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SPORT RELATED CONCUSSION KNOWLEDGE IN YOUTH FEMALE SOCCER
PLAYERS AND THEIR PARENTS IN MISSOULA.

By

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Thesis

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Sports Related Concussion Knowledge in Youth Female Soccer Players and Their Parents In Missoula.

Chairperson: Valerie Moody

The number of female athletes participating in youth soccer is steadily increasing as is the number of sports related concussions (SRC) diagnosed per year.¹ However many SRCs are still left undiagnosed, or purposely not reported. The literature shows youth athletes have an insatiable desire to win and be accepted by coaches and teammates alike.² This passion is what ultimately lead to Washington state passing of the first piece of legislation outlining the provisions and care of concussed athletes at school sanctioned events.³ Research indicates that educational outreach and legislation by themselves show minimal positive impact towards SRC recognition and athlete safety.⁴ However, in combination these two processes are already preventing brain injuries, and changing society's archaic view towards SRC as a legitimate injury.⁴ This study used a descriptive survey to examine SRC knowledge level of female youth soccer athletes and their parents. Results in combination with results from youth football and hockey were used to construct SRC educational outreach materials. We hypothesized that athletes as well as their parents would demonstrate poor knowledge levels in regards to concussive symptoms, and most would report not having any formal SRC education.

Acknowledgment

“For everyone who stuck beside me and helped me to complete this journey, especially my beautiful wife Vanika, and two girls Boo-Boo, and Bugzy. I couldn’t have done it without you!”

“A special thanks to my mommy, the sacrifice you made to safely get me to adulthood and beyond will never be forgotten I owe you more love than could be repaid in a million lifetimes.”

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Chapter 1

Introduction

Statement of the Problem:

Historical data reports that approximately 1.6 to 3.8 million sports related SRCs (SRC) occur each year.⁵ The sports that caused the highest SRC rates were football, wrestling, and soccer.^{5,6} The overall incidence rate per 1000 athlete exposures for football was 4.36, wrestling was 2.5, and boys and girls soccer were 2.43 and 2.36 respectively.⁶ Other studies indicated that girls are approximately two-times more likely to sustain a SRC than boys; and girls' soccer is the second largest producer of SRC among the sports studied.⁵

Cultural explanations play a large role in the description of these observed gender differences. Traditionally society is much more protective of females than males.⁷ This likely subconsciously lead coaches, parents and athletic trainers (AT) to treat females more conservatively than males.⁸ Other explanations for females increased risk included biomechanical factors such as head size and neck strength.^{7,9,10}

The lack of parental SRC knowledge is concerning due to youth athletes' vulnerability. Younger athletes have an immature nervous system, decreased myelination, thinner frontal and temporal bones, a larger head body ratio, and weaker neck musculature placing them at greater risk.¹¹ Literature suggests that consequences of SRC are magnified in youth due to brain development and the constant acquisition of knowledge.¹² A child's brain continuously develops in areas such as concentration,

memory, reasoning, and problem solving,¹³ whereas adult brains have reached its full development.¹² An increase in research of mature brains has helped clinicians tremendously now that knowledge must be used to prevent and protect our younger athletes.¹¹

Literature indicates 2% to 6.5% of all injuries sustained at the youth level involved SRC.¹⁴ Also suggested is that athlete's struggle to self-report symptoms of SRC.^{2,15} Indicating that motivation to win and gain acceptance were likely to influence young athletes decision to report symptoms.² Poor judgements like this led to Washington State enacting the first piece of legislation outlining the care of children with SRC.³ By January 2014 all states and Washington, DC had passed similar legislation.^{3,16}

Theoretical Framework

Young athletes possess an incredible amount of motivation to win, desire to advance within their sport, and to gain acceptance from their teammates. Sometimes these qualities outweigh their decision to play safe and report potential SRC.^{14,17} Because of this, added pressure is placed on athletic trainers and parents to take the appropriate steps seeking medical attention, and engineering a culture of healthy behavior regarding SRC.¹⁸ Society must de-glorify the notion of playing through the pain or symptom and start promoting the appropriate recovery periods regarding SRC. Young athletes emulate the behavior of their sports idol; a basic principle described by social learning theory.^{18,19} As a whole we must pressure the media to stop praising risky behavior such as playing while injured, and hold professional athletes accountable for the lesson they teach every time they play injured.

These types of learned behaviors and expectations send children the wrong message that it is more important to play through an injury than resting. Health professionals and athletes involved in sport have a social duty to encourage a safe and rewarding attitude towards player health. Gielen et al.²⁰ identified and concluded that to create successful behavior change both active and passive portions of behavior must be addressed.²⁰ The current study aimed to capture the knowledge level regarding SRC, and provide an avenue with which to start the actions necessary to achieve cultural change.²⁰

Purpose of Study

Research about SRC demonstrated that outside of the medical community, misconceptions are evident,¹⁸ indicating a serious problem with the identification and treatment of SRCs. Multiple studies reported a lack of parental and athlete knowledge that could lead to catastrophic repercussions if not addressed.^{11,18,21-23}

The purpose of this study was to determine the amount of knowledge that youth female soccer players and their parents in Missoula, MT possessed regarding SRC, and determine if they had been educated, formally or informally, about SRC. We hypothesized that both athletes and parents would exhibit poor knowledge of and little education about SRC. The data was then used to help in development of a local educational outreach program. In order to change our culture regarding SRC, young athletes and parents must be extensively educated.²⁴

Quantitative Research Question(s)

1. Were youth female soccer players able to correctly identify signs and symptoms of a SRC?
2. Were youth female soccer players able to recognize the dangers of playing with a SRC?
3. Had female youth soccer players received any, formal or informal, education regarding SRCs?
4. Were parents of youth female soccer players able to correctly identify signs and symptoms of a SRC?
5. Were parents of youth female soccer player's able to recognize the dangers of their child playing with a SRC?
6. Had parents of youth female soccer players received any, formal or informal, education regarding SRCs?

Quantitative Hypothesis

1. We hypothesized that female youth soccer players could not correctly identify signs and symptoms of a SRC.
2. We hypothesized that female youth soccer players could not recognize the dangers of playing with a SRC.
3. We hypothesized that youth female soccer players have not received formal or informal training regarding SRCs.
4. We hypothesized that parents of female youth soccer players could not correctly identify signs and symptoms of a SRC.

5. We hypothesized that parents of female youth soccer players could not recognize the dangers of playing with a SRC.
6. We hypothesized that parents of youth female soccer players have not received formal or informal training regarding SRCs.

Significance of the Study

The significance of this study was to determine the level of SRC knowledge among female youth soccer players and their parents. Many SRC still go unreported, untreated, and mismanaged.²⁵ Most likely a combination of biomechanical and physiologic differences, research concluded youth athletes were more vulnerable than adults to SRC.^{18,21,25,26} Literature also indicated that youth athletes experience more serious symptoms and longer recovery.^{22,27-29} It was clear that recent prevention and education efforts are having a positive impact, however, it is not enough.²⁵ Parents of young athletes play a keynote role in the identification and management of SRC. Often times however, they were unaware of short and long term consequences, and struggled to comprehend new SRC management techniques.^{22,25,30}

At the time today's parents played sports, it was believed and taught that mild head injuries were not in need of medical evaluation, or necessitate rest from sport or academics.^{25,31} Multiple studies discounted this notion, but gaps in basic translational research exploring parental knowledge regarding SRC and their ability to explain the injury and importance of reporting symptoms to their young athlete exists. Furthermore evidence in literature concluded parental lack of knowledge has actually prevented the implementation of educational programs.^{25,32}

Definition of Terms

1. Sport-related SRC (SRC) – Classified as a sub-type of mild traumatic brain injury, occurs from an external force or blow to the head or body that causes an alteration in neurologic functioning, with impairment in concentration, working memory and executive functioning.³³
2. Youth athlete – Athlete aged 10-13 years.
3. Traumatic brain injury (TBI) -Brain dysfunction caused by an outside force, usually a violent blow to the head.³⁴
4. Mild Traumatic brain injury (mTBI) - Traumatically induced physiological disruption of brain function.³⁴
5. Active strategies – include what is done by athlete (i.e. education, self-reporting etc.).²⁰
6. Passive strategies – include things not controlled by athlete (i.e. safety equipment, rules, etc.).²⁰
7. Adenosine Triphosphate - ATP - a compound consisting of an adenosine molecule bonded to three phosphate groups, present in all living tissue. The breakage of one phosphate linkage (to form *adenosine diphosphate, ADP*) provides energy for physiological processes such as muscular contraction.³⁵
8. Athletic Trainer (AT) – Health care professionals who specialize in preventing, recognizing, managing and rehabilitating injuries.³⁶
9. High-school (HS) – School attended after primary school.³⁶

10. Center for disease control and prevention (CDC) - Federal agency that conducts and supports health promotion, prevention and preparedness activities in the United States with the goal of improving overall public health.³⁷
11. Standardized SRC assessment tool (SCAT) – Standardized method of evaluating athletes for presence of SRC.³⁸
12. King-Devick (KD) – Based on speed of rapid number naming, requires saccadic (fast to target) eye movement.³⁸
13. Standardized assessment of SRC (SAC) A component of SCAT3, brief cognitive battery that captures domains of orientation, immediate memory, concentration, and delayed recall.³⁸

Delimitations

1. Female youth soccer athletes aged 10-13 years in Missoula, MT.
2. Parents' of female soccer athletes aged 10-13 years in Missoula, MT.

Limitations:

Limitations occur within research when influences outside of the researcher's hands affect an experiment. Limitations reflect possible eventualities that the researcher was unable to account for thereby affecting the studies end result.³⁹ Factors that limited the current study included sample size, expected knowledge outcomes, participant attitude, scheduling and self-report limitations.

The population around Missoula is approximately 70,000. Besides the Missoula YMCA, the one other soccer club with prospective participants was the Missoula Strikers which limited overall outcome generalizability. Scheduling also played into the

limitations of the study. Teams practiced at the same times on the same nights in different locations.

Data collection was one of the most sensitive portions of this research study. Due to the nature of the study, using self-report instrumentation, some respondents not all were discouraged because they had questions that jeopardized the instrument integrity that were left unanswered.³⁹ Participants were forced to rely on the survey instructions which were clear and concise, which they realized upon taking the time to read them. Expected knowledge outcome marked another limitation. I did not ask for information about parent's career and therefore could not make inference on which if any parents worked within the medical field. Also some difficulty arose convincing parents and even some coaches that taking time to complete the survey would be beneficial.

Threats to Internal Validity

Subject variability affects the ability of project findings to be generalizable to the population.⁴⁰ Individual variability, expressed the potential for over representation from our sample because of small size we were able to sample. A formula provided by Nulty et al.⁴¹ was used to express adequate sample size of 30 athletes and 29 parents, thus ensuring the projects validation.⁴⁰⁻⁴²

Threats to External Validity

External validity refers to whether the results of the study were able to be generalized from the sample and applied to the larger population. Threats to the external validity included interaction of subject selection and research and research

environment, which encompasses self-reporting, gaining access to subjects and the potential for misunderstandings or misinterpretations.⁴³

Seliger et al.⁴⁰ indicated that a threat to external validity occurs when using paid or incentivized volunteer participants as they may not be representative of the population. We minimized this threat by not disclosing to participants the possibility of the incentive until after the survey was completed and returned.

Next was the effect of the research environment. Subject who were aware of their participation in research studies often change their behavior purposefully or by accident which can distort the results.⁴⁴ In this project, data collection instruments were handed out to participants at practice and filled out immediately, then collected upon completion. This method helped to limit the negative effect created by the research environment. It should be noted however that conducting the study in this manner did have a negative effect on the recruitment of participants. A vast number of parents chose not to participate or allow their athlete to participate due to the timing of practice and other family obligations, or parents just didn't show up because their athlete carpooled with a friend.

Chapter 2

Review of the Related Literature

Overview:

SRC are the result of more fatalities per year than any other sporting injury.³² Also known as mild traumatic brain injury (mTBI), it is estimated that between 1.6 and 3.8 million cases occur in competitive and recreational sport per year.³² mTBI's occur either by a direct blow to the head causing injury to the brain on the same side as the blow, known as a coup injury,³² or on the recoil from movement the opposite side of the brain is damaged, known as a countercoup injury.³² Both cause abrupt movement of the brain, either through acceleration or deceleration.⁴⁵ Leading to linear or rotational forces compressing the dura-mater against itself, increasing the risk for injury and the resultant neurocognitive and neurobehavioral symptoms.⁴⁶

Physiology of a SRC:

Sports related concussions are defined as a complex pathophysiological process affecting the brain.¹² A SRC results in a myriad of physical, cognitive, emotional, and sleep affecting symptoms. Some brain cells are destroyed immediately by direct force from the trauma. Other cells suffer increased risk of trauma secondary to changes in cerebral blood flow, intracranial pressure and apnea secondary to the initial trauma.⁴⁷ The time immediately after the injury, known as the neuro-metabolic cascade is characterized by changes to cellular membrane permeability.⁴⁸ Abnormal ion distribution triggers excessive excitatory neurotransmitter release further complicating cellular metabolism.⁴⁸

The neuro-metabolic cascade begins with ionic flux and hyper-acute indiscriminate glutamate release.⁴⁹ Potassium efflux begins; simultaneously sodium and calcium influx because of mechanoporation of the lipid membrane.⁴⁹ Initial flux coupled with membrane depolarization triggers opening of voltage gated ion channels effectively destroying the ion gradient of the cell.⁵⁰ It is suggested that this may be the biological beginning of post-concussive impairments.^{48,49}

Physiological reactions to the ionic shifts place sodium potassium pumps into overdrive in an attempt to restore homeostasis.⁴⁸ Adenosine triphosphate (ATP) fuels the ionic pumps and burns at a feverish rate, causing hyperglycolysis, a depletion of intracellular energy reserves.⁴⁹ During the initial stages of this cascade reduced cerebral blood flow creates irregularities between energy supply and demand.⁴⁹ Calcium begins to flux early and often times persisted longer than other ions.⁴⁹ The quantity and duration of calcium irregularity is important because the body accommodates the sequestration of calcium into the mitochondria.⁴⁹ This short term solution results in mitochondrial dysfunction, further increasing the lack of oxidative metabolism which worsened the energy crisis.^{49,50}

Increased glycolysis results in increased lactic acid levels and decreases cellular pH,⁵⁰ until pH reaches the point off cellular acidosis, which results in catastrophic cell membrane, and blood-brain barrier damage.⁵⁰ After the initial period of hyper-glycolysis and metabolic uncoupling, the rate of glucose utilization drops drastically, within a 7-10 day period.⁵⁰ Interestingly this time period is also associated with individual's impairment in spatial learning, and ultimately the rescinding of symptoms.⁴⁹

Signs and Symptoms:

Signs and symptoms of SRCs cover a wide range and are extremely difficult to assess.²³ Often the clinical signs produced mirror those of an athlete who is dehydrated or have performed max effort strenuous activities.^{33,51,52} To make an accurate diagnosis an assessment of the entire symptom range to include; clinical symptoms (see Table 1),^{9,22,51,53} physical signs, cognitive impairment, neurobehavioral features, and sleep disturbances.¹

Long-Term Consequences:

The relationship linking SRC with long term cognitive health is currently not clear.⁵¹ Survey studies of former professional athletes suggest the potential for cumulative concussive and sub-concussive impacts increase the risk of long-term cognitive impairment.⁵¹ Repeated cranial impacts increased the risk of pathologies such as depression, persistent headache, persistent dizziness, chronic traumatic encephalopathy, early onset dementia, early onset Alzheimer, and early onset Parkinson.^{1,21,51}

A study of retired professional football players who averaged 6 years as a pro and had a self-reported history of 3 or more SRCs, concluded the athletes were 3 times more likely, and those with 1 or 2 SRCs were 1.5 times more likely to be diagnosed with clinical depression than their peers who reported 0 SRCs.⁵¹ Another study reported on the effects of concussive and sub-concussive forces, concluded a positive association between number of impacts and increased risk for late life cognitive impairment, depression, and chronic traumatic encephalopathy,⁵⁴ a progressive neurodegenerative

disorder resulting in the buildup of tau protein.⁵⁵ Recent literature suggested that damaged tau oligomers are the triggering molecule for the spread of tau pathology in Alzheimer disease.⁴⁹ Furthermore, literature suggests increased risk for late life cognitive impairment based on concussive or sub-concussive impacts is not a function of years played so much as it is of total number of concussions.^{51,54,56} Once an athlete reaches 3 concussions, risk factors for impairment increase at an alarming rate.^{51,54,56}

Despite the subtle changes in brain function following concussive or sub-concussive forces, alternate cerebral pathways were capable of recruitment and goal achievement in young adults without clinical deficits.⁵⁵ However, with age and the continued influence of these forces, alternate cerebral pathways become less effective, resulting in deficiencies to both cognitive and motor function not observed in subjects brains that experienced less trauma.^{50,55}

Broglio et al.⁵⁵ suggested significant changes to balance and gait after SRC indicating they may have a lasting effect on gross motor control.⁵⁵ By applying approximate entropy to center of pressure patterns in the anterior-posterior (AP) and medial-lateral (ML) directions, Broglio recorded a shift in balance strategy by participants with SRC history.⁵⁵ He also noted during gait testing, that those with a history of SRC subconsciously elect to maintain a more conservative and safer gait pattern.⁵⁵

Current research identified a relationship in injury reporting between SRC and lower extremity injuries.⁵⁷ The study of former NFL players concluded that the overall odds of reporting a musculoskeletal injury increased with increasing numbers of reported concussions.⁵⁷ Another study followed European football (soccer) players discovering

that after SRC athletes are at higher risk for suffering a musculoskeletal injury.⁵⁸ Also, the increased risk remained in an elevated state for the following year as well.^{57,58} This data suggested that SRC initiated aberrant alterations in neuromuscular systems increasing the risk of musculoskeletal injury by decreasing capabilities of the neurocognitive and motor system.^{57,58} Data like this supported the ideas that SRC are not transient injuries that heal quickly.⁵⁵

Prevalence:

The Center for Disease Control and Prevention (CDC) estimated approximately 45 million children (5-19 years) participate in sports per year,³³ approximately 1.6 to 3.8 million of these athletes are affected by SRC each year.¹⁶ It is also suggested of athletes sustaining SRC, 5-10% will not develop or recognize symptoms until later making emergency care diagnosis the only option.³³ A less quantifiable number of athletes sustain injury but withhold symptoms or do not present to medical professionals.⁵⁹ Conder et al.³³ reported, in 2013, 8 SRC fatalities occurred nationally, all played football and were high-school students.³³ Such statistics at the high school level raise concern regarding the health and safety of pre-high school student athletes.

When looking at the overall all incidence rate, football ranks first followed closely by girls' soccer.⁵ This mirrors the majority of similar such studies which also indicates girls' soccer having two times the risk rates as compared to that of boys' sports.^{10,33,60,61} Literature suggests one cause could be a difference in mechanism of injury (MOI).^{5,10} The idea is girls' SRCs are associated with playing surface or ball contact, and that boys' SRCs are caused by player to player contact.^{5,10} Suggesting the importance of

differentiation between genders while conducting clinical evaluation for a suspected SRC.⁵

Presentation Differences Male/Female:

Frommer et al.⁷ reported in high-school athletes the symptoms recorded for diagnosed SRC differed between males and females.⁷ His study indicated that males reported amnesia and confusion/disorientation, all cognitive symptoms, at a higher rate than females who reported drowsiness (a neurobehavioral symptom) and sensitivity to noise (a somatic symptom) more than males.⁷ Indicating a difference exists within injury presentation between genders to health-care professionals.⁷

As previously indicated, age, type of sport, and gender account for variance in the diagnosis of SRC.³³ Reports indicate 90% of college athletes returned cognitive functioning to baseline levels within 2 weeks,³³ whereas, 50% of high-school students recover in approximately 7-10 days, with 90% returning to baseline within 4 weeks.³³ Conversely professional athletes recover at a much quicker pace.³³ Literature recommends conservative management of younger athletes, indicating longer removal from play and extended period of asymptomatic rest and restricted physical exertion is needed for youth athlete recovery.^{28,29,33,46,55,62,63}

As stated, females have increased risk for SRC compared to males.^{10,33} Different factors account for higher risk including reduced skull thickness, smaller neck musculature, and hormonal influences.³³ Research also suggests that females are more willing to report and not hide symptoms.⁶² Differences exist amongst presentation of symptoms however; the most basic symptoms were reported by both genders.¹⁶

Approximately 97% of females and 95% of males reported headaches and dizziness and 77% of both genders reported vestibular dysfunction.^{10,16,33}

Diagnosis:

Diagnosis of SRC in youth athletes is difficult because the brain is still maturing, creating two major obstacles.¹² First, vulnerability is increased because neuronal maturation is disturbed as a result of head trauma.¹² Second, unlike adults where cognitive function is relatively stable over time, children's cognitive function is constantly changing and unstable.¹² Therefore any assessment of baseline or post-injury cognitive function has to take into account a normal developmental increase since the last baseline was established.^{12,64} Literature indicates a substantial improvement in cognitive testing occurs between the age of 9 and 15 on tests of simple and choice reaction time, working memory, and new learning.¹²

No specific guidelines exist for diagnosis and management of SRC in children.¹² McCrory et al.¹⁷ found no consensus between doctors regarding importance of clinical symptoms or recommendations for time off school and sport for youth athletes recovering from SRC.¹² Research indicates that individuals comparative baseline and posttests remained the most powerful assessment tool.¹² McCrory et al.¹² suggests baseline assessment during the ages of 8-15, when rapid cognitive maturation is occurring, and retesting to be done every six months.¹² This helps to ensure diagnosis accuracy if and when it is pertinent for athletes to seek medical attention due to the presentation of SRC symptoms.

Healthcare professionals are often not always readily available at youth sporting events. Clinicians in outpatient settings may be evaluating athletes from hours to days after injury, increasing the risk for misdiagnosis and mismanagement.⁶⁴ The current cornerstone to management of SRC in youth is cognitive and physical rest.^{51,64} Concerns about long-term injury to the developing brain merits a more conservative approach than required for adults.⁶⁴ Field et al.⁶⁵ suggested that high-school aged (14-18) children have prolonged cognitive recovery as compared to adults (18-25), but symptom recovery was equivalent between the two groups.⁶⁵ Thus, cognitive testing and symptom rating are differentially sensitive to SRC in minors.⁸

King-Devick, SCAT3, and the Standardized Assessment of Concussion (SAC), are the most dependable tests used for SRC diagnosis. Impact testing is available as well and provides measurable outcomes specific and sensitive to SRC cognitive symptoms, but in the youth setting proves a difficult tool for clinicians to use due to the possibility of athletes tanking baseline testing so as to not register SRC scores post-traumatic event. King-Devick (K-D) is based on the speed of rapid number naming and tests saccadic eye movement, which is the eyes capability to track fast and accurately to target.³⁸ Athletes can complete the entire test within 2 minutes, allowing for a rapid return to play decision. The symptom evaluation of the Sports Concussion Assessment Tool (SCAT) consists of 3 sections, Balance Error Scoring System (BESS), Standardized Assessment of Concussion (SAC) and the Symptom Evaluation.^{38,66} The SAC consists of a cognitive battery including, orientation, Immediate memory, concentration, and delayed recall.³⁸

Dorsolateral prefrontal cortex (DLPFC) is the highest cortical area associated with working memory and motor planning. Galetta et al.⁶⁷ suggested its due to its location the DLPFC is at increased risk of injury.⁶⁷ Research correlated decreased SAC immediate memory test scores and increased K-D response times in the presence of DLPFC injury.⁶⁷ Benedict et al.³⁸ indicated the DLPFC has direct influences on rapid number naming and immediate memory.³⁸ Literature supports the development of age and gender adjusted Symptom Evaluation tests, along with posted normative data scores for BESS, K-D, and SAC.^{38,68}

Management Guidelines:

SRC guidelines recommend baseline cognitive evaluation of athletes yearly, prior to participation in contact sports, and every six months for athletes between the ages of 8-15.^{12,17,51} Cognitive performance remains stable over time for athletes aged 16 and greater when taking the same tests used in SRC diagnosis.^{12,47,64} Heterogeneous comparison of individual baseline and post injury test scores allowed the greatest sensitivity to identification of post-SRC symptom and cognitive dysfunction.^{12,51} Collecting data on symptom presentation specifically related to youth athletes is needed and will be invaluable to the development of SRC management guidelines for the youth athlete population.^{12,47,64}

Expert consensus recommends physical and cognitive rest after a SRC followed by a stepwise return to activity dependent on physiological reactions at each step.⁶⁹ Early mental and physical activity may exacerbate negative outcomes of recovery.⁶⁹ Thomas et al.⁶⁹ challenged the idea concluding the recommendation of rest did not improve

neurocognitive symptoms, or balance outcomes in youth.⁶⁹ In fact the opposite occurred and young athletes prescribed strict rest reported more symptoms during recovery.⁶⁹ This study was a controlled trial of rest strategies in pediatric patients; however was not the first study to test the efficacy of rest after acute SRC. Relander et al.⁷⁰ tested adult patients with bedrest or active therapy concluding that subjects assigned to active therapy were able to return to work on average 14 days earlier, again supporting the need for age differentiation.^{69,70}

Rivera et al.⁶⁴ reported when SRC are managed conservatively, athlete return to baseline physical and cognitive scores within three weeks at a rate of greater than 80%.⁶⁴ In order to do so children must be allowed adequate yet not too much physical and cognitive rest.⁶⁴ Rivera et al.⁶⁴ recommended for best results; increased rest, time off from school, limits to homework, minimal use of visually stimulating electronics, no unnecessary travel, and highly monitored limited exercise.⁶⁴ The best management practices include a multidisciplinary individualized plan that actively involves the student, family, daily medical providers, and relevant school and athletic department staff.⁶⁴

When athletes have recovered from the SRC across all domains a return to play assessment is needed.⁵¹ A graduated return to play protocol is necessary in which athletes are not allowed any medications that may mask the symptoms of SRC.¹ A sample return to play protocol based on the recommendations of the 2012 Zurich Consensus Statement on SRC in Sport is provided, (see Table 2).¹

Dangers associated with premature attempted return to play or continuing to play while SRC symptoms persist necessitates a need for improved understanding of SRC,

by athletes, coaches, and parents. McCrea et al.² reported that more than one third of high school football players failed to report a SRC only because they did not recognize the need to report the symptom.² McAllister-Deitrick et al.¹⁴ indicated a misunderstanding of the signs and symptoms of SRCs.¹⁴ The concern for medical professionals is to prevent catastrophic episodes such as “second impact syndrome,” which often results in a rapid course of neurologic deterioration, typically too swift for higher medical intervention, generally culminating in death or severe disability.⁷¹ Implementation of better educational materials tailored to athletes and parents is suggested to increase overall knowledge and potentially lower casualty rates among contact sports.^{2,14}

Legislation:

Washington State enacted the first comprehensive SRC law in 2009.^{3,16} Their law has since become a model for the rest of the country. Three main principles are embedded within legislation including (1) education of athletes, parents/guardians, and coaches regarding SRC; (2) immediate removal from play in the event of a suspected SRC; and (3) written clearance from a licensed health care professional prior to returning to play.¹⁶ Today, all 50 states have some type of similar legislation regarding SRC.⁴ The effectiveness of each state’s law is dependent upon how the law was written, and who is held accountable for athletes health in the event a SRC was diagnosed.^{4,16}

A study conducted a year after the implementation of Washington State’s SRC law demonstrated that parents of youth soccer players possessed a good general knowledge about SRC and legislation.⁷² However, it also demonstrated parents have no information regarding club level SRC management or return to play criteria.⁷² Mackenzie et al.⁷³

studied the relationship between Rhode Island passing SRC legislation, and athletes use of emergency services throughout the year.⁷³ Findings indicated a 2.2-fold increase in visits to the emergency room during the fall sports season,⁷³ suggesting that coaches, parents and even the athletes were more vigilant in recognition of SRC after the law was passed.⁷³

Despite increasing parental concern and awareness towards SRC, gaps in knowledge, prevention and management of SRC in youth sports remains evident.^{3,72} Combining educational and legislative efforts seemed to increase the message delivery and helped prevent SRC.⁴ Washington State led the way requiring clearance after any SRC sustained on a public field as well as during school-sanctioned sporting events.⁷²

Education:

Adolescent athletes and parents lack of knowledge about SRC is one of the main predictors of a premature return to play after SRC occurs.^{2,21,74,75} Based on social learning theory, young athletes emulate and learn behavior and opinions by watching what is acceptable and tolerated within society.⁷⁵ Cusimano et al.¹⁸ insisted that from the way young players talk, to their style of play and type of gear used, youth athletes represent a scaled-down version of professional athletes.¹⁸ Studies also highlighted the influence of professional athletes on youth athletes frame of reference.⁷⁶ Media and marketing agencies play their part as well. Today it is not uncommon, while watching a game to hear commentators glorify players who played through injuries, while simultaneously they condemn or ridicule those who took the appropriate precautions.¹⁸

Learned social behaviors sends children the message that it is more important to play with an injury than to rest and recover.¹⁸ As stated, research indicates that more than a third of players fail to report their SRC, because they do not recognize the symptoms associated with SRC.² Research exploring athletes' knowledge of concussive symptoms and implications noted more than a quarter of those questioned continued to play while experiencing dizziness directly following an impact sustained to the head.^{14,75} Also, more than 50% of athletes reported no understanding of long-term consequences resulting from SRC mismanagement.^{14,75,77,78} More literature on high school athletes suggests that underreporting of SRCs prevalent and many HS athletes continued to play and practice while symptoms persisted.^{14,79} In general athletes with more knowledge were more likely to report SRC.^{14,79}

Young athletes rely on parents for medical advice, therefore parental understanding of SRC prevention and management is critical.^{25,80} Unsettling results in a number of studies demonstrate deficiencies in parental understanding of SRC.²⁵ One such study involved the parents of youth football players and indicated only 13% were able to identify appropriate statements regarding recommendations and return to play protocols for SRC.¹¹ Other studies demonstrate similar gaps in parental knowledge including, an inability to recognize post-concussive symptoms in their children.^{11,22,23,31}

In 2009, Washington State enacted the first set of laws outlining the medical care of children and adolescents with SRC (the Lystedt Law).⁸¹ Partially ensuring athletes receive education on SRC and understand the importance of self-reporting symptoms which is necessary for proper medical diagnosis and management.⁵¹ Athletes report

struggling to recognize and articulate the complex categories of symptoms associated with SRC.^{21,51} Therefore it was important for Washington to ensure parents of these athletes are proficient in recognizing and understanding the signs and symptoms of SRC.¹¹

Mannings et al.¹¹ concluded that many parents have difficulty identifying a SRC as a mild TBI.¹¹ Their research indicates that when children are given a diagnosis of SRC, he or she is more likely to return to school earlier than if diagnoses was mTBI.^{11,22,66,82} This reflects parents not fully understanding what a SRC is.¹¹ In fact research indicates two thirds of parents failed to recognize that a SRC is considered a mTBI.^{11,82}

The Heads up Program was implemented by the CDC as a means to address this public health concern. The Children's Health Act of 2000 (H.R. 4365)³² charged the CDC with the implementation of a campaign that would broaden the public's awareness to the consequences of SRC's.³² Since its inception the Heads Up initiative has identified 5 target audiences: health care professionals, high school coaches, youth sports coaches, school professionals, and parents.³² The five Heads UP initiatives include: Heads Up to Clinicians, Heads Up SRC in HS sports for HS coaches, Head Up SRC in youth sports for coaches, Heads up to schools know your SRC ABCs for school professionals, and Heads up to parents.³²

Positive change was evident in SRC management among healthcare professionals exposed to the Heads Up material. They were less likely to recommend returning to play the day after a SRC, which remains consistent with current clinical guidance.³⁷ Another

study demonstrated that 38% of HS coaches exposed to Heads Up material made changes in how they reacted and managed SRC.⁸³

The CDC disseminated educational resources to a wide range of audiences, in a moderately successful campaign, they have raised awareness for the improved prevention recognition and response to SRC.^{4,37} Adler et al.⁴ suggested that educational outreach alone is not the answer, believing that State Governments must implement and enforce regulatory legislation to ensure the health and wellbeing of our children.⁴ From 2009 through 2012, states with SRC legislation had a 92% increase in treated SRC-related health care, while states with no legislation still increased utilization but by only 75%.⁸¹

In short, current literature indicates the need to continue educating athletes and parents on the diagnosis and management of SRC. A multi-faceted approach to accomplishing the goal of increasing the knowledge level shows promising results. By disseminating educational material, improving the medical coverage at sporting events, and having a strong legislative backing cultural as well as societal views on SRC are changing. The need is greater now than ever to continue to evolve as a medical profession to ensure the SRC epidemic doesn't continue to grow unchecked and unabated.

Chapter 3

Method

Overview:

The use of questionnaires and surveys are the most prevalent means of collecting data within athletic training today.⁴³ Survey research involves the use of a self-administered questionnaire designed to capture specific data through a self-reporting system.⁴³ Self-reporting is not a direct method of subject observation, however no better method exists to assess a subjects psychologically based variable's (such as perceptions, fears, motivations, attitudes or opinions).⁴³ Successful survey research must be purposeful, useful and applicable, with a guiding purpose or reason to collect the data. The purpose of survey research is to assess if a predetermined issue truly exists.⁴³ The development of a survey research study, like experimental studies should follow a pre-set plan of action.⁴³ The six step plan of action used included; developing a research question, investigation of existing literature, clarify and refocus the research question if appropriate, establish validity of instrument, determine the sample, and acquire and analyze the data.⁴³

Participants, Selection-Eligibility Characteristics, and Sampling

Youth female soccer players who were registered through the YMCA and Striker's club soccer teams and their parents were asked to complete a survey. Approximately 80 female youth soccer players were expected to participate in the fall season, ranging in age from 10-13 years old. Surveys were handed out and completed by the participants during the beginning or end of practice.

Population Size/Characteristics

USA youth soccer estimates that approximately 3 million youth athletes participated in soccer in the fall of 2015, with half a little more than half being female.⁸⁴ A convenience sample of 70-80 female youth soccer players in Missoula were recruited to participate. Participants and their parent or guardian were asked to complete a survey during the first week of fall practice. The research team distributed and collected all survey's and no participant was able to take the survey home and return it at another time.²¹

Quantitative Instruments:

Two separate surveys were used to capture the data regarding SRC identification and knowledge; one for the athletes and one for their parents or guardians. Both surveys were titled Sport Related Concussion Knowledge in Youth Sports Participants and Their Parents in Missoula (SRCKYSPPM). The data for this project was collected utilizing a 3 section 11 open/closed ended, questionnaire developed from previous studies. The survey was meant to capture the educational level of parents and athletes.

The first section contained 2 questions, and asked participants to identify symptoms of a SRC from a list of 10 possible choices. Each question contained 3-5 distractors not associated with SRC symptoms. The next section contained 2 questions regarding potential consequences resulting from inappropriate care of SRC. The last section contained 7 questions regarding SRC education asking if respondents had ever received educational material on SRC, whether they had discussed SRC with their parent or child, what they should do if they suspect they have a SRC, if they know the signs and

symptoms of SRC, if they are aware of the dangers of SRC, and how they would like to receive educational materials regarding SRC. The reading level of the survey 5.9.

Development Procedures for SRC Knowledge in Youth Sports Participants and Their Parents in Missoula

The most time consuming portion of this study involved the creation and validation of the survey instrument Sport Related Concussion Knowledge in Youth Soccer Participants and Their Parents in Missoula (SRCKYSPPM). Two major parts were involved in developing this survey, first, deciding what questions to ask, and second, how to ask those questions.^{43,85} The majority of questions on the survey involved assessments of attitudes, beliefs, behaviors or attributes of SRC. Belief questions helped to assess what participants believe about SRC.⁴³ With no way of knowing what a participant is actually thinking, descriptive self-report studies are not without limitations.⁴³ Lastly, attribute questions provided a manner with which to capture participant's demographic data. This research instrument included attribute questions for that purpose.^{43,85}

Many possibilities exist in which to write survey questions. Each method required different considerations for analysis.⁴³ Open and closed ended questions and scales represented the majority of data collection methods.⁴³ The SRCKYSPPM included both closed ended and Likert scale methods.^{43,85} Close ended questions involve predetermined answers selected by the research team, which allowed for ease in coding and consistency in survey responses.⁴³ Possible responses were presented in random order.^{43,86} Lastly, scaled questions were used to identify the knowledge base that participants possessed regarding SRC signs, symptoms, and potential outcomes. These

presented a set of statements that increased in intensity, regarding the characteristic of measurement.⁴³

Validation Procedures for New Instrument

In order to ensure that data collected was accurate, it was essential to validate the data collection instrumentation prior to use.^{43,86} This ensured that our instrument captured the data we intended it too, ultimately helping answer the research questions.⁴³ Turocy et al.⁴³ insisted that when conducting survey research, 4 assessments must be used in order to determine validity including; face validity, content validity, construct validity and criterion-related validity.⁴³

Determining face validity included an evaluation by experts and sample participants, determining whether the instrument worked as intended.⁸⁶ This subjective assessment method helped to ensure instrument SRCKYSPPM was acceptable for those who administer, take, and use the results.⁴³ The survey was administered to a small group fitting the characteristics of our sample including parents average time of completion was recorded. Once the pilot group was finished they recorded feedback so the instrument could be altered if needed. Experts within the medical field, including licensed healthcare providers were asked to review the instrument to provide feedback to establish content validity.⁴³

The importance of criterion-related validity was essentially ensuring that we could use the results of a percentage of the population in the determination of knowledge level across the entire population.⁴³ determining concurrent validity, it must be shown that results from one instrument correlate with findings from an existing instrument.^{43,86} A

pilot test group of 4 female athletes who had previously but were not currently playing soccer and their parents agreed to pilot the survey. Upon their completion results were compared ensuring that the younger athletes understood the content and material and could without help complete all parts of the survey along with their parents. This process provided a rationale for using this measurement as a predictor for the rest of the research study population.^{43,86}

Quantitative Procedures

Ethical Nature of Data Collection

IRB approval was obtained and informed consents were used. All participants data were collected and used in an ethical manner. There was no discomfort for those participating in this study, and risk to participants was minimal. All participants signed an informed consent, and participants who were minors required parental consent forms. Institutional review board approval was received prior to data collection.

Research Design

This project was cross-sectional in its design. Most often used for the purpose of estimating the prevalence of an outcome of interest within a population, cross-sectional designs are commonly used for the purpose of public health planning.^{87,88} Public health planning fits well within the scope of this study. With our previously mentioned intent being the determination of SRC knowledge level for youth female soccer players and their parents. Our ultimate goal was to develop educational outreach material in an effort to help educate our community on the potential dangers involved while playing

youth contact sports. Also this type of design is commonly used with descriptive studies describing a population with respect to an outcome or a set of risk factors.⁸⁸

This study design allowed for data to be collected on individual characteristics and provided information about the outcome. It effectively provided a 'snapshot' of the outcome (educational level) and the characteristics associated with it.^{87,88} A cross-sectional design was carried out in order to investigate the commonalities between risk factors and the outcome of interest. It was limited by the fact that it was carried out once at only one point in time.^{87,88}

Quantitative Analysis

Data from each questionnaire were entered into Excel (Version 2010; Microsoft Corporation, Redmond, Wa). Descriptive statistics were used to determine the frequency of identification of each symptom and the consequence of SRCs, as well as the percentage of participants who had received education from their parents or another formal source.²¹ An overall score (percentage correct) was calculated for each participant, and all correlations between education and correct identification of symptoms were assessed using SPSS (version 21.0; IBM Corporation, Armonk, NY).

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Table #1

SRC signs/symptoms adapted from *Principles of Athletic Training 14th edition*.³⁶

Blurred Vision	Dizziness	Drowsiness
Excess sleep	Easily distracted	Fatigue
Feel “in a fog”	Feel “slowed down”	Headache
Inappropriate Emotions	Irritability	Loss of consciousness
Loss of orientation	Memory problems	Nausea
Nervousness	Personality change	Poor balance / coordination
Poor concentration	Ringing in ears	Sadness
Seeing stars	Sensitivity to light	Sensitivity to noise
Sleep disturbance	Vacant stare / glassy eyed	Vomiting

Table 2: Return to Play Protocol			
Stage	Activity	Functional Exercise At Each Stage	Objective of stage
1.	No Activity	Symptom-limited physical and cognitive rest	Recovery
	When 100% symptom free for 24 hours proceed to stage 2. (Recommend longer symptom-free periods at each stage for younger student athletes).		
2.	Light Aerobic exercise	Walk, Swim, Bike <70% max HR, No resistance training.	Increase HR
3.	If symptoms reemerge with this level of exertion, then return to previous stage. If 24 hour symptom free, proceed to next stage.		
	Sport Specific Ex.	Begin specific drills for sport athlete plays skating drills for hockey, running for soccer.	Add Movement
4.	If symptoms reemerge with this level of exertion, then return to previous stage. If 24 hour symptom free, proceed to next stage.		
	Noncontact training drill	Progress sport specific drill to more complex movement.	Ex, coordination and cognitive load.
	If symptoms reemerge with this level of exertion, then return to previous stage. If 24 hour symptom free, proceed to next stage.		
5.	Full contact practice	Following medical clearance full participation in practice environment.	Restore confidence, asses skill,
	If symptoms reemerge with this level of exertion, then return to previous stage. If 24 hour symptom free, proceed to next stage.		
6.	Return to play	Return to normal game play.	No restrictions
Graduated return to play approach is recommend for young athletes, based on recommendations by the 2012 Zurich Consensus Statement on SRC in Sport. ⁴⁸			

Table 3: Time Line for Research Project

Date	Task
August 2015	Obtain IRB approval from institution
September 2015	Formal proposal conducted in front of committee
September 2015	Data collection
September 2015	Data analysis and Development of Educational Seminar and materials
October 2015	Educational seminar's conducted
November 2015	Abstract submission to the NATA & NWATA Foundation Free Communications Program
January 2016	Thesis Defense
March 2016	Presentation of Findings at NWATA District Meeting
April 2016	Presentation of Findings at UM Graduate Research Seminar
June 2016	Presentation of Findings at NATA Annual Meeting

Appendix A

SRC Knowledge in Youth Sports Female Participants and Their Parents in Western Montana

Athlete Survey

What sport do you currently play? (Circle one)
Soccer

Football Hockey

Age: _____
Female

Gender (Circle): Male

How many years have you played this sport? _____

Section 1 Symptoms

1. Which of the following are symptoms of a SRC after sustaining a hit to the head? **Please circle all that apply.**
 - a. Vacant stare/glassy eyed
 - b. Drowsiness
 - c. Difficulty Breathing
 - d. Nausea or Vomiting
 - e. Irritability (Bad Temper)
 - f. Neck Pain
 - g. Inappropriate emotions (Out of Place Feelings)
 - h. Pale skin
 - i. Excess Sleep (sleeping longer than usual)
 - j. Sensitivity to light (photophobia)
2. Which of the following are symptoms of a SRC after sustaining a hit to the head? **Please circle all that apply.**
 - a. Muscle spasms in your neck
 - b. Black eye
 - c. Sensitivity to noise
 - d. Feeling like "in a fog"
 - e. Poor balance/coordination
 - f. Epistaxis (bloody nose)
 - g. Fatigue (low energy, tired)
 - h. Jaw pain
 - i. Sadness (Depression)
 - j. Ringing in ears (Tinnitus)

Section 2 Outcomes

3. Which of the following do you think are consequences of inappropriate care of a SRC? **Please circle all that apply.**
 - a. Early onset dementia
 - b. Increased risk of stroke
 - c. Persistent dizziness
 - d. Persistent neck pain
 - e. Death
 - f. Persistent headache

4. Which of the following do you think are consequences of inappropriate care of a SRC?

Please circle all that apply.

- a. Bleeding in the brain
- b. Early onset Alzheimer
- c. Increased risk of blindness
- d. Early onset Parkinson's
- e. Persistent dizziness
- f. Persistent jaw pain

Section 3 Education.

5. Have you ever talked about the consequences of a SRC with your parents or guardians?

- a. Yes
- b. No

6. Have you ever had formal education about SRC? (In school, or online)

- a. Yes
- b. No

7. I understand the dangers of SRCs. **(Select one)**

Disagree completely	Somewhat disagree	Neither Agree	Somewhat Agree	
Agree Completely		Or Disagree (3)	(4)	(5)
(1)	(2)			

8. I know the signs and symptoms of a SRC. **(Select one)**

Disagree completely	Somewhat disagree	Neither Agree	Somewhat Agree	
Agree Completely		Or Disagree (3)	(4)	(5)
(1)	(2)			

9. If I am hit in the head and have a headache, it is OK to continue to play, as long as I didn't lose consciousness (i.e., black out). **(Select one)**

Disagree completely	Somewhat disagree	Neither Agree	Somewhat	
Agree Completely		Or Disagree (3)	(4)	(5)
(1)	(2)			

10. If I think I may have a SRC, it is OK to continue to play soccer. **(Select one)**

Disagree completely	Somewhat disagree	Neither Agree	Somewhat Agree	
Agree Completely		Or Disagree (3)	(4)	(5)
(1)	(2)			

11. Given the choice, in what form would you like to receive educational info?

- a. Power-point
- b. Poster
- c. Pamphlet
- d. Flyer
- e. Other

SRC Knowledge in Youth Sports Participants and Their Parents in Western Montana

Parent/Guardian Survey

What sport do is your son/daughter currently playing? (Circle one) Football Hockey Soccer

What is your age? _____ Gender (Circle): Male Female

Section 1 Symptoms

1. Which of the following are symptoms of a SRC after sustaining a hit to the head? **Please circle all that apply.**
 - f. Vacant stare/glassy eyed
 - g. Drowsiness
 - h. Difficulty Breathing
 - i. Nausea or Vomiting
 - j. Irritability
 - k. Neck Pain
 - l. Inappropriate emotions (out of character)
 - m. Pale skin
 - n. Excess Sleep
 - o. Sensitivity to light (Photophobia)

2. Which of the following are symptoms of a SRC after sustaining a hit to the head? **Please circle all that apply.**
 - p. Muscle spasms in your neck
 - q. Black eye
 - r. Sensitivity to noise
 - s. Feeling like "in a fog"
 - t. Poor balance/coordination
 - u. Epistaxis (bloody nose)
 - v. Fatigue or low energy
 - w. Jaw pain
 - x. Sadness
 - y. Ringing in ears

Section 2 Outcomes

3. Which of the following do you think are consequences of inappropriate care of a SRC? **Please circle all that apply.**
 - a. Early onset dementia
 - b. Increased risk of stroke
 - c. Persistent dizziness
 - d. Persistent neck pain
 - e. Death
 - f. Persistent headache

4. Which of the following do you think are consequences of inappropriate care of a SRC? **Please circle all that apply.**
 - a. Bleeding in the brain
 - b. Early onset Alzheimer
 - c. Increased risk of blindness
 - d. Early onset Parkinson's

- e. Persistent sadness
- f. Persistent jaw pain

Section 3 Education

5. Have you ever discussed the risks associated with SRCs with your child?
 - a. Yes
 - b. No
6. Have you ever had formal training about SRCs? (Online or in school).
 - a. Yes
 - b. No
7. I understand the dangers of SRCs. **(Select one)**

Disagree completely	Somewhat disagree	Neither Agree	Somewhat Agree	Agree
Completely		Or Disagree		

8. I know the signs and symptoms of a SRC. **(Select one)**

Disagree completely	Somewhat disagree	Neither Agree	Somewhat Agree	Agree
Completely		Or Disagree		

9. If your child is hit in the head and has a headache, it is OK for them to continue to play, as long as they didn't lose consciousness (i.e., black out). **(Select one)**

Disagree completely	Somewhat disagree	Neither Agree	Somewhat Agree	Agree
Completely		Or Disagree		

10. If you think your child may have a SRC, it is OK for them to continue to play soccer. **(Select one)**

Disagree completely	Somewhat disagree	Neither Agree	Somewhat Agree	Agree
Completely		Or Disagree		

11. Given the choice, in what form would you like to receive educational info?

- a. Power-point
- b. Poster
- c. Pamphlet
- d. Flyer

Chapter 4: Manuscript

Sport Related Concussion Knowledge in Youth Female Soccer Athletes and Their Parents

Key Points:

1. Youth female soccer athletes and parents of youth female soccer athletes display lack of sport related concussion knowledge.
2. Youth female soccer athletes and parents of youth female soccer athletes display a need and want to receive quality educational material on sports related concussions.

Key Words: Head Injuries, Adolescent, Symptoms, Consequences

Abstract:

Context: Continued participation in sports while experiencing symptoms of a concussion is dangerous. Youth athletes (aged 10-13) and their parent's lack of concussion knowledge may influence the decision to seek evaluation and diagnosis from a medical professional.

Purpose: To assess female youth soccer athletes and their parent's sport related concussion knowledge and determine a preferred means to increase athlete's and parent's level of concussion knowledge.

Results: Both athletes and their parent's struggled to identify neck pain, nausea/vomiting, inappropriate emotions n=59 (45%), irritability, fatigue n=59 (39%), and sadness n=59 (34%) as signs and symptoms of concussion, and only a fraction of participants were able to identify Parkinson' n=59 (40%) and Alzheimer's n=59 (41%), as potential outcomes resulting from inappropriate care. A composite score was calculated by subtracting the number of missed symptoms and potential outcomes from a total possible of correct answers and assigned to each participant.

Conclusions: The female soccer players and parents we surveyed, did not have appropriate knowledge of the symptoms and consequences of concussions. Personality and behavioral changes were often missed by participants, and only a small portion identified Parkinson's, Alzheimer's and death as possible consequences of inappropriate care after a concussion. Thirty percent of athletes and 45% of parents reported discussion SRC with each other illustrating a discrepancy in communication.

Introduction: Historical data suggests approximately 1.6 to 3.8 million sports related concussion (SRC) occur each year.^{1,2} The sports causing the highest rates are football, wrestling and boys followed by girls' soccer.¹ Research suggests that girls are at a two time higher risk of SRC.¹ Many of these injuries go undiagnosed or are under-reported in part because of participating athletes educational deficits.³ However athletes are not alone; approximately fifty percent of parents failed to recognize headaches as a SRC symptom.⁴

Young competitive athletes struggle to self-report symptoms for three main reasons; first young athletes emulate their sports heroes and their competitive nature so they don't want to miss playing time. Secondly, forming bonds and gaining acceptance from teammates is important, and lastly neither athlete or parent possess the level of knowledge sufficient to identify the symptoms or the related consequences from improper SRC management.^{4,5}

The lack of parental SRC knowledge is concerning due to youth athletes' vulnerability. Younger athletes have an immature nervous system, decreased myelination, thinner frontal and temporal bones, a larger head body ratio, and weaker neck musculature placing them at greater risk.³ Literature suggests that consequences of SRC are magnified in youth due to brain development and the constant acquisition of knowledge.⁶ A child's brain continuously develops in areas such as concentration, memory, reasoning, and problem solving,⁷ whereas adult brains have reached its full development.⁶ An increase in research of mature brains has helped clinicians understand that knowledge must be used to prevent and protect our younger athletes.³

Literature indicates 2% to 6.5% of all injuries sustained at the youth level involved SRC.⁸ Also suggested is that athlete's struggle to self-report symptoms of SRC.^{5,9} Young athletes possess an incredible amount of motivation to win, desire to advance within their sport, and to gain acceptance from their teammates. Sometimes these qualities outweigh their decision to play safe and report potential SRC.^{8,10} Because of this, added pressure is placed on coaches, athletic trainers and parents to take the appropriate steps seeking medical attention, and engineering a culture of healthy behavior regarding SRC.¹¹ Society must de-glorify the notion of playing through the pain or symptom and start promoting the appropriate recovery periods regarding SRC. Young athletes emulate the behavior of their sports idol; a basic principle described by social learning theory.^{11,12} As a whole we must pressure the media to stop praising risky behavior such as playing while injured, and hold professional athletes accountable for the lesson they teach every time they play injured.

These types of learned behaviors and expectations send children the wrong message that it is more important to play through an injury than resting. Health professionals and athletes involved in sport have a social duty to encourage a safe and rewarding attitude towards player health. Gielen et al.¹³ identified and concluded that to create successful behavior change both active and passive portions of behavior must be addressed.¹³ The current study aimed to capture the knowledge level regarding SRC, and provide an avenue with which to start the actions necessary to achieve cultural change.¹³

Research about SRC demonstrated that outside of the medical community, misconceptions are evident,¹¹ indicating a serious problem with the identification and treatment of SRCs. Multiple studies reported a lack of parental and athlete knowledge that could lead to catastrophic repercussion if not addressed.^{3,11,14-16}

The purpose of this study was to determine the amount of knowledge that youth female soccer players and their parent's in Missoula, MT. possessed regarding SRC, and determine if they had been educated, formally or informally, about SRC. We hypothesized that both athletes and parents would exhibit poor knowledge of and little education about SRC.

Methods:

Participants: We contacted 10 local soccer coaches from the YMCA and Striker soccer organizations and asked permission to distribute a written questionnaire evaluating their athletes and parents level of knowledge about SRC. Six coaches agreed to participate. Researchers attended in-season practice to distribute our questionnaire during the fall soccer season of 2015. A total sample of 59 participants, 30 athletes and 29 parents participated in our survey (table 1).

Instrument: The survey, was developed using a literature review and expert review. The signs of concussions were taken from the Sport Concussion Assessment Tool (version 3),²⁵ and the CDC's "Heads Up" information program for athletes.²⁶ The first two questions asked for the participant to identify the signs of a concussion within a list of 10 choices which also included distractors. The next two questions asked participants to identify potential consequences of inappropriate care of a concussion from a list also

containing distractors. The remaining questions asked about education and whether discussion between athlete and parent had occurred.

Procedures: This study was approved by the Institutional Review Board (IRB) for the protection of human research Subject by the University of Montana. Once approved we contacted a total of 10 coaches from the Missoula YMCA and Strikers soccer club. Six coaches agreed to participate in our study, and we then scheduled days to distribute the survey either prior to or directly after one of the regular season practices. During the data collection athletes and parents were given consent and assent forms along with the survey and directions. It took approximately 7-10 minutes to complete the survey and as an incentive when the surveys were turned in all participants were given a raffle ticket to fill out for a chance to win cleats or shin-guards.

Data Analysis: We entered data from each questionnaire into Excel (version 2010; Microsoft Corporation, Redmond, WA). Descriptive statistics were used to determine the frequency of identification of each symptom and the consequence of concussions, as well as the percentage of participants who had received education from a formal source. We calculated an overall composite score for each participant by coding the correct and incorrect answers to symptom and consequence questions. A possible of 22 correct answers were identified and the composite score was subtracted from the total number of possible answers. We then evaluated the association between the education received and the composite score with linear regression using SPSS (Version 21.0; IBM Corporation, Armonk, NY).

Results: We distributed and collected a total of 59 surveys. Each survey was reviewed at the time it was turned in for errors or unanswered questions. If an error or question was left unanswered the participant was asked to make the correction at that time, so all surveys were tabulated. The athlete average composite score was 8.1/22, 36.7% while their parents averaged a slightly higher score of 12.4/22, 56.3%. Cronbach α was calculated for responses on the symptoms scale (athlete Cronbach α =0.72, parent Cronbach α =0.81, and combined subjects Cronbach α =0.83) and regarding consequences dealing with SRC (athlete Cronbach α =0.62, parent Cronbach α =0.70, and combined subjects Cronbach α =0.71).

Symptoms

Athletes most commonly identified drowsiness n=30 (76%), poor balance/coordination n=30 (76%), sensitivity to light n=30 (66%) and ringing in the ear n=30 (63%) (Table 2). Nausea or vomiting as well as excess sleep was recognized by n=30 (53%) of athletes surveyed, few participants recognized sensitivity to noise n=30 (36%), and even fewer were able to identify irritability, inappropriate emotions (out of place feelings), or sadness (Table 2). The most common distractors athletes chose were epistaxis, and jaw pain at n=30 (33%) each. Parents identified vacant stare/glassy eyed n=29 (83%), nausea or vomiting n=29 (97%), and poor balance/coordination n=29 (93%) at impressive rates (Table 3). They had a more difficult time recognizing sadness n=29 (52%) and irritability n=29 (62%) (Table 3). Parent's high recognition of symptoms is slightly misleading, as they also incorrectly identified symptom distractors such as neck spasm n=29 (62%), jaw pain and difficulty breathing n=29 (48%), and pale skin n =29 (48%).

Consequences

Persistent dizziness n=30 (73%), persistent headache n=30 (67%), bleeding in the brain n=30 (60%), followed closely by early onset dementia and death n=30 (53% and 50% respectively) were the consequences most correctly identified by athletes (Table 4). Early onset Alzheimer's, and early onset Parkinson's both long term consequences of repetitive concussions were only identified by 33% and 30% respectively (Table 4). Athletes incorrectly identified persistent jaw pain n=30 (50%), persistent neck pain and increased risk of blindness n=30 (43%), and increased risk of stroke n=30 (37%) to a moderate degree. Whereas parents correctly identified bleeding in the brain n=29 (100%), persistent dizziness and headache n=29 (93% & 93%), death n=29 (93%) and long term consequence early onset dementia n=29 (66%) very well (Table 5). Unfortunately, they also improperly identified increased risk of stroke n=29 (66%), persistent neck pain n=29 (62%), increased risk of blindness n=29 (55%), and persistent jaw pain n=29 (48%) at high rates as well (Table 5).

Education

Thirty-six percent of participating athletes n=30 stated they had received formal education on SRC, whereas only 20% n=29 of the parents stated the same. Interestingly, 30% n=30 of athletes stated that they have had a discussion about SRC and the dangers with their parents however; 46% n=29 of parents stated that they had discussed SRC and the dangers with their athlete.

Influence of Education on Knowledge Regarding SRC

To quantify the correlation between education and overall composite score, we ran a linear regression resulting in R^2 values combined of 0.09, just parents 0.08, and just athletes 0.03 indicating a very poor correlation between the ability to recognize symptoms and consequences of SRC and whether participants had formal education or not.

Discussion: Sports related concussion remains a common injury youth athletes experience. Continued participation of sport while experiencing any symptoms is detrimental and can result in prolonged symptoms (post-concussion syndrome), second-impact syndrome or even death.^{2,14} Less than half of athletes are likely to self-report symptoms pertaining to SRC.^{5,14} Twenty-five percent of football players participated in games or practice while experiencing symptoms of a SRC.²⁷ One of the largest areas of consensus in the literature explaining why athletes do not report symptoms related to SRC is a lack of knowledge by athlete populations.^{2,14,27-29} Our findings support lack of knowledge as a factor, but not just from athletes. It is evident that parents struggled to identify symptoms and consequence related to SRC. As mentioned parental data in our study at first glance is promising. Parents did have high rates of symptom and consequence recognition; however, a trend displayed that over half of the parental participants chose every option for symptom and consequence recognition questions.

This study suggests that a cultural shift is beginning. Previous research indicated that only 25% of adults and 25% to 50% of athletes were unable to name 1 symptom of SRC.^{14,28} Subjects participating in our study were able to identify major physical

symptoms of SRC, such as headache, poor balance/coordination, and sensitivity to light. However, athletes and their parents were ineffective at recognizing behavioral symptoms such as irritability, improper emotions, and sadness (16%-62%). Other factors besides level of knowledge that impede the athlete's ability to recognize SRC symptoms include the subtleness of symptoms, apparent resolution in less than 15 minutes or delayed symptoms 24-36 hours post-injury, and a mirroring effect created because of the close resemblance of symptoms to more common pathologies such as; dehydration and heat exhaustion.^{11,14,30,31}

Our study suggests that lack of knowledge about SRC is a result of lack of SRC education. Results indicated that approximately 80% of parents and 74% of athletes have never had formal education on the subject. A recent Harris Poll, of parents with and without athletically involved children demonstrated that parents of athletes display greater SRC knowledge than their peers.³² We observed the identification of consequences such as early onset Alzheimer's and early onset Parkinson's was less than half of all participants. It is also worthwhile to note that consequential distractors were chosen by participants at a rate of 49% and higher. Numerous experts advocate SRC education as the main component of prevention and management.^{5,11,14,33} It is our belief that increasing knowledge about SRC would serve athletes and their parents by helping them identify symptoms as well as encourage the athletes to report symptoms effectively changing the cultural climate in sports about SRC. High-school football players reported disclosing symptoms to an athletic trainer at a rate of greater than 75%, reporting their confidence in the athletic trainer and positive rapport as the main reasons why.⁵ One

step toward preventing the unwanted consequences of SRC as well as promoting education would be to require athletic trainers at all public schools beginning at middle-school ages. Pre-participation meetings, instructional videos, symptom identification cards, and Web-based programs are a few examples that have already been suggested and in some areas implemented with successful outcomes.^{5,14} Furthermore, educational opportunities and materials should be provided to athletes and parents often. The more educational programs and opportunities available the better educated our youth athletes and their parents will be.¹⁴

Limitations: Like all research projects, our study had limitations. The study was descriptive in nature; therefore, no causal conclusions can be drawn. External validity limitations include the inability to generalize our findings to larger target population across the entire country. However, our goal was not to generalize our results across the country but to descriptively state what is happening within our area regarding SRC education and identification.

Conclusion: Youth female soccer athletes and their parents did not have a well-developed understanding regarding symptoms and consequences of SRC. Symptoms such as poor balance/coordination, sensitivity to light, fatigue or low energy and excess sleep were identified at a high rate by all subjects. Major emotional symptoms such as sadness, inappropriate emotions, and irritability were missed by more than half of all participants. Some major consequences such as death, early onset dementia, and bleeding in the brain were identified by over 50% of participants, slightly higher than past studies however;

other major consequences including early onset Parkinson's and early onset Alzheimer's were identified by less than 40%.

Other approaches can be used to provide quality information and education about SRC to young athletes and parents. Pre-participation meetings, instructional videos, and Web-based programs are only a few examples that have already been introduced and shown to have a positive impact.^{5,14} Such approaches should be evaluated to ensure their future efficacy, and all athletic trainers should be aware of the level of knowledge about SRC that the athletes and parents they work with possess.

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Table 1: Demographic Data Female Youth Soccer Athletes & Parents.			
	Age \pm SD	Years Played	Gender
Athletes N=30	10.6 \pm .56	4.3 \pm 1.88	30 F
Parents N=29	42.7 \pm 8.67		15 M 14 F

Table: 2 Frequency of symptom identification for youth female soccer athletes (n=30)						
Symptom:					No.	(%)
Vacant stare / Glassy eyed					17	56.60%
Drowsiness					23	76.60%
Nausea or Vomiting					16	53.30%
Irritability					5	16.60%
Neck Pain					13	43.30%
Inappropriate Emotions (out of place feelings)					5	16.60%
Excess Sleep (sleeping longer than usual)					16	53.30%
Sensitivity to Light					20	66.60%
Sensitivity to Noise					11	36.60%
Feeling like "in a fog"					14	46.60%
Poor balance/Coordination					23	76.60%
Fatigue or Low Energy					18	60%
Sadness					5	16.60%
Ringing in Ear					19	63.30%
Distractors:						
Difficulty Breathing					7	23.30%
Pale Skin					9	30%
Neck Spasm					7	23.30%
Blackeye					9	30%
Epistaxis (nosebleed)					10	33.30%
Jaw Pain					10	33.30%

Table: 3 Frequency of symptom identification for parents of youth female soccer athletes (n=29)						
Symptom:					No.	(%)
Vacant stare / Glassy eyed					24	83%
Drowsiness					22	76%
Nausea or Vomiting					28	97%
Irritability					18	62.10%
Neck Pain					20	69%
Inappropriate Emotions (out of place feelings)					22	76%
Excess Sleep (sleeping longer than usual)					22	76%
Sensitivity to Light					23	79.30%
Sensitivity to Noise					22	76%
Feeling like "in a fog"					24	83%
Poor balance/Coordination					27	93.10%
Fatigue or Low Energy					25	86.20%
Sadness					15	52%
Ringling in Ear					24	83%
Distractors:						
Difficulty Breathing					14	48%
Pale Skin					13	45.00%
Neck Spasm					18	62%
Blackeye					11	38%
Epistaxis (nosebleed)					12	41%
Jaw Pain					14	48%

Table: 4 Frequency of Consequences of Inappropriate Care of Concussion by Female Youth Soccer Athletes (n=30).						
Consequence:				No.	(%)	
Early onset Dementia (impaired thinking)				16	53%	
Persistent Dizziness				22	73%	
Death				15	50%	
Persistent Headache				20	67%	
Bleeding in the Brain				18	60%	
Early onset Alzheimer				10	33%	
Early onset Parkinson's				9	30%	
Distractors:						
Increased risk of Stroke				11	37%	
Persistent Neck Pain				13	43%	
Increased risk of Blindness				13	43%	
Persistent Jaw Pain				15	50%	

Table: 5 Frequency of Consequences of Inappropriate Care of Concussion by Parents of Female Youth Soccer Athletes (n=29)					
Consequence:				No.	(%)
Early onset Dementia (impaired thinking)				19	66%
Persistent Dizziness				27	93%
Death				27	93%
Persistent Headache				27	93%
Bleeding in the Brain				29	100%
Early onset Alzheimer				14	48%
Early onset Parkinson's				15	52%
Distractors:					
Increased risk of Stroke				19	66%
Persistent Neck Pain				18	62%
Increased risk of Blindness				16	55%
Persistent Jaw Pain				14	48%