HEADACHE DOES NOT PREDICT SIDELINE NEUROSTATUS OR BALANCE IN HIGH SCHOOL FOOTBALL PLAYERS

BY

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THESIS

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ABSTRACT

Context: Headache is reported to be the most common concussion related symptom. This has resulted in a heavy reliance on symptoms for the sideline assessment of concussive injuries. It is unclear however, if all athletes reporting headache demonstrate impairment in other commonly evaluated concussion domains. Objective: To determine the relationship between those with and without a headache resulting from football participation on neurostatus and balance. Design: A two group repeated-measures design. Setting: Three high schools in central Illinois. Participants: Varsity football athletes (N=32; age 16.3±0.8 years, range 16-18; weight 82.8±21.8 kg; height 177.0±7.5 cm), participated in this study. Interventions: All athletes completed a baseline evaluation of the Graded Symptom Checklist (GSC), Balance Error Scoring System (BESS) and Standardized Assessment of Concussion (SAC). Athletes reporting a headache (n=16) following a game or practice were re-administered the same test battery, as well control participants (non-headache: n=16) matched for age, playing position, weight and height. Main Outcome Measures: Performance on the GSC, BESS and SAC were evaluated using group by time repeated measures analysis of variance. Significance was noted when $p<0.05$. Results: Following football participation, total GSC scores increased significantly ($p=.004$) in the headache group (8.1±8.9 to 16.1±15.3), but significantly decreased ($p=.01$) in the non-headache group (6.1±7.0 to 3.1±4.4). A significant decrease ($p<.000$) in BESS performance was noted in both groups: headache (15.0±7.4 to 20.3±8.9) and non-headache (13.3±6.7 to 18.1±6.7). No significant differences were noted on SAC performance ($p>0.05$). Conclusions: Performance on common concussion assessment tools does not appear to be influenced by athlete reports of football related headache. These findings indicate that the use of headache,

exclusively or in combination with other concussion related symptoms, is not a valid marker of the injury. This supports previous works suggesting clinicians should adopt a multifaceted approach to concussion management. Further, physical exertion appears to have an effect on BESS performance independent of symptoms, suggesting careful interpretation of BESS scores when administered on the sideline.

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Chapter 1: Introduction

Concussions are injuries that sometimes go underreported or unnoticed, particularly in the athletic scene. Pressure is placed on athletes to return to competition as soon as possible, regardless of injuries they sustain. There are between 1.6 and 3.8 million sport-related concussions in the United States annually (Langlois, Rutland-Brown, & Wald, 2006). Some sports have an increase in the risk of sustaining a concussion. In the United States, it is estimated that 250,000 concussions occur playing football alone (Gerberich, Priest, Boen, Staub, & Maxwell, 1983). In sports, a concussion is the most common head injury sustained (Guskiewicz, Weaver, Padua, & Garrett Jr., 2000) and as much as nine percent of all sports injuries are thought to be concussions (Erlanger, Kutner, Barth, & Barnes, 1999). It has been estimated that as much as 50% of all high school football concussion cases are unreported (McCrea, Hammeke, Olsen, Leo, & Guskiewicz, 2004). Since concussions sometimes go unnoticed, athlete recognition of what a concussion is, and what symptoms that follow a concussion are, could lead to higher number of concussion cases reported (McCrea et al., 2004).

Aubrey et al. (2001) defined a concussion as a pathophysiological process affecting the brain induced by traumatic biomechanical forces. They noted that components of a concussion can include a direct blow to the head, face, neck, or elsewhere, on the body with an “impulsive” force transmitted to the head. In addition, concussion typically results in the rapid onset of short-term impairment of neurological function that resolves spontaneously. Concussions also occur when there are neuropatholigcial changes but the acute clinical symptoms largely reflect a functional disturbance rather than structural injury. Finally, concussions are accompanied with a graded set of clinical syndromes that may involve loss of consciousness.

Many athletes participate in games or practices while experiencing symptoms of a concussion. Some of these symptoms can include confusion, disorientation, unsteadiness, dizziness, and headache (Giza & Hovda, 2001), nausea, vomiting, difficulty falling asleep, sleeping more than usual, feeling fatigued, drowsiness, sensitive to light or noise, feeling dinged, dazed, or stunned, seeing stars or flashing lights, ringing in the ears, or double vision (Aubrey et al., 2002). The most common symptom of a concussion is headache, which occurs in 85.2% of concussion cases (Guskiewicz et al., 2003). It is not uncommon for athletes to experience headache during times of intense activity (i.e. games or strenuous practice). As much as 81% of football players had experienced headache in 25% of games played (Sallis & Jones, 2000). Certified athletic trainers (ATCs) and other personnel will often look for the presence of headache as a key to a concussion diagnosis (Guskiewicz et al., 2004). Using headache as a guideline for diagnosing concussions can be misleading. As much as 71% of sport and exercise headaches occur without trauma (Williams & Nukada, 1994). Thus, there could be a false positive correlation between presence of headache and concussions.

Headache is postulated to occur through two mechanisms. One pathway involves a direct trauma to the head, neck, or body and the other occurs without trauma. A direct trauma mechanism of injury can occur with an acceleration or deceleration force on the head, neck, or body that which can be accompanied with a variety of symptoms associated with concussion. When this type of headache occurs, it is commonly associated with sensation of pressure in the skull that can be generalized to one part of the head (Lovell, 2009). However, one does not need to sustain a blow to the head to receive a headache. There are varying reasons for a non-traumatic sport and exercise related headache, however the primary cause observed for a headache was related to running or jogging (35%), followed by weight lifting or gym exercise (11.6%) (Williams & Nukada, 1994).

There are different classifications of posttraumatic headache. These can vary from tension, migraine type, and mixed posttraumatic headaches (Packard, 1999). Tension-type headaches are most commonly observed, and account for 85% of all cases (Evans, 2004). A tension-type headache's pain can be described as a dull ache that is nonthrobbing, and consistent in the bifrontal and occipital regions (Dimeff, 1992). Post-traumatic headaches tend to change intensity from mild to severe; however, it appears to worsen throughout the day (Dimeff, 1992).

Treatment of headache in the athletic population especially when accompanied by a blow to the head should be treated as a suspected concussion. There are a variety of assessment tools that are used to classify concussions. Some tools that are commonly used are the Standardized Assessment of Concussion [SAC], Balance Error Scoring System [BESS], graded symptom checklist [GSC], Automated Neuropsychological Assessment Metrics [ANAM], CogSport, Concussion Resolution Index, and Immediate Postconcussion Assessment and Cognitive Testing [IMPACT]. All of these tools aim to help determine the grade, or severity of injury. However, these assessment tools test different aspects of a concussion. Specifically, these assessment tools test mental status, postural-stability, and neuropsychological function. This study will incorporate the use of SAC, BESS, and GSC after exercise when headache is experienced. These tools are widely used with as many as 85% of certified athletic trainers [ATCs] use a symptom checklist, 48% use the SAC, and 18% use the BESS when evaluating for the presence of a concussion (Notebaert & Guskiewicz, 2005).

STATEMENT OF PURPOSE

The purpose of this study is to determine the effects of headache after a time of increased physical activity and its relationship with neurostatus (i.e. SAC performance) and postural control (i.e. BESS performance) in interscholastic football athletes.

HYPOTHESIS

Those athletes that experience headache after physical activity will score worse on the SAC, BESS, and symptoms checklist compared to athletes who do not report headache when controlling for age, weight, and height.

Chapter 2: Literature Review

The word ‘concussion’ is derived from the Latin word concutere, which means to shake violently. In 1966, the Committee of Head Injury Nomenclature of the Congress of Neurological Surgeons defined concussion by the body as a clinical syndrome characterized by immediate and transient post-traumatic impairment of neural functions, such as alteration of consciousness, disturbance of vision, equilibrium, etc. due to brain stem involvement.

A more in depth definition by Aubrey et al., (2001) defined a concussion as a pathophysiological process affecting the brain induced by traumatic biomechanical forces. They noted that components of a concussion can include a direct blow to the head, face, neck, or elsewhere, on the body with an “impulsive” force transmitted to the head. In addition, they stated that a concussion typically results in the rapid onset of short-term impairment of neurological function that resolves spontaneously. They also occur when there are neuropatholigcial changes but the acute clinical symptoms largely reflect a functional disturbance rather than structural injury. The researchers also found that concussions are accompanied with a graded set of clinical syndromes that may involve loss of consciousness. Finally, they noted that concussions are typically associated with grossly normal structural neuroimaging studies.

The mechanism of injury of a concussion usually results from an acceleration or deceleration force on the head or neck that can also include rotation of the head or neck or movement in a linear plane (Barth, Freeman, Broshek, & Varney, 2001). Concussions are accompanied with a variety of symptoms that can include, but not limited to confusion, disorientation, unsteadiness, dizziness, and headache (Giza & Hovda, 2001), nausea, vomiting, difficulty falling asleep, sleeping more than usual, feeling fatigued, drowsiness, sensitivity to light or noise, feeling ‘‘dinged,’’ dazed, or stunned, flashing lights, ringing in the ears, and double vision (Aubrey et al., 2002). There are many terms that are associated with a concussion, for example; mild traumatic brain injury, mild traumatic head injury, and closed head injury. For this reason, we will use concussion to describe the above mentioned.

Grades of Concussions

There are at least 14 different grading scales that define a concussion (Prentice, 2003) and some of scales more frequently used are Cantu, Colorado, and American Academy of Nuerology grading scales. The American Academy of Nuerology (1997) has sub-grouped concussions into three separate grades. A grade 1 concussion results in transient confusion, no loss of consciousness, and symptoms of a concussion or mental status abnormalities that resolve in less than 15 minutes. A grade 2 concussion can be defined as an athlete experiencing transient confusion, no loss of consciousness, and concussion symptoms or mental status abnormalities that last more than 15 minutes. The most severe concussion on this scale is grade 3, when an athlete loses consciousness. When the severity of a concussion has been diagnosed, a timetable is followed to ensure proper return to play guidelines. Athletes that experience a grade 1 concussion are allowed to return to play the same day, when asymptomatic at rest and after exertion if symptoms resolved within 15 minutes. Grades 2 and 3 are not allowed to return to play during the same day of the injury. Those that are allowed to return to play after asymptomatic for at least one week are; multiple grade 1 concussions, one grade 2 concussions and one grade 3 concussions that briefly lose consciousness. Athletes that are withheld for two weeks will have sustained multiple grade 2 concussions or one grade 3 concussion that had a prolonged period of unconsciousness. Although many concussion grading scales are based on loss of consciousness and amnesia, many other symptoms associated with a concussion are much more prevalent (Guskiewicz et al., 2000). This leads to the conclusion that possibly other factors could be better indicators when trying to diagnose a concussion.

In the United States it is estimated that each year, 1.6 to 3.8 million Americans sustain a concussion annually (Sosin, Sniezek, & Thurman, 1996) (Langlois, Rutland-Brown, & Wald, 2006). Of these 1.6 to 3.8 million injuries, 20% occurred while playing a sport, and the vast majority of these cases are comprised of people between the ages of 15-24 (Sosin, Sniezek, & Thurman, 1996). In sports, a concussion is the most common head injury sustained (Guskiewicz et al., 2000) and as much as nine percent of all sports injuries are thought to be concussions (Erlanger et al., 1999). Also, the most commonly related symptom with the high school athletes was headache (40.1%), dizziness (15.3%), and confusion (8.6%) **(**Gessel et al., 2007).

Guskiewicz et al. (2000) noted that high school athletes are at a slightly greater risk of sustaining a concussion than older athletes. They found an incidence rate of 5.6% in high school athletes, compared to 4.4% in National Collegiate Athletic Association Division I athletes, 4.5% in Division II athletes, and 5.5% in Division III athletes. There may be many reasons why this is the case. One idea is that high school athletes tend to play both offense and defense resulting in more time to be at risk of contact, or they wear improper equipment, or they could have undeveloped brains at this chronological time of life. A young athlete that sustains a concussion could have detrimental effects if their brain has not yet fully developed.

Giza and Hovda (2001) discussed what happens to young athletes brain that is still developing. They noted a critical time of brain development is during the time of increased plasticity. They hypothesized that if one were to sustain a concussion during this time, it could lead to an impairment of this phase (Giza & Hovda, 2001). Younger athletes also tend to be at a higher risk for second impact syndrome [SIS]. SIS has been defined as an athlete who has sustained an initial head injury, most often a concussion, and sustains a second head injury before symptoms associated with the first have fully cleared (Cantu & Voy, 1995). This can become problematic because the second impact results in cerebral vascular congestion, which leads to cerebral swelling (McCrory, 2001). Almost all cases of SIS are in athletes under the age of 18 (Guskiewicz et al., 2004). Thus, knowing how to monitor the signs and symptoms of a concussion become critical, especially at the high school level. Also, both high school and college players that sustain one concussion are three to four times more likely to sustain another concussion in the same season than those who have not sustained a concussion (Guskiewicz, Ross, & Marshall, 2001). Thus, early recognition of a concussion can become critical to ensure athletes safety.

A study done by Powell and Barber-Foss (1999) looked at ten high school sports over a three-year period. They investigated which sports were most likely to experience a concussion. The sport that had the greatest amount of concussions was football, which accounted for 63.4% of all concussion cases. The next closest sports were wrestling (10.5%), girl's soccer (6.2%), and men's soccer (5.7%). These may lead sports in incidence of concussion rates because of the increase risk of contact.

Not only can playing a particular sport increase in the risk of injury, but also playing a specific position can alter the rate of sustaining a concussion. Powell and Barber-Foss (1999) looked at the different positions played during football and found that playing the linebacker position had the highest occurrence of concussions (14.3%), followed by running backs (14.0%), and offensive linemen (13.4%). In addition, injury rates were 11 times higher during games than practice (Powell & Barber-Foss, 1999). This could be attributed to that fact that there is a greater chance of injury during a game due to the increase in physical contact and well as an increase in intensity. Finally, this study found that the greatest frequency for a concussion occurred when a player was taking part in the tackling process, meaning that they were either getting tackled or tackling someone (Powell & Barber-Foss, 1999).

Recent data suggests that between 5-15% of high-school football players experience a concussion during the course of a season (Guskiewicz et al, 2000) (McCrea et al., 2004).

However, many concussions go unnoticed or unreported leaving room for a higher percentage if all were accounted for. A study by McCrea et al. (2004), wanted to investigate why so few athletes reported concussions. The investigators surveyed 1,532 football players from 20 high schools. Questions were asked regarding the athletes previous history of concussions. They asked that if they did experience a concussion, did they report it, or if they did not report it, why. The investigators found that 29.9% of athletes reported a concussion at some point during their playing career. Of those who experienced a concussion, only 47.3% reported the concussion to someone, leaving a majority of concussions to go unreported. However, they noted that the person the athletes were most likely to report the concussion to was a certified athletic trainer [ATCs] (76.7%). ATCs assess an average of 8.2 concussions annually (Notebaert & Guskiewicz, 2005). One of the main reasons why athletes do not report their concussion was because they did not know the symptoms of a concussion or think the event was serious enough to seek medial attention (McCrea et al., 2004).

Headache a symptom of concussion

Headache is the most common symptom related to a concussion (Packard & Ham, 1997). During the time of a sustained concussion, 85.2% of the cases reported headache as a symptom (Guskiewicz et al., 2003). Many experts in the medical field use the presence of a headache as a guideline of recovery from a concussion. The American Academy of Neurology concussion guidelines defines persistent headaches after head trauma as a concussion (Practice Parameter, 1997).

Headache effects on neurocognition

A study by Register-Mihalik et al. (2005) looked at neurocognitve function in athletes who have sustained a concussion and either reported no posttraumatic headache, posttraumatic headache, or posttraumatic migraine. This study showed that those individuals with posttraumatic migraine performed worse on visual memory and reaction time compared to the non-headache and posttraumatic headache groups. Although the posttraumatic migraine group performed the worst, both headache groups showed a decline from their baseline measurements. Thus, it can be concluded that any athlete sustaining a head or neck injury with any symptoms of a concussion (i.e. headache) should be monitored for neurocognitive dysfunction.

A study by Sallis and Jones (2000) found that 85% of players had headaches related to playing football, but only 28% of players had reported previous diagnosis of a concussion in their entire career. When asked how often they experienced a headache in a game, 81% reported that a headache was experienced in 25% of games played, 12% said it occurred in at least 50% of games, and 4% said it occurred in 75% games played. Many athletes report headache after a period of physical activity. Not all headache cases reported a concussion. However, it is yet to be determined if there are any deficits noted with athletes reporting headache after exercise using concussion assessment tools.

Headache Classifications

Posttraumatic headaches can occur after collision or contact sports (Dimeff, 1992) and are more commonly associated in mild head injuries. Types of posttraumatic headache can vary from tension, migraine, and mixed posttraumatic headaches (Packard, 1999). It has been reported that as high as 86% of concussions involve posttraumatic headache (Guskiewicz et al., 2000) and as much as 85% of these are classified as tension-type headaches (Evans, 2004). A tension-type headache pain is described as a dull ache that is nonthrobbing, and consistent in the bifrontal and occipital regions of the head (Dimeff, 1992). Post-traumatic headaches tend to change intensity from mild to severe; however, it appears to worsen throughout the day (Dimeff, 1992).

Williams and Nukada (1994) investigated sport and exercise headaches. They found 29% of athletes experienced headache with a head trauma. Of those that had headache with contact, 22% were classified as posttraumatic headache. The investigators also found that headaches do not have to arise because of contact. They noted 71% of sport and exercise headaches occur without trauma. The most common way to receive a headache without contact was by running or jogging (35%), followed by weight lifting or gym exercise (11.6%). There are many possible causes of why non-traumatic headache occurs. Some theories include raised intrathoracic pressure (Lambert Jr. & Burnet, 1985) compressed blood vessels via muscle tension (McCarthy, 1988), neck muscle tension (Paulson, 1983), and vasodilation of cerebral blood vessels caused from stress (Rose, 1986). The most common type of headache noted was non-migraine, effort-exertion type headache (60%). The duration of effort-exertion headache lasted up to 24 hours, and was noted to be either mild or moderate in nature compared to a sports migraine. The investigators also noted that the location of the pain was either generalized or occurring at the forehead, and the type of pain was a dull, aching, pounding, or throbbing.

Assessment Tools used to Identify Concussion

Treatment of headache in the athletic population especially when accompanied by a blow to the head should be treated as a suspected concussion. There are a variety of concussion assessment tools that are used to classify concussions. Some tools that are commonly used are the Standardized Assessment of Concussion [SAC], Balance Error Scoring System [BESS], and the graded symptom checklist [GSC]. All of these tools aim to help determine the grade, or severity of injury; however, these tests assess different aspects of a concussion. Specifically, these assessment tools test mental status, postural-stability, and neuropsychological function.

The SAC test was designed to be administered on the sidelines, locker room, training room, or other acute scenario settings. The purpose of this test is to provide a quick and efficient way to measure mental status after a suspected concussion (McCrea, 2001). The SAC tests an athlete's orientation to person, place, and time, as well as memory tasks, concentration, and delayed word recall that is scored on a 30-point scale (McCrea, Randolph, & Kelly, 1997). To acquire an accurate reading post concussion, a baseline score should be noted. By taking a baseline score, it allows a health care provider the ability to compare results at the time of an injury. A decline of 1 point of more from baseline measurements grouped concussed and non-concussed athletes with a 94% sensitivity rate (Barr & McCrea, 2001).

The BESS is another concussion assessment tool that can be administered in acute situations. The BESS is used to test postural stability. This is done by having an athlete stand in a variety of postures on both even and uneven surfaces. To score the BESS a health care provider watches the athlete while they balance. A one point deduction is noted if one was to do any of the following; lift hand off iliac crest, open eyes, step, stumble or fall, move the hip into more than 30 degrees of flexion or abduction, lift the forefoot or heel, or remain out of the test position for more than 5 seconds (Riemann & Guskiewics, 2000). Six trials are run with three being on a flat surface and three on foam surface for twenty seconds. The athlete stands on their non-dominate leg and the postures the athlete performs are: single leg, double leg, and tandem stance. The athlete's eyes are closed to start the test and then the time begins. Baseline measures are used for comparison from a concussed to non-concussed state.

A graded symptom checklist [GSC] is a way to monitor an athlete's symptoms post concussion subjectively. This checklist includes a variety of symptoms listed that are associated with a concussion. An investigator can record the symptoms at the time of the injury, and recheck the symptoms at a variety of times. Symptoms that are commonly used are blurred vision, dizziness, drowsiness, excess sleep, easily distracted, fatigue, feeling "in a fog", feeling “slowed down, headache, inappropriate emotions, irritability, loss of consciousness, loss of orientation, memory problems, nausea, nervousness, personality change, poor balance, poor concentration, ringing in ears, sadness, seeing stars, sensitivity to light (Guskiewicz et al., 2004) These symptoms get rated on a seven-point Likert-like scale from 0 (no symptom experienced) to 6 (very severe).

All three of these concussion assessment tools can be administered minimal resources such as a pen and paper, and are commonly used in the athletic scene due to the simplicity of use and effectiveness in monitoring injured athletes. A study by Notebaert and Guskiewicz (2005) performed a study that looked at which assessment tools were used most frequently. They found that 85% of certified athletic trainers used the symptom checklist, 48% used the SAC, and 16% used the BESS when identifying a concussion (Notebaert & Guskiewicz, 2005).

Assessment Tool Reliability

A study by Broglio and Puetz (2008) looked at the SAC, BESS, and symptom checklist to evaluate the effect of concussion on test performance. They found that administering the SAC had its largest effect if administered immediately in the post-concussion assessment with an effect size of -1.01 to -0.60 (Broglio & Puetz, 2008). However, they noted that as more days pass from post-concussion, sensitivity declines. Another test that is used immediately after a suspected concussion is self-reported symptoms. The researchers found that this assessment tool showed the largest effect at the immediate post-concussion assessment with an effect size of -6.35 to -0.27. However, they recommended caution when using this assessment tool because symptoms are subjectively reported by the athlete, which can increase variability. A final aspect of assessing a concussion that was investigated in this study was postural control. They discussed the NeuroCom Sensory Organization Test (SOT) and the BESS as part of postural control. They noted that postural control assessment tools also showed a large effect

(-6.44 to 1.32) immediately after an injury. In conclusion, they found that all of the assessment tools, in the above mentioned showed a change from baseline to post-concussion and was the tests were most sensitive to detection of a concussion immediately after the injury. However, the severity of the change was dependant on which test was given, and when they were administered.

A study by Valovich McLeod, Perrin, and Gansneder (2003) investigated the intratester reliability of the SAC and BESS. Meaning that this study wanted to look how reliable the test administer was from day to day when conducting these tests. The investigators found that when administering the BESS, the tester had a reliability score between .87 - .98 depending on which stance was being recorded. This information is beneficial to know because this proved that using the same tester on different days could result in similar scoring measures. Also, athletes have a learning effect when administered the BESS, but not the SAC (Valovich McLeod et al., 2004). The biggest decrease in total errors occurred during tandem standing seven days post baseline administration. They hypothesized that the learning effect might be seen in the tandem stance because it is the hardest for young athletes to perform at baseline. When testing the SAC, they found no learning effect through seven days post baseline score.

Balance and Exercise

A study by Fox, Mihalik, Blackburn, Battaglini, and Guskiewicz (2008) compared anaerobic and aerobic exercise effects on balance immediately post exercise. They used the BESS to find when balance returned after exercise. They found that regardless of the exercise prescribed, errors in balance increased post exercise compared to baseline. Postural control returned to baseline on average between 8 and 13 minutes post exercise (Fox et al., 2008).

The environment can play a role as to how one performs on the BESS. Onate, Beck, and Van Lunen (2007) compared how individuals scored on the BESS when environment was varied. They had a control environment of only the investigator and the subject in a quiet locker room, whereas the uncontrolled environment was tested during live practice or games. The sideline environment performed worse on the BESS when compared to the control environment. The controlled environment group had an average mean score using the BESS of 10.95 ± 6.55, in comparison the uncontrolled environment, or sideline group, scored 14.24 ± 5.65. This shows that where the test is administered can affect performance on this particular assessment tool.

SAC and Exercise

Koscs, Kaminski, Swanik, and Edwards (2009) compared SAC scores after exercise and also at rest. They found that there was no significant difference in the overall SAC score when comparing rest to exercise. The mean SAC score for the exercise group was 26.38 ± 2.28, whereas the rest group was 26.82 ± 1.90. They also found that there was no significant difference within the four components of the SAC, which include orientation, immediate memory, concentration, and delayed recall.

A study by Register-Mihalik, Guskiewicz, Mann, and Shields (2007) examined the effects of posttraumatic headache and preseason baseline headache levels on neurocognitive function. They did this by having high school and college students perform a variety of mental status and postural stability tests. They used a GSC, ANAM, SAC, and BESS to obtain their data. To assess posttraumatic headache scores [PTH], subjects where split into three groups, those that did not experience a headache at baseline, those that experienced mild posttraumatic headache, and those with severe posttraumatic headache. This study found that those that reported headache at baseline had a higher rate of symptoms experienced and the severity of symptoms was also higher compared to the non-headache group. Also, as the severity of PTH increased the more neurocognitive deficits were observed. The no PTH group reported an average of; 2.32 symptoms on the GSC, scored 27.50 on the SAC, and 10.71 on the BESS one day post-injury. In comparison, the moderate-severe PTH reported an average of 19.16 symptoms, 26.63 on the SAC, and 16.02 on the BESS on day post-injury. This shows a relationship between the severity of PTH and neurocognitive dysfunction. However, as the time moved further away from injury, the symptoms and assessment scores returned back to baseline levels.

Previous Concussion History

A study by Register-Mihalik, Mihalik, and Guskiewicz (2009) looked at previous history of concussions and presence of symptoms when administering a GSC at baseline. They wanted to compare the results between high school and college students, as well as those who have not had a previous history of concussion, those that had 1-2 previous concussions, and those that had 3 or more concussions. They found that headache was prevalent at a slightly higher rate in high school students (25.7%) compared to college students (23.4%). Also there was a dose dependant association between symptoms reported and the number of previous concussions sustained. As the concussions increases, so did the symptoms reported at baseline. For example, those that had sustained three or more concussions reported headache at a much higher rate at baseline (52%) compared to those that had not sustained a concussion (22.9%). They also found that half of the symptoms on the GSC were experienced in 25% of the three or more concussion group. This data suggests that if you sustain a concussion, the likelihood of you experiencing symptoms of a concussion at baseline is much higher then if you had not previously sustained a concussion.

Chapter 3: Methods

Subjects will be comprised of varsity football players from three high schools located in the central Illinois area. Athletes will range from 16 to 18 years of age. Subjects that will be allowed to participate will complete an inclusion/exclusion form and consent and assent form (see Appendix I, II, III). Preseason measurements of height, weight, and position(s) played will be recorded prior to the start of the season. This information will be used to match players of the same demographic information for comparison between an athlete experiencing a headache and one that is not. Subjects will be matched in order of importance: age, weight, height, and position played. The control subjects age will be matched by year of birth, weight will be matched ± 20 lbs, height will be matched ± 2 inches, and position will be matched by grouping subjects into skilled vs. lineman as well as offense vs. defense.

Baseline measurements of the GSC, SAC, and BESS will be counterbalanced prior to the start of the season. To decrease variability, the same individual will administer either the BESS or SAC during baseline testing as well as at follow-up. Subjects that report a headache will be tested 20 minutes after exercise using the same order administered during baseline testing. Testing will be administered in a closed classroom controlled for noise.

The Standardized Assessment of Concussion (SAC) test is a tool used for the detection of a concussion. It contains four parts to it: orientation, memory, concentration, and delayed recall (McCrea et al., 1998). It is an easy test that has the ability to be administered on the sidelines and takes approximately five minutes to complete (Koscs et al., 2009). The test ranges from 0 to 30 points. Lower scores show more neurocognitive impairment (Guskiewicz et al., 2004). Recent evidence suggests that a decline of 1 point or more from baseline screening classified injured and uninjured players with a level of 94% sensitivity and 76% specificity (Barr & McCrea, 2001).

The BESS is used to test postural stability. This is done by having an athlete stand on flat and foam surfaces on their non-dominate leg in a variety of positions. The positions used are double leg, single leg, and tandem stance. Six trails are run (3 on flat and 3 on foam) using each stance. Each stance is recorded for 20 seconds while the subject's eyes are closed. A one point deduction is noted if one was to do any of the following; lift hand off iliac crest, open eyes, step, stumble or fall, move the hip into more than 30 degrees of flexion or abduction, lift the forefoot or heel, or remain out of the test position for more than 5 seconds (Riemann & Guskiewics, 2000). (see Appendix V)

The GSC is a questionnaire that allows the athlete to note which symptoms they are experiencing and how severe the symptoms are. Symptoms that are used are blurred vision, dizziness, drowsiness, excess sleep, easily distracted, fatigue, feeling "in a fog", feeling "slowed down, headache, inappropriate emotions, irritability, loss of consciousness, loss of orientation, memory problems, nausea, nervousness, personality change, poor balance, poor concentration, ringing in ears, sadness, seeing stars, sensitivity to light (Guskiewicz, Bruce, Cantu, Ferrara, Kelly, McCrea, et al., 2004). These symptoms are rated on a seven-point scale from 0 (no symptom experienced) to 6 (very severe). Administration of this test can be done immediately after a concussion is suspected, 2-3 hours post injury, 24 hours post, and 48 hours post, and 72 hours post injury for comparison of symptoms reported (see Appendix VI).

Chapter 4: Manuscript

ABSTRACT

<u>Context:</u> Headache is reported to be the most common concussion related symptom. This has resulted in a heavy reliance on symptoms for the sideline assessment of concussive injuries. It is unclear however, if all athletes reporting headache demonstrate impairment in other commonly evaluated concussion domains. **<u>Objective</u>**: To determine the relationship between those with and without a headache resulting from football participation on neurostatus and balance. **<u>Design:</u>** A two group repeated-measures design. **<u>Setting</u>**: Three high schools in central Illinois. **<u>Participants:</u>** Varsity football athletes (N=32; age 16.3±0.8 years, range 16-18; weight 82.8±21.8 kg; height 177.0±7.5 cm), participated in this study. **<u>Interventions:</u>** All athletes completed a baseline evaluation of the Graded Symptom Checklist (GSC), Balance Error Scoring System (BESS) and Standardized Assessment of Concussion (SAC). Athletes reporting a headache (n=16) following a game or practice were re-administered the same test battery, as well control participants (non-headache: n=16) matched for age, playing position, weight and height. **<u>Main Outcome Measures</u>:** Performance on the GSC, BESS and SAC were evaluated using group by time repeated measures analysis of variance. Significance was noted when p<0.05. **<u>Results:</u>** Following football participation, total GSC scores increased significantly (p=.004) in the headache group (8.1±8.9 to 16.1±15.3), but significantly decreased (p=.01) in the non-headache group (6.1±7.0 to 3.1±4.4). A significant decrease (p<.000) in BESS performance was noted in both groups: headache (15.0±7.4 to 20.3±8.9) and non-headache (13.3±6.7 to 18.1±6.7). No significant differences were noted on SAC performance (p>0.05). **<u>Conclusions</u>:** Performance on common concussion assessment tools does not appear to be influenced by athlete reports of football related headache. These findings indicate that the use of headache, exclusively or in combination with other concussion related symptoms, is not a valid marker of the injury. This supports previous works suggesting clinicians should adopt a

multifaceted approach to concussion management. Further, physical exertion appears to have an effect on BESS performance independent of symptoms, suggesting careful interpretation of BESS scores when administered on the sideline.

INTRODUCTION

In sport, a concussion is the most common head injury sustained (Guskiewicz et al., 2000) and as much as nine percent of all sports injuries are thought to be concussions (Erlanger et al., 1999). There are between 1.6 and 3.8 million sport-related concussions in the United States annually (Langlois, Rutland-Brown, & Wald, 2006), and of those concussions it is estimated that 250,000 result from playing football alone (Gerberich et al.,1983). Guskiewicz and Weaver (2000) noted that high school athletes are at a slightly greater risk of sustaining a concussion than collegiate athletes. They found an incidence rate of 5.6% in high school athletes, compared to 4.4% in National Collegiate Athletic Association Division I athletes, 4.5% in Division II athletes, and 5.5% in Division III athletes. It has been estimated that as many as 50% of all high school football concussion cases are unreported **(**McCrea et al., 2004)**.** Since concussions sometimes go unnoticed or unreported, athlete recognition of what a concussion is, and what symptoms that follow a concussion are, could lead to higher number of concussion cases discovered (McCrea et al., 2004).

Many athletes continue to participate in games or practices while experiencing symptoms of a concussion. Some of these symptoms can include confusion, disorientation, unsteadiness, dizziness, and headache, nausea, vomiting, difficulty falling asleep, sleeping more than usual, feeling fatigued, drowsiness, sensitive to light or noise, feeling dinged, dazed, or stunned, seeing stars or flashing lights, ringing in the ears, or double vision (Giza & Hovda, 2001)(Aubrey et al., 2002). The most common symptom of a concussion is headache, which occurs in 85.2% of concussion cases (Guskiewicz et al., 2003).

It is not uncommon, however, for athletes to experience headache during times of intense activity (i.e. games or strenuous practice), without changes in head acceleration typically associated with concussion mechanisms. As much as 81% of football players experience headache in one out of every four games played (Sallis &Jones, 2000). Certified athletic trainers (ATCs) and other personnel will often look for the presence of headache as a key to a concussion diagnosis (Guskiewicz et al., 2004). Using headache as a guideline for diagnosing concussions can be misleading. As much as 71% of sport and exercise headaches occur without trauma (Williams & Nukada, 1994). Thus, there could be a false positive correlation between the presence of headache and concussions.

There are a variety of assessment tools administered to classify concussions. Some of which that are commonly used on the field are; the Standardized Assessment of Concussion [SAC], Balance Error Scoring System [BESS], graded symptom checklist [GSC]. All of these tools aim to help determine the grade, or severity of injury. The SAC is a brief nuerostatus exam that contains four parts to it: orientation, memory, concentration, and delayed recall (McCrea et al., 1998). It is an easy test that has the ability to be administered on the sidelines and takes approximately five minutes to complete (Koscs et al., 2009). The BESS is a concussion assessment tool used to evaluate postural-stability. Recent evidence has found that performing three or more errors during a BESS exam can be significant enough to diagnose a concussion (Barr & McCrea, 2000; Valovich McLeod et al., 2006). The GSC is a questionnaire that allows the athlete to note which symptoms they are experiencing and how severe each symptom is. As many as 85% of certified athletic trainers [ATCs] use a symptom checklist, 48% use the SAC, and 18% use the BESS when evaluating for the presence of a concussion (Notebaert & Guskiewicz, 2005). This study will incorporate the use of SAC, BESS, and GSC after exerciswe hen headache is experienced.

The purpose of this study is to determine the effects of headache after a time of increased physical activity and its relationship with symptoms related to concussion (i.e. GSC), neurostatus (i.e. SAC performance), and postural control (i.e. BESS performance) in interscholastic football athletes.

METHODS

Thirty-two youth athletes volunteered to participate in this investigation. The sample included sixteen high school football players reporting a headache after a game or practice (16.31±0.79 years, 178.83±7.77 cm, 87.23±30.77 kg), as well as sixteen matched participants that did not experience a headache (16.38±0.72 years, 175.46±7.42 cm, 82.69±15.01 kg). The participants who did not sustain a headache after a game or practice served as the control group for this study. Football players were used in this study because of the high incidence of head injury that appears unrelated to concussion (Sallis & Jones, 2000). All participants were given the Criteria for Inclusion Questionnaire (Appendix A) prior to participation to determine inclusion or exclusion status based on health related questions. Participants were excluded if they had a history of chronic headaches or migraines, if they were taking medications for dizziness, headaches, migraines, cold symptoms, or ear infections, if they had a learning disability, if they had a serious lower extremity surgery, if they were still experiencing symptoms from a previous concussion, or if they had a history of balance disorders. Upon inclusion, all participants read and signed the approved informed assent document (Appendix B), the parent/guardian read and signed an informed consent document (Appendix C) and were oriented to the testing procedures.

Test Procedures

Each participant completed a baseline evaluation prior to the start of the football season. The tests that were administered were the Standardized Assessment of Concussion (SAC), Balance Error Scoring System (BESS), and Graded Symptoms Checklist (GSC). Later in the season, athletes that reported a headache following a game or practice, as well as a matched counterpart, were retested using the same assessment tools. Participants were matched in a hierarchical order; age (within a year), weight (±9.07 kg), height (±5.1 cm), and position played. Testing was administered in a quiet, controlled environment. To decrease variability, the same clinician administered the BESS or SAC during baseline testing as well as at follow-up.

The GSC questionnaire (Appendix D) allowed the participant to note which symptoms they were currently experiencing and the severity. Symptoms were rated on a seven-point scale from 0 (no symptom experienced) to 6 (very severe). There were a variety of symptoms found in this survey that included: blurred vision, dizziness, drowsiness, excess sleep, easily distracted, fatigue, feeling "in a fog", feeling "slowed down", headache, inappropriate emotions, irritability, loss of consciousness, loss of orientation, memory problems, nausea, nervousness, personality change, poor balance, poor concentration, ringing in ears, sadness, seeing stars, sensitivity to light (Guskiewicz et al., 2004).

The SAC (Appendix E) tested neurostatus and incorporated four parts: orientation, memory, concentration, and delayed recall (McCrea et al., 1998). The test ranged from 0 to 30 points, with lower scores showing more neurocognitive impairment. Recent evidence suggests that a decline of 1 point or more from baseline screening classified injured and uninjured players with a level of 94% sensitivity and 76% specificity (Barr & McCrea, 2001). Alternate SAC forms were used at baseline and follow-up.

The BESS (Appendix F) was used to assess postural stability. This is performed by having a participant stand on firm and foam surfaces on their non-dominate leg in a variety of positions. The positions used were double leg, single leg, and tandem stance. Six trials were run (3 on flat and 3 on foam) using each stance. Each stance was recorded for 20 seconds while the subject's eyes were closed. A one point deduction was noted if a participant did any of the following; lift hand off iliac crest, open eyes, step, stumble or fall, move the hip into more than 30 degrees of flexion or abduction, lift the forefoot or heel, or remain out of the test position for more than 5 seconds as previously described (Riemann & Guskiewicz, 2000).

Statistical Analysis

Performance on the GSC, BESS, and SAC were evaluated using group by time repeated measures analysis of variance. Significant results were further analyzed by comparing the means of the two groups and two time points. Significance was noted when $p<0.05$.

RESULTS

Descriptive information on the 32 participants enrolled in the investigation can be found in Table 1. Analysis of the three concussion tests showed significant results ($p<.05$) when looking at the BESS data over time and GSC data between groups. However, there were no significant differences with the SAC scores between groups or over time. The overall mean composite score for BESS at baseline was 14.13±7.02, whereas the follow-up score was 19.22±7.82. A significant decrease ($p<.000$) in BESS performance was noted in both groups over time: headache (14.94±7.43 to 20.31±8.87) and non-headache (13.31±6.72 to 18.13±6.74). The GSC overall baseline score was 7.44±8.06, whereas the follow-up score was 9.53±12.89. The data shows a significant difference ($p=.003$) between groups during the follow-up scores. An increase in symptoms was noted with the headache group over time (8.06±8.87 to 16.06±15.29), whereas the non-headache group showed a decrease (6.81±7.41 to 3.00±4.34). The overall SAC baseline score was 24.63±2.86, and the follow up score 24.84±3.86. In addition, the non-headache group had a baseline score of 24.50±2.90 and a follow-up score of 24.88±4.79. The headache group had a baseline score of 24.75±2.91 and a follow up mean score of 24.81±3.02.

DISCUSSION

Many experts in the medical field use the resolution of symptoms as a concussion guideline for athlete recovery. The American Academy of Neurology concussion guidelines define persistent headaches after head trauma as a concussion (Practice Parameter, 1997). In our study, we used the most commonly related symptom of a concussion (i.e. headache) (Packard & Ham, 1997) to determine when to administer concussion assessment tools (i.e. BESS, SAC, GSC). Our hypothesis was that athletes who experienced a headache after a bout of exercise would perform the same on the neurocognitive and postural control tasks compared to their baseline scores and matched counterparts who did not report a headache after exercise. The results of this study show that, based on the presence of headache, the SAC was not affected over time or between groups. However, the BESS data showed that both groups decreased postural stability over time. Also, symptomology increases in the headache group over time, whereas the non-headache group decreased reported symptoms.

The BESS helps medical care providers assess postural control to generate objective information to help the concussion evaluation process. We found a significant increase in overall errors in the headache group over time. This finding is similar to previous research that noted a concussion decreased postural stability on day 1 post injury in comparison to their baseline measure. (Guskiewicz, Ross, & Marshall, 2001). In addition, research has shown that concussed athletes with posttraumatic headache experience greater declines in balance than concussed athletes without posttraumatic headache (Register-Mihalik, Mihalik, & Guskiewicz 2008). Our findings showed that using the presence of a headache might not be a good marker in determining differences in postural stability. However, use of postural stability assessment tools can be advantageous to use when trying to determine when an athlete with a concussion may return to competition (Riemann & Guskiewicz, 2000).

Research by Guskiewicz, Ross, and Marshall (2001) found that there was no difference over time for the control group that did not sustain a concussion and postural stability. However, our findings show that the non-headache control group did significantly increase BESS errors from baseline to follow up. This could be attributed to a variety of factors. One of which is the time between exercise completion and administration of the BESS is sensitive. Recent research suggests that postural stability declines immediately after exercise, and that it may take as long as 8 to 13 minutes on average for balance to return to baseline levels (Fox et al., 2008). This information is useful for medical professionals when dealing with an athlete that has a suspected concussion. Although we were cognizant of the affects of acute exercise on postural stability by sequencing the administering of the BESS last, it is possible that follow-up testing was still altered even following a window of recovery within this study.

Our data indicates that using the GSC after a time of increased activity shows various results between groups. The headache group observed an increase in symptoms related to a concussion after exercise, whereas those who did not observe a headache had a decrease in symptoms related with a concussion after exercise. One of the biggest problems with self-reporting symptoms is that they are subjective. One thought as to why we saw the headache group show an increase, whereas the non-headache group showed a decrease was because they did not take the time to report their symptoms or since they did not have a headache, they did not take the rest of the form seriously. This is concurrent with previous findings that stated the main reason that athletes did not report symptoms related with a concussion to clinicians was because they did not think the symptoms were serious enough to warrant medical attention (McCrea et al., 2004).

An explanation as to why the headache group reported an increased of symptoms could be because they conceivably took the time to appropriately fill out the GSC when they were experiencing a headache. When they did this they noted a significant increase in other symptoms related with a concussion. However, clinicians must consider that increases in symptomology could be attributed to dehydration (Patel, Mihalik, Notebaert, Guskewicz, & Prentice, 2007) or strenuous exercise (Williams & Nukada, 1994**).**

There were not any significant findings when looking at the SAC test by group or time. Our findings are similar to previous research, which found that the SAC test had no difference in scores regardless of hydration status (Patel et al., 2007). Also, our study found that there was not a learning effect with repeated administration of the SAC. Again, this is concurrent with previous research that found that after repeated administration a practice effect did not occur (Valovich McLeod, Perrin, & Gansneder, 2003; Valovich McLeod et al., 2004)

Currently, there are more than 20 concussion grading systems and return to play protocols, of which, the Cantu Evidence-Based Grading system and return to play guideline is the most commonly cited in the literature (Cantu, 2001). Most of these systems are based off of athlete LOC and amnesia as a predictor of the severity of injury. However, LOC is reported in only 8.9% of concussion cases and amnesia in 27.7% (Guskiewicz et al., 2000). Our aim was to see if headache, the most common symptom of concussion, after physical activity was a good indicator of neurostatus (i.e. SAC performance) and postural control (i.e. BESS performance) in interscholastic football athletes. We used the BESS, GSC, and SAC due to their simplicity and effectiveness when evaluating concussions immediately after physical activity. Although we know that headache is the most commonly reported symptom associated with a concussion (Guskiewicz, McCrea, Marshall, Cantu, Randolph, & Barr, 2003) and medical care providers sometime use the presence of a headache as a key to concussion assessment (Guskiewicz, et al., 2004), a headache may not influence performance on various concussion assessment tools. To ensure athletes return to play safely, clinicians should take into consideration a multifaceted approach to concussion management.

CONCLUSION

Performance on common concussion assessment tools does not appear to be influenced by athlete reports of football related headache. These findings indicate that the use of headache, exclusively or in combination with other concussion related symptoms, is not a valid marker of the injury. This supports previous works suggesting clinicians should adopt a multifaceted approach to concussion management. Further, physical exertion appears to have an effect on BESS performance independent of symptoms, suggesting careful interpretation of BESS scores when administered on the sideline.

TABLES AND FIGURES

Table 1. Descriptive analysis for the 32 subjects reported in average and standard deviation

	Headache	Non-Headache
Age	16.31 (0.79)	16.38 (0.72)
Height (cm)	178.83 (7.77)	175.46 (7.42)
Weight (kg)	87.23 (20.77)	82.69 (14.01

Figure 1. Total symptoms as reported on the GSC.

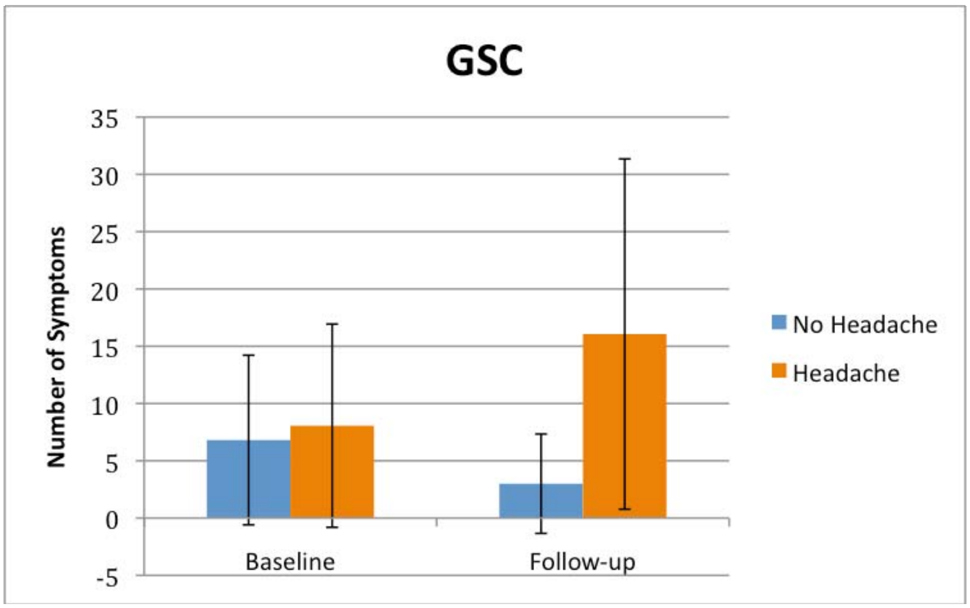


Figure 2. Total number of errors performed on the BESS.

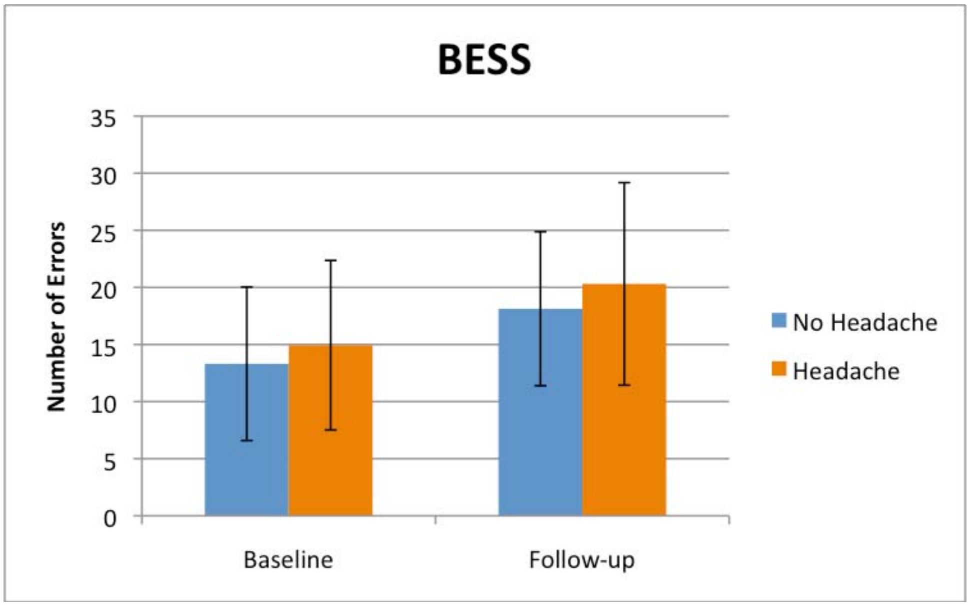
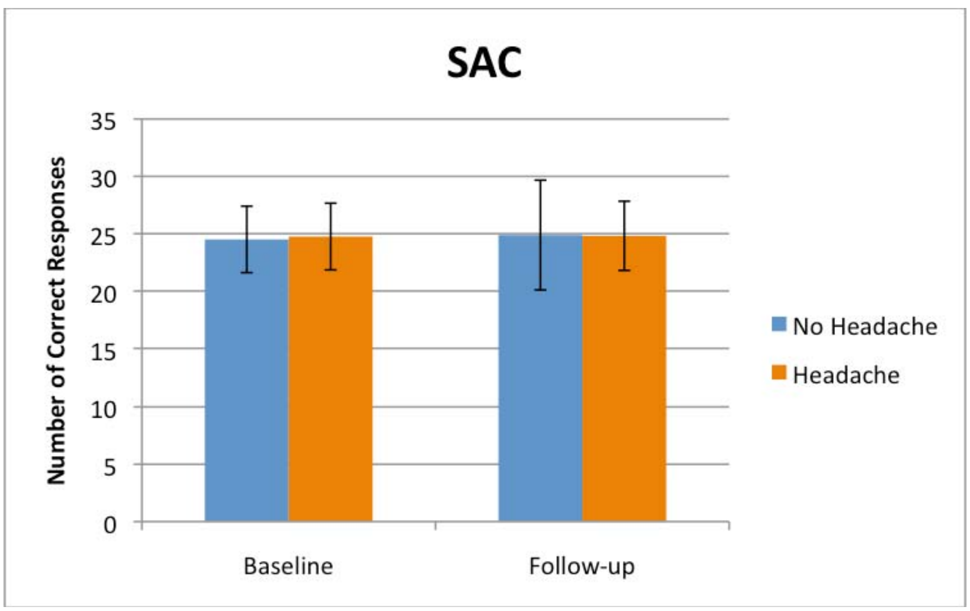


Figure 3. Total number of correct responses on the SAC.



Appendix A

Health History:

Age ____________________________________

Height ____________________________________

Weight ____________________________________

Position ____________________________________

How many years have you played football? ____________________________________

Have you ever been diagnosed with a concussion, if so how many?

____

Please list the approximate date(s) and how long you experienced symptoms

Approx. Date: ____________________

Length of Symptoms Experienced: ____________________

Approx. Date: ____________________

Length of Symptoms Experienced: ____________________

Approx. Date: ____________________

Length of Symptoms Experienced: ____________________

Exclusion criteria:

Do you have a history of chronic headaches/migraines?	Y	N
Are you currently taking any medications for any of the following: dizziness, headaches, migraines, cold symptoms, or inner ear infection?	Y	N
Have you been diagnosed with a learning disability or attention deficit disorder?	Y	N
Have you had any serious symptomatic ankle, knee, or hip trauma requiring medical attention within the last 3 months?	Y	N
Have you been diagnosed with a concussion previously and still experiencing symptoms from that concussion?	Y	N
Do you have a history of any balance disorders?	Y	N

Appendix B

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Department of Kinesiology
Louise Freer Hall
906 South Goodwin Avenue
Urbana, IL 61801-3895

PARENTAL CONSENT

Headache in football

Thank you for considering to allow your child to participate in the research study titled, **Headache in football**, which is being conducted by Dr. Steve Broglio (217-244-1830) Bridget Van Boxtel, Matthew Nohren, Matthew Sabin, and Karla Wessels of the Department of Kinesiology and Community Health. Your child's participation in this research is voluntary. The decision to participate, decline, or withdraw from participation will have no effect on grades, status, or future relations with the high school, or the University of Illinois. You and your child have the right to refuse participation or may withdraw consent at any time without penalty from coaching staff.

PURPOSE:

The purpose of this investigation is to understand the relationship between a football induced headache and measures of balance and memory. The results of this study will be used to improve the medical care for all high school football athletes.

PROCEDURES:

Student athletes who participate in this study, and whose parent or guardian give their consent, will complete three tests at the start of the study for baseline information. They are the Standardized Assessment of Concussion (SAC), the Balance Error Scoring System (BESS), and a Symptom Inventory, which is a list of concussion-related symptoms. More information on each test is described below. Following a game or practice, the student athlete may be asked to complete the same tests again if he reports a headache to one of the researchers or if he is selected as a control participant. Total time to complete the tests is 15 min on each occasion.

1. The Standardized Assessment of Concussion (SAC) contains four sections: orientation, memory, concentration and delayed recall. For each section the athlete will be asked by an investigator to recall the day/time, a series of words, or a string of numbers. Time to complete the SAC is approximately 5 minutes.

2. The BESS consists of three different stances (double leg, single leg, and tandem stance) on a firm and foam surface. All testing will be completed with the eyes closed and with the hands on hips. Total time to complete one BESS assessment is approximately five minutes

3. The symptom inventory will ask if the athlete is experiencing symptoms commonly associated with concussion. This will take less than 2 minutes to complete.

RISKS AND BENEFITS

Student athletes who participate in this study may benefit from state-of-the-art assessment of concussive injuries. In addition, he will gain a better understanding and knowledge of concussion. At the conclusion of the study, the athlete may request to receive written or verbal information about performance on the SAC and BESS tests.

There are no more than minimal risks associated with taking the SAC, BESS or symptom inventory tests. The athlete may find the test challenging but he will not be placed in any danger for injury or discomfort. He may suspend testing at any time.

CONFIDENTIALITY

The athlete's participation in this study and the results of this participation will not be given to anyone outside the research study group. To ensure privacy and confidentiality, a code number will be assigned to each participant, and all data collected will be recorded using only the code number. Some data may be discussed at professional meetings or in publications, but at no time will any participant be identified by name. Any data used for research will not be released in any individually identifiable form without prior written consent, unless otherwise required by law.

CONTACT INFORMATION

There are no costs to you for taking part in this study and all testing will occur at no cost to you or your child.
There is no compensation for participation in this study.

If at any time you have questions about this research project, or if you experience any problems related to your participation in the project, please feel free to contact the responsible project investigator: Steven P. Broglio PhD, Department of Kinesiology and Community Health, 906 S. Goodwin Ave, Urbana, IL 61801, 217.244.1830, Broglio@uiuc.edu.

If you would like to speak to someone about your child's rights as a participant in this study, you may contact the University of Illinois Institutional Review Board at 217-333-2670 or irb@illinois.edu. You may call the University of Illinois IRB collect if you identify yourself as a research participant.

I understand that I am agreeing by my signature on this form for my child to take part in this research project and understand that I will receive a signed copy of this consent form for my records.

Steven P. Broglio	______________________	__________
Name of Researcher	Signature	Date

____
Name of Participant

______________________	______________________	__________
Name of Parent/Guardian	Signature	Date

Please sign both copies, keep one and return one to the researcher.

Appendix C

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Department of Kinesiology
Louise Freer Hall
906 South Goodwin Avenue
Urbana, IL 61801-3895

PARTICIPANT ASSENT
Headache in football

Thank you for considering participating in the research study titled, **Headache in football**, which is being conducted by Dr. Steve Broglio (217-244-1830) Bridget Van Boxtel, Mathew Nohren, Mathew Sabin, and Karla Wessels of the Department of Kinesiology and Community Health. Your participation in this research is voluntary. The decision to participate, decline, or withdraw from participation will have no effect on grades, status, or future relations with the high school, or the University of Illinois. You have the right to refuse participation and may withdraw consent at any time without penalty from the coaching staff.

PURPOSE:

The purpose of this investigation is to understand the relationship between a football induced headache and measures of balance and memory. The results of this study will be used to improve the medical care for all high school football athletes.

PROCEDURES:

If you agree to participate in this study, you will complete three tests at the start of the study for baseline information. They are the Standardized Assessment of Concussion (SAC), the Balance Error Scoring System (BESS), and a Symptom Inventory, which is a list of concussion-related symptoms. More information on each test is described below. Following a game or practice you may be asked to complete the same tests again if you report a headache to one of the researchers or if you are selected as a control participant. Total time to complete the tests is 15 min on each occasion.

4. The Standardized Assessment of Concussion (SAC) contains four sections: orientation, memory, concentration and delayed recall. For each section you will be asked by an investigator to recall the day/time, a series of words, or a string of numbers. Time to complete the SAC is approximately 5 minutes.

5. The BESS consists of three different stances (double leg, single leg, and tandem stance) on a firm and foam surface. All testing will be completed with the eyes closed and with the hands on hips. Total time to complete one BESS assessment is approximately five minutes

6. The symptom inventory will ask if you are experiencing symptoms commonly associated with concussion. This will take less than 2 minutes to complete.

RISKS AND BENEFITS

If you participate in this study you may benefit from state-of-the-art assessment of concussive injuries. In addition, you will gain a better understanding and knowledge of concussion. At the conclusion of the study, you may request to receive written or verbal information about your performance on the SAC and BESS tests.

There are no more than minimal risks associated with taking the SAC, BESS or symptom inventory tests. You may find the test challenging but he will not be placed in any danger for injury or discomfort. You may stop testing at any time.

CONFIDENTIALITY

Your participation in this study and the results of this participation will not be given to anyone outside the research study group. To ensure privacy and confidentiality, a code number will be assigned to each participant, and all data collected will be recorded using only the code number. Some data may be discussed at professional meetings or in publications, but at no time will any participant be identified by name. Any data used for research will not be released in any individually identifiable form without prior written consent, unless otherwise required by law.

CONTACT INFORMATION

There are no costs to you for taking part in this study. There is no compensation for participation in this study.

If at any time you have questions about this research project, or if you experience any problems related to your participation in the project, please feel free to contact the responsible project investigator: Steven P. Broglio PhD, Department of Kinesiology and Community Health, 906 S. Goodwin Ave, Urbana, IL 61801, 217.244.1830, Broglio@uiuc.edu.

If you would like to speak to someone about your rights as a participant in this study, you may contact the University of Illinois Institutional Review Board at 217-333-2670 or irb@illinois.edu. You may call the University of Illinois IRB collect if you identify yourself as a research participant.

I understand that I am agreeing by my signature on this form to take part in this research project and understand that I will receive a signed copy of this consent form for my records.

__Steven P. Broglio____	______________________________	__________
Name of Researcher	Signature	Date
___________________________	______________________________	__________
Name of Participant	Signature	Date

Please sign both copies, keep one and return one to the researcher.

Appendix D

Ex. GSC Form

Baseline/Intervention

ID#__________________________ **Date**_____________________

Graded Symptoms Checklist

Symptom	**Presence**		**Mild**		**Moderate**			**Severe**
Blurred vision	Yes	No	1	2	3	4	5	6
Drowsiness	Yes	No	1	2	3	4	5	6
Excess Sleep	Yes	No	1	2	3	4	5	6
Easily Distracted	Yes	No	1	2	3	4	5	6
Fatigue	Yes	No	1	2	3	4	5	6
Feel “in a fog”	Yes	No	1	2	3	4	5	6
Feel “slowed down”	Yes	No	1	2	3	4	5	6
Headache	Yes	No	1	2	3	4	5	6
Inappropriate emotions	Yes	No	1	2	3	4	5	6
Irritability	Yes	No	1	2	3	4	5	6
Loss of consciousness	Yes	No	1	2	3	4	5	6
Loss of orientation	Yes	No	1	2	3	4	5	6
Memory problems	Yes	No	1	2	3	4	5	6
Nausea	Yes	No	1	2	3	4	5	6
Nervousness	Yes	No	1	2	3	4	5	6
Personality change	Yes	No	1	2	3	4	5	6
Poor balance/coordination	Yes	No	1	2	3	4	5	6
Poor concentration	Yes	No	1	2	3	4	5	6
Ringing in ears	Yes	No	1	2	3	4	5	6
Sadness	Yes	No	1	2	3	4	5	6
Seeing stars	Yes	No	1	2	3	4	5	6
Sensitivity to light	Yes	No	1	2	3	4	5	6
Sensitivity to noise	Yes	No	1	2	3	4	5	6
Sleep disturbance	Yes	No	1	2	3	4	5	6
Vacant stare/glassy eyed	Yes	No	1	2	3	4	5	6
Vomiting	Yes	No	1	2	3	4	5	6

Appendix E

Ex. SAC Form

1) Orientation:

Month: ______	0	1
Date: ______	0	1
Day of week: ______	0	1
Year: ______	0	1
Time (within 1 hr): ______	0	1
Orientation Total Score ______	/	5

2) Immediate Memory: (all 3 trials are completed regardless of score on trial 1 & 2; total score equals sum across all 3 trials)

List	Trial 1		Trial 2		Trial 3	
Word 1	0	1	0	1	0	1
Word 2	0	1	0	1	0	1
Word 3	0	1	0	1	0	1
Word 4	0	1	0	1	0	1
Word 5	0	1	0	1	0	1
Total						

Immediate Memory Total Score ______ / 15

(Note: Subject is not informed of delayed recall testing of memory)

Neurologic Screening:

Loss of Consciousness: (occurrence, duration)

Retrograde & Posttraumatic Amnesia:
(recollection of events pre- and post-injury)

Strength:

Sensation:

Coordination:

3) Concentration:

Digits Backward (If correct, go to next string length. If incorrect, read trial 2. Stop after incorrect on both trials.)

4-9-3	6-2-9	______	0	1
3-8-1-4	3-2-7-9	______	0	1
6-2-9-7-1	1-5-2-8-6	______	0	1
7-1-8-4-6-2	5-3-9-1-4-8	______	0	1

Months in Reverse Order: (entire sequence correct for 1 point)

Dec-Nov-Oct-Sep-Aug-Jul Jun-May-Apr-Mar-Feb-Jan	______	0	1
Concentration Total Score	______	/	5

Exertional Maneuvers
(when appropriate):

5 jumping jacks — 5 push-ups
5 sit-ups — 5 knee bends

4) Delayed Recall:

Word 1		0	1
Word 2		0	1
Word 3		0	1
Word 4		0	1
Word 5		0	1
Delayed Recall Total Score	______	/	5

Summary of Total Scores:

Orientation	______	/	5
Immediate Memory	______	/	15
Concentration	______	/	5
Delayed Recall	______	/	5
Overall Total Score	______	/	30

Appendix F

Ex. Bess Form

Participant ID: _______________ Date: _______________

Baseline or Follow-Up Preferred Kicking Leg: R L

BESS

	Double Leg Stance	Single Leg Stance	Tandem Stance
Stable Surface			
Foam Surface			

Total Errors = _____________

Errors:

1) Eyes open
2) Hands off hips
3) Hips move greater than 30°
4) Loose balance and touch out of stance area
5) Stay out of position greater than 5 seconds
6) Heel comes off of the surface (firm or foam)

Other Testing Notes:

1) Nondominant leg (non-kicking leg) used in single leg stance and placed forward in the tandem stance
2) Stable surface first
3) Each condition tested for 20 seconds

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