants included 38 total players, 19 with 3 or more prior concussions and 19 with none. All subjects participated in the University of Pittsburgh Medical Center Sports Concussion Program.	d again within 5 days of injury. Careful documentation was completed.	processing speed, memory)	For memory composite score, there was a significant main effect for time. Athletes with multiple concussions were 7.7 times more likely to demonstrate a major drop in memory performance than the athletes with no previous concussions. For on field markers, the groups did not differ in their experience of LOC, retrograde amnesia or disorient	lower memory scores at baseline. Preseason and symptom and memory findings were interpreted to be suggestive of cumulative, lingering effects of multiple concussions. Athletes with multiple concussions had more adverse consequences in the acute recovery period from their next concussion.

						ation.	
Tracey Covassin, David Stearne, Robert Elbin III (2008)	Concussion History and Postconcussion Neurocognitive Performance and Symptoms in Collegiate Athletes	Journal of Athletic Training Volume 43, No. 2	The purpose of this study was to investigate whether concussed collegiate athletes with a history of 2 or more concussions demonstrated neurocognitive impairments when compared with concussed athletes with no history of concussions. Participants included 57 collegiate athletes (36	Used a repeated-measures design to compare baseline and post concussion neurocognitive scores and symptoms. IV were history of concussion, and time. DV were verbal memory, visual memory, reaction time, visual processing speed, and individual and total concussion-related symptoms. ImPACT	The ImPACT provided composite scores for verbal memory, visual memory, reaction time, and visual processing speed. Also provided individual scores for concussion symptoms. X (squared) using the Fisher exact test was performed on concussion severity by history of concussion. 3 X 2 mixed-	Athletes with a history of concussion did not have a greater likelihood of sustaining a more severe concussion compared with a grade I concussion. Athletes with a history of 2 or more concussions demonstrated a lower verbal memory score and slower reaction time than athletes without a history. Day 1	Concussed collegiate athletes reporting a history of concussion may take longer to recover on neurocognitive measures of verbal memory and reaction time than athletes without a concussion history. Findings suggest neurocognitive deficits in athletes who report a history of concussion.

			without concussion history, 21 with a history of 2 or more concussions. Came from 5 northeastern universities active in men and women's basketball, soccer, lax, men's baseball, football, and wrestling; and women's gymnastics, softball, volleyball, and cheerleading.	testing used to assess neurocognitive function and concussion symptoms. Had baseline test done, then day 1 and day 5 post concussion.	factors design multiple analysis of variance was conducted with time (baseline, day 1 post concussion, day 5 post concussion) and group (no history of concussion, 2 or more concussions) as the factors and the ImPACT indices as the dependent variables. A multiple analysis of variance was conducted on all concussion	post injury, 81 % of subjects with a concussion history demonstrated at least 1 reliable decline for reaction time, 57% for visual processing speed, 52% for verbal memory, and 48% for visual memory. Day 1 post injury in athletes without a concussion history, at least 1 reliable decline was seen in 56% of subjects for visual	

					sympto ms across days and groups. All analyses done using SPSS software (version 15.1; SPSS Inc., Chicago, IL).	processi ng speed, 50% for reaction time, 44% for visual memory, and 39% for verbal memory. Day 5 post injury, 57% with history showed at least 1 reliable decline for both reaction time and verbal memory, 48% for visual processi ng speed, and 29% for visual memory. Day 5 post injury without history, at least 1 reliable decline found in	

						31% of subjects for processing speed, 22% for visual memory, 14% for reaction time, 11% for verbal memory.	
CL Collins, SK Fields, RD Comstock (2008)	When the rules of the game are broken: what proportion of high school sports-related injuries are related to illegal activity?	Injury Prevention Volume 14, No. 1	To compare sport and gender differences in injury rates and proportions of injuries related to illegal activity and to describe the epidemiology of injuries related to illegal activity. Participants included athletes taking part in	Illegal activity-related injuries analyzed using data from 2005-06 and 2006-07 National High School Sports-Related Injury Surveillance Study.	N/A	Estimated 98,066 injuries directly related to illegal activity. 0.24 injuries per 1000 athletic competition exposures. 6.4% of all HS sports related injuries related to illegal play. A greater proportion of injuries related to illegal play	Illegal activity is an overlooked risk factor for sports related injury. Reducing illegal activity through enhanced enforcement of sports rules and targeted education about the dangers of illegal activity for players,

			nine sports: boys football, soccer, basketball, wrestling, and baseball, and girls soccer, volleyball, basketball, and softball.			were to head/face (32.3%) and were concussions (25.4%).	coaches, and referees/ officials may reduce sports related injuries.
Tamara C. Valovich McLeod, Curtis Bay, Alison R. Snyder (2010)	Self-Reported History of Concussion Affects Health-Related Quality of Life (HRQOL) in Adolescent Athletes	Athletic Training & Sports Health Care Volume 2, No. 5	The purpose of this study was to examine the relationship between self-reported concussion history and HRQOL in adolescent athletes. Participants included 303 adolescent male athletes	All participants completed a brief demographic survey, a concussion history questionnaire based on the pre participation examination, the Medical Outcomes Short Form (SF-36) and the Headache Impact Test	Kolmogorov-Smirnov Test determined that all dependent variables violated the assumption of normality. Mann-Whitney U test was used to determine group differences. Bonferroni correction for	63.6% of negative concussion group, and 66.2% of positive group reported regular participation in rec activities. Of those reporting concussion history, 66.1% of those occurred more than 1 year ago, 19.1%	Main finding was that adolescents with a self-reported concussion history demonstrated lower HRQOL on several SF-36 subscales, including those related to mental health & a greater impact of

			recruited from 5 local high schools.	(HIT-6) during baseline testing.	multiple analyses was used for the SF-36 because there is some relationship between the various subscales used in this study.	within the past year, 7% within the past 6 months, 6.1% within the past 3 months, and 1.4% within the month prior to completion of the survey. On SF-36, positive group reported significantly lower scores on the bodily pain, general health perceptions, vitality, and mental health subscales & on SF-36 mental composit	headache on their general health. Overall, findings suggest that history of concussions may negatively affect the mental health of adolescent athletes.

						e score. On HIT-6, positive group reported a greater impact of headache on HRQOL compared with the negative group.	
Charles H. Tator (2011)	The Coach Is The Most Important Person	Coaches PLAN Volume 18, No. 1	This is more of an informative analysis of the authors ThinkFirst Canada program, which examines exactly how brain injuries occur, develops targeted injury prevention programs and advocate for safe	Summary: Brain injury prevention occurs at 3 stages, primary, secondary and tertiary. Concussions occur in hockey between 10-18 years old and there are fewer at the college level and	Summary Cont.: Many educational resources available such as presentation to coaches, websites for coaches, concussion cards and posters, mandatory concussion education and the role of coaches,	Summary Cont.: Coaches can help insure that the helmets are in good condition and are well fitting and worm with the chinstrap done up tightly. Rules have been set to help aid in prevention of	Conclusion: Coaches play major role in improving sports community's knowledge of concussion, other brain injuries and spinal injuries. Education is a key strategy for injury reduction.

			practices. The article describes some of the initiatives relating to caches that ThinkFirst is undertaking to reduce the incidence and effects of brain and spinal cord injuries in sports and rec.	higher. More people need to become informed about concussions and its new definition. They can occur with or without losing consciousness.	pre season sports team meeting on concussion education led by coaches and other coaching strategies. It is important to educate the athletes, their parents, coaches, trainers, refs, the league, media, schoolteachers, and health professionals.	injuries. The enforcement of these rules is extremely important in prevention of injury.	Education alone is insufficient by itself, and needs to be used along with careful recording of injury data, engineering enhancements, and rules introduction and enforcement.
Susan C. Davies & Brenna M. Bird (2015)	Motivations for Underreporting Suspected Concussion in College	Journal of Clinical Sport Psychology Volume 9, No. 2	Purpose was to (1) determine the percentage of college student-athletes	193 students replied to the survey. Researcher attended coaches meeting	Data was analyzed by calculating the response percentage of each survey	Out of 193 respondents, 14% suspected they sustained a concussion in	Data reported from before the season said 38% of student athletes

	Athletics		who report suspected concussions or the suspected concussions of teammates, (2) to investigate why student-athletes refrain from reporting their suspected concussions or the suspected concussions of teammates, and (3) to determine whether athlete variables, such as their sport or academic level, affected concussion	at university. Researcher explained purpose of the survey and asked coaches to encourage their athletes to take part. Researcher collected data over the course of a month. After the initial email was sent about the survey, 162 responses were recorded. An additional 31 were recorded a week later when second email	question. These analyses revealed whether the university student-athletes reported their suspected concussions and the suspected concussions of their teammates during their college athletic careers. The results yielded ordinal and interval data.	college before the 2012-2013 season. 8% of respondents suspected they had a concussion during the 2012-13 season. 60 % said that they suspected a SRC in a teammate during the 2-12-13 season. Before the season, 62% of athletes said they reported suspected concussions, which 38% said no. During the season,	did not report their suspected concussions; during the season, 45% did not report. Strongest motivator for not reporting was that athletes felt the concussion wasn't a severe enough injury. Students do not want to be seen as weak for reporting injury. 28% said they didn't know it was a concussion so they didn't

			reporting rates. Participants included 283 college athletes at a D1 NCAA university. It was a midsized private university in Midwestern U.S. Both male and female	was sent.		55% said yes, 45% said no. For teammates, 50% said yes and the other 50% said no. First analysis compared the participant's sport with suspected concussions sustained before 2012-13 seasons. A chi square analysis was used to compare the participant's academic level with suspected concussions before 2012-13 seasons. Second	report it. Athletes not reporting injuries because they feel they are not severe enough clearly don't know the serious repercussions that a concussion can have to their health.

						analysis compared academic level with suspected concussions during the season.	
Steven P. Broglio (2017)	Is the Sky Falling? The Persistent Effects of Concussion.	Kinesiology Review 2017, Vol. 6, Issue 1	Purpose is to figure out how concussions may affect individuals' years down the road and also to compare concussion rates in high school and college sports. Participants include high school and college, male and female athletes.	This was more of an informative article, there was no formal study conducted. This may be a literature review.	Data analysis occurred through comparing data from different sources.	Concussions occur in both college and HS athletics. Although generally lower rates in HS, there are many more HS athletes (7.8 Million) then college athletes (450,000). Discuss banning sports, but if you start to do that, many	There is a need for prospective longitudinal research on male and female athletes with and without exposure to repeated head impacts and/or concussions to establish who is at risk and why, advanced engineering to develop and

						athletes will no longer be participating in sports.	refine protective equipment in sports that permit their use to reduce or eliminate concussion risk, alterations to existing rules, regulations, and penalties to a degree that will impede athletes from intentionally injuring another player while maintaining the integrity of the sport.
Scott L. Zuckerman, Zachary Y. Kerr, Aaron	Epidemiology of Sports-Related Concussion in	The American Journal of Sports Medicine, Vol.	Purpose is to describe the epidemiology of	Methods: Sport related concussion data from the	First calculated sport specific concussion rates	From 2009-10-2013-14, Sport related concussi	SRC incidence appears to be increasin

Yengo-Kahn, Erin Wasserman, Tracey Covassin, Gary S. Solomon (2015)	NCAA Athletes From 2009-2010 to 2013-2014	43, No. 11	SRC in 25 NCAA sports.	NCAA Injury Surveillance Program during the 2009-2010 to 2013-2014 academic years were analyzed. Concussion injury rates, rate ratios, injury proportion ratios were reported with 95% CIs. National estimates were also calculated to examine linear trends across time.	overall and by event type. Rate ratios compared rates by event type and sex within soccer, basketball, ice hockey, lax, and baseball/ softball. Then looked at sport specific injury proportions by recurrence, injury mechanism, and injury activity. Injury proportion ratios were considered statistically significant. Last, analyzed linear trends	on made up 6.2% of all injuries in the NCAA ISP. Total of 1670 reported. 888 during competition (53.2%) and 782 (46.8%) during practice.	g, which may reflect increased reporting. The majority of SRC's occur in practice, although the competition rate in higher. About 1 in 11 SRCs were reported to be recurrent. Player contact remains leading cause of SRC in NCAA sports, although contact from the surface and equipment also contribute to concussion incidence.

					across time via linear regression.		
Marcos A. Abreu, Fred J. Cromartie, Brandon D. Spradley (2016)	Chronic Traumatic Encephalopathy (CTE) and Former National Football League Player Suicides.	Sport Journal 2016	Purpose is to examine if the psychological and cognitive consequences that are associated with CTE are factors in the suicide death of several former NFL players.	Literature used in this paper acquired through searches in EBSCO host.	A literature review was conducted to break down information.	Findings Reinforce Dr. Omalu findings that ID these psychological and cognitive consequences as key variables associated in suicide death of an alarming amount of NFL players, who resort to suicide as a result of diminished neurological capabilities and accumulation of symptoms.	Additional research should determine the extent to which the psychological and cognitive consequences are possible variables associated with former NFL player suicide. Continued studies that use the FDDNP-PET brain imaging method to measure he accumulation of tau protein in the

							brain should add accuracy to the determination of the effect and determine how dominant is the symptoms associated with this CTE.
Paul McCrory et al., (2013)	Consensus Statement on Concussion in Sport: The 4th International Conference on Concussion in Sport, Zurich, November 2012	Journal of Athletic Training 2013:48(8):554-575	This was not a study, but its purpose was to build on principles outlined in the previous documents and to develop further conceptual understanding of this problem using a formal consensu	Consensus has multiple sections, first is a summary of concussions & management, second is background info about consensus meeting process, third is a summary of specific consensus	There really was no formal data analysis. Information collected for the consensus report had to be carefully reviewed and understood.	There were many consensus questions that were answered within the article.	Although agreement exists concerning principle messages within this document, the authors acknowledge that the science of concussion is evolving, and because of that, manage

			s-based approach.	questions discussed at meeting, and last is that it should be read along with the SCAT3 assessment tool, the Child SCAT3, and the Concussion Recognition Tool			ment and return to play decisions remain in the jurisdiction of clinical judgment on an individualized basis.

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