CONCUSSION AWARENESS & RECOGNITION:

YOUTH SPORT PARENTS' PERCEPTIONS

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Marissa Jae Lindback

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Title

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

MASTER OF ATHLETIC TRAINING

ABSTRACT

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Youth sport concussion has recently become a topic of concern for health care professionals. Young athletes are at greater risk of sustaining a concussion because children have a greater head-to-body ratio and their cervical musculature and cranial bones are not fully developed. Access to on-site medical professionals is limited for young athletes, leaving recognition and management of the injury to the parents. Limited research has examined parental knowledge of concussion. The purpose of this study was to examine youth sport parents' knowledge regarding the recognition, assessment, and management of concussion. A cross-sectional descriptive design utlizing a SurveyMonkey™ questionnaire was emailed to all parents associated with two gymnastics organizations in the Fargo-Moorhead metro area. Included in the survey were outcome measures that included knowledge of concussion etiology, the ability to recognize concussive symptoms, and knowledge of concussion management. Eighty-nine parents of youth sports athletes participated in this study, a 25 percent response rate. A novel survey instrument was developed to assess parental concussion knowledge. Internal reliability of the instrument was established prior to the study with a pilot group (Cronbach's alpha = 0.67). Data analysis included information regarding frequency and percentages of overall results and demographic data. Overall, participants in this study had moderate knowledge of concussion recognition, diagnosis, and management. Participants with and without prior medical training differed significantly in their knowledge of concussion etiology (P= 0.0016). There was no significant difference between these groups in their ability to recognize concussive symptoms (P= 0.08) or in the knowledge level regarding concussion management (P= 0.68). There was no significant difference between parents with children who participate in more than one sport and those whose children participate in gymnastics only (P= 0.76). Those who have personally (themselves or their children) been diagnosed with a concussion and those who had never been diagnosed with a concussion were not significantly different in their overall concussion knowledge (P= 1.92). Parents have a moderate level of knowledge regarding some aspects of concussive injuries. Additional educational opportunities for parents may help increase concussion awareness.

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CHAPTER I:

INTRODUCTION

The National Athletic Trainers Association Research and Education Foundation estimates that there are more than 30 million children participating in organized sports in the United States (Ward, 2004). Increasingly, over the past decade, children are participating in organized competitive sports at earlier ages. Many children are beginning to play organized sports at young ages, and are participating in athletics year-round. Some athletes are even participating in multiple sports, year-round. This has been evident in club level gymnastics over the past two decades. In 2003, there were approximately 60,000 club level gymnasts registered with USA gymnastics, and the number continues to rise due to the popularity the sport has obtained in recent history. Training for these athletes can begin as early as age three or four, and continues for 10 or more years, increasing in level and duration as their career progresses. Gymnasts often train at an intense level, twelve months of the year, for approximately 24-40 hours a week (Caine et al., 2003). Consequently, it has been suggested that the increased level of participation, repetitive exposures, and the increase of skill difficulty over the last several decades may be associated with an increased injury risk (Caine et al., 2003).

Injuries are an inevitable occurrence in any athletic population, with the number of injuries reported being proportional to the amount of participation. Youth sport injury is a concern among the pediatric and medical communities as young athletes are more susceptible to injury due to multiple risk factors (Radalet, Lephart, Rubenstein, & Meyers, 2002). According to the Sports Medicine Handbook (NCAA, 2002), gymnastics ranks second, only to spring football, in practice injury rates with 6.2 injuries per 1000 athlete exposures. The high rate of injury for gymnastics may be attributed to the amount of force that is involved in their landing skills. Many gymnasts land with minimal flexion at the hip, knee, and ankle. This causes a great amount of force that is absorbed by the body as it travels up the kinetic chain, increasing the risk of injury (Sands, 2000).

Although there are a variety of injuries occurring in organized youth athletics, one of the most commonly sustained injuries is concussion (Kelly, Lissel, Rowe, Vinceton, & Voaklander, 2001). Athletes participating in competition, contact or not, are at risk of suffering a concussion. A concussion is defined as a, "complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces (Aubry, et al., 2002)." A recent study observed that children between ages 6 and 16 were six times more likely to suffer a concussion while playing an organized sport than if they were playing recreationally (Brown & Lam, 2006). Several common features that incorporate clinical, pathological, and biomechanical injury constructs may be used to diagnose a concussive head injury. These include: (1) a direct blow to the head, face, neck, or elsewhere on the body with force transmitted to the head, (2) the rapid onset of short lived impairment of neurological function that resolves spontaneously, (3) neuropathological changes, but the acute symptoms largely reflect a functional disturbance rather than structural injury, (4) a graded set of clinical syndromes and cognitive symptoms that typically follow a sequential course of recovery, (5) typically concussions are associated with grossly normal structural neuroimaging studies (Aubry et al., 2002, p. 6)."

Sport-related concussion has been estimated at 1.6 to 3.8 million injuries annually (Langlois, Rutland-Brown, & Wald, 2006). As many as eight percent of sport-related injuries are reported to be concussions among athletes under the age of 16 (Kelly et al., 2001). Due to the high incidence and risk rate, sport-related concussion in youth athletics has become a public health issue.

It is believed that the number of concussions occurring in athletics is much higher than currently reported (Williamson & Goodman, 2006). There are a number of reasons that sport-related youth concussion would not be diagnosed and reported. Athletes may purposely underreport the severity of their symptoms to avoid being removed from activity or to return to play quickly. In addition to athletes underreporting injuries, a lack of knowledge regarding the mechanism of injury, signs and symptoms, and management could play a role in concussions going undiagnosed. Finally, children's cognition continues to rapidly develop until they are 15 years old, thereby possibly masking the severity of their injury (McCrory, Collie, Anderson, & Davis, 2004).

Previous studies (Browne & Lam, 2006; Kelly et al., 2001) have observed that there is higher risk and incidence of concussion in youth athletics and that many youth sport organizations employ on-site medical staff for competitions, but disregard the same employment of medically qualified personnel at the team practices. This leaves recognition of injury to the athlete, coach or parents. If the athlete, coach, or parents have no knowledge of concussive signs and symptoms or management, this could contribute to the underreporting of concussions in the youth population. Due to the lack of health care providers at practices on the youth athletic field, untrained providers may be treating athletic injuries, making decisions that exceed their educational training (Ransone & Dunn-Bennett, 1999). This causes a great deal of concern as the recognition, diagnosis, and management of sport-related concussion can be one of the most difficult duties, even for a trained sports medicine practitioner.

There are many common misconceptions surrounding concussion that untrained personnel may mistakenly believe. A particularly worrisome erroneous belief is that a person must suffer a blow to the head in order to be diagnosed with a concussion (Coughlin Myles, & Howitt, 2009). Although this is one cause of concussion, concussions can also be caused by a hit to the neck, face, jaw, or thorax (Aubry et al., 2002; McCrory et al., 2004). A whiplash mechanism can also cause a concussion as long as the force is transmitted through the body to the head (Aubry et al., 2002; McCrory et al., 2004). If parents, athletes, and coaches are uneducated about these things, recognition and treatment of concussion can go unreported, lowering reporting without lowering the incidence of concussion in youth athletics.

Unlike adults, who have experienced a plateau in cognitive development, children under the age of 15 have a steady incline in cognitive development (Anderson, 2001; McCrory et al., 2004). Some authors believe that the largest improvement in cognitive functioning, according to test performance, occurs between the ages of 9 and 15 (Collie, Darby, & Maruff, 2001). After age 15, test performance tends to plateau. This affects report rate because recognition and assessment of cognitive function is a factor in the accelerated maturation of the young brain. If this is not accounted for, a concussion diagnosis could be overlooked. Authors have reported that an undiagnosed concussion, including mild concussions and early return to play decisions, put youth athletes at a higher risk of recurrent injury. Additionally, there is a higher risk of increased severity of symptoms that can last for extended periods of time -- a situation that could decrease the overall functionality of the child (Iverson, Gaetz, Lovell, & Collins, 2004; Ponsford et al., 1999). There is also a negative secondary impact that can accompany a primary or recurrent concussion (Coughlin et al., 2009). Educational and social attainment, like acquiring knowledge and completing school work, are essential processes that occur with children on a daily basis. Concussion impacts the ability to focus attention, lowering a child's ability to obtain vital information and abilities during the management of symptoms.

Due to the increased popularity of sport for the young athlete and the lack of on-site medical staff in organized youth athletics, parents are in a good position to recognize a possible concussion during and after competition or training. When a concussion is suspected, it is also the parents' duty to seek proper clinical care for their child to prevent inappropriate return to play decisions being made by an untrained provider. Proper clinical care will allow the child to recover from a sustained concussion by not allowing the child to return to play while symptomatic, lowering the risk of subsequent concussion. If parents are unknowledgeable about concussions or are unaware of their child's experience during a competition or training session, a mild headache or behavior change could be overlooked and considered normal behavior. Overlooking concussive signs and symptoms may result in a premature return-to-play decision during a period of diffuse cerebral swelling. Any successive impact during this time can lead to rapid accumulation of swelling, due to disordered cerebral vascular autoregulation -- a situation that can trigger brainstem herniation and death (Bruce, 1984; Bruce, Alavi, Bilaniuk, Dolinskas, & Uzzell, 1981; Kors et al., 2001; McCrory & Berkovic, 1998; Pickles, 1950; Snoek, Minderhoud, & Wilmink, 1984). Therefore, it is imperative for parents to be able to recognize a possible concussion, allowing a qualified health care provider to assess the severity and make the return to play decision. This will decrease the likelihood of a cerebral emergency occurring.

Many studies (Kaut, DePompei, Kerr, & Congeni, 2003; LaBotz, Martin, Kimural, Hetzler, & Nichols, 2005; O'Donoghue, Onate, Van Lunen, & Peterson, 2009; Sawyer et al., 2008; Sye, Sullivan, & McCrory, 2006; Valovich McLoed, Schwartz, & Bay, 2007) have focused on the assessment of knowledge regarding concussion awareness in college and high school athletes as well as coaches. There have been a few studies (Coughlin et al., 2009; Cusimano, 2009; Gourley, Valovich McLeod, & Bay, 2010; Sullivan et al., 2009) that concentrate on parental knowledge of concussion in regards to contact or collision sports only. Studies involving parental knowledge regarding the recognition and management of concussion in non-contact sports are scant.

Statement of Purpose

The primary purpose of this study was to determine if parents of organized youth sport athletes had knowledge regarding the causes of concussion. A secondary purpose of this study was to establish if these same parents had knowledge regarding recognition of the signs and symptoms of concussion, as well as knowledge concerning management of concussion after diagnosis of a concussion.

Research Questions

1. What were parental perceptions regarding the causes of concussion?
2. What were parental perceptions regarding the symptoms of concussion?
3. What were parental perceptions regarding the diagnosis and management of concussion?

Limitations

- Unsupervised participation: Understanding of the survey questions was not guaranteed and participants had the ability to research the correct answer or collaborate answers.
- Regional or specific bias: Only the parents from two gymnastics organizations in Fargo-Moorhead were included.
- Parents of children who participated in a non-contact sport were the primary people surveyed, which could have affect the results.
- Low response rate: Difficulty generalizing the results of the study.

Definition of Terms

Adenosine Triphosphate - Adenosine, an organic base, with three phosphate groups attached to it. Energy stored in adenosine triphosphate is used in nearly all of the endergonic (requiring energy) reactions in cells (Seeley, Stephens, & Tate, 2008).

Anoxia - A condition characterized by an absence of oxygen supply to an organ or a tissue (Seeley et al., 2008).

Axon - Main central processor of a neuron that normally conducts action potentials away from the neuron cell body (Seeley et al., 2008).

Diffuse injury - Injury over a large body area, usually because of low velocity-high mass forces (Seeley et al., 2008).

Gait - the manner or style of walking (Anderson, Parr, & Hall. 2009).

Macroscopic - Large enough to be perceived or examined by the unaided eye (Seeley et al., 2008).

Mild traumatic brain injury (MTBI)- Immediate but transient posttraumatic impairment of brain function (Starkey, Brown, and Ryan, 2010).

Otorrhea - Any discharge from the external ear (Cuppett & Walsh, 2005).

Posturography - is a general term that covers all the techniques used to quantify postural control in upright stance in either static or dynamic conditions (Seeley et al., 2008).

Psychometric testing - The field of study concerned with the theory and technique of educational and psychological measurement, which includes the measurement of knowledge, abilities, attitudes, and personality traits (Kaplan & Saccuzzo, 2009).

Rhinorrhea- Thin watery discharge from the nose, or flowing of cerebralspinal fluid from the nose following injury to the head (Cuppett & Walsh, 2005).

Sequele - A condition (or conditions) occurring as a consequence of a given illness or disease (Cuppett & Walsh, 2005).

Tensile force - A pulling or stretching force directed axially through a body or body part (Anderson et al., 2009).

Visuomotor - Of or relating to motor activity dependent on or involving sight (Seeley et al., 2008).

Visuospatial - Of or relating to visual perception of spatial relationships among objects (Seeley et al., 2008).

CHAPTER II:

REVIEW OF LITERATURE

The primary purpose of this study was to determine if parents of organized youth sport athletes have knowledge regarding the causes of concussion. A secondary purpose of this study was to establish if these same parents have knowledge regarding recognition of the signs and symptoms of concussion, as well as knowledge concerning management of concussion after diagnosis.

Introduction

Concussion is a common type of head injury that often presents with obscure symptoms; these symptoms can lead to long-term neurological deficits if not caught early and treated properly. It has recently been proposed that some coaches and parents/guardians don't realize how a concussion may occur, how it is diagnosed, and how a concussion must be managed after diagnosis (Coughlin et al., 2009).

Recent research has determined that there are specific misconceptions regarding concussion (Valovich McLeod et al., 2007). It has been proposed that education may increase an individuals', whether it is a coach or a parent, knowledge of concussion which may enhance early recognition, diagnosis, and treatment (Volovich McLeod et al., 2007; Coughlin et al., 2009; Gourley et al., 2010).

Valovich McLeod et al. (2007) observed that coaches were able to correctly recognize 9.78 ± 2.07 symptoms when they were given a total of 16 correct concussive symptoms. Coaches in this sample were able to correctly identify amnesia (61%, 94/156), confusion (89%, 138/156), dizziness (89%, 139/156), headache (78%, 121/156), and loss of consciousness (80%, 125/156) as concussive symptoms. These previously mentioned set of symptoms are among the most common symptoms that are present during a concussion episode. These observations are comparable to a study done by Coghlin et al (2009). In a survey of 114 parents of bantam aged hockey athletes, parents were all able to correctly recognize that headaches and difficulty with memory were both concussive symptoms (Coghlin et al, 2009). Gourley et al. (2010) made these observations as well; 100 parents of youth sport athletes were surveyed in the Phoenix, AZ metro area, correct symptom response rate for these parents was 9.23 ± 3.03 (of 16). In this same study, parents were able to correctly identify confusion, headache, loss of memory, loss of consciousness, and dizziness as symptoms of a concussion in 80% of the surveys (Gourley et al., 2010). The aforementioned suggests that coaches and parents had a moderate level of knowledge regarding symptoms of concussion, as these concussive symptoms are the most apparent during a concussive episode.

There were also symptoms in this study that were not consistently recognized by parents as concussive symptoms: difficulty falling asleep (54%, 62/114), inability to describe time and place (29%, 33/114), and increased emotion and irritability (24%, 27/114). These data are also comparable to the study done by Valovich McLeod et al. (2007), in this case, visual disturbances (54%) , nausea (55%), and sleep disturbances (13%) were not identified correctly (84/156, 87/156, & 20/156, respectively). These observations suggest that parents, while knowledgeable in regards to the more common symptoms, are less educated about the more subtle concussive symptoms. If these symptoms were present in their children, and there were no other symptoms, a concussion may go untreated and may manifest itself for a long period of time, causing the child unnecessary neurological trouble.

Concussive misconceptions, prevalent in the general population, were also observed by Valovich McLeod et al., (2007). Of the 156 coaches surveyed, 42% (65/156) of all participants thought that loss of consciousness was necessary for a concussion to be diagnosed; 32% (50/156) did not think that a grade one concussion warranted removal from participation; and 26% (40/156) would allow a symptomatic athlete to return to play after experiencing a head trauma (Valovich McLeod et al., 2007).

Although the studies by Valovich McLeod (2007), Coughlin et al. (2009), and Gourley et al. (2010) illustrate that parents and coaches, in general, were moderately knowledgeable with regard to concussion, there were also limitations to these studies – limitations that included completing the surveys in an unsupervised environment. Results of future studies might benefit from distributing the survey at a preseason meeting, allowing the investigator to supervise the completion of surveys, and ensure that responses were based on the knowledge of the parents themselves. This would also give parents the opportunity to ask questions if they were struggling to understand any of the posed questions. Another limitation of the mentioned studies is that they all involved a regional or small sample of parents or coaches – a situation that often makes it difficult to generalize the results of the study to the greater population.

As mentioned above, research is limited involving parental perceptions relating to the causes and the management of a concussion following formal diagnosis of a concussion. However, an abundance of important information can be found in the literature with respect to structural and metabolic events that coincide with concussion etiology, concussion signs and symptoms, and concussion management, and how that information relates to the allied health professionals who might have a duty to assist with medical situations involving head trauma. It is also important to note that the following information is the current foundation and basis for helping parents of youth sport athletes become more aware and informed about concussion etiology, signs and symptoms, and concussion management.

Definition of Concussion

There are several terms that are used to describe a concussion. Traumatic brain injury is the most common term used in the reference of concussion. This can be further separated into two categories: focal and diffuse. Focal are also referred to as posttraumatic intracranial mass lesions and include subdural hematomas, epidural hematomas, cerebral contusions, and intracerebral hemorrhages and hematomas. These are very serious injuries that are not often seen in sport. Signs and symptoms of these focal vascular emergencies include loss of consciousness, cranial nerve pathology and mental status deterioration. These signs and symptoms will continue to worsen with time. After a possible head injury, medical health professionals should be extremely concerned if these signs and symptoms occur following an initial lucid period in which the athlete seemed to be functioning normally (Guskiewicz et al., 2004).

A diffuse brain injury causes large-scale disruption of neurologic function and is not normally associated with brain lesions that can be seen macroscopically. Most diffuse traumatic brain injury cases involve an acceleration-deceleration motion in a linear plane, rotational direction or both. When this happens, small lesions are caused by the brain being shaken within the skull (Guskiewicz et al., 2004).

Cerebral spinal fluid suspends the brain within the skull with the help of dural attachments to bony ridges. When there is an acceleration-deceleration movement in a linear plane (side-to-side/front-to-back), tissue damage can be caused by changes in momentum. Rotational acceleration-deceleration injuries are believed to be the primary cause of the most severe diffuse brain injuries, most severe is structural diffuse axonal injury. This is when axon disruption occurs, many times, resulting in disturbances in overall cognitive function. The most severe cases of diffuse axonal injury occur when the brain stem is disrupted causing changes in breathing, heart rate, and wakefulness (Guskiewicz et al., 2004).

Most sport-related concussions are referred to as a cerebral concussion, and are considered a mild traumatic brain injury (Guskiewicz et al., 2004). While there is no universal agreement on the standard definition of concussion, it has been defined by the Concussion in Sport Group (Aubry et al., 2002, p. 6) as a "complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces. Several common features that incorporate clinical, pathological, and biomechanical injury constructs that may be used in defining the nature of a concussive head injury include: (1) a direct blow to the head, face, neck, or elsewhere on the body with an impulsive force transmitted to the head, (2) the rapid onset of short lived impairment of neurological function that resolves spontaneously, (3) neuropathological changes, the acute symptoms largely reflect a functional disturbance rather than structural injury, (4) a graded set of clinical syndromes that may or may not involve loss of consciousness, resolution of these clinical and cognitive symptoms typically follows a sequential course, (5) associated with grossly normal structural neuroimaging studies."

Mechanism of Concussion

Three types of stresses, compressive, tensile, and shearing, can be generated by an external force to injure the brain. These stresses can occur individually or simultaneously. Compression occurs when the tissue cannot absorb any additional load and is caused by a crushing force. Tensile forces include pulling or stretching of a tissue past its point of elasticity. Shearing involves a force that moves across the parallel organization of the tissue. Tensile and shearing forces are not as well tolerated by the brain and are therefore the cause of most concussions (Guskiewicz et al., 2004).

There are two mechanisms of brain injuries: (1) coup and (2) contrecoup. Both injuries are caused by a forceful blow to the resting, moveable head producing injury beneath the point of impact. Shearing force is maximal when the head is accelerated before impact. This causes the brain to lag towards the opposing surface of impact. This brain lag creates an abundance of CSF at the point of impact and creates a brain injury opposite the site of cranial impact, a contrecoup injury. When the head is stationary before impact, there is an equal amount of CSF covering all portions of the brain, resulting in a coup injury, an injury beneath the point of impact. Concussions can also be the result of a combined coup-contrecoup mechanism of injury (Guskiewicz et al., 2004).

Biological Implications of Concussion

Giza and Hovda (2001) report that after suffering a concussion, the sodium potassium pumps at the cellular level must work overtime to restore normal membrane potential. This requires an increased amount of adenosine triphosphate (ATP/energy), which triggers an increase in glucose metabolism. This state of hypermetabolism occurs while there is diminished cerebral blood flow, decreasing the amount of glucose that is available. The disparity between supply and demand (energy mismatch) is what causes postconcussive vulnerability, lasting a month or longer (Giza & Hovda, 2001; Meyer, Kondo, Nomura, Sakamoto, & Teraura, 1970).

Following a concussion diagnosis, an athlete who exercises is at risk for worsening symptoms due to the increase in glucose hypermetabolism that results from physical exertion. This can worsen the athletes' previous state of energy mismatch.

Epidemiology

Prevalence of Concussion

Sport-related injuries represent approximately 20% of the estimated 1.54 million head injuries that occur annually in the United States (Erlanger, Kutner, Barth & Barnes, 1999). Nine percent of all sports injuries are thought to be concussions and between 2% and 10% of all athletes are at risk for sustaining a concussion (Erlanger et al., 1999). More than 1,000,000 concussions occur in the United States annually (Erlanger et al., 1999). It has been estimated, that more than 300,000 sport-related concussions occur in the United States each year (Erlanger et al., 1999). The Centers for Disease Control and Prevention reported a concussion rate of 7.5/100,000 for 5- to 14-year-old boys and 10/100,000 for 15- to 24-year-old male subjects (Sawyer et al., 2008). This may be attributed to the large number of athletes participating in a variety of youth, high school, collegiate, professional and recreational sports.

As sport becomes more of a fixture in the lives of Americans, the responsibility falls on the shoulders of the various organizations, clinicians, and researchers to provide an environment that minimizes the risk of catastrophic injuries, including concussions, in all sports. For example, between 1976 and 1980 there were researched-based recommendations that resulted in a reduction of nonfatal catastrophic injuries. Numbers were reduced from 36 in 1968 to zero in 1990 and have recently averaged approximately 5 annually since then (Guskiewicz et al., 2004; Mueller & Cantu, 2002). This decrease was attributed to a number of factors including (1) rule changes specifically in regards to tackling; (2) player education of rule changes and penalties for not following them; (3) stricter requirements involving minimal equipment standards; (4) implementation of new assessment techniques; and (5) increased concussion awareness education (Guskiewicz et al., 2004).

In a survey of athletic trainers (Ferrera, McCrea, Peterson, & Guskiewicz, 2001), the number of concussions evaluated annually by athletic trainers, in clinical settings was observed to be 7.04 (±5.0). Over a three year observational study (Guskiewicz, Weaver, Padua, & Garrett, 2000), it was observed that 5.1% (888/17,549) of high school and college football players sustained concussions. Of those 888, 14.7% (130) sustained a second injury during the same season. These data suggest that football players who sustained one concussion, and were returned to play, were three times more likely to sustain a second during the same season than those who were not previously injured (Guskiewicz et al., 2000). These observations also indicate that the incidence of concussions in football is not nearly as high as previous research (Gerberich, Priest, Boen, Straub, & Maxwell, 1983) has reported. The variation in incidence could be due to the type of survey collected. Gerberich et al. (1983), used a retrospective survey given to high school players well after they had completed the football season and Guskiewicz et al. (2000), used a prospective survey that was collected from ATC's who immediately documented the incident.

Incidence of Concussion

The incidence of sport-related concussion is dependent on many factors including (but not limited to), level of play, age of athlete, previous years of participation, type of sport, total sports activities, playing surface and gender (Guskiewicz et al., 2000).

High school students appear to be sustaining concussions at a significantly greater rate compared to collegiate athletes participating in the same sport (Guskiewicz et al., 2000; McKeever & Schatz, 2003). It has been observed that 5.6% (400/6089) of high school football players suffer from concussion whereas division I football players have an injury rate of 4.4% (260/5572) (Guskiewicz et al, 2000). This statistically significant association between school level and incidence of concussion might be attributed to the increased exposure (athletes playing both offense and defense) often seen at the high school level. Current research has also observed that the younger brain is more vulnerable to concussion because children have a greater head-to-body ratio and their cervical musculature and cranial bones are not fully developed. Other explanations that may be valid are the quality and condition of protective equipment, as well as the skill level of the athletes.

The overall rate of concussions per 1000 athlete exposures has been observed to be 0.70. However, when only considering exposures experienced during live play the number almost doubled (1.28). When considering the injuries by total contact athlete-exposures, as opposed to total athlete-exposures, the level of play is also a factor. Athletes in a high school setting had a higher incidence rate than any college division. It was observed that the rate at the high school level (1.63/1000) was nearly twice that of the division I level (0.94/1000) (Guskiewicz et al., 2000). These data are thought to be a more accurate representation of the time-at-risk for football players than total athlete-exposures. These data are also indicative of a greater percentage of players on a high school team being exposed to playing time as compared with players on a division I college team.

Young athletes appear to be at increased risk for concussion as there is a high rate of concussions for athletes in the 5 to 14-year-old bracket (7.5/1000) (Dalsgaard et al., 2004). This is thought to be because of the age that they begin to play (McKeever & Schatz, 2003) and because of the current indicator of return to play in adults: return to baseline testing (Patel, Shivdasani, & Baker, 2005). While this standard may work well in the adult population, the rapidly progressing neurodevelopment that occurs between the ages of 8-15 prevents this from being successful in the younger population. Due to the plasticity in the young brain, return to baseline testing may not be the gold-standard for adolescents because of continued improvement in cognitive abilities, which can mask the effects of concussion (Patel et al., 2005). Increased susceptibility to concussion in adolescents, as compared to adults, has been attributed to decreased myelination, a greater head-to-body ratio, and thinner cranial bones. All of these reduce the bodies' protection of the developing cortex (McKeever & Schatz, 2003).

The incidence of concussion in young athletes, although already high, is thought to be a low estimate. Studies have observed (Coghlin, et al., 2009; Gourley et al., 2010) that many youth sport organizations only employ on-site medical staff for competitions, not practices. This leaves recognition of injury up to the athlete, coach or parents. This can result in the underreporting of concussion in the youth population due to a lack of knowledge regarding concussive signs and symptoms. With the high potential for a lack of health care providers at practices on the youth athletic field, untrained providers may be treating athletic injuries, making decisions that exceed their educational training (Erlanger et al., 2003). This causes a great deal of concern as the recognition, diagnosis, and management of sport-related concussion can be one of the most difficult duties even for a trained sports medicine practitioner.

The highest number of sport-related head injuries has been reported in contact and collision sports resulting from direct blows to the head, as well as in non-contact sports resulting from acceleration-deceleration and rotational forces (Patel et al., 2005). American football has been observed to have the highest rate of concussion (Guskiewicz et al., 2004). However head injuries can also occur in other sports including, soccer, rugby, wrestling, ice hockey, field hockey, gymnastics, snowboarding, martial arts and lacrosse (Patel, et al., 2004). Previous studies (Erlanger et al., 2003) have observed that 18/47 (38.3%) of concussions occur in football followed closely by soccer (14/47, 30%).

Moser and Schatz (2002) observed that there is a significant difference in the number of sports in which youth participate. Previously, young athletes participated in one sport a season, however, youth sport seasons today overlap each other or are played year-round. Today youth are more likely to be shuttled from soccer to basketball to gymnastics practice. This increases the risk of sustaining concussive injuries.

The rate of concussion in sport may also be due to the mechanism of injury or playing surface in which the athletes are competing and practicing. The most common mechanism of a concussion is contact with another player (808/1003, 81%), followed by contact with the ground (101/1003, 10%). Of the 101 injuries occurring as a result of ground contact, 18 (18%) occurred on artificial turf and 83 (82%) occurred on natural grass (Guskiewicz et al., 2000). This disparity could be attributed to uneven/ inconsistent playing surfaces or type of athletic shoe worn. It may also be due to the availability, or lack thereof, of artificial turf.

While there are not many studies done solely on gender, it has also been a questionable risk factor for sport-related concussion. Erlanger et al. (2003) observed that more men than women sustain sport-related concussions (27/47 [57%] and 20/47 [43%] respectively). This is in contradiction to McKeever and Schatz (2003) who observed that female athletes were at a consistently higher risk for sustaining concussions than males who participated in the same high school sport. Gender disparities between females and males were observed to be 5:4 for soccer, 4:3 for basketball, and 2:1 for softball and baseball (respectively). However, these trends do not carry over to athletes of all age ranges, college athletes appear to have nearly identical concussion rates for these same sports (Erlanger et al., 2003). The incongruity in high school concussion rate may be due to differences in brain chemistry, skill level, or other factors not well studied.

Perhaps the most important conclusion in the study done by Guskeiwicz et al. (2000) was the rate of recurrent injury. It was determined that high school and college football players were nearly three times more likely to sustain a second concussion in the same season as those players who have not sustained a previous injury. These data are fairly consistent with a study (Gerberich et al., 1983) that observed the recurrent concussion risk factor to be four times greater. It is believed that recurrent concussions are prevalent because of the temporary disturbance of brain function due to metabolic, chemical, or neurological changes without structural change. After a concussive brain injury, the brain cells that are not immediately irreversibly destroyed, remain alive but in a fragile state. These brain cells are vulnerable to minor changes in cerebral blood flow, increases in intracranial pressure and anoxia. Without neuroanatomic or physiologic measurements that can precisely determine when the injury has fully healed, the concussed athlete is at risk for early return to play status (Cantu, 2001).

Indication of Concussion

Cognitive Features of Concussion

Cognitive features of an athlete are extremely important to take into consideration when there has been a suspected head injury. Although a player does not need to experience a loss of consciousness or amnesia to have suffered a concussion, these are two situations that may occur during a concussive episode. Guskeiwicz et al. (2000), observed that loss of consciousness was only associated with concussion in 9% (89/1003) of all cases while amnesia was observed to occur at a rate of 28% (278/1003). Amnesia can further be divided into two types: retrograde and anterograde. Retrograde amnesia is defined as, "partial or total loss of the ability to recall events that occurred during the period immediately preceding brain injury. Anterograde amnesia is a deficit in forming new memory after the accident, which can lead to decreased attention and inaccurate perception (Cantu, 2001)." Other cognitive features that should be examined are confusion and awareness of period, opposition, score, time, date and place (Aubry et al., 2002). Confusion or disorientation may be a better indicator of concussion as 59% (592/1003) of injuries are associated with mental confusion and 48% (481/1003) resulted in disorientation to names, places and times (Aubry et al., 2002; Guskiewicz et al., 2000).

Objective Signs of Concussion

An athlete with a concussion may display a combination of any of the following signs: loss of consciousness, impaired memory, poor coordination, loss of balance, concussive convulsion, seizure, gait unsteadiness, slow response time, inability to follow directions, poor concentration, displaying unusual or inappropriate emotion, nausea, vomiting, vacant stare, glossed-over eyes, slurred speech, personality changes, inappropriate playing behavior (running in wrong direction), and decreased playing ability (Aubry et al., 2002; Cantu, 2001; Erlanger et al., 2003; Guskiewicz et al., 2004; Majerske et al., 2008; Patel et al., 2005).

The Concussion in Sport Group has recognized that conventional structural neuroimaging contributes little to concussion evaluation because images of the brain generally do not show any abnormalities after a concussion. However, if intracerebral pathology is suspected, based on the presence and severity of symptoms, a computed tomography or magnetic resonance image is necessary (Aubry et al., 2002; Coghlin et al., 2009; Gourley et al., 2010).

Subjective Symptoms of Concussion

While observation of the athlete is necessary in the recognition of concussion, talking to the athlete may be just as helpful in determining injury status. The athlete, in many cases, will report symptoms voluntarily; however, it may be necessary to ask the athlete if they are experiencing any of the symptoms that include: headache, dizziness, nausea, unsteadiness, loss of balance, feeling "dinged" or "stunned" or "dazed", seeing stars or flashing lights, ringing in the ears, abnormal vision, sleepiness, fatigue, and feeling of slowness (Aubry et al., 2002; Cantu, 2001; Erlanger et al., 2003; Guskiewicz et al., 2000; Guskiewicz et al., 2004; Majerske et al., 2008; Patel et al., 2005).

Guskiewicz et al., (2000), determined that headache is the most commonly reported symptom of concussion (863/1003, 86%). Dizziness and blurred vision are also two commonly reported symptoms (677/1003 [67%] and 356/1003 [35%] respectively). Guskeiwicz et al. (2000) also revealed a consistent association between recurrent injury and reported symptoms, those with a previous history of concussion reported 5.5 symptoms whereas athletes with non-recurrent injuries reported experiencing 3.5 symptoms.

Pharmacological therapies can be incorporated in the treatment of sport-related concussion. There are two situations in which pharmacological agents are beneficial; 1) to manage prolonged symptoms, and 2) to modify the pathophysiology of concussion. The goal of pharmacological therapy, in both instances, is to reduce the severity and duration of the symptoms (McCrory et al., 2005; McCrory et el., 2009). Return-to-play decisions should be made only when the athlete can participate without signs or symptoms returning and when no pharmacological agent is masking these signs and symptoms.

Evaluation of Concussions

Degree of Concussion

Perhaps the most challenging aspect of managing sport-related concussion is recognition of the injury, especially in athletes with no obvious signs that a concussion has occurred. The immediate management of the head-injured athlete depends on the nature and severity of the injury. The severity of concussion ranges from mild to severe, with a moderate category splitting the difference. There are several grading scales (Appendix A) that have been used to determine which injury an athlete has suffered. None of these scales are universally accepted or followed with consistency (Guskiewicz et al., 2004). All concussion grading scales have been focused on presence and duration of loss of consciousness and amnesia (retrograde or anterograde). One of the most widely used grading scales was developed by Robert Cantu and is based on the duration of unconsciousness or amnesia (or both).

Cantu's grading scale includes measures for mild, moderate and severe concussions. The mildest concussion (grade I) occurs without loss of consciousness, and the only neurological deficit is a brief period of amnesia which lasts for less than 30 minutes. The moderate (grade II) concussion usually includes a brief period of unconsciousness (<5 minutes). Sometimes, when consciousness is not lost, a moderate concussion can include a longer period of amnesia lasting for more than 30 minutes but less than 24 hours. A severe (grade III) concussion occurs with a more expanded period of unconsciousness (>5 minutes). Rarely, it occurs without loss of consciousness or with a shorter period of unconsciousness, however it does include, a very long period of amnesia, lasting longer than 24 hours (Patel et al., 2005).

Due to prospective studies over the last 10 years that have correlated duration of post-concussive symptoms and amnesia to abnormal results on neurological tests, Cantu's grading system has been altered to include post-concussive symptoms (Cantu, 2001). According to this grading system, the mildest concussion (grade I) occurs without loss of consciousness, and the neurological deficit can be a brief period of amnesia or post-concussive symptoms which last for less than 30 minutes. The moderate (grade II) concussion includes a brief period of unconsciousness (<1 minute). Sometimes, when consciousness is not lost, a moderate concussion can include a longer period of amnesia or post-concussive symptoms lasting for more than 30 minutes but less than 24 hours. A severe (grade III) concussion occurs with a more protracted period of unconsciousness (>1 minute). Rarely, it occurs without loss of consciousness but with a very long period of amnesia that lasts longer than 24 hours and/or symptoms of concussion last longer than seven days (Erlanger et al., 2003).

In a survey of athletic trainers, Guskiewicz and colleagues (2000) reported an incidence of 88.9, 10.6, and .4% for grade I, II, and III concussions respectively. These data were collected using the Cantu scale for 1003 athletes with suspected concussions. These data are in contrast to those collected by Collins et al. (1999), who observed an incidence rate of 68, 21, and 11% for grade I, II, and III concussions, respectively, was reported when applying the American Academy of Neurology (AAN) guidelines to 19 injured athletes. The disparity in the data could be indicative of the scale that was used to identify the grade of concussion. The AAN guidelines differ from the Cantu guidelines greatly. According to the AAN, the mildest concussion (grade I) is defined as including transient confusion, no loss of consciousness, and mental status abnormalities lasting for less than 15 minutes. A moderate (grade II) concussion includes transient confusion, no loss of consciousness and mental status abnormalities lasting for longer than 15 minutes. Severe (grade III) concussions include any loss of consciousness. Another explanation for the inconsistency could be attributed to the differences in the experimental design itself. Information was collected from athletic trainers by Guskeiwicz et al. (2000), using a retrospective survey of 1003 injured football players and Collins et al. (1999), collected information directly from 19 injured college football players. These data may have been affected by the number of subjects included in the data, the grading system used, or the self report measures.

Historically, the return to play guidelines went beyond the determination of concussion severity to create a generic timeline of when an athlete can return to play after a concussion (Cantu, 2001). However, the AAN and Cantu guidelines (Appendix B) for return to play recommend consideration of an athlete's history of concussion, in addition to signs and symptoms, when determining whether the injured athlete should return to play (Cantu, 2001). According to Cantu's guidelines a preseason, detailed concussion history is extremely important in determining the athletes' risk of suffering a concussion. A preparticipation history allows the healthcare provider to obtain knowledge regarding previously undiagnosed concussive episodes and educate the athlete about the implication of concussion (McCrory et al., 2004; McCrory et al., 2009). This is important because athletes with a history of concussion seem to increase the risk of successive concussion. Athletes who suffer successive concussive episodes, especially during the same season, experience more severe symptoms and generally take longer to recover (Cantu, 2001; Gerberich et al., 1983; Guskiewicz et al., 2000). The Concussion in Sport Group developed a list of factors (Appendix C), called "modifiers" that are thought to direct healthcare providers in the appropriate management of concussion and predict the potential for prolonged symptoms. According to these authors, it is imperative to consider these modifiers when obtaining a thorough concussion history (McCrory et al., 2004; McCrory et al., 2009).

The Concussion in Sport Group also developed a list of graded activities that should be incorporated in concussion management and return to play guidelines (Appendix D). These graded activities guide the athlete towards a full return to play and can be altered for variance between individuals. These graded activities are separated into stages or levels. Each level should take 24 hours, allowing the athlete to return to play in approximately one week. If post-concussive symptoms occur during any level of the progression the athlete should regress to the previous asymptomatic level and progress from there after a 24 hour period of rest. In some cases the timeframe to complete this stepwise program will take longer and should be overseen by a medical doctor trained in concussion management (McCrory et al., 2004; McCrory et al., 2009).

It has been proposed that grading scales are not necessary in the diagnosis and return to play progression of concussion (McCrory et al., 2004; McCrory et al., 2009). However, the sports medicine team must have a proven method of concussion assessment and management that all members know and follow; resulting in the avoidance of hazardous decision making that can result in unnecessary risks for the athlete (Ferrera et al., 2001).

Assessment of Concussion

Determining when athletes are ready to return to play, after a concussion, is one of the greatest challenges facing athletic trainers and team physicians. The complexity of the brain and the lack of objective signs and symptoms after injury create vast differences between individuals, causing confusion and eliminating the possibility of a concrete concussion management protocol (Guskiewicz et al., 2000). This challenge is confounded by the pressure the athlete experiences for an early return to play, which may tempt the athlete to underreport subjective symptoms. When underreporting is suspected and, upon brief examination of the athlete, there is no evidence of mental abnormality, objective neurocognitive measures of memory, reaction time, and processing speed could be helpful to determine the athlete's readiness for return to play.

According to a survey of athletic trainers (Ferrera et al., 2001), clinicians appear to be using a multidimensional approach to concussion assessment, which incorporates clinical examination, concussion grading scale criteria, symptom checklist information, return to play guidelines, standardized tests, and neuropsychological testing. Health Professionals are currently looking to objective standardized cognitive assessment, postural stability and formal neuropsychological testing to guide their clinical return to play decision making (Ferrera et al., 2001). These objective measures allow the clinician to quantify the severity of injury and measure the athlete's progress over the course of recovery (Guskiewicz et al., 2004).

Recently a combination of concussion assessment tools has been developed. This technique includes evaluation of signs and symptoms, cognitive functioning, and postural stability on the sideline immediately after injury and neuropsychological testing to track recovery beyond the time of injury (Guskiewicz et al., 2004).

Baseline Measures for Concussion Assessment

Baseline testing of concussion assessment measures are recommended to establish the individual athlete's "normal" pre-injury performance and to provide the most reliable benchmark to measure post-injury recovery. These baseline tests are able to control for extraneous variables such as, attention deficit disorder, learning disabilities, age, education, performance differences, and previous injury effects (Guskiewicz et al., 2004; Collie et al., 2001). Brown, Guskiewicz, & Bleiberg (2007), observed that individual baseline testing can also be effected by sex, SAT score, alertness and sport played.

Without baseline measures, the athlete's post-injury performance will have to be interpreted using available population normative values, which are not specific to the individual (Brown et al., 2007). While this is helpful when personal baseline information is not available, individual baseline measurements provide the greatest clinical accuracy in interpreting post-injury test results, due to the uniqueness of response to injury.

Clinical Examination of Concussion

Many clinicians perform a physical examination of the athlete to determine the degree of injury on the field, if it is dangerous to transport the athlete, or when the concussed athlete is brought to the sideline (McCrea, 2001; Notebaert & Guskiewicz, 2005). This initial examination focuses on airway, breathing, and circulation. More accurate assessments are obtained if the remainder of the assessment can be done in a quiet area. After inspecting for any deformities, the clinician palpates the athlete's head and neck to check for structural abnormalities. Functional movements are then checked (opening and closing of the mouth), rhinorrhea and otorrhea are indications of a skull fracture. A neurological examination to measure strength, sensation and reflexes is done before balance and coordination are assessed. (McCrea, 2001) Clinicians assessing concussions with this method usually check the athlete every fifteen minutes to determine if there are increased or decreased symptoms (McCrea, 2001). While this method does not use any specific assessment tools, it is the most widely used criterion for return to play decision making (Broglio, Macciocchi, & Ferrera, 2007; Ferrera et al., 2001; Majerske et al., 2008; McCrea, 2001).

Sport Concussion Assessment Tool

The Sport Concussion Assessment Tool (SCAT), created by the Concussion in Sport Group, is a standardized tool that combines a variety of the existing concussion assessment tools (Aubry et al., 2002; McCrory et al., 2004; McCrory et al., 2009). The SCAT serves a dual purpose: patient education and assessment of concussion. This new standardized tool was created by combining existing tools (McCrory et al., 2004; McCrory et al., 2009). Included in the SCAT are: (1) memory assessment; (2) symptom assessment;

(3) cognitive assessment; (4) balance assessment; and (5) neurological screening (Patel et al., 2005). The SCAT has been evaluated for face and content validity on the basis of clinical experience and scientific literature (Appendix E) (Coghlin et al., 2009).

Memory Assessment

Memory assessment is based on modified Maddocks questions, a set of questions specifically designed to assess memory and orientation immediately after concussion. Maddocks questions combine scientific validity with a quick and easy tool which can be administered either on-field or on the sidelines. Maddocks questions include, but are not limited to: (1) What field are we at? (2) What team are we playing? (3) Which half/period is it? (4) Which team scored last? (5) What team did we play last? (6) Did we win our last game? Any incorrect response, which is uncharacteristic of the individual athlete, indicates concussion and requires removal from the playing field for further medical evaluation (Patel et al., 2005).

This abridged testing protocol is designed for quick concussion diagnosis on the sidelines, and is not meant to replace comprehensive neurological and neuropsychological testing, which can detect small deficits that continue beyond the acute episode. Although this is a useful tool that may be used by non-medically trained individuals to suspect a concussion, it is recommended that a medical examination, conducted by a medically trained individual, follow this conditional diagnosis as soon as possible.

Symptom Assessment

Although there is no universal agreement on return to play criteria after a concussion, there is unanimous agreement that an athlete still suffering post-concussion symptoms at rest and during or after exertion should not return to contact or collision sports. Self-reported symptoms are the most recognizable way to assess the effects of a concussion. If any self-reported symptoms are experienced the athlete should not return to play. Athletes should be symptom free at rest and exertion for seven days before returning to full participation (Guskiewicz et al., 2004).

There have been a number of concussion symptom scales and checklists that have been used in clinical settings (Guskiewicz et al., 2004; Majerske et al., 2008; Piland, Motl, Ferrera, & Peterson, 2003). A symptom checklist (Appendix F) provides a list of symptoms in which the athlete reports "yes" the symptom is present or "no" the symptom is not being experienced. A symptom scale (Appendix G) is a Likert-type scale that allows the athlete to rate the severity of the symptom from 0 (not present) to 6 (extremely severe). Both of these scales can be summed to form an overall quantitative score that measures the severity and can be used to track recovery (Guskiewicz et al. 2004).

Piland et al. (2003), researched the validity of these measures and has provided evidence for the factorial and construct validity of the 9-item head injury scale (HIS). It was observed that scores from the 9-item HIS performed optimally in evaluating self-reported concussion-symptom resolution (Piland et al., 2003).

The incorporation of a valid self-report symptom scale into a concussion assessment test battery is necessary in making return to play decisions involving a concussed athlete (Piland et al., 2003). These validated assessment tools may provide the best measure of injury assessment and will help make decisions regarding return to play status when other testing methods are not available and can help guide the evaluator to the appropriate assessment tools (Broglio et al., 2007).

Cognitive Assessment

Cognitive screening instruments attempt to objectify what is usually a subjective impression of cognitive irregularity. There are various mental status screening batteries (Dalsgaard et al., 2004; Guskiewicz et al., 2004; McKeever & Schatz, 2003; Majerske et al, 2008; Patel et al., 2005) that are used in the clinical setting. The most researched of which is the Standardized Assessment of Concussion [(SAC) CNS Inc, Waukesha, WI, USA]. The SAC (Appendix H) does not require knowledge of psychometric testing, has three alternative forms, takes 5-10 minutes to administer and measures orientation, immediate memory recall, concentration and delayed recall. The SAC also includes a standard neurological screen to assess deficits in strength, sensation, and coordination (Guskiewicz et al. 2004).

To measure orientation, the athlete is questioned about the month, date, day of week, year and time of day and is awarded one point for each correct answer. The second aspect of the assessment is immediate memory recall. Immediate recall is measured by giving the athlete five words to repeat, subsequently asking the athlete to repeat these words three times. Each of the repeated words is awarded a point if the athlete can recall them. The third aspect of this screen is concentration. This is measured by giving the athlete a string of numbers and asking the athlete to repeat them backwards four times. The first string includes three numbers, the second includes four, the third includes five, and the final includes six. Each trial has two separate (but different) sets of trial numbers. If the athlete gets the first string incorrect, the administrator would continue with the same string of numbers from the second trial. This part of the assessment is complete when the athlete correctly recites all of the strings in one trial. The final part of this section of the assessment is to have the athlete state the months of the year in backwards order. Repeating, backwards, each string of numbers correctly for all four trials would give the athlete four points and a fifth point would be awarded for the entire sequence of months. If the athlete is able to complete this portion of the assessment without error it may be appropriate to test the athlete after some type of induced physical exertion (jumping jacks, sit-ups, push-ups of knee bends). The final portion of assessment measures delayed memory recall. The administrator asks the athlete to repeat the five words that he or she was given during the second portion of the assessment. If the athlete is able to do this he or she is allotted five points. The outcome of the SAC is a 'summary score' out of 30 (Guskiewicz et al., 2004; McCrea, 2001; McKeever & Schatz, 2003; Patel et al., 2005).

More recently an electronic version of the SAC was developed (eSAC), which can be used to administer sideline assessments using a handheld personal digital assistant. The eSAC is able to store historical information about athletes that may be helpful to athletic trainers on the sideline, such as a roster of all athletes, emergency contact numbers, pertinent medical information and baseline scores (McKeever & Schatz, 2003). Many teams, when traveling, do not bring their own athletic trainer, leaving an athletic trainer who does not know the individual and their usual behavior to make the return to play decision. This handheld device has the ability to reduce the amount of athletes that are allowed to return to full participation prematurely.

McCrea (2001) reported on the value of mental status exams like the SAC to measure the extent of a concussion. Standardized cognitive testing (SAC) was observed to be sensitive to small deficits in orientation, memory and concentration in injured subjects who were not showing other signs of disorientation, amnesia, or neurological dysfunction.

It was reported that injured athletes who sustained a concussion, as defined by the AAN, had a decrease of more than four points on the SAC assessment (Guskiewicz et al., 2004; McCrea, 2001). It was also reported that a drop in one point or more from preseason baseline scores on the SAC was 95% sensitive and 76% specific in the diagnosis of concussion (McCrea, 2001). Valovich et al. (2003), have observed that, due to the three alternative forms of the SAC that are available, repeat administration does not affect long-term retention or reveal development improvements in cognitive efficiency. These results allow athletic trainers to administer the SAC as many times as necessary to obtain the information that is needed to make a return to play decision.

Not only is the SAC useful in the diagnosis of a concussion it also creates a useful, quantifiable, index in which to track resolution of acute concussive injury back to the athlete's baseline scores. Although the SAC has been found to be a useful tool in assessing symptom resolution (Dalsgaard et al., 2004; Guskiewicz et al., 2004; Majerske et al., 2008; McKeever & Schatz, 2003; Patel et al., 2005), it does not represent a solitary method for giving clearance to play after concussion.

Postural Assessment

Reiman and Guskiewicz (2000) developed the Balance Error Scoring System (BESS) based on existing theories on posturography. This assessment used balance errors to determine the severity of a concussion. The athlete is measured with their eyes closed and hands on their iliac crests in three positions [both feet on the ground, balanced on one leg, and tandem stance (toes of one foot to heel of the other)] and on two surfaces [firm ground and a foam block] The concussed athlete is asked to perform six trials that last 20 seconds each, one under each condition. The administrator of the test measures errors during observation of each condition. An error is considered and recorded when stepping, stumbling, opening eyes, hands lifted off of iliac crests, forefoot of heel lifted, hip moved more than 30 degrees, and when subject is out of test position for more than five seconds (Dalsgaard et al., 2004; Guskiewicz et al., 2004; Patel et al., 2005; Reimann & Guskiewicz, 1999; Reiman & Guskiewicz, 2000; Wilkins, Valovich-McLeod, Perrin, & Gansneder, 2003).

When administrating this assessment, protocol factors such as fatigue should be taken into consideration. Wilkins et al. (2004), observed a significant increase in total errors from pre-test to post-test when the subject was fatigued (14.36 ± 4.73 versus 16.93 ± 4.32). This suggests that clinicians who use the BESS in their sideline protocol should not administer this test immediately after a concussion due to the effects of fatigue (Wilkins et al., 2004). However, when compared to force plate measures the BESS has established good reliability and validity (Reimann & Guskiewicz, 1999). The BESS has been observed to detect decreased stability through a five day period after injury. This indicates that the BESS is sensitive to the postural-stability alterations that occur after a concussion (Wilkins et al., 2004).

In many cases, however, the BESS is administered on multiple occasions after a concussion to assess the progress of a concussed athlete. This may lead to practice effects, in which the athlete gets better at the test simply by repeating it, not because of symptom resolution (Valovich McLeod et al., 2003). Valovich McLeod et al. (2003), observed that significantly fewer errors were made by subjects by the third and fourth administration of the test. These results differ from Reimann and Guskiewicz (2000), who did not observe any practice effects over three sessions. These differences could be attributed to the disparity in sample size and number of testing sessions in these two investigations.

Although the BESS is becoming more frequently used as a way to objectively grade postural stability in athletes after concussion, it should not be used as a sole measure for monitoring an athlete or making a return to play decision (Broglio et al., 2007).

Neuropsychological Assessment

It has been shown that cognitive recovery may precede or follow resolution of clinical symptoms, suggesting that the assessment of cognitive function should be an important component in any return to play protocol (Aubry et al., 2002; McCrea, 2001). While large cognitive deficits can be observed using the SAC, neuropsychological tests can distinguish smaller changes in baseline values.

Neuropsychological Testing

There are multiple cognitive domains that are susceptible to the effects of concussion. Neurological testing has been used, for many years, to objectively measure the effects of concussion on these cognitive domains. More recently, the field of sports medicine has turned to neuropsychology, the scientific study of brain-behavior relationships, to provide methods that can be used in the athletic training room for assessment of sport-related concussive changes in orientation, concentration, and memory (Guskiewicz et al., 2004).

Neuropsychologists are doctoral-level professionals who specialize in the evaluation of diseases that affect the brain. Neuropsychologists have developed tests for assessing impairments in attention, memory, and higher-order executive functions that occur as a result of concussions. None of these tests, used in isolation, are effective in diagnosing the presence or absence of concussion. This is why neuropsychologists administer tests in groups, known otherwise as test batteries (Barr, 2001).

When an athlete suffers what is believed to be a concussion, they are sent to a neuropsychological consultant for testing within 24 to 48 hours after the injury to determine if there were changes from baseline performances. Athletes who display features of cognitive disturbance that can be attributed to concussion are then given additional testing until their scores return to baseline. If baseline performances are not available on a given athlete, the neuropsychologist must lengthen the test battery to include overall intelligence tests (Barr, 2001).

There are many conventional test batteries that neuropsychologists use to assess memory, speed of information processing, planning, executive function, visuospatial abilities, visuomotor abilities, and attention (Appendix I) (Barr, 2001).

The purpose of neuropsychological test batteries is to look for any consistency of symptoms exhibited in multiple test scores. Typically, a test battery requires a 4-8 hour window to administer. During the administration of the test battery, the neuropsychologist examines the athlete's motivational and emotional states, in addition to measuring the amount of cognitive dysfunction (Barr, 2001).

While these tests appear to be the most objective form of assessment, there are also factors that restrict how widely neuropsychological testing is used in the assessment of sport-related concussion. Many states require advanced training and licensure to purchase and use neuropsychological tests for clinical purposes. This means that a licensed psychologist is necessary to oversee and supervise the process and consultation fees can be sizeable if work is not done on a pro bono basis (Guskiewicz et al., 2004). There are also inherent problems with these tests such as, normal ranges, sensitivity and specificity of tests, practice or learning effect, as well as the observation that players can return to baseline before the absence of symptoms (Aubry et al., 2002). Another aspect that needs to be considered is when entire teams or programs are assessed for baseline measurements. This can be both labor and time-intensive, creating a financial burden for the institution and may discourage the institution from the use of neuropsychological assessment (McKeever & Schatz, 2003).

Computerized Neurological Testing

While pencil-and-paper test batteries have historically been administered successfully to measure the effects of concussion on cognitive domains, improvements in technology have allowed for these tests to be created in a computer-based format (McCrea, 2001). A fully computerized battery of tests may be the best approach to objective assessment of sports-related concussions for multiple reasons. First, these tests offer a consistent test administration and scoring and improved measurement accuracy. Second, time and cost constraints and the availability of trained personnel are negated. Finally, if a player moves from one team to another, between junior high, high school and college or between school sports and organized sports, baseline data and subsequent trials can easily be transferred from one database to another (McKeever & Schatz, 2003). There are also infinite randomized forms that reduce learning effects available for computerized neuropsychological tests (Brown et al., 2007).

There are a number of computerized neuropsychological testing programs available for the assessment of athletes after a concussion (Appendix J). Like their pencil-and-paper counterparts, these computerized tests also examine effects on memory, speed of information processing, planning, executive function, visuospatial abilities, visuomotor abilities, and attention. Makdissi et al. (2001), suggest that computerized tests may be particularly sensitive to the cognitive abnormalities caused by concussion, and that pencil-and-paper neuropsychological tests do not share this same sensitivity in mildly concussed athletes. The computer based programs are able to do this because there is randomized stimulus presentation, high reliability, lack of floor and ceiling effects, alternate forms, and a minimization of tester bias.

Both pencil-and-paper neuropsychological and computerized neuropsychological tests measure the same thing and have been substantiated by validity and reliability testing (Broglio, Ferrera, Macciocci, Baumgartner, & Elliott, 2007; Franzen, 2000). When applied to the assessment of sport-related concussion, both forms of neuropsychological testing were observed to have good test-retest coefficients (reliability) and external validation when compared to the trailmaking test, digit symbol substitution test, and the grooved pegboard test (Collie, Darby, & Maruff, 2001; Erlanger et al., 2003; Maroon et al., 2000). Appendix K shows the psychometric and practical considerations of both the pencil-and-paper and computerized neuropsychological tests. Although neuropsychological tests are useful in the clinical setting, they should not be used as a sole measure in the decision of when the athlete should return to play (Broglio et al., 2007).

The Concussion in Sport Group (Aubry et al., 2002; McCrory et al., 2004; McCrory et al., 2009) recognizes the importance of evaluating signs and symptoms, cognitive functioning, and postural stability on the sideline immediately after injury and neuropsychological testing to track recovery beyond the time of injury. A combination of assessment tools should be used. Using a sole measure to evaluate the presence and severity of concussion increases the risk that an athlete will be returned to play prematurely (Broglio et al., 2007).

Summary

Although there are a variety of injuries that can occur in organized youth athletics, one of the most commonly sustained injuries is concussion (Dalsgaard et al., 2004). Athletes participating in competition, contact or not, are at risk of suffering a concussion. Concussion can be further divided into traumatic brain injuries and mild traumatic brain injuries, with sport-related concussions being categorized as mild (Guskiewicz et al., 2004). Mild traumatic brain injury, concussion, is a complex physiological process affecting the brain. This process is induced by traumatic biomechanical forces. Features of a concussion include: (1) an impulsive force transmitted to the head, (2) impairment of neurological functioning, (3) multiple signs and symptoms that may or may not include loss of consciousness, and (4) a grossly normal structural neuroimage of the brain (Aubry et al., 2002).

Concussion is a very common sports-related injury, between 2% and 10% of all athletes are at risk for sustaining concussion (Erlanger et al., 1999). The incidence of concussion is affected by factors that include, but are not limited to: level of play, age of athlete, previous years of participation, sport played, total sports activities, playing surface, and gender (Guskiewicz et al., 2000). Concussion signals can be divided into two categories, objective physical signs and subjective symptoms. The most common objective physical signs include: loss of consciousness, impaired memory, poor coordination, and decreased playing ability. Some of the common symptoms include: headache, dizziness, nausea, blurred vision, and fatigue (Aubry et al., 2002; Patel et al., 2005).

The clinical examination continues to be the most popular concussion assessment used by clinicians (Broglio et al., 2007; Ferrera et al., 2001; Majerske et al., 2008; McCrea, 2001). However, information obtained from symptom reports, memory assessments, cognitive assessments, postural assessments, and neuropsychological assessments should be used to support the findings of the clinical examination (Ferrera et al., 2001). Current literature (Ferrera et al., 2001) suggests that athletic trainers are beginning to consider results from these standardized sideline assessment methods and neuropsychological testing to be valuable, but continue to place more emphasis on their own clinical examination and the subjective symptoms reported by the injured athlete when determining return to play status.

No two concussions are identical, and while the resulting symptoms can be very different, each injury may manifest differently in individuals (Ferrera et al., 2001; Guskiewicz et al., 2004). Regardless of the specific assessment tools used, no test should be used in isolation for sport-related concussion evaluation or assessment because the greatest sensitivity to the injury occurs when multiple assessment measures are used collaboratively (Brioglio et al., 2007). Recording baseline measurements for standardized assessments can remove much of the subjectivity of concussion assessment and can save time for the clinician when trying to determine when an athlete may return to play (Guskiewicz et al., 2004).

Many of the assessments are available for use on the sideline where most injuries occur (McCrea, 2001). These measures, along with the clinical examination will give the clinician a relatively objective measure of the severity of the injury and can prevent early return to play, which will help to reduce the probability of persistent sequele and successive concussions due to incomplete healing processes. By decreasing the likelihood of these occurrences, the probability of premature death due to second impact syndrome is greatly reduced (Erlanger et al., 2001).

CHAPTER III:

METHODS

The primary purpose of this study was to determine if parents of organized youth sport athletes had knowledge regarding the causes of concussion. A secondary purpose of this study was to establish if these same parents had knowledge regarding recognition of the signs and symptoms of concussion, as well as knowledge concerning management of concussion after diagnosis of a concussion.

Population

Approximately 450 parents of youth sports athletes, associated with one of two separate gymnastic organizations in the Fargo-Moorhead metro area, were invited, with permission (Appendix L & M), to participate in this study. Each gymnastics organization provides parents with the opportunity to enroll their children in recreational classes, competitive and/or acrobatic team competition or events. In households where there are two parents present, only one parent was asked to participate in the study. Approval was granted by the North Dakota State University Institutional Review Board prior to the beginning of the study (Appendix N).

Instrument

A questionnaire was the method used for this study (Appendix O). All parents of gymnastics participants at two local gymnastics organizations received an internet link to the site which hosted the SurveyMonkey™ based questionnaire. Since all parents, at both sites, were included in the study, the entire population was utilized, thus making the study a census. The participants at these gymnastics organizations range in age from 3 to 17. The survey utilized for this study combined and modified two survey instruments from recently peer-reviewed studies (Coughlin, et al., 2009; Gourley et al., 2010, Valovich McLeod et al., 2007). A majority of the questions in the Coghlin et al. (2009) study were taken from the Sport Concussion Assessment Tool (SCAT) – a concussion assessment tool that has been validated for content validity (Appendix E) (Johnston, K., McCrory, P., Mohtadi, N., & Meeuwise, W., 2001).

The first section of the questionnaire included questions about the respondent's knowledge of the management and causes of concussions. The initial section of the survey also included questions about the participants' level of confidence regarding the causes and symptoms of concussion. The response choices for these questions (very confident/confident/not very confident/not confident at all) gave some indication of each participant's confidence in their ability to assess and manage concussion. The remaining questions in this section had three possible answer choices 1) agree; 2) disagree or 3) I don't know – questions and answers that pertained to parents' knowledge regarding the causes of concussion. Aubry et al. (2002), Coughlin et al. (2009), McCrory et al. (2004) and Patel et al. (2005) all provided evidence-based information in the literature with respect to the survey instrument questions about mechanism or potential causes of concussion, stating that a direct hit to the head, torso, or a whiplash motion can all cause a concussion. The premise for question number four revolved around previous studies that state that there are significant differences between adults and children in regard to recovery time after a concussion (McCrory et al., 2004; Patel et al., 2005). Question number five attempted to measure parents' knowledge regarding successive concussions. Previous studies have determined that once an athlete has sustained a primary concussion, they are more likely to sustain successive concussions that are cumulative; the successive concussions will be more severe with more post-concussive symptoms (Cantu, 2001; Gerberich et al., 1983; Guskiewicz et al., 2000; Patel et al., 2005). Question number six highlighted confirmed information that conventional structural neuroimaging (x-rays) contributes little to concussion evaluation in cases involving the most common type of concussion (a mild traumatic brain injury) because images of the brain generally do not show any structural abnormalities following a concussion injury (Aubry et al., 2002; Coughlin et al., 2009; Gourley et al., 2010; McCrory et al., 2005; McCrory et al., 2009). Question number seven was directed toward parental knowledge of brain energy demands following a concussive event. Giza and Hovda (2001) report that after suffering even a mild concussion, increased energy demands occur, but concomitantly, there is a reduced blood flow to certain areas of the brain. Consequently, the evidence is very clear that adolescents should never be immediately returned to play, even in the event of only a very mild concussive event. The following question inquired about the relationship involving a loss of consciousness and a confirmed diagnosis of a concussive event (Guskiewicz et al, 2004; McCrory et al. 2004). The remaining questions in section 1 highlighted the management of concussion and revealed parents' perceptions of the duration of concussive signs or symptoms, return-to-play decisions, and use of over-the-counter medications following a concussive event. Question 13 and 14 concentrated on studies that observed that in addition to acute symptoms, athletes may develop symptoms, like fatigue, over several weeks (Landry, 2002; Patel et al., 2005). The following two questions focused on return to play criteria, with the thought in mind that a stepwise progression should be included in any return to play decision (Aubry et al., 2002; CAoSMC, 2000; McCrory et al., 2005; McCrory et al., 2009). The final question of the survey inquired whether it is appropriate to give over the counter medications to an acutely concussed adolescent. The concussion in sport group recommends that medications should not be used in the acute phase of concussion management because they mask the severity of the injury (McCrory et al., 2005; McCrory et al., 2009).

Section two of the survey instrument asked study participants about their agreement status with regard to potential symptoms that are possible with a concussion. Participants were also asked about their level of concern regarding any of the noted symptom descriptions (n = 16). Aubry et al. (2002), CAoSMC (2000), McCrory et al. (2005), and McCrory et al. (2009) identify the most common signs and symptoms that are currently being used to determine whether a child has suffered a concussion. Eight detractor /incorrect signs or symptoms have been included with this section of the survey in order to avoid the participant's assumptions that all the answers are correct, and to make this section of the survey more thought provoking.

In the final section of the survey, participants were asked to provide demographic information about themselves as parents of youth sport athletes (n= 16). Included in this section were questions regarding the participants' gender, employment, previous medical training, and history of concussion for both themselves and their children. This section also included questions about the age of their children and the level/type of gymnastics in which they participate. Information regarding the level/type of gymnastics their child(ren) participate in was be collected to determine if higher levels or different types of competition had an effect on the parents' knowledge. Any history of concussion with the study participant or their child may be important in determining if personal experience with a diagnosed concussion situation would have a bearing on their overall knowledge of concussion assessment and management. Also included in this section is a question regarding whether the study participant's child(ren) currently participates (or in the past has participated) in any other organized youth sports. This question was included to help determine whether organized youth sports, outside of gymnastics, could have an effect on the amount of knowledge parents have regarding assessment and management of concussion in their children.

Face validity of the questionnaire was determined by asking for expert opinions from certified athletic trainers and medical doctors regarding questions of concussion etiology, concussion signs and symptoms, and concussion management. The survey instrument demonstrates strong content validity with the research cited throughout the literature review accompanying this study. The reliability of the survey instrument was measured using Cronbach's alpha (0.67) to estimate the internal consistency of the survey items.

Procedures

The SurveyMonkey™ based questionnaire link was sent electronically to all parent members of the gymnastics organization. The informed consent for this survey accompanied the invitation to participate in this study on page one of the SurveyMonkey™ instrument. All components of the NDSU graduate school informed consent requirements were included with the invitation to participate in this study. The final line of the invitation to participate/informed consent page included a box for parents to check that states they have read and understand the informed consent document. The checked box also indicated that the parent wished to participate in the study and gave their consent to continue by completing the questionnaire (Appendix P).

Potential study participant email addresses were obtained from the executive or management directors for each respective gymnastic organization. In addition to the informed consent, the invitation to participate in this study and the questionnaire itself, an incentive to complete and return the questionnaire in a timely fashion was also included. The initial invitation (Appendix Q) included an incentive to complete and return the questionnaire in a timely fashion. The incentive involved offering the first ten study participants returning a completed survey a $10 Target gift card. Three days following the initial invitation to participate in the study, a second reminder (Appendix R) was sent to all participants via email, reminding them of their invitation to participate in the study. The reminder to participate in this study (second reminder) contained essentially the same information as the initial email/invitation to participate in this study, with the exception of offering the first five study participants a $10 Target gift card for returning a completed questionnaire. Successive reminders (without incentives) were sent at one week and two weeks following the initial invitations to participate in this study. One week and two week reminder emails again contained essentially the same information as the initial email invitation to participate in this study (Appendix S).

It was decided that this study was going to be an internet survey because the researchers wanted a high response rate, the amount of people invited to participate, and the researcher-participant dynamic would not have to be factored in as a limitation. Coomber (1997) indicated that the use of online or e-surveys, in social research, was the new interface between researcher and a wide range of potential respondents. Unlike the traditional telephone interview or postal surveys, De Leeuw (2005) observed that respondents to online surveys are allowed more anonymity, making them less likely to be motivated towards a particular response. Shannon and Bradshaw (2002) compared the response rates, response times, and costs of mailed and web survey investigations concluding that web surveys are more cost effective and participants respond faster and at a higher rate than the participants who were sent a postal survey. Until just recently there was concern regarding the availability of the internet and email access, however with the development of wireless internet and internet café's offering free wireless internet, popularity of the internet has increased. Mehta and Sivadas (1995) secured a higher internet response than the conventional postal mail equivalent (63% to 45% respectively). Similarly, Glover and Bush (2005) measured the response rate of 407 surveys and observed that the internet survey received a higher response rate than the conventional postal survey (43% to 28% respectively). A variable within this survey was support for the organization that was conducting the survey. Overall, a 70% response rate was observed, possibly because they felt that they were under greater pressure to help an organization that was familiar to them. Response rate is not the only benefit. Survey research also allows greater access to large samples; low administration costs and also provides already transcribed data to the researcher (Glover and Bush, 2005).

Data Analysis

The results of this survey were used to provide descriptive data analysis information for the results and discussion sections of this thesis. Analysis also included information regarding frequency and percentages of overall results and demographic data. Independent t-tests were used to analyze the data as we determined significant differences among and between groups where it was applicable. Significance was set at $P \leq 0.05$, two-tailed. Data were analyzed using the SAS© v. 9.2 statistical program (SAS Institute Inc., Cary, NC).

CHAPTER IV:

THE PRESENT STUDY

Abstract

Objective: Youth sport concussion has recently become a topic of concern for health care professionals. Young athletes are at greater risk of sustaining a concussion because children have a greater head-to-body ratio and their cervical musculature and cranial bones are not fully developed. Access to on-site medical professionals is limited for young athletes, leaving recognition and management of the injury to the parents. Limited research has examined parental knowledge of concussion. The purpose of this study was to examine youth sport parents' knowledge regarding the recognition, assessment, and management of concussion. **Design and Setting:** A cross-sectional descriptive design, utlizing a SurveyMonkey™ questionnaire was emailed to all parents associated with two gymnastics organizations in the Fargo-Moorhead metro area. Included in the survey were outcome measures that included knowledge of concussion etiology, the ability to recognize concussive symptoms, and knowledge of concussion management. **Subjects:** Eighty-nine parents of youth sports athletes participated in this study, a 25 percent response rate. **Measurements:** A novel survey instrument was developed to assess parental concussion knowledge. Internal reliability of the instrument was established prior to the study with a pilot group (Cronbach's alpha = 0.67). Data analysis included information regarding frequency and percentages of overall results and demographic data. **Results:** Overall, participants in this study had moderate knowledge of concussion recognition, diagnosis, and management. Participants with and without prior medical training differed significantly in their knowledge of concussion etiology (P= 0.0016). There was no significant difference between these groups in their ability to recognize concussive symptoms (P= 0.08) or in the knowledge level regarding concussion management (P= 0.68). There was no significant difference between parents with children who participate in more than one sport and those whose children participate in gymnastics only (P= 0.76). Those who have personally (themselves or their children) been diagnosed with a concussion and those who had never been diagnosed with a concussion were not significantly different in their overall concussion knowledge (P= 1.92). **Conclusion:** Parents have a moderate level of knowledge regarding some aspects of concussive injuries. Additional educational opportunities for parents may help increase concussion awareness.

Introduction

There are more than 60 million parents in the United States whose children participate in organized youth athletics annually (Ward, 2004). In recent decades, participation in organized youth athletics has increased, and has paralleled a similar increase in sport-related injuries (Caine et al., 2003). Although there are a variety of injuries that are associated with organized youth athletics, concussion is generally one of the most misunderstood (Valovich McLeod, Schwartz, & Bay, 2007). For the purpose of this study a concussion is defined as a, "complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces" (Aubry, et al., 2002, p. 6). Any athlete, regardless of age or sport, is at risk of suffering a concussion.

An estimated 1.6 to 3.8 million sport-related concussions occur annually; eight percent of these concussions are reported to occur in athletes who are under the age of 16 (Langlois, Rutland-Brown, Wald, 2006; Kelly, Lissel, Rowe, Vincenten, & Voaklander, 2001). Athletes between the ages of 6 and 16 were six times more likely to suffer a concussion when playing organized youth sports than if they were participating at a recreational level (Brown & Lam, 2006). It is believed that concussions are under-reported because of common misconceptions held by the untrained population. If parents, coaches, and athletes are uneducated with respect to the recognition and treatment of concussion, this can cause a concussion to go undiagnosed and unreported.

Due to a continued and increasing interest in organized youth athletics, as well as a lack of on-site medical staff at organized youth sporting events, parents are responsible for the recognition and management of possible concussions during and after training or competition. Rapid recognition of a possible concussion allows parents to notify coaching staff and seek proper medical treatment. If parents are uneducated about the recognition and treatment of concussions, athletes could continue to participate in athletics and put themselves at higher risk for further injury. Moreover, not recognizing a concussion may also increase risk for subsequent concussion and second impact syndrome.

Although concussive injuries can be extremely dangerous and should ideally be treated by trained medical personnel, there are few statewide or nationally mandated programs that educate parents about concussion. To date, little information is known about the ability of parents of youth sport athletes to recognize sport-related concussion. Therefore, the purpose of this study was to determine if parents of organized youth sport athletes have knowledge regarding the causes, recognition of symptoms, and management of concussions.

Methods

Participants

A total of 445 SurveyMonkey™ questionnaires were sent electronically to parents of youth sport athletes associated with two gymnastic organizations in a local community area. Invited participants were parents of gymnasts between 3 and 17 years of age. Incomplete questionnaires were the only exclusion criterion.

Instrumentation

All potential participants received an email invitation to complete a questionnaire, which included an internet link to the SurveyMonkey™ website. A questionnaire was created by combining and modifying two current survey instruments from previous, peer-reviewed, studies (Coughlin, Myles, & Howitt, 2009; Gourley, Valovich McLeod, & Bay, 2010). A majority of the questions developed for this survey were constructed with information found in the Sport Concussion Assessment Tool (SCAT), a previously validated instrument (Aubry et al., 2001). Focus groups and a pilot study were conducted to assist with the proper construction of the questionnaire. All of the survey questions or statements were created considering evidence-based literature to support their foundation, giving the instrument strong content validity. Internal reliability of the questionnaire was determined prior to the study with a pilot subject group (Cronbach's alpha = 0.67). The questionnaire was screened for face and content validity by experienced, certified athletic trainers at a local university, and was approved for inclusion in this study by the University's Institutional Review Board.

The initial section of the survey highlighted questions pertaining to the participants' confidence and knowledge level concerning 1) causes of a concussion, 2) concussion symptoms, and 3) management of concussions. The response choices revealed each participant's confidence or level of agreement with respect to all three facets of the study. The majority of questions in section one focused on the etiology and management of a concussion, along with parents' ability to recognize the mechanism of concussion, parents' knowledge regarding recovery time following a diagnosed concussion, and the risk of future concussions following a primary concussive episode. Additionally, this section included questions that highlighted parental knowledge of diagnostic tests, neurometabolic energy requirements, the duration of concussive symptoms, return to play criteria, and use of over-the-counter pharmaceuticals following a concussion.

Section II of the survey consisted of 16 questions asking parents to identify symptoms of concussion. The questionnaire instructed the participants to check yes or no depending on whether they believed that the items were symptoms of a concussion. A choice of "I don't know" was also offered to the participants if a respondent was undecided about any of the noted symptoms. Of the 16 possible concussion symptoms, half were real symptoms and the other half were erroneous symptoms. The erroneous symptoms were: loss of hearing, neck pain, excessive thirst, sinus congestion, excessive salivation, inability to swallow, nosebleed, and abnormal sense of smell. These incorrect symptoms were used as detractors in at least one of three previous studies (Coughlin et al., 2009; Gourley et al., 2010; Valovich McLeod, 2007) and were included to encourage participants to critically think about the topic, and to avoid the probability that participants would guess that all the symptoms were correct.

The final portion of Section II utilized many of the same symptoms as the initial portion of Section II, however, with the latter set of questions focused on the level of concern that a parent might have regarding symptoms experienced after a concussion.

Possible answers indicated parents' level of concern if their child were experiencing a symptom after a possible head injury. This portion of the survey was designed to determine if parents thought certain symptoms were more serious than others.

Section III of the survey included 17 demographic questions designed to indicate the gymnastics organization in which they were members, the gender and occupation of the participant, previous experience with concussion, and the number and ages of children participating in each gymnastics program. Information regarding outside sport participation and previous medical training was also requested. Information about the age of each participant's child was collected in order to determine whether higher levels of competition would have an effect on parental knowledge of concussion. Finally, questions were posed to determine whether outside sport participation influenced the level of concussion awareness that participants possessed.

Statistical Analysis

Frequency distributions were used to provide descriptive statistics for the demographic data, concussion symptom score, concern of concussion symptom score, confidence level, and responses for the causes and management of concussion. Four separate independent t tests were performed to compare data between each of three different groups: 1) parents who have never been diagnosed with a concussion (themselves or their children) and those who have been diagnosed with a concussion; 2) Parents with children who play sports (other than gymnastics) with those who have children exclusively participating in gymnastic activities; and 3) Parents who indicated having medical training or medical backgrounds with those who did not have any medical training or background. The four measures that were included for each comparison were: 1) knowledge of concussion etiology, 2) ability to recognize correct symptoms of concussion, 3) ability to recognize incorrect symptoms of a concussion, and 4) knowledge of concussion management.

Independent t tests were also conducted to compare parents' stated confidence levels (very confident and confident versus not very confident and not confident at all) with correct response rates for questions regarding the etiology of a concussion, recognition of a concussion, and management of a concussion. Significance was set at $P \leq 0.05$. Data were analyzed using the SAS© v. 9.2 statistical program (SAS Institute Inc., Cary, NC).

Results

A 20% (89/445) response rate was observed in this study. Seventy-five of the respondents were female and 14 were male. The 89 parents who completed the survey, reported data regarding themselves and demographic information about their children involved in the sport of gymnastics (Table 1) -- a total of 107 children, between the ages of 3 and 17. The mean age of the gymnastic athlete was 10.17 ± 5.42., involved with one of three gymnastics programs; a competitive group (38, 35.5%), an acrobatic group (48, 44.9%), and a recreational group (21, 19.6%).

On average, parents were able to recognize 7.45 ± 1.14 concussion symptoms correctly (of the 8 correct symptoms provided). However, of the eight incorrect symptoms provided, only 3.36 ± 2.23 were correctly identified as false symptoms. Overall, participants were able to recognize 8.83 ± 2.57 symptoms (of 16) correctly (Table 2). Of the thirteen questions that were designed to measure knowledge of concussion etiology (Table 3) and management (Table 4), parents had correct scores of 8.75 ± 2.24, indicating a lack of knowledge in those two areas regarding concussive injuries.

Table 1. Demographic Data of Respondents

Sex of respondent	Male Female	14 75
Employed in a health care profession	Yes No	30 59
Respondent previously diagnosed with a concussion	Yes No	13 76
Child previously diagnosed with a concussion	Yes No	9 80
Child participates in outside sport(s)	Yes No	62 27
Previous medical training	Yes No	41 48

The majority of parents (62/89, 69.7%) have children who currently participate in sports besides gymnastics. Parents of multiple sport athletes and parents whose children participate solely in gymnastics did not differ significantly in any measure; knowledge of concussion etiology (t=1.42, P=0.16), ability to recognize correct concussive symptoms (t=0.56, P=0.85), ability to recognize incorrect concussive symptoms (t=0.50, P=0.68), and knowledge regarding the management of concussion (t=0.24, P=0.81) (Table 5).

The data collected regarding prior concussion diagnosis by a licensed healthcare professional, for themselves (13, 14.6%) and/or their child (9, 10.1%), indicates that a total of 21 (23.6%) parents have had direct experience with a concussive event. When comparing those who have had prior experience with a concussion with those who have not, there were also no significant differences in any measure; knowledge of concussion etiology (t=1.31, P=0.19), ability to recognize correct concussive symptoms (t=0.10, P=0.92), ability to recognize incorrect concussive symptoms (t=1.54, P=0.13), and knowledge of the management of concussion (t=0.09, P=0.93).

Table 2. Frequencies and Percentages of Correct Symptom Identification
(Concussion symptoms in bold)

Symptom	Correct Response
Loss of Consciousness	**88 (98.9%)**
Loss of hearing	5 (5.6%)
Memory loss	**86 (96.6%)**
Neck Pain	12 (13.5%)
Loss of balance	**86 (96.6%)**
Excessive thirst	17 (19.1%)
Abrupt emotional change	**65 (73%)**
Sinus congestion	28 (31.5%)
Fatigue	**81 (91%)**
Excessive salivation	19 (21.3%)
Headache	**87 (97.8%)**
Inability to swallow	13 (14.6%)
Abnormal vision	**85 (95.5%)**
Nosebleed	18 (20.2%)
Nausea	**85 (95.5%)**
Abnormal sense of smell	13 (14.6%)

A majority of parents in this study (59, 66.2%) reported that they were not employed in a healthcare profession; however, 19 respondents had participated in prior medical training (CPR/First aid certification, coaching certificates, and injury prevention classes). This suggests that approximately 55% (49/89) of the studied population had prior medical training. There was a significant difference in correct response rate for questions regarding knowledge of concussion etiology (8) between these two groups. Participants who had prior medical training were able to correctly answer 6.27 ± 1.33 questions whereas participants who had not had prior medical training were only able to correct answer 5.29 ± 1.5 questions ($t=3.25$, $P= 0.0016$). The other three measures of difference were insignificant; ability to recognize correct concussive symptoms ($t=1.78$, $P=0.08$), ability to recognize incorrect concussive symptoms (t=0.87, P=0.39), and knowledge of the management of concussion (t=0.42, P=0.68).

There was a significant difference between parents who stated that they were confident (55, 61.8%) in their knowledge of concussion etiology and those who were not confident (34, 38.2%). Of the eight questions that pertained to knowledge of concussion etiology (B1-B8), parents who were confident in their knowledge were able to correctly answer 6.77 ± 1.28 and parents who were not confident correctly answered 5.09 ± 1.52 (t=3.93, P≤0.001).

Table 3. Parental Responses Regarding the Etiology of Concussion
(% of respondents)

	Agree	Disagree	Unknown
A concussion can be caused by a direct hit to the trunk (torso) of the body.	**34.8**	41.6	23.6
A concussion can be caused by a direct hit to the head.	**100**	0	0
A concussion can be caused by a whiplash motion.	**92.1**	2	5.9
Recovery time (return to preinjury status) from a concussive injury is generally the same for an adolescent aged child and an adult.	3.3	**60.7**	36
The adolescent athlete is at a greater risk of concussive injury following a previous concussion.	**86.5**	1.1	12.4
A concussion can only be diagnosed by an x-ray image from a doctor's office.	3.3	**67.4**	29.3
Concussions cause the brain to require more energy so that it can function normally.	**48.3**	6.7	45
A concussion can only be diagnosed if the athlete blacks out (loss of consciousness)	0	**92.1**	7.9

* Correct responses bolded.

Table 4. Parental Responses Regarding the Management of Concussion (% of respondents)

	Agree	Disagree	Unknown
Following a concussion, symptoms can last anywhere from minutes to months.	**87.6**	4.4	8
Fatigue lasting longer than 7-10 days, following a mild concussion, is generally not a symptom to be concerned about when considering return-to-play decisions.	7.9	**78.7**	13.4
Athletes can return to play immediately after concussion symptoms subside.	2.2	**80**	17.8
Return-to play decisions following a diagnosed concussion must be made be a medical doctor only.	75.3	**11.2**	13.5
Administering over-the-counter medications to relieve symptoms of a concussion is acceptable given that it is done within the first 24-72 hours from the onset of the concussion.	10.1	**36**	53.9

* Correct responses bolded.

When comparing parents who stated that they were confident (50, 56.2%) in their ability to correctly identify symptoms of a concussion with those who were not confident (39, 43.8%), there was a mixture of results. When correctly identifying concussive symptoms (8), there was a significant difference between confident parents' scores (7.72 ± 0.57) and parents who were not confident in their ability to recognize correct symptoms (7.10 ± 1.54, $t= 2.62$, $P \leq 0.01$). However, these two groups, confident parents (1.42 ± 2.22) and parents who lacked confidence (1.33 ± 2.02), did not significantly differ in their abilities to correctly identify eight false concussive symptoms ($t=0.19$, $P=0.85$).

Finally, parents who were confident (33, 37%) in their knowledge of concussion management and those who were not confident (56, 63%) were compared. Of the five questions that pertained to concussion management (B9-B13) those who stated that they were confident and those were not confident significantly differed (t=3.78, P≤ 0.001) in the amount of questions they correctly answered (3.48 ± 0.91 and 2.60 ± 1.14, respectively).

Table 5. P-Values and t-Values of Independent T-Tests

Concussion knowledge	Outside sport participation	Prior concussion diagnosis	Prior medical training	Confident in Knowledge
Concussion etiology	t=1.42 P=0.16	t=1.31 P=0.19	t=3.25 * P≤ 0.01	t=3.93 * P≤0.001
Correct concussive symptoms	t=0.56 P=0.85	t=0.10 P=0.92	t=1.78 P=0.08	t= 2.62 * P≤ 0.01
Incorrect concussive symptoms	t=0.50 P=0.68	t=1.54 P=0.13	t=0.87 P=0.39	t=0.19 P=0.85
Concussion management	t=0.24 P=0.81	t=0.09 P=0.93	t=0.42 P=0.68	t=3.78 * P≤ 0.001

* Significantly Different (P≤ 0.05)

Discussion

The most important observation in this study was that participants were moderately successful in correctly identifying the etiology (causes) of concussion. All participants responded that a direct hit to the head could cause a concussion. Approximately 92% (82/89) of all participants correctly stated that a concussion could be caused by a whiplash motion. While these two mechanisms of concussion were well known by participants, only a small number of parents (34.8%, 31/89) correctly recognized a direct hit to the trunk (torso) as being a possible mechanism of concussion. This is particularly concerning as Aubry et al. (2002), Coughlin et al. (2009), McCrory et al. (2004) and Patel, Shivdasani, & Baker (2005) all provide evidence-based literature which states that a concussion can be caused by a direct hit to the head, torso, or a whiplash motion. Coughlin et al. (2009)

reported that 86.8% (99/114) parents were aware that a blow to the neck, jaw, or elsewhere on the body are possible causes of a concussion. Considering these results, it would seem that the knowledge level of parents involved in this study, regarding mechanism of concussion, was deficient in comparison. However, we listed each possible mechanism as a single question whereas Coughlin et al. (2009) grouped all mechanisms into one question. This may have led participants to answer correctly based on the knowledge of only one of the mechanisms listed. We are unaware of any other studies measuring parental knowledge regarding whiplash as a mechanism of concussion.

More than 85% (77/89) of participants correctly answered that an adolescent athlete is at a greater risk of concussive injury following a previous concussion. Coughlin et al. (2009) reported that 95% (109/117) of parents were aware that if a player has suffered a concussion, they should not return to play that day. In another similar study, Gourley et al. (2010) determined that 89% (89/100) of parents were aware that an athlete experiencing any symptoms of a concussion should not be allowed to return to play. These measures are heartening because evidence-based literature has determined that athletes sustaining a primary concussion are more likely to sustain successive concussions, compounding the initial injury. In combination with a primary concussive injury, the successive concussions tend to be more severe and often times include post-concussive symptoms (Cantu, 2001; Gerberich, Priest, Boen, Straub, & Maxwell, 1983; Guskiewicz, Weaver, Padua, & Garrett, 2000; Patel et al., 2005).

A minority of participants (29, 32.6%) were unaware that other health care practitioners (ie., licensed or registered certified athletic trainers, physician assistants, nurse practitioners) have the ability to evaluate and diagnose a concussion without an x-ray image from a doctor's office. This is concerning because conventional structural neuroimaging (x-rays) have been determined to contribute little to concussion evaluation in cases involving the most common type of concussion (a mild traumatic brain injury) because images of the brain generally do not show any structural abnormalities following a concussive injury (Aubry et al., 2002; Coughlin et al., 2009; Gourley et al., 2010; McCrory et al., 2005; McCrory et al., 2009).

There was a significant difference, in knowledge of concussion etiology, between parents who had prior medical training and those who did not. These results imply that medical training may be an effective tool in increasing concussion etiology knowledge base for youth sport parents. This observation is in direct agreement with Gourley et al. (2010), who suggest that parents of youth sport athletes should be educated in the etiology of concussion, so they can seek proper immediate medical care and become an advocate for proper return-to-play decisions.

In general, parents were successful in correctly identifying the symptoms of a concussion. More than 90% of all participants correctly identified loss of consciousness, memory loss, loss of balance, fatigue, headache, abnormal vision, and nausea as concussion-related symptoms. The correct response rate for these symptoms is not surprising as they are often present during a concussive episode (Aubry et al., 2002; Cantu, 2001; Erlanger et al., 2003; Guskiewicz et al., 2004; Majerske et al., 2008; Patel et al., 2005). Previous studies have reported that these symptoms were also identified by 80% of parents and 60% of youth sport coaches (Gourley et al., 2010 and Valovich McLeod et al., 2007, respectively). Although parents and coaches seem to have proper knowledge of concussive symptoms, a retrospective survey of intercollegiate athletes reported a lack of knowledge of concussion symptoms, 30% (139/461) of athletes continued to play after a blow to the head that caused a headache, and 28% (129/461) athletes continued to play with dizziness (Kaut, DePompei, Kerr, & Congeni, 2003). This information is similar to data collected from youth sport athletes in a study of 73 athletes where 30% or more were unable to recognize confusion, loss of consciousness, and nausea as common symptoms of concussion (Gourley et al., 2010). These results indicated that parents were moderately aware of common concussive symptoms while, in other situations, coaches and athletes were even less educated with regard to common concussive symptoms, indicating the coaches and athletes, themselves, should not make return to play decisions.

Although parents in this study seemed to be moderately aware of common concussive symptoms, less common concussive symptoms were overlooked. In the current study, abrupt emotional change, an authentic concussive symptom, was correctly identified as a concussion symptom at a lower rate (65, 73%) than other concussive symptoms. This could be a matter of concern as emotional change is a viable, concussive symptom (Aubry et al., 2002; Cantu, 2001; Erlanger et al., 2003; Guskiewicz et al., 2004; Majerske et al., 2008; Patel et al., 2005). Authors of a previous study reported that between 0% and 59% of parents identified sleep disturbances and problems concentrating on class work as concussive symptoms (Gourley et al., 2010). Coughlin et al. (2009) reported that a high percentage of participants did not recognize sleep disturbances (54.4%), difficulty describing time and place (28.9%), and abrupt emotional change (23.7%) as concussive symptoms. Uncommon symptom recognition could become problematic with regard to concussion management and the associated return-to-play protocols. A lack of knowledge of the less common symptoms could be problematic, a concussion that produces only symptoms that are less common could cause an athlete to think that the "less common" symptoms are caused by an extraneous factor, leaving the concussion undiagnosed.

Although loss of consciousness was identified by all but one participant as a symptom of concussion, 92% (82/89) of participants also knew that loss of consciousness was not necessary for a concussion diagnosis to occur. Gourley et al. (2010) and Coughlin et al. (2009) recently observed that 85% (85/100) and 76.3% (87/114) of the participants in their studies were also aware that loss of consciousness was not necessary for a concussion diagnosis. However, Valovich McLeod et al. (2007) determined that approximately half (76/150) of the youth sport coach participants were unaware that a concussion could occur without a loss of consciousness The disparity between these numbers could be attributed (in part) to the period in which Valovich McLeod's research was completed and reported. In the past five years, concussions have received more attention in the national media, possibly increasing concussion awareness as a general matter (Center for Disease Control and Prevention [CDC], 2010) As noted in our study along with Gourley et al. (2010) and Coughlin et al. (2009), a positive trend involving concussion education appears to be occurring.

While our participants were generally knowledgeable about the symptoms of concussion, there was a lack of correct responses regarding the false symptoms of concussion. It was observed that a correct response rate of 31.5% (28/89) was the highest of any regarding the false symptoms noted on the survey (sinus congestion). This meant that for each of the eight false symptoms, 61(68.5%), or more, people incorrectly identified distractor items as true symptoms of a concussion. Other authors (Coughlin et al., 2009) observed that parents of youth sport athletes incorrectly indicated that hearing voices

(47%), lowered pulse rate (47%), inability to swallow (44%), and feelings of euphoria (44%) were all concussive symptoms. These data could be attributed to participants being over cautious when considering their child's health.

Prior medical training did not aid our participants' ability to identify correct concussive symptoms. Similarly, Valovich McLeod et al. (2007) observed that 45% (67/150) of coaches with medical training were unable to recognize more symptoms than those coaches who had no medical training at all. This information contradicts research from Gourley et al. (2010) that reports a significant difference in number of correctly identified symptoms by parents with general medical training (10 ± 2.83) and those who had no medical training (8.4 ± 2.77). This discrepancy between studies may be due to the operational definition of medical training. Gourley et al. (2010) defined medical training as first aid certification or general medical training whereas our study allowed participants to identify the type of medical training that they had and the authors included in the analysis those who had prior first aid certification, CPR certification, employment in a health care field, and concussion education classes.

Regarding symptom duration, 87.6% (78/89) of our parents correctly answered that symptoms can last for months after a diagnosed concussion, and that fatigue is also a contraindication for return-to-play (70, 78.7%). These data are comparable to a study by Gourley et al. (2010), who observed that 89% (89/100) of parents were aware that return to play should not occur if the athlete is experiencing any symptoms, regardless of the intensity of those lingering symptoms. The majority of participants (71, 80%) in the current study also recognized that athletes should not immediately return to play after they recover from symptoms. Gourley et al. (2010) observed that only 56% (56/100) of parents were aware that a gradual return to play was most advantageous to the athlete. These data are concerning as guidelines are found in the literature, specifically the Canadian Academy of Sports Medicine, and the Concussion in Sport Group recommended that a stepwise progression should be included in any return to play decision (Aubry et al., 2002; CAoSMC, 2000; McCrory et al., 2005; McCrory et al., 2009). With this stepwise progression, the athlete should spend a minimum of 24 hours on each of the recommended steps, progressing to the next level of activity if the athlete remains asymptomatic at the current level (Aubry et al., 2002; CAoSMC, 2000; McCrory et al., 2005; McCrory et al., 2009).

The majority of parents 67/89 (75.3%) believed that return-to-play decisions must be made (solely) by a medical doctor. This concussion management question was included with the survey because of the recent attention centered around the Zackery Lystedt law, a Washington State law enacted and passed in the spring of 2009 that protects young athletes from returning to play too soon after a concussion. The law requires that, following the diagnosis of a concussion, a licensed health care provider (specifically a Medical Doctor [MD], a Doctor of Osteopathy [DO], an Advanced Registered Nurse Practitioner [ARNP], a Physician's Assistant [PA], or a Licensed/Certified Athletic Trainer [ATC/L]) must provide written authorization to the child's coach or athletic supervisor before he or she can return to practice, training, or competition (Herring, 2009). While this law has not been enacted uniformly in all states throughout the United States, a similar concussion law has been passed in 14 different states (ND included), and was pending approval in approximately 20 additional states at the time of this study. Only 10 participants (11.2%) of the studied group disagreed with the statement claiming that an MD was the exclusive licensed healthcare professional allowed to permit a youth sport athlete to return-to-play.

The results of the current study showed that the majority of participants (57, 64%) failed to correctly identify that administration of over-the-counter medication to relieve acute symptoms of a concussion is not acceptable. The Concussion in Sport Group suggests that over-the-counter medications can be used to treat prolonged symptoms, however, these types of medications should not be used in the acute phase of concussion management because they mask the severity of the symptoms. It is possible that if the extent of injury cannot be determined, an intracerebral hemorrhage could occur, which is a life threatening medical emergency (McCrory et al., 2005; McCrory et al., 2009).

A significant difference was observed in the ability to recall proper management techniques of concussion. Parents who were confident in their knowledge of proper concussion management were able to correctly answer $3.48 \pm .91$ concussion management questions whereas parents who did not have confidence in their abilities answered 2.6 ± 1.14 questions correctly (of 5).

We observed no significant difference in overall concussion knowledge between parents who have children participating in multiple sports and parents whose children participate in gymnastics only ($t= 0.31$, $P= 0.76$). This suggests that parents of gymnasts, a non-contact sport, may be as knowledgeable regarding concussion etiology as those parents whose children also participate in outside sports. Among those outside sports reported in the survey were volleyball, soccer, track, swimming, hockey, tennis, football, basketball, wrestling, and baseball. The outside sports reported included a wide range of participation level, from low-risk (non-contact) to high-risk (contact/protective equipment) sports. This lack of significance may be due to the high rate of injury that occurs in gymnastics, which is attributed to the amount of force that is involved in their landing skills. Many gymnasts land with minimal flexion at the hip, knee, and ankle, ultimately causing a great amount of force that is absorbed by the body as it travels up the kinetic chain, increasing the risk of concussive injury, due to a whiplash motions (Sands, 2000).

In the current study, there was also no significant difference in overall concussion knowledge between parents who, themselves or their children, have been diagnosed with a concussion and those parents who, themselves or their children, have not been diagnosed with a concussion ($t= 1.31$, $P=1.92$). This indicates that personal experience, in this population, did not alter the knowledge base that parents have accumulated regarding concussions.

Limitations

A primary limitation of this study included completion of surveys in an unsupervised environment, allowing participants the opportunity to ask others for help or performing research to obtain correct answers. Having participants complete surveys unsupervised also prevented participants from asking study investigators for clarification regarding any of the posed questions. Another limitation was the possibility of regional bias, due to the inclusion of parents from two local gymnastics organizations. Further, there was a low response rate, making it difficult to generalize the results of this study from this sample group to the general public.

Future research may benefit from including a variety of medical education interventions, each concretely defined, all including concussion education. At a minimum, some type of basic medical training appears to advance a person's ability to correctly answer questions regarding concussion etiology, symptoms, and management.

Conclusions and Clinical Implications

Many youth sport organizations do not employ trained medical personnel to supervise practice sessions involved with their respective sport. If parents are unfamiliar with concussion etiology, recognition and management, youth sport athletes may be at a higher risk of being treated by untrained providers. (Erlanger et al., 2003). This is concerning because early recognition, diagnosis, and management of sport-related concussion is, at times, difficult even for highly trained medical professionals. Providing educational opportunities for parents may help increase concussion awareness, resulting in early treatment of concussion along with decreasing the probability of a long-term sequele and successive concussions due to inappropriate return to play decisions. By decreasing the likelihood of improper management, the probability of premature death due to second impact syndrome is reduced (Erlanger et al., 2001).

The results from the current study and others (Coughlin et al., 2009; Gourley et al., 2010; Valovich McLeod et al., 2007) highlight the need for improving overall concussion knowledge of parents. Current educational tools, created by the Center for Disease Control and Prevention, provide important concussion information. Concussion "toolkits" are available for youth athletes and their parents, as well as high school athletes and their parents. These tools are available, free of charge, on the Center for Disease Control and Prevention website (CDC, 2010). It would be beneficial for youth sport organizations to hold required, pre-participation informational meetings that stress the importance of early concussion recognition and management for both parents and athletes. If athletes were more fully informed of the etiology, recognition, and management of a concussion, athletes might be more inclined to report suspect concussive symptoms. If parents were more aware and informed of the etiology, recognition, and management of a concussion, the opportunities to recognize a possible concussion, when trained medical personnel are unavailable during and after competition or training, would be enhanced.

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CHAPTER V:

REFLECTION

The process of writing a thesis is not a fluid progression; outside distractions cause energy depletion and reduce an individual's drive towards thesis completion, eliminating the amount of time allotted for what is needed most: quiet, reflective time. Now, at the culmination of my journey, a period of reflection is necessary and must begin at its inception.

This thesis was born from a preliminary interest of injury prevention, diagnosis, and management. From this interest, an intense curiosity, based entirely on a lack of knowledge, of concussion emerged. This lack of knowledge, as all type A personalities will attest, creates a need-to-know environment that borders on obsession.

After thorough concussion research, enough to write a rough literature review, it became clear that there was an enormous amount of evidence-based literature already published about concussions. This was the first speed bump on the journey towards thesis completion. However, more research revealed an article published in the journal of Athletic Training and Sports Health Care identifying a deficit in parental knowledge regarding the concussions of youth sport athletes. This article also suggested that concussion education should be implemented for this particular population.

Studying the organized youth sport parents' knowledge of concussions became an important journey because of the personal experience I had with organized youth sport teams. Individually, I have been involved with organized youth sports as a participant, spectator, coach, and, occasionally, medical coverage provider. These experiences with organized youth sports were vital to my decision to write a thesis about youth sport concussions. Although the journey initially seemed overwhelming, when the entire project was split into smaller goals, it seemed feasible. The overall goal for this thesis was two-fold: The first was to absorb knowledge on the topic of concussion and, in turn, write a thorough literature review regarding concussive injuries. The second was to complete a study that involved education and knowledge of parents of organized youth sport athletes.

Throughout the past year, with the assistance of many significant mentors, I have implemented multiple revisions to this project with the hopes of submitting the individual article within this project for publication in a peer-reviewed journal. In the future, whether in pursuit of additional education or to advance my professional career, I would like to investigate this topic further, as there appears to be minimal research published about organized youth sport athletes and concussion.

When reflecting on the process of writing a thesis, a familiar quote by Ursula LeGuin comes to mind that describes my experience during this project, "It is good to have an end to journey toward, but it is the journey that matters, in the end." Originally, I was under the impression that the completion of a thesis would be the most beneficial aspect of this process and would be the pivotal aspect in achieving my educational and career goals. In retrospect, however, I believe that the journey itself has provided an avenue for extreme personal growth.

Throughout the journey, there were numerous personal characteristics that needed to be learned or refined in order to achieve the aforementioned growth. These included, but were not limited to, endurance, acceptance, balance, and appreciation. There have been setbacks, some more significant than others -- all of which I originally viewed as catastrophic. After each setback, when the initial panic was gone, and inevitably the "dust cleared," it became apparent that this journey is not a sprint; it is a marathon, and until this project I had never been an enthusiast of long distance running. Although there were times that I thought I would never finish this project, there were many individuals, advisors, classmates, family and friends who were instrumental in helping me to see that eventually I would ultimately be successful, crossing the finish line.

Acceptance was also pivotal throughout this process. Internal and external obstacles prevented me from having absolute control over the process. Although this was a foreign experience for me, it taught me to accept the things that I was unable to control and to accept help, if available, in the process. I had always been under the impression that this would be viewed as weak, leaving myself vulnerable to attack. The opposite was actually the case; I was able to draw strength from others. The combination of two people, whether or not it was the same two people throughout the entire process, was a powerful experience, and taught me unwavering composure. Learning to accept help, knowing there were no ulterior motives involved, also taught me trust, at a foundational level, an amazing experience.

Balance was also an important aspect of this journey. Learning balance may have been the hardest thing that I have ever done. This project has taught me the importance of balancing perfectionism and diligence. While many people view perfectionism to be a positive trait, it can also be extremely detrimental to deadlines. At the beginning of this project, I believed that I was in control of my type A perfectionistic traits, but I discovered that I was incorrect. This is evident when one compares the original and current timelines. Towards the end of this journey, I had an epiphany; attentativeness and thoroughness are not synonyms of perfectionism. I realized that I needed to strive to become thorough with attention to detail, but I need not be perfect. This reduced the amount of pressure that I placed on myself and, ultimately, allowed me to complete this project in a more relaxing environment.

I cannot begin to express the appreciation that I feel for the many people who played an integral role in my journey. These individuals are people who saw me as an individual, with strengths and weaknesses, and who had my best interest at heart. Throughout the process, there were varying degrees of gratitude expressed, not because I didn't appreciate the effort of others, but because I was focused on achieving the goals of this project. Reflecting on this journey, I realize now that without these individuals, I would not be at the culminating point of my journey. I cannot express enough the amount of appreciation and gratitude I feel for my committee advisor, my family, my friends, my instructors and colleagues, and my committee members, all who have unselfishly treated me as an equal and worked scrupulously to help me achieve my educational and professional goals. I can only hope that one day I will be in a position to do for others what these instrumental individuals have done for me.

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APPENDIX A:

CONCUSSION GRADING SCALES

Cantu Grading System

Grade 1 No loss of consciousness; posttraumatic amnesia < 30 minutes
Grade 2 Loss of consciousness < 5 minutes in duration or posttraumatic amnesia lasting >30 minutes but < 24 hours in duration.
Grade 3 Loss of consciousness for more than 5 minutes or post-traumatic amnesia for > 24 hours.

Colorado Medical Society Grading System for Concussion

Grade 1 Confusion without amnesia; no loss of consciousness
Grade 2 Confusion with amnesia; no loss of consciousness
Grade 3 Loss of consciousness

AAN Practice Parameter Grading System for Concussion

Grade 1 Confusion without amnesia; no loss of consciousness; concussion symptoms or mental status abnormalities on examination resolve in < 15 minutes
Grade 2 Transient confusion; no loss of consciousness; concussion symptoms or mental status abnormalities on examination last > 15 minutes.
Grade 3 Any loss of consciousness, either brief (seconds) or prolonged (minutes).

Jordan Grading System for Concussion

Grade 1 Confusion without amnesia; no loss of consciousness.
Grade 2 Confusion with amnesia lasting < 24 hours; No loss of consciousness.
Grade 3 Loss of consciousness with an altered level of consciousness < 3 minutes; posttraumatic amnesia lasting more than 24 hours.
Grade 4 Loss of consciousness with an altered level of consciousness > 3 minutes.

Roberts Grading System for Concussion

Grade 0 No loss of consciousness; no posttraumatic amnesia; symptoms < 10 minutes.
Grade 1 No loss of consciousness; posttraumatic amnesia less than 30 minutes; symptoms > 10 minutes.
Grade 2 Loss of consciousness < 5 minutes; posttraumatic amnesia > 30 minutes.
Grade 3 Loss of consciousness > 5 minutes; posttraumatic amnesia > 24 hours.

Nelson grading System for Concussion

Grade 0 Head struck or moved rapidly; not stunned or dazed initially; subsequently complains of headache and difficulty in concentrating.
Grade 1 Stunned or dazed initially; no loss of consciousness or amnesia; sensorium clears in < 1 minute.
Grade 2 Headache; cloudy sensorium > 1 minute in duration; no loss of consciousness; may have tinnitus or amnesia; may be irritable, hyperexcitable, confused, or dizzy.
Grade 3 Loss of consciousness < 1 minute in duration; no coma; demonstrated grade 2 symptoms during recovery.
Grade 4 Loss of consciousness for > 1 minute; no coma; demonstrates grade 2 symptoms during recovery.

Evidence-based Cantu Grading System for Concussion

Grade 1 No loss of consciousness; posttraumatic amnesia or postconcussion signs or symptoms lasting < 30 minutes.
Grade 2 Loss of consciousness lasting < 1 minute; posttraumatic amnesia or postconcussive signs or symptoms lasting > 30 minutes but < 24 hours.
Grade 3 Loss of consciousness lasting > 1minute or posttraumatic amnesia lasting > 24 hours; postconcussion symptoms lasting > 7 days.

Modified from: "Examination of orthopedic and athletic injuries," by C. Starkey, S. Brown, and J. Ryan, 2010, F.A. Davis Company, Philadelphia, PA, p. 892.

APPENDIX B:

RETURN TO PLAY SCALES

Classification of Concussion	1st Concussion	2nd Concussion	3rd Concussion
Grade I			
AAN	Return to play when asymptomatic for > 15 minutes	Return to play when asymptomatic for > 1 wk	Return to play when asymptomatic for > 1 wk
CANTU	Return to play when asymptomatic	Return to play in 2 wks when asymptomatic for 1 wk (consider terminating season)	Terminate season; may return next season
Grade II			
AAN	Return to play with asymptomatic for > 1 wk	Return to play after 2 wks if asymptomatic	Return to play after 2 wks if asymptomatic
CANTU	Return to play with asymptomatic for > 1 wk	Return to play after 1 mo if asymptomatic for 1 wk (consider terminating season	Terminate season; may return next season
Grade III			
AAN	Return to play when asymptomatic for > 1-2 wks	Return to play when asymptomatic for > 1 mo	Return to play when asymptomatic for 1 mo
CANTU	Return to play 1 mo after injury if asymptomatic for 2 wks	Terminate season	XXXXXXXXXXXXXX

Modified from: "Examination of orthopedic and athletic injuries," by C. Starkey, S. Brown, and J. Ryan, 2010, F.A. Davis Company, Philadelphia, PA, p. 893.

APPENDIX C:

CONCUSSION MODIFIERS

Factors	**Modifier**
Symptoms	Number Duration (> 10 days) Severity
Signs	Prolonged LOC (> 1 min), Amnesia
Sequelae	Concussive convulsions
Temporal	Frequency- repeated concussions over time Timing- injuries close together in time Recency- recent concussion or TBI
Threshold	Repeated concussions occurring with progressively less impact force or slower recovery after each successive concussion.
Age	Child and adolescent (< 18 years old)
Co and pre-morbidities	Migraine, depression or other mental health disorders, attention deficit hyperactivity disorder (ADHD), learning disabilities (LD), sleep disorders
Medication	Psychoactive drugs, anticoagulants
Behavior	Dangerous style of play
Sport	High risk activity, contact and collision sports, high sporting level

Modified from: "Consensus statement on concussion in sport – The 3rd international conference on concussion in sport held in Zurich, November 2008," by P. McCrory, W. Meeuwisse, K. Johnston, J. Dvorak, M. Aubry, M. Molloy, and R. Cantu, 2009, South African Journal of Sports Medicine, 21(2), p. 40.

APPENDIX D:

GRADED RETURN TO PLAY PROTOCOL

Rehabilitation Stage	Functional Exercise	Objective of Stage
1. No activity	Complete physical and cognitive rest	Recovery
2. Light, aerobic exercise	Walking, swimming or stationary cycling keeping intensity < 70% MPHR; No resistance training	Increase heart rate
3. Sport-specific exercise	Skating drills in hockey Running drills in soccer No head impact activities	Add movement
4. Non-contact training drills	Progression to more complex training drills, may start progressive resistance training	Exercise, coordination, and cognition
5. Full contact practice	Following medical clearance participate in normal training activities at practice	Restore confidence and assess functional skills by coaching staff
6. Return to competition	Normal game play	Full participation

Modified from: "Consensus statement on concussion in sport – The 3rd international conference on concussion in sport held in Zurich, November 2008," by P. McCrory, W. Meeuwisse, K. Johnston, J. Dvorak, M. Aubry, M. Molloy, and R. Cantu, 2009, South African Journal of Sports Medicine, 21(2), p. 39.

APPENDIX E:

SPORT CONCUSSION ASSESSMENT TOOL

Patient Education
Sport Concussion Assessment Tool

This tool represents a standardized method of evaluating people after concussion in sport. This tool has been produced as part of the Summary and Agreement Statement of the Second International Symposium on Concussion in Sport, Prague 2004. For more information see the Summary and Agreement Statement of the Second International Symposium on Concussion in Sport. in the: Clinical Journal of Sport Medicine 2005; British Journal of Sports Medicine 2005; Neurosurgery 2005; Physician and Sportsmedicine 2005.

Sports concussion is defined as a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces. Several common features that incorporate clinical, pathological and biomechanical injury constructs that may be utilized in defining the nature of a concussive head injury include: 1. Concussion may be caused either by a direct blow to the head, face, neck or elsewhere on the body with an impulsive force transmitted to the head. 2. Concussion typically results in the rapid onset of short-lived impairment or neurological function that resolves spontaneously. 3. Concussion may result in neuropathological changes but the acute clinical symptoms largely reflect a functional disturbance rather than structural injury. 4. Concussion results in a graded set of clinical syndromes that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course. 5. Concussion is typically associated with grossly normal structural neuroimaging studies.

Post Concussion Symptoms

Ask the athlete to score themselves based on how they feel now. It is recognized that a low score may be normal for some athletes, but clinical judgment should be exercised to determine if a change in symptoms has occurred following the suspected concussion event. It should be recognized that the reporting of symptoms may not be entirely reliable. This may be due to the effects of a concussion or because the athlete's passionate desire to return to competition outweighs their natural inclination to give an honest response. If possible, ask someone who knows the athlete well about changes in affect, personality, behavior, etc.

Remember, concussion should be suspected in the presence of ANY ONE or more of the following:

- Symptoms (such as headache), or
- Signs (such as loss of consciousness), or
- Memory problems

Any athlete with a suspected concussion should be monitored for deterioration (i.e., should not be left alone) and should not drive a motor vehicle.

The SCAT Card

What is a concussion? A concussion is a disturbance in the function of the brain caused by a direct or indirect force to the head. It results in a variety of symptoms (like those listed below) and may, or may not, involve memory problems or loss of consciousness. **How do you feel?** Score yourself on the following symptoms, based on how you feel now.

Post Concussion Symptom Scale

	None Moderate Severe
Headache	0 1 2 3 4 5 6
"Pressure in head"	0 1 2 3 4 5 6
Neck Pain	0 1 2 3 4 5 6
Balance problems/dizzy	0 1 2 3 4 5 6
Nausea or vomiting	0 1 2 3 4 5 6
Vision problems	0 1 2 3 4 5 6
Hearing problems/ringing	0 1 2 3 4 5 6
"Don't feel right"	0 1 2 3 4 5 6
Feeling "dinged/dazed"	0 1 2 3 4 5 6
Confusion	0 1 2 3 4 5 6
Feeling slowed down	0 1 2 3 4 5 6
Feeling like "in a fog"	0 1 2 3 4 5 6
Drowsiness	0 1 2 3 4 5 6
Fatigue or low energy	0 1 2 3 4 5 6
More than emotional	0 1 2 3 4 5 6
Irritability	0 1 2 3 4 5 6
Difficulty concentrating	0 1 2 3 4 5 6
Difficulty remembering	0 1 2 3 4 5 6
(Follow up symptoms only)	
Sadness	0 1 2 3 4 5 6
Nervous or anxious	0 1 2 3 4 5 6
Trouble falling asleep	0 1 2 3 4 5 6
Sleeping more than usual	0 1 2 3 4 5 6
Sensitivity to light	0 1 2 3 4 5 6
Sensitivity to noise	0 1 2 3 4 5 6
Other:	0 1 2 3 4 5 6

What should I do?

Any athlete suspected of having a concussion should be removed from play, and told to seek medical evaluation.

Signs to watch for:

Problems could arise over the first 24-48 hours. You should not be left alone and must go to a hospital at once if you:

- Have a headache that gets worse
- Are very drowsy or can't be awakened (woken up)
- Can't recognize people or places
- Have repeated vomiting
- Behave unusually or seem confused; are very irritable
- Have seizures (arms and legs jerk uncontrollably)
- Have weak or numb arms or legs
- Are unsteady on your feet; have slurred speech

Consult your doctor after a suspected concussion.

What can I expect?

Concussion typically results in the rapid onset of short-lived impairment that resolves spontaneously over time. You can expect that you will be told to rest until you are fully recovered Then, your doctor will likely advise that you go through a gradual increase in exercise over several days (or longer) before returning to sport.

Modified from: "Summary and agreement statement of the 2nd international conference on concussion in sport, Prague 2004," by P. McCrory, K. Johnston, W. Meeuwisse, M. Aubry, R. Cantu, J. Dvorak, T. Graf-Baumann, J. Kelly, M. Lovell, and P. Schamasch, 2005, British Journal of Sports Medicine, 39, p. i81-82.

The SCAT Card (Medical Evaluation)

Name: ______________________ Date: ________
Sport/Team: _________________ Mouth guard? Y N

1) SIGNS

Was there loss of consciousness/unresponsiveness? Y N
Was there seizure or convulsive activity? Y N
Was there a balance problem / unsteadiness? Y N

2) MEMORY

Modified Maddocks questions (check if athlete answers correctly)

At what venue are we? ____ Which half is it? ____ Who scored last? ____

What team did we play last? ____: Did we win last game? ____

3) SYMPTOM SCORE

Total number of positive symptoms (from patient education side of the card) = _____

4) COGNITIVE ASSESSMENT (5 word recall)

(Examples) Immediate Delayed
Word 1 _____ cat ________ ________
Word 2 _____ pen ________ ________
Word 3 _____ shoe ________ ________
Word 4 _____ book ________ ________
Word 5 _____ car ________ ________

Months in reverse order:

Jun-May-Apr-Mar-Feb-Jan-Dec-Nov-Oct-Sep-Aug-Jul

Digits Backwards (check correct)

5-2-8 3-9-1 _____
6-2-9-4 4-3-7-1 _____
8-3-2-7-9 1-4-9-3-6 _____
7-3-9-1-4-2 5-1-8-4-6-8 _____

Ask delayed 5-word recall now

5) NEUROLOGIC SCREENING

Pass Fail
Speech ____ ____
Eye Motion and Pupils ____ ____
Pronator Drift ____ ____
Gait Assessment ____ ____

Any neurologic screen abnormality necessitates formal neurologic or hospital assessment

RETURN TO PLAY

Athletes should not be returned to play the same day of injury.

When returning athletes to play they should follow a stepwise symptom-limited program, with stages of progression. For example:

1. Rest until asymptomatic (physical and mental rest)
2. Light aerobic exercise (e.g stationary cycle)
3. Sport-specific training
4. Non-contact training drills (start light resistance training)
5. Full contact training after medical clearance
6. Return to competition (game play)

There should be approximately 24 hours (or longer) for each stage and the athlete should return to stage 1 if symptoms recur. Resistance training should only be added in the later stages. Medical clearance should be given before return to play.

Instructions:

The side of the card is for the use of medical doctors, physical therapists, or athletic therapists. In order to maximize the information gathered from the card, it is strongly suggested that all athletes participating in contact sports complete a baseline evaluation prior to the beginning of their competitive season. This card is a suggested guide only for sports concussion and is not meant to assess more severe forms of brain injury.

Please give a COPY of this card to the athlete for their information and to guide follow up assessment.

Signs:

Assess for each of these items and circle Y (yes) or N (no).

Memory:

Select any 5 words (an example is given). Avoid choosing related words such as .dark. and .moon. which can be recalled by means of word association. Read each word at a rate of one word per second. The athlete should not be informed of the delayed testing of memory (to be done after the reverse months and/or digits). Choose a different set of words each time you perform a follow-up exam with the same candidate.

Concentration / Attention:

Ask the athlete to recite the months of the year in reverse order, starting with a random month. Do not start with December or January. Circle any months not recited in the correct sequence. For digits backwards, if correct, go to the next string length. If correct, read trial 2. Stop after incorrect on both trials.

Neurologic Screening:

Trained medical personnel must administer this examination. These individuals might include medical doctors, physiotherapists or athletic therapists. Speech should be assessed for fluency and lack slurring. Eye motion should reveal no diplopia in any of the 4 planes of movement (vertical, horizontal and both diagonal planes). The pronator drift is performed by asking the patient to hold both arms in front of them, palms up, with eyes closed. A positive test is pronating the forearm, dropping the arm, or drift away from midline. For gait assessment ask the patient to walk away from you, turn and walk back.

Return to Play:

A structured, graded exertion protocol should be developed, individualized on the basis of sport, age, and the concussion history of the athlete. Exercise or training should be commenced only after the athlete is clearly asymptomatic with physical and cognitive rest. Final decision for clearance to return to competition should ideally be made by a medical doctor.

Notes:

____
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Modified from: "Summary and agreement statement of the 2nd international conference on concussion in sport, Prague 2004," by P. McCrory, K. Johnston, W. Meeuwisse, M. Aubry, R. Cantu, J. Dvorak, T. Graf-Baumann, J. Kelly, M. Lovell, and P. Schamasch, 2005, British Journal of Sports Medicine, 39, p. i81-82.

APPENDIX F:

CONCUSSION SYMPTOM CHECKLIST

Symptom	Time of Injury	2-3 hours post injury	24 hours post injury	48 hours post injury	72 hours post injury
Blurred Vision					
Dizziness					
Drowsiness					
Excess sleep					
Easily distracted					
Fatigue					
Feel "in a fog"					
Headache					
Inappropriate emotions					
Irritability					
Loss of consciousness					
Disorientation					
Memory problems					
Nausea					
Nervousness					
Personality change					
Poor balance					
Poor concentration					
Ringing in ears					
Sadness					
Seeing stars					
Sensitivity to light					
Sensitivity to noise					
Sleep disturbance					
Vacant stare					
Vomiting					

Modified from: "Summary and agreement statement of the 2nd international conference on concussion in sport, Prague 2004," by P. McCrory, K. Johnston, W. Meeuwisse, M. Aubry, R. Cantu, J. Dvorak, T. Graf-Baumann, J. Kelly, M. Lovell, and P. Schamasch, 2005, British Journal of Sports Medicine, 39, p. i81-82.

APPENDIX G:

CONCUSSION SYMPTOM SCALE

	NONE		MODERATE			SEVERE	
Headache	0	1	2	3	4	5	6
Nausea	0	1	2	3	4	5	6
Vomiting	0	1	2	3	4	5	6
Drowsiness	0	1	2	3	4	5	6
Numbness or tingling	0	1	2	3	4	5	6
Dizziness	0	1	2	3	4	5	6
Balance problems	0	1	2	3	4	5	6
Unusual sleeping patterns	0	1	2	3	4	5	6
Sensitivity to light	0	1	2	3	4	5	6
Sensitivity to noise	0	1	2	3	4	5	6
Feeling in a fog	0	1	2	3	4	5	6
Difficulty concentrating	0	1	2	3	4	5	6
Difficulty remembering	0	1	2	3	4	5	6
Trouble sleeping	0	1	2	3	4	5	6
Unusual emotions	0	1	2	3	4	5	6
Irritability	0	1	2	3	4	5	6
Sadness	0	1	2	3	4	5	6
Nervousness	0	1	2	3	4	5	6
Other	0	1	2	3	4	5	6

Modified from: “Examination of orthopedic and athletic injuries,” by C. Starkey, S. Brown, and J. Ryan, 2010, F.A. Davis Company, Philadelphia, PA, p. 890.

APPENDIX H:

STANDARDIZED ASSESSMENT OF CONCUSSION

Name: ______________________________
Team:___________ Examiner:________
Date of Exam:_____ Time:___________
Exam: Bline Injury Post-Game
Follow up day:_______________

INTRODUCTION:
I am going to ask you some questions. Please listen carefully and give your best effort.

ORIENTATION:

What month is it?	0	1
What's the date today?	0	1
What's the day of the week?	0	1
What year is it?	0	1
What time is it? (w/in 1 hr)	0	1

1 pt for each correct answer

Orientation score ________

IMMEDIATE MEMORY:
I am going to test your memory. I will read you a list of words and when I am done, repeat back as many words as you can remember, in any order. I will do this three times.

List	Trial 1		Trial 2		Trial 3	
Tiger	0	1	0	1	0	1
Orange	0	1	0	1	0	1
Puddle	0	1	0	1	0	1
Truck	0	1	0	1	0	1
Baseball	0	1	0	1	0	1
Total	____		____		____	

1 pt for each correct response

Immediate memory score _________

EXERTIONAL MANEUVERS:
If subject is not displaying or reporting symptoms, conduct the following maneuvers to create conditions under which symptoms are likely to be elicited and detected. Do not conduct these maneuvers if symptomatic. If not conducted, allow two minutes to keep time delay constant before testing delayed recall. These methods should be administered for baseline testing of normal subjects.

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

NEUROLOGIC SCREENING

Loss of consciousness Y N
Length:
Post-Traumatic Amnesia Y N
Length:
Retrograde Amnesia Y N
Length:

Strength
Right Upper Extremity
Normal ☐ Abnormal ☐
Left Upper Extremity
Normal ☐ Abnormal ☐
Right Lower Extremity
Normal ☐ Abnormal ☐
Left Lower Extremity
Normal ☐ Abnormal ☐
Sensation: Finger to nose/Romberg
Normal ☐ Abnormal ☐
Coordination: Tandem walk/finger to nose
Normal ☐ Abnormal ☐

CONCENTRATION
Digits backward: I am going to read a string of numbers and when I am done, you repeat them back to me backwards, in reverse order of how I read them to you. For example, if I say 7-1-9, you would say 9,1,7. If correct go to the next string length. If incorrect, read trial 2. 1 pt possible for each string length. 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: Now tell me the months in reverse order. Start with the last month and go backward. 1 pt if the entire sequence is correct.
Dec-Nov-Oct-Sept-Aug-Jul-Jun-May-Apr-Mar-Feb-Jan
0 1

Concentration total score ________

DELAYED RECALL:
Do you remember the list of words I read a few times earlier? Tell me as many words from the list as you can remember in any order. Circle each word correctly recalled. Total score equals number of words recalled.

Tiger Orange Puddle Truck Baseball

Delayed recall score ________

SAC SCORING SUMMARY
Exertional maneuvers & neurologic screening are important for examination, but not incorporated into SAC total score.

Orientation	**/5**
Immediate Memory	**/15**
Concentration	**/5**
Delayed recall	**/5**
SAC TOTAL SCORE	**/30**

Modified from: "Examination of orthopedic and athletic injuries," by C. Starkey, S. Brown, and J. Ryan, 2010, F.A. Davis Company, Philadelphia, PA, p. 891.

APPENDIX I:

CONVENTIONAL NEUROPSYCHOLOGICAL TESTS

Neuropsychological Test	Cognitive Domain
Controlled oral word association test	Verbal fluency
Hopkins verbal learning test	verbal learning, immediate and delayed memory
Trail making: Parts A and B	Visual scanning, attention, information processing speed, psychomotor speed
Wechsler letter number sequencing test	Verbal working memory
Wechsler digit span: Digits forward and digits backward	Attention, Concentration
Wechsler digit symbol test	Psychomotor speed, attention, concentration
Symbol digit modalities test	Psychomotor speed, attention, concentration
Paced auditory serial addition test	Attention, concentration
Stroop color word test	Attention, information processing speed

Modified from: "Examination of orthopedic and athletic injuries," by C. Starkey, S. Brown, and J. Ryan, 2010, F.A. Davis Company, Philadelphia, PA, p. 880.

APPENDIX J:

COMPUTERIZED NEUROPSYCHOLOGICAL TESTS

Neuropsychological test	Developer	Cognitive Domains
Automated Neuropsychological Assessment Metrics (ANAM)	National Rehabilitation Assistive Technology and Neuroscience Center, Washington, D.C.	Simple reaction metrics Sternberg memory Math processing Continuous performance Matching to sample Spatial processing Code Substitution
CogSport	CogState Ltd, Victoria, N.Y.	Simple reaction time Complex reaction time One-back Continuous learning
Concussion Resolution Index	HeadMinder Inc, New York, N.Y.	Reaction time Cued reaction time Visual recognition 1 Visual recognition 2 Animal decoding Symbol Scanning
Immediate Postconcussion Assessment and cognitive Testing (ImPACT	University of Pittsburgh Medical center Pittsburgh, P.A.	Verbal memory Visual memory Information processing speed Reaction time Impulse control

Modified from: " National athletic trainers' association position statement: management of sport-related concussion," by K. Guskiewicz, S. Bruce, R. Cantu, M. Ferrara, J. Kelly, M. McCrea, M. Putukian, and T. Valovich McLeod, 2004, Journal of Athletic Training, 39, p. 289.

APPENDIX K:

PROPERTIES OF NEUROPSYCHOLOGICAL TESTS

	Conventional Tests	Computerized Tests
Psychometric Considerations		
Alternative Forms	None-few	Many-infinite
Stimulus randomization test/subjects	Within test only	Within test, between
Test-retest reliability measures	Wide range	Generally high for RT
Normative data	Mainly cross-sectional	Very little for most tests
Practice Effects	Large for most tests because of lack alternative forms	Small because of many of alternative forms and randomization of forms
Output	Level of performance	Level of performance and Variability in performance
Practical Considerations		
Administration time	1 minute - 4 hours	1 minute – 2 hours
Support required	Neuropsychologist or trained technician For administration, scoring, interpretation	Some tests may be self administered and scored
Accessibility	Poor. Requires trained personnel	High. May be internet delivered
Data storage and analysis	Time consuming and costly	Automated

Modified from: " National athletic trainers' association position statement: management of sport-related concussion," by K. Guskiewicz, S. Bruce, R. Cantu, M. Ferrara, J. Kelly, M. McCrea, M. Putukian, and T. Valovich McLeod, 2004, Journal of Athletic Training, 39, p. 291.

APPENDIX L: AMERICAN GOLD GYMNASTICS CONSENT LETTER

AMERICAN GOLD
GYMNASTICS, INC.
2001 17th Avenue South
Fargo, North Dakota 58103
(701) 280-0400 Fax (701) 280-2691
www.americangoldgymnastics.com
Home of F-M Acro & Competitive Teams

"TO ENCOURAGE AND TEACH CHILDREN TO BELIEVE IN THEMSELVES THROUGH QUALITY GYMNASTICS INSTRUCTION"

January 31, 2011

From: Kathy Klug
Executive Director
American Gold Gymnastics

To: Whom it may concern,

Please note that as Executive Director of American Gold Gymnastics, I am officially giving Marissa Lindback permission to survey the parents of our youth sport athletes for her Master's Thesis titled "Concussion Awareness & Recognition; Youth Sport Parents' Perceptions."

I understand that the accompanying survey will be administered anonymously and on a volunteer basis only. The identities of the participants will not be revealed and individual responses will be kept confidential. Group comparisons however, may be reported in summary form.

I also understand that if I have any questions about this project, I have been encouraged to call Marissa Lindback at 612.845.9346 or her advisor, Dr. Jay Albrecht at 701.231.6738. The following email addresses have also been given to me as a way to inquire about the project; marissa.lindback@ndsu.edu or Jay.albrecht@ndsu.edu. If I have questions about the rights of human participants in research, or to report a problem, I should contact the North Dakota State University Institutional Review board (NDSU IRB) Office at 701.231.8908.

It is also my understanding that this study and accompanying survey will be conducted only after approval has been granted by the NDSU IRB. Additionally, I have been informed that the results of this study will be made available to American Gold Gymnastics upon request.

Sincerely,
Kathy Klug
Executive Director
American Gold Gymnastics
2001 17th Ave. S., Fargo, ND 58103
Ph: 701-280-0400
aggkathy@aol.com

APPENDIX M:

TNT KID'S FITNESS AND GYMNASTICS CONSENT LETTER

TNT Kid's Fitness and Gymnastics Academy

2800 Main Avenue • Fargo ND 58103
www.tntkidsfitness.com
701-365-8868

To: Marissa Lindback

From: Whitney Beck
Competitive Director/Head Coach
TNT Kid's Fitness & Gymnastics Academy

CC: Kim Pladson
Executive Director
TNT Kid's Fitness & Gymnastics Academy

Date: 2/22/2011

Re: Survey

To whom it may concern:

As competitive director at TNT Kid's Fitness & Gymnastics Academy, I consent to running a survey regarding concussions using our athletes (and families) as subjects The survey to be conducted by NDSU student Marissa Lindback as part of her thesis.

Whitney Beck
Competitive Director/Head Coach
TNT Kid's Fitness & Gymnastics Academy

APPENDIX N:

IRB APPROVAL

NDSU NORTH DAKOTA STATE UNIVERSITY

Institutional Review Board
Office of the Vice President for Research, Creative Activities and Technology Transfer
NDSU Dept. 4000
1735 NDSU Research Park Drive
Research 1, P.O. Box 6050
Fargo, ND 58108-6050

701.231.8995
Fax 701.231.8098

Federalwide Assurance #FWA00002439
Expires April 24, 2011

Tuesday, March 15, 2011

Dr. Jay Albrecht
Health, Nutrition & Exercise Sciences
BBFH 6B

Re: IRB Certification of Human Research Project:

"Concussion Awareness & Recognition: Youth Sport Parents' Perceptions"
Protocol **#HE11219**

Co-investigator(s) and research team: **Marissa Lindback**

Study site(s): **TNT Kids Fitness and American Gold Gymnastics** Funding: **n/a**

It has been determined that this human subjects research project qualifies for exempt status (category # 2) in accordance with federal regulations (Code of Federal Regulations, Title 45, Part 46, *Protection of Human Subjects*). This determination is based on the protocol form received 3/9/2011 and consent/recruitment notices received 3/14/2011.

Please also note the following:

- This determination of exemption expires 3 years from this date. If you wish to continue the research after 3/14/2014, the IRB must re-certify the protocol prior to this date.
- The project must be conducted as described in the approved protocol. If you wish to make changes, pre-approval is to be obtained from the IRB, unless the changes are necessary to eliminate an apparent immediate hazard to subjects. A *Protocol Amendment Request Form* is available on the IRB website.
- Prompt, written notification must be made to the IRB of any adverse events, complaints, or unanticipated problems involving risks to subjects or others related to this project.
- Any significant new findings that may affect the risks and benefits to participation will be reported in writing to the participants and the IRB.
- Research records may be subject to a random or directed audit at any time to verify compliance with IRB policies.

Thank you for complying with NDSU IRB procedures; best wishes for success with your project.

Sincerely,

Kristy Shirley

Kristy Shirley, CIP, Research Compliance Administrator

APPENDIX O:

QUESTIONNAIRE

SECTION I
Confidence Level

Thinking about the following statements, please complete each statement by clicking the circle to the left of the answer that best describes your current knowledge regarding concussions:

I feel confident that my current level of knowledge regarding HOW CONCUSSIONS OCCUR can best be described as:

- o Very confident
- o Confident
- o Not very confident
- o Not confident at all

I feel confident that my current level of knowledge regarding SYMPTOMS OF A CONCUSSION injury can best be described as:

- o Very confident
- o Confident
- o Not very confident
- o Not confident at all

I feel confident that my current level of knowledge of HOW TO CARE FOR AN ADOLESCENT/CHILD WHO HAS SUFFERED A CONCUSSION can best be described as:

- o Very confident
- o Confident
- o Not very confident
- o Not confident at all

SECTION I
Concussion Etiology

1. A concussion can be caused by a direct hit to the trunk (torso) of the body.
   - o Agree
   - o Disagree
   - o I don't know

2. A concussion can be caused by a direct hit to the head.
   - o Agree
   - o Disagree
   - o I don't know

3. A concussion can be caused by a whiplash motion.
   - Agree
   - Disagree
   - I don't know

4. Recovery time (return to preinjury status) from a concussive injury is generally the same for an adolescent aged child and an adult.
   - Agree
   - Disagree
   - I don't know

5. The adolescent athlete is at a greater risk of concussion injury following a previous concussion.
   - Agree
   - Disagree
   - I don't know

6. A concussion can only be diagnosed by an x-ray image from a doctor's office.
   - Agree
   - Disagree
   - I don't know

7. Concussions cause the brain to require more energy so that it can function normally.
   - Agree
   - Disagree
   - I don't know

8. A concussion can only be diagnosed if the athlete blacks out (i.e., loss of consciousness).
   - Agree
   - Disagree
   - I don't know

SECTION I
Concussion management

9. Following a concussion, symptoms can last anywhere from minutes to months.
   - Agree
   - Disagree
   - I don't know

10. Fatigue lasting longer than 7-10 days, following a mild concussion, is generally not a symptom to be concerned about when considering return-to-play decisions.
   - Agree
   - Disagree
   - I don't know

11. Athletes can return to play immediately after concussion symptoms subside.
    - Agree
    - Disagree
    - I don't know

12. Return-to-play decisions following a diagnosed concussion must be made by a medical doctor only.
    - Agree
    - Disagree
    - I don't know

13. Administering over-the-counter medications to relieve symptoms of a concussion is acceptable given that it's done within the first 24-72 hours from the onset of the concussion.
    - Agree
    - Disagree
    - I don't know

SECTION II

For each of the noted symptoms of a concussion, please indicate your level of agreement by clicking below the YES column, or by clicking below the NO column, or by clicking under the I DON'T KNOW column.
Additionally, in the second list of symptoms, please click below the adjacent circles to indicate your "level of concern" with respect to each of the potential concussion symptoms below

Would you consider any of the following for symptoms of a concussion?

Loss of consciousness	Yes	No	I don't know
Loss of hearing	Yes	No	I don't know
Memory loss	Yes	No	I don't know
Neck pain	Yes	No	I don't know
Loss of balance	Yes	No	I don't know
Excessive thirst	Yes	No	I don't know
Abrupt emotional change	Yes	No	I don't know
Sinus congestion	Yes	No	I don't know
Fatigue	Yes	No	I don't know
Excessive salivation	Yes	No	I don't know
Headache	Yes	No	I don't know
Inability to swallow	Yes	No	I don't know
Abnormal vision	Yes	No	I don't know
Nosebleed	Yes	No	I don't know
Nausea	Yes	No	I don't know

Abnormal sense of smell	Yes	No	I don't know

If your child was experiencing any of the following symptoms, what would your level of concern be in regards to each individual symptom?

Loss of consciousness	None	Little	Somewhat	Very	Extremely
Loss of hearing	None	Little	Somewhat	Very	Extremely
Memory loss	None	Little	Somewhat	Very	Extremely
Neck pain	None	Little	Somewhat	Very	Extremely
Loss of balance	None	Little	Somewhat	Very	Extremely
Excessive thirst	None	Little	Somewhat	Very	Extremely
Abrupt emotional change	None	Little	Somewhat	Very	Extremely
Sinus congestion	None	Little	Somewhat	Very	Extremely
Fatigue	None	Little	Somewhat	Very	Extremely
Excessive salivation	None	Little	Somewhat	Very	Extremely
Headache	None	Little	Somewhat	Very	Extremely
Inability to swallow	None	Little	Somewhat	Very	Extremely
Abnormal vision	None	Little	Somewhat	Very	Extremely
Nosebleed	None	Little	Somewhat	Very	Extremely
Nausea	None	Little	Somewhat	Very	Extremely
Abnormal sense of smell	None	Little	Somewhat	Very	Extremely

SECTION III
Demographic Information

Please complete the following demographic information, clicking all that apply for each question or statement unless
otherwise directed:

1. Your gender:
   - o Male
   - o Female

2. Are you (or your spouse) employed in a profession that you would consider as a "healthcare" profession?
   - o Yes
   - o No

3. Have you even been diagnosed with a concussion by a licensed healthcare professional?
   - o Yes
   - o No

4. Has your child (or any of your children) ever been diagnosed with a concussion by a licensed healthcare professional?
   - o Yes

- o No

5. How many children do you currently have participating in a gymnastics program at American Gold Gymnastics?
(Please indicate with a number)

____

6. Please indicate the age of your oldest child currently participating in the gymnastics program at American Gold Gymnastics.
(Please indicate with a number)

____

7. The child (noted above) currently participates (as an athlete) in which of the following type(s) of gymnastics program?
(Please check all that apply)
   - o Competitive
   - o Acrobatic
   - o Recreational

8. Do you have other younger children participating in a gymnastics program at American Gold Gymnastics?
If not, please skip to question number 13.
If so, please provide information (below) for each of your other younger children who also participate in the gymnastics program at American Gold Gymnastics.

9. What is the age of your next (younger) child participating in a gymnastics program at American Gold Gymnastics?
(Please indicate with a number)

____

10. The child (noted above) currently participates (as an athlete) in which of the following type(s) of gymnastics programs?
(Please check all that apply)
   - o Competitive
   - o Acrobatic
   - o Recreational

11. What is the age of your next (younger) child participating in gymnastics program(s) at American Gold Gymnastics?
(Please indicate with a number)

____

12. The child (noted above) currently participates (as an athlete) in which of the following type(s) of gymnastics programs?
(Please check all that apply)
   - o Competitive

- o Acrobatic
- o Recreational

13. Does your child(ren) participate in any other sports?
    - o Yes
    - o No

If you answered "no" please skip to question number 15.
14. If you answered "yes" to the previous question, please list all other sports that your child/children currently play, or have played earlier during their childhood:

____

15. Have you ever had any type of medical training (in general)?
If you answered "no" please skip to question 17.
- o Yes
- o No

16. If you answered "yes" to the previous question, please list the type of medical training you currently have, or have had at some point in the past:

____

Thank you for completing the survey!

17. By entering your email address in the informational box below, we'll be able to notify you if you were one of the first ten participants to complete this survey, winning a $10 Target gift certificate. Again, as noted in the invitational email, all information will be kept confidential with regard to any information that might identify you personally as a participant in this study. All information collected for incentive purposes will be deleted or destroyed immediately at the conclusion of the study.

____

APPENDIX P:

INFORMED CONSENT

North Dakota State University
Department of Health, Nutrition, and Exercise Sciences
BBFH Rm 1 / Box 6050
Fargo, ND 58108-6050

Greetings! My name is Marissa Lindback. I am a graduate student at North Dakota State University (NDSU) in Fargo, ND. A major emphasis of the program is to develop a cumulative project that includes a topic of interest not only for myself, but also for the general public. The research project that I am investigating is titled "Concussion Awareness & Recognition; Youth Sport Parents' Perceptions."

The purpose of this study is to understand better what parents of youth sport athletes currently know about the recognition, assessment, and management of concussion. A primary goal of this research project is to create an awareness of concussion in parents of youth sport athletes and, as a result, create further opportunities for parents of youth sport athletes to obtain concussion education in a more formal setting, from a trained instructor.

You are invited to participate in this study by completing the following questionnaire- a process that will take approximately 10 minutes to complete. You efforts to complete the survey are greatly appreciated. Also note that your participation in this study is completely voluntary, and that you may withdraw from participating at any time. By completing the following survey, it is understood that you are giving your informed consent to participate in the study. The survey will be administered keeping individual responses confidential, however, group comparisons may be reported in summary form.

If you have any questions regarding this study, please call me at 612-845-9346, or call my advisor, Dr. Jay Albrecht at 701-231-6738. For questions about rights of research participants, or complaints about this research, please contact the NDSU Institutional Review Board (IRB) office at 701-231-8908 or email your questions to ndsu.irb@ndsu.edu.

In advance, thank you for your participation in this research. If you wish to receive a copy of results of this study or a key of the correct answers, please send your request via email to marissa.lindback@my.ndsu.edu or call me at 612-845-9346.

- o I wish to participate in this study.

APPENDIX Q:

INITIAL INVITATION EMAIL

North Dakota State University
Department of Health, Nutrition, and Exercise Sciences
BBFH Rm 1 / Box 6050
Fargo, ND 58108-6050

Dear Youth Sport Parent,
What do you know about recognizing, assessing, and managing concussion in a member of an organized youth sport? The following questions may help us to answer this particular question.

Greetings! My name is Marissa Lindback. I am a graduate student at North Dakota State University (NDSU) in Fargo, ND. A major emphasis of the program is to develop a cumulative project that includes a topic of interest not only for myself, but also for the general public. The title of the research project that I am proposing is "Concussion Awareness & Recognition; Youth Sport Parents' Perceptions."

The purpose of this study is to understand better what parents of youth sport athletes currently know about the recognition, assessment, and management of concussion. The goal of this research project is to create an awareness of concussion in parents of youth sport athletes and, as a result, create further opportunities for parents of youth sport athletes to attend concussion education in a formal setting, from a trained instructor.

You are invited to participate in this study by completing the following questionnaire- a process that will take approximately 10 minutes to complete. The first ten participants to return a completed survey will be given a $10 Target gift card. Your efforts to complete the survey are greatly appreciated. Also note that your participation in this study is completely voluntary, and that you may withdraw from participating at any time. By completing the following survey, it is understood that you are giving your informed consent to participate in the study. The information gathered will be protected; keeping individual responses confidential. However, group comparisons may be reported in summary form.

Simply place the cursor over the "http//www...address (the uniform resource locator [URL] address) noted below, hold down the "ctrl" key (located on the lower, left hand side of the keyboard), and click to begin the survey:

If you have any questions regarding this study, please call me at 612-845-9346, or call my advisor, Dr. Jay Albrecht at 701-231-6738. For questions about rights of research participants, or complaints about this research, please contact the NDSU Institutional Review Board (IRB) office at 701-231-8908 or email your questions to ndsu.irb@ndsu.edu.

In advance, thank you for your participation in this research. If you wish to receive a copy of results of this study or a key of the correct answers, please send your request via email to marissa.lindback@my.ndsu.edu or call me at 612-845-9346.

APPENDIX R:

SECOND REMINDER EMAIL

Please disregard this invitation if you have already participated in the survey.

North Dakota State University
Department of Health, Nutrition, and Exercise Sciences
BBFH Rm 1 / Box 6050
Fargo, ND 58108-6050

Dear Youth Sport Parent,
What do you know about recognizing, assessing, and managing concussion in a member of an organized youth sport? The following questions may help us to answer this particular question.

Greetings! My name is Marissa Lindback. I am a graduate student at North Dakota State University (NDSU) in Fargo, ND. A major emphasis of the program is to develop a cumulative project that includes a topic of interest not only for myself, but also for the general public. The title of the research project that I am proposing is “Concussion Awareness & Recognition; Youth Sport Parents’ Perceptions.”

The purpose of this study is to understand better what parents of youth sport athletes currently know about the recognition, assessment, and management of concussion. The goal of this research project is to create an awareness of concussion in parents of youth sport athletes and, as a result, create further opportunities for parents of youth sport athletes to attend concussion education in a formal setting, from a trained instructor.

You are invited to participate in this study by completing the following questionnaire- a process that will take approximately 10 minutes to complete. The first five participants to return a completed survey will be given a $10 Target gift card. Your efforts to complete the survey are greatly appreciated. Also note that your participation in this study is completely voluntary, and that you may withdraw from participating at any time. By completing the following survey, it is understood that you are giving your informed consent to participate in the study. The information gathered will be protected; keeping individual responses confidential. However, group comparisons may be reported in summary form.

Simply place the cursor over the “http//www…address (the uniform resource locator [URL] address) noted below, hold down the “ctrl” key (located on the lower, left hand side of the keyboard), and click to begin the survey:

If you have any questions regarding this study, please call me at 612-845-9346, or call my advisor, Dr. Jay Albrecht at 701-231-6738. For questions about rights of research participants, or complaints about this research, please contact the NDSU Institutional Review Board (IRB) office at 701-231-8908 or email your questions to ndsu.irb@ndsu.edu.

In advance, thank you for your participation in this research. If you wish to receive a copy of results of this study or a key of the correct answers, please send your request via email to marissa.lindback@my.ndsu.edu or call me at 612-845-9346.

APPENDIX S:

SUCCESSIVE REMINDER EMAILS

Please disregard this invitation if you have already participated in the survey.

North Dakota State University
Department of Health, Nutrition, and Exercise Sciences
BBFH Rm 1 / Box 6050
Fargo, ND 58108-6050

Dear Youth Sport Parent,
What do you know about recognizing, assessing, and managing concussion in a member of an organized youth sport? The following questions may help us to answer this particular question.

Greetings! My name is Marissa Lindback. I am a graduate student at North Dakota State University (NDSU) in Fargo, ND. A major emphasis of the program is to develop a cumulative project that includes a topic of interest not only for myself, but also for the general public. The title of the research project that I am proposing is "Concussion Awareness & Recognition; Youth Sport Parents' Perceptions."

The purpose of this study is to understand better what parents of youth sport athletes currently know about the recognition, assessment, and management of concussion. The goal of this research project is to create an awareness of concussion in parents of youth sport athletes and, as a result, create further opportunities for parents of youth sport athletes to attend concussion education in a formal setting, from a trained instructor.

You are invited to participate in this study by completing the following questionnaire- a process that will take approximately 10 minutes to complete. Your efforts to complete the survey are greatly appreciated. Also note that your participation in this study is completely voluntary, and that you may withdraw from participating at any time. By completing the following survey, it is understood that you are giving your informed consent to participate in the study. The information gathered will be protected; keeping individual responses confidential. However, group comparisons may be reported in summary form.

Simply place the cursor over the "http//www...address (the uniform resource locator [URL] address) noted below, hold down the "ctrl" key (located on the lower, left hand side of the keyboard), and click to begin the survey:

If you have any questions regarding this study, please call me at 612-845-9346, or call my advisor, Dr. Jay Albrecht at 701-231-6738. For questions about rights of research participants, or complaints about this research, please contact the NDSU Institutional Review Board (IRB) office at 701-231-8908 or email your questions to ndsu.irb@ndsu.edu.

In advance, thank you for your participation in this research. If you wish to receive a copy of results of this study or a key of the correct answers, please send your request via email to marissa.lindback@my.ndsu.edu or call me at 612-845-9346.