AN ASSESSMENT OF HIGH SCHOOL ATHLETES' AND COACHES' KNOWLEDGE, ATTITUDES, AND BEHAVIORS CONERNING SPORT-RELATED CONCUSSION

Johna K. Register-Mihalik

A dissertation submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Interdisciplinary Human Movement Science (School of Medicine).

Chapel Hill, North Carolina
2010

Approved By:

Kevin M. Guskiewicz , PhD, ATC, Advisor

Laura A. Linnan, ScD, Reader

Stephen W. Marshall, PhD, Reader

Frederick O. Mueller, PhD, Reader

Tamara Valovich McLeod, PhD, ATC, Reader

ABSTRACT

Johna K. Register-Mihalik

An Assessment of High School Athletes' and Coaches' Knowledge, Attitudes, and Behaviors of Concerning Concussion

(Under the direction of Kevin M. Guskiewicz)

Cerebral concussions are one of the most perplexing sports injuries to identify and manage. As a result, many of these injuries go unreported and untreated. Few studies to date have addressed the behavior of concussion reporting, specifically among young athletes. The overall purpose of this dissertation was to assess knowledge, attitudes, intentions, and behaviors concerning concussion using a pre-validated survey instrument. A convenience sample of 25 high schools participated in the study. Meetings were held at each school to explain the study and distribute the survey instruments to coaches and athletes. The Theory of Reasoned Action and Planned Behavior guided the direction of the study. A sample of 167 high school athletes (football, soccer, lacrosse, cheerleading) and 59 high school coaches completed the pre-validated survey instrument during the 2009-2010 school year. There was major under-reporting of concussive events with respondents indicating only 40% of concussion events and 13% of bell ringer events indicated had been reported. The major factors associated with increased reporting of recalled concussion/bell ringer event reporting and participating with concussions signs/symptoms in the sample of athletes included: 1) increased athlete concussion knowledge and attitude, 2) increased intention to report concussions, 3) increased positive influence form social referents, 4) decreased number of previous concussive injuries. No association was observed between school level coach knowledge/attitude scores and athlete knowledge/attitude scores. This study illustrates the

multi-factorial issues concerning concussion in young athletes. The factors listed above could serve as the foundation for a multi-level intervention designed to improve concussion reporting and to decrease participation while experiencing signs and symptoms from concussion. The data obtained from this study illustrates necessary targets of future educational and behavioral interventions concerning concussion among high school athletes.

ACKNOWLEDGEMENTS

The task of completing a PhD and a dissertation cannot be undertaken without the support, mentorship, and investment of other people. I am indebted to many for their support in the pursuit of this adventure. To Dr. Kevin Guskiewicz, I am both humbled and honored at the opportunity to have been your student and to continue to learn and study with you in the future. You are such a passionate, humble, and supportive mentor whose dedication and pursuit of change are contagious. Your dedication to both your family and your work are things I hope to emulate both personally and professionally. Thank you for taking a chance on the undergrad from Alabama a few years back. To Dr. Stephen Marshall, thank you for your mentorship, honest feedback, and insight into the world of public health. You stepped out and often spent extra time to help me bridge the gap between two worlds. Thank you for teaching me how to think more globally and outside of the box. To Dr. Laura Linnan, thank you for your openness to work with me and teach me the skill sets concerning health behavior to enable me to pursue the ideas in this project and those I hope to in the future. Your ideas and feedback inspire me to think more and work harder. To Dr. Frederick Mueller. Thank you cannot sum up the appreciation I have for your mentorship, feedback, and support not only for this dissertation, but throughout my doctoral journey. To Dr. Tamara Valovich McLeod, thank you for the example that you are to women in our field and for your mentorship, insight, and feedback through this process. To my parents, Johnny and Janet, and my sister Jenna, thank you for putting up with me through this long journey, for encouraging me to ask questions, and for so much love and support in all things. To my husband, my colleague, and my best friend, Jason, your support both at home and at work

made this dream possible. Your listening ear, your shoulder to cry on, and your hand to hold through this journey were the little things that kept me going. I love you.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AT	Certified Athletic Trainer
Att	Attitude
CDC	Centers for Disease Control
GEE	Generalized Estimating Equation
KAB	Knowledge, Attitude, and Behavior
LOC	Loss of Consciousness
NFL	National Football League
PRECEDE	Predisposing, Reinforcing, and Enabling Constructs in Educational Diagnosis and Evaluation
PCB	Perceived Behavioral Control
PTA	Posttraumatic Amnesia
SN	Subjective Norm
TBI	Traumatic Brain Injury
TRA	Theory of Reasoned Action
TPB	Theory of Planned Behavior

CHAPTER I

INTRODUCTION

1.1 The Problem of Concussion

Cerebral concussion (referred to as concussion in this document) often results in functional, not structural damage. As a result, this injury can be difficult to identify and manage. It is estimated that between 1.6 and 3.8 million sports-related brain injuries occur each year.[1] Approximately 1.5 million of these are estimated to be concussions. In some individuals the signs and symptoms may be delayed in presentation.[2] Because of this variability in presentation, and general lack of awareness concerning concussion in the athletic community[3-5], many concussions go unidentified. In conjunction with the difficulty of identifying a concussion, are motivations of athletes and coaches. These motivations may also affect reporting of concussion to someone in an authoritative position. There is also no gold standard of diagnosis for concussion, further complicating the evaluation of possible concussive injuries. Lastly, ambiguity in terminology surrounding concussion among athletes, coaches, and medical professionals, may also contribute to injuries not being indentified and properly managed. This lack of identification is an issue. Current literature suggests long term and cumulative effects of concussion including depression, mild cognitive impairment, risk for subsequent injury, and longer recovery following subsequent injuries.[6-10] These long-term consequences result in decreased quality of life and increased burden to the

health care system. Recently, concussion has received increased media and social attention as result of provoking studies reinforcing the negative and long-term sequelae associated with this injury.

1.2 Concussion in the Adolescent Population

In the young, adolescent population, TBI results in more disabilities and changes in normal healthy people than any other condition.[11] Concussion accounts for a large majority of injuries in this category. Brain injury in the adolescent athlete is alarming as the brain is continuing to develop and may be more vulnerable to injury. Severe consequences such as second impact syndrome may also be a concern for the young athlete when returning to activity while the brain is still in a vulnerable state.[12] Participation in high school sports has also grown from an estimated 4 million participants in 1972 to over 7 million in 2006[13]. An estimated 60,000 concussions occur among high school athletes each year[14]. This number may be a gross underestimate as many concussions may go unreported. However, only one published study[15] to date has attempted to examine the behavior of under-reporting concurrently with factors that may contribute to this behavior in athletes. Although studies have begun to examine knowledge and attitude concerning concussion[3, 5, 16] no studies have examined this behavior across sports in high school athletes.

The long term consequences and effects of concussion in the adolescent population are also understudied. However, literature suggests decreased grade point averages, more severe sequelae, and longer recovery from subsequent injury in this age group compared to older athletes.[6, 17, 18] These difficulties may be a result of the variable sequelae of concussion in this age group and their stage of brain development. [2, 12, 19] Also of concern, are the

unknown effects of concussion on neural plasticity and development. Recurrent concussion over an individual's lifespan, particularly 3 or more concussions (regardless of severity), may lead to long-term effects. These effects include increased initial severity of subsequent concussions, memory issues, concentration deficits, regular headache presence, psychological issues such as depression and anxiety, or more complicated, later-life issues such as chronic traumatic encephalopothy. [6, 7, 9, 17, 20] An individual may be more susceptible to recurrent concussion and more complicated injury if the initial injury is not managed properly.[9, 10] A more complicated injury can include increased signs and symptoms and longer recovery time. In rare circumstances a severe outcome such as second impact syndrome may result.[12, 17] Prevention of recurrent concussion should be a priority as the relative risk for sustaining a concussion is over 5 times higher for individuals with a previous history of concussion than for individuals with no previous history.[10] This statistic is a concern, as over 50% of concussions may not be reported in high school athletes.[3, 15] As mentioned, only 1 study[15] to date has attempted to quantify "unreported" concussions, and this study may be subject to reporting bias and was limited to only high school football players.

An additional factor that may influence reporting of concussion is the presence of a medical professional during athletic practices and games. Certified Athletic Trainers (AT) are often the individuals present during daily athletic events. Certified Athletic Trainers play a vital role in recognition possibly leading to an increased number of identified concussions. Understanding the influence of the presence of ATs on reporting of concussion and knowledge/attitude toward concussion may aid in providing further evidence in support of the presence of certified athletic trainers at high schools across the United States. The

National Athletic Trainers' Association[21] estimates that only 42% of secondary schools have access to the services of a certified athletic trainer (AT), and this number may be an over-estimate. Physician presence may also have an influence on reporting of concussion. However, physicians have limited interaction with high school athletes and are rarely present for practices and events outside of football. This limited interaction further emphasizes the importance of hiring an AT who can manage injuries occurring on a daily basis.[22] Health care literature suggests better care and outcomes in individuals with access to health care, which presence of ATs at schools can provide. However, little of this literature has focused on high school athletes.[23-25] Little is also known about the influence of AT presence on injury prevention, reporting of injury, and knowledge and attitudes surrounding injury in sport. This study aimed to investigate the influence of ATs on these characteristics as they relate to concussion.

1.3 Influence of Psychosocial Characteristics on Reporting of Concussion

Recent studies suggest that high school athletes have limited knowledge of signs and symptoms of concussion, which may play a role in reporting of the injury.[3, 15] The proposed study expands on these findings to include a more specific examination of factors influencing reporting of concussion. McCrea et al [15] reported three of the most common reasons for not reporting concussion as not thinking the injury was serious enough to report, motivation to not be withheld from competition, and lack of awareness of probable concussion. As previously mentioned, this study is limited by reporting bias, measurement issues related to reporting, and the inclusion of only high school football athletes. However, it is the only study to attempt to address possible reasons behind not reporting possible concussive

injuries. Although this study attempted to understand reasons behind under-reporting, little is known about the influence of knowledge level, attitudes, and intentions on the behavior of reporting a possible concussion. Gender may also play a role in reporting of concussive injuries. Current research suggests that females in some settings may be at a greater risk for sustaining a concussion.[26] However, with the gross number of concussions possibly not reported, and possible differences in reporting across gender, this finding is speculative.[27]

Other variables affecting concussion reporting and management involve the knowledge and attitude of the coach. Studies suggest a relationship between coach and athlete beliefs concerning success such as toughness and effort. [28, 29] Despite studies of this nature, influence of the coach on injury reporting among athletes remains largely unknown. The culture of sport may influence all of the above-discussed factors, including athlete behavior, as motivations of athletes are different than the average person's motivations as they relate to mental toughness, playing through pain, and success on the playing field.[30] These motivations and values often drive the actions and behaviors of athletes both on and off the playing field. However, limited data exist on how these motivations may affect reporting of concussion in high school athletes. In addition, teammates may play a role in reporting as peer-support is significantly valued among adolescent individuals.[31-33] Together with coaches, an athletic team provides a unique group of social referents concerning behavior in sport. Although parents may also be important, coaches and teammates are the individuals most closely connected to the outcomes often associated with reporting such as losing playing time or letting teammates and coaches down.[15]

1.4 Current State of Concussion Prevention

Over the past 15 years, concussion awareness and prevention have improved dramatically as reflected in developed consensus statements.[34, 35] New technologies now exist to assess the biomechanics related to concussion[36-38] and a more comprehensive management approach has been suggested.[39] The increase in apparent incidence of concussion may be a result of the increased awareness created by the media, recent research studies, and consensus statements concerning concussion.[1, 40] The Centers for Disease Control and Prevention (CDC) have also developed various educational materials for high school and youth coaches, parents and athletes. These materials are termed tool-kits and include information on concussion, a card listing signs/symptoms of concussion, posters for the coach to display, and possible management techniques for concussion. The high school coach's tool-kit is the most researched of the materials.[41, 42] Dissemination and use research has been conducted and suggests that coaches who used the tool-kit found it useful and easy to understand.[41] However, most of these materials were developed based largely on expert opinion and literature, with little involvement from stakeholders in the athletic community.[43] A recent study investigated the usefulness of the tool-kit in addition to how it was used, with only 7% of coaches passing the information meant for athletes along to his/her team(s).[42]

As with any type of intervention or program, community involvement is important and should be a priority in the development and assessment of concussion education and intervention programs. The presented study aimed to gather information form the athletic community to assist in proposed recommendations for concussion education and prevention materials. In addition, few applications of health behavior theory and intervention planning have been used concerning concussion. This study aimed to apply these concepts to

concussion reporting behaviors using the Theory of Reasoned Action and Planned Behavior (TRA-TpB).

1.5 Statement of the Problem Concerning Reporting of Concussion

Concussion is often referred to as a silent epidemic as few of the signs and symptoms of concussion, particularly mild concussion are visible. Because of these less visible signs and symptoms, concussions often go unidentified and not reported to medical professionals, coaches, or parents. Under-reporting may lead to an increased risk of future injuries and improper management of the injury. Both of these issues may pose greater issues for adolescent athletes as their brains are still developing. Despite a large percentage of concussions that are potentially unidentified and unreported, little empirical information exists on the behavioral and environmental factors influencing this alarming behavior in athletes. Therefore, the primary purpose of this study was to examine the knowledge, attitudes, and behaviors (KAB) concerning concussion in high school athletes and coaches in an effort to gain empirical evidence on the behavior of concussion management and reporting of concussion in the high school athletic setting. This study also examined the influence of access to a certified athletic trainer (AT) on these characteristics in both athletes and coaches. The TRA-TpB guided large portions of the questionnaire and study findings. A secondary purpose was to use these characteristics (KAB) in conjunction with data obtained from personal interviews to apply the Theory of Reasoned Action and Planned Behavior[44] and to develop a PRECEDE (predisposing, reinforcing, and enabling constructs in educational diagnosis and evaluation) public health planning model concerning reporting of concussion in high school athletes. This planning model will help to make recommendations for future

multi-level interventions concerning concussion among high school athletes. The following research questions directed this dissertation.

1.6 Research Questions

1. Is there a relationship between high school coaches' knowledge (school level) and attitude and athletes' knowledge and attitude concerning concussion?
    a. Is there a positive relationship between high school coaches' knowledge concerning concussion and his/her schools' athletes' knowledge concerning concussion as measured by a computed knowledge score?
    b. Is there a positive relationship between high school coaches' attitude concerning concussion and his/her schools' athletes' attitude concerning concussion as measured by a computed attitude score?
2. What factors are associated with reporting of possible concussions in high school athletes?
    a. Gender
    b. Athlete Knowledge
    c. Athlete Attitude
    d. Coach Knowledge
    e. Coach Attitude
    f. AT Access
3. What TRA-TpB factors are associated with behavioral intention and reporting behavior concerning concussion during sport in high school athletes?

a. Are the TRA-TpB direct constructs (attitude, subjective norm, and perceived behavioral control) associated with intention to report concussion?
b. Are the TRA-TpB indirect constructs (attitude, subjective norm, and perceived behavioral control) associated with intention to report concussion?
c. Is intention to report concussion associated with the behavior of concussion reporting?

4. Is there an association between access to an AT and coach/athlete knowledge and attitude scores concerning concussion?
    a. Do coaches whose school has access to an AT have higher knowledge and attitude scores concerning concussion than coaches whose school does not have access to an AT?
    b. Do athletes whose school has access to an AT have higher knowledge and attitude scores concerning concussion than athletes whose school does not have access to an AT?

1.7 Research Hypotheses

1. H_R: There will be a significant relationship between high school coaches' knowledge and attitude and his/her athletes' knowledge and attitude concerning concussion.
    a. There will be a positive relationship between high school coaches' knowledge concerning concussion and his/her schools' athletes' knowledge concerning concussion as measured by a computed knowledge score.

b. There will be a positive relationship between high school coaches' attitude concerning concussion and his/her schools' athletes' attitude concerning concussion as measured by a computed attitude score.

2. H_R: Gender (female), increased athlete knowledge and attitude, increased coach knowledge and attitude, and access to an AT will be associated with increased likelihood of reporting of concussion in high school athletes.
3. H_R: Attitude, subjective norms, perceived behavioral control (direct/indirect) will be positively associated with behavioral intention towards reporting of concussion during sport in high school athletes. Increased intention will be associated with concussion reporting behavior.
4. H_R: There will be a significant association between access to an AT and athlete and coach knowledge and attitude scores concerning concussion.
    a. Coaches with access to an AT will have higher knowledge and attitude scores concerning concussion than coaches without access to an AT.
    b. Athletes with access to an AT will have higher knowledge and attitude scores concerning concussion than athletes without access to an AT.

1.8 Independent Variables

RQ 1: School level loach knowledge score, school level coach attitude score

RQ 2: Gender, athlete knowledge, athlete attitude, coach knowledge, coach attitude, access to an AT

RQ 3: Attitude, subjective norm, and perceived behavioral control (direct and indirect), and intention

RQ 4: Access to an AT (yes/no)

1.9 Dependent Variables

RQ 1: Athlete knowledge score, athlete attitude score

RQ 2: Proportion of people reporting of 50% of *concussion* events *bell ringer* events (Y/N); proportion of recalled *concussion/bell ringer* events reported (games, practices, concussion only, and *bell ringer* only); proportion of people indicating continued participation in games and practices while symptomatic (Y/N). There are 8 total reporting outcomes for each IV.

RQ 3: Behavioral Intention, Reporting variables listed for Research Question 2

RQ 4: Coach knowledge score, coach attitude score, athlete knowledge score, athlete attitude score

1.10 Definition of Terms

1. Concussion: An injury resulting from a blow to the head or sudden blow to the body causing an alteration in mental status and one or more of the following symptoms: headache, nausea, vomiting, dizziness/balance problems, fatigue, difficulty sleeping, drowsiness, sensitivity to light or noise, blurred vision, memory deficits, and difficulty concentrating [2, 9]

2. Quality of Life: degree of well being felt by an individual or a group of people

3. Attitude: A learned predisposition to respond in a consistently favorable or unfavorable manner with respect to a given object[44]

3. Behavioral Assessment: Systematic analysis of behavioral links to goals or problems identified in the social or epidemiological assessment [45, 46]

4. Environmental Assessment: Parallel analysis of factors in the immediate social/physical/health care environment that could be causally linked to the behavior or directly related to the outcomes [45, 46]

5. Predisposing (motivating) Factors: antecedents to behavioral change that provide rationale or motivation for the behavior [45, 46]

6. Enabling (facilitating) Factors: antecedents to behavioral or environmental change that allow a motivation or environmental policy to be realized [45, 46]

7. Reinforcing (maintaining) Factors: factors following a behavior that provide the continuing reward or incentive for the persistence or repetition of the behavior [45, 46]

5. Personal Interview: Interview with an individual from the community knowledgeable about the issue of interest.

1.11 Operational Definitions

1. High School Athlete: Player on the roster of the boys'/girls' lacrosse, boys'/girls' soccer, football, or cheerleading team

2. Knowledge Total Score: Total correct out of 35 questions (higher=better)

3. Attitude Total Score: Score on the attitude questions on the questionnaires (higher=better)

3. Reporting of Concussion: Proportion of recalled number of concussions and bell ringer events indicated as reported by athletes

4. High School Coach: Coaches on the roster of the boys'/girls' lacrosse, boys'/girls' soccer, football, or cheerleading teams

5. Access to an AT: The school has access to an AT daily as reported by the designated school contact at each school

6. Recruitment Meeting: Meeting at each school during phases 3 when the principal investigator or study contact at the school explained the study and distribute questionnaires to high school athletes and coaches

1.12 Assumptions

1. The athletes and coaches answered the questions truthfully and with maximal effort
2. The questionnaires were valid and reliable
3. The athletes and coaches did not receive help from other sources on the questionnaires
4. Each subject completed the questionnaire according to the directions in the instruction letter
5. All participants were honest about their concussion history and reporting of these concussions
6. The questionnaire was completed in a similar environment by all participants

1.13 Delimitations

1. All participants were players or coaches on the varsity boys'/girls' lacrosse, boys'/girls' soccer, football, or cheerleading team roster at his/her high school
2. All athlete participants were 14-18 years of age
3. Selection of schools was done based on a convenient sample
4. All recruitment meetings were conducted by the principal investigator or assigned study contact

1.14 Limitations

1. All information was self-report

2. All subjects were not completing the questionnaire in the same environment

3. The amount of access to ATs in the AT access schools may not have been the same

4. The sample was not a truly random sample (convenient)

5. Limited return percentage

6. Time of reporting was not assessed

7. Coach influence was only assessed at the school level

1.15 Significance of the Proposed Study

The objective of this study was to assess knowledge, attitudes, and behaviors concerning concussion in high school athletes and coaches in an effort to provide the background necessary for developing evidenced based intervention programs surrounding concussion. There is limited empirical evidence on the behavior of under-reporting of concussion in high school athletes and the behavioral and environmental factors that may influence this behavior. Culture of sport, coach influence, parental influence, teammate influence, knowledge, and self-perception may all influence behavior. However, the influences of these factors on reporting of concussion remain largely unknown. Reporting of concussion is essential in order for athletes to receive appropriate care and management of the injury. Athletes may continue to play with the injury if the injury goes undiagnosed, placing them at risk for further and possibly more complicated injuries.

This study is unique as it was the first to collectively investigate knowledge, attitudes, and behaviors concerning concussion in both athletes and coaches. It was also one of the

first to use health behavior theory in guidance of understanding injury behaviors in sport. This study has the potential to address a large gap in the concussion literature by examining the high school athletic community's perception of concussion, reporting of concussion, and the role ATs may play in the perception and actions related to concussion. This study also aimed to address limitations in the previous study concerning reporting of concussion by using a more diverse sample, collecting concussion reporting data in multiple ways, and controlling for consistency in administration of the survey instrument. To our knowledge, it is also one of the first studies to employ a public health program-planning model in efforts to make recommendations for future concussion related interventions. It occurred at a time when recent public attention was focused on safely returning to play following a brain injury.

CHAPTER II

REVIEW OF LITERATURE

Concussion, although often mild, is a type of brain injury that can lead to cumulative and long-term effects if not identified and managed properly. Even high school athletes with mild concussions, have been shown to experience neurocognitive deficits and increases in symptoms that persist well beyond the day of injury.[47] This raises an issue as these young athletes brains are still developing. Many quality of life factors may be affected as a result of concussive injury at a young age. Not reporting a possible concussive injury to someone in an authoritative position may lead to possible mismanagement of the injury and risk for additional and perhaps more complicated injury.[6, 9, 18] Given these possible effects, it is important to understand the possible reasons behind under-reporting of concussion in high school athletes.

2.1 Terminology of Concussion

The definition of concussion has evolved dramatically over the past 50 years. Despite this evolution, little consistency exists among the medical community. It was once thought that an individual must lose consciousness and/or have amnesia to be diagnosed with a concussion. However, literature over the past 10 years suggests that only 9% of individuals presenting with a variety of concussive signs and symptoms following a blow to the head or body, experience loss of consciousness (LOC) and only 23% experience post-traumatic

amnesia (PTA).[2] Many of the grading scales for concussion also imply that LOC may be the best indicator of severity. More recent literature suggests that LOC is not correlated with recovery, neurocognitive deficits, or symptom increases.[48-50] The role of amnesia is somewhat more controversial. Recent research suggests amnesia is a better predictor of neurocognitive and symptom deficits following injury.[48, 49, 51] Following advancement in concussion research, new grading scales and return to play guidelines have been considered to account for duration of signs and symptoms.[51-55] Despite these developments, very few of these guidelines and grading scales are evidenced based. There are also multiple guidelines and grading scales often leading to variability in management of concussion. This variability in management across clinicians may add to the problem of under-reporting of concussion among high school athletes. Athletes may experience a similar injury that is minimized by one caretaker and managed more conservatively by another. However, steps are being taken to decrease the ambiguity with numerous studies surrounding assessment and management of concussion being conducted every year. Many sports medicine groups have also developed consensus statements in an effort to help standardize and clarify the management of these injuries.[34, 35, 39] Despite these efforts, some clinicians still operate under the assumption that LOC is necessary for a concussion to occur. In 2007 an article was published in the *New England Journal of Medicine*, with this idea included, revealing the issue that more steps should be taken among the medical community to educate individuals on recent important research and ideas surrounding concussion.[56] Studies conducted using professional athletes have also added ambiguity to the definition and return to play dilemma by making statements such as "…with normal medical examinations, although some players may return with headaches" in turn minimizing headache as a symptom of concussion.[57] This article and two

additional articles from a series of articles surrounding concussion in the National Football League (NFL) imply that over 75% of athletes are returned the same day with no later issues, and that very few injuries result in 7 or more days lost to injury.[58, 59] Although these studies are directly related to professional athletes, the authors are critical and quick to refute the findings of more thorough studies on recovery of concussion which suggest long-term effects and a recovery period of 7-10 days for over 90% of injuries in the collegiate and high school populations. The NFL studies attempt to refute studies[7-9, 40, 47, 60-63] suggesting athlete be held out of play until completely asymptomatic. The series of NFL studies also often do not account for concussion history, repeat injuries, and true outcomes (quality of life, memory issues, etc) following injury. These studies provide further ambiguity for younger athletes regarding concussion and may provide information causing athletes to minimize and therefore not report possible concussive injuries. Despite the limitations of these studies, they were among the first to examine concussion in professional athletes and recovery of concussion in this age group of athletes using objective clinical measures. It is important that clinicians realize that these study findings pertain to professional aged athletes and should not be applied to younger athletes. More recently, the National Football League has imposed policies stating return to play during the same game as a concussion occurred is prohibited. However, the negative effects of this policy such as decreased reporting are yet to be determined.

More attention has focused on concussion in high school sports, with a message that many of these athletes may know they have a concussion but choose not to report the injury for various reasons. There has also been an increase in apparent incidence in concussion over the past 5-10 years, which may likely be the result of increased recognition and

awareness.[1, 40, 64] One current study examining self-report concussion history demonstrated that when athletes were asked if they "had their bell rung/dinged" compared to "did you have a concussion," increased reporting of possible concussions and that 92% of individuals reporting concussion symptoms following a possible injury did not indicate a previous concussion. These findings again reinforce the influence of terminology ambiguity on reporting of concussion.[4] Despite varying definitions among the medical community, most agree concussion is a serious injury and should be treated accordingly. The consensus in the literature suggests that the seriousness of concussions, particularly those milder in nature, is still not well understood among the athletic community.

2.2 Epidemiology of Concussion

2.2.1 Overview

Traumatic brain injury (TBI) is one of the most burdensome public health problems across the United States. Traumatic brain injury results in an estimated 1, 224, 000 emergency department visits, 290,000 hospitalizations, and 51, 000 deaths each year.[65] The disabilities following even concussion can lead to many problems decreasing quality of life including emotional, physical, academic, cognitive, and social deficits. An estimated 1.6-3.8 million sports-related brain injuries occur each year according the Centers for Disease Control (CDC).[1] Brain injury in the high school population accounts for 5-10% of injuries, with the majority of these injuries being concussions.[14] Additionally, brain injury in this young population is of particular concern.

2.2.2 Adolescent Population/High School Athletics

Participation in high school athletics has grown from approximately 4 million participants to over 7 million participants over the last 30 years. [13] According to the National Federation of State High School Associations, this number continues to increase with each passing year partially as a result of increased interest but also as a result of population growth. High Schools are also offering increased opportunities for participation through a variety of sports. During 1995-1997, Powel and Barber-Foss examined traumatic brain injury in high school athletes and found that football accounted for the majority of concussions in high school sports. This study included 235 high schools that participated in the study at least 1 academic year from 1995-1997. The study presented the following injury rates per 1000 A-Es and 95% confidence intervals: Baseball 0.05 (0.02-0.07); Boys Basketball 0.11 (0.08, 0.15); Football 0.59 (0.19-1.04); Soccer .18 (0.14-0.22); Wrestling 0.25 (0.24-0.29); Girls Basketball 0.16 (0.12-0.21); Field Hockey 0.09 (0.04-0.15); Softball 0.10 (0.06-0.14); Girls Soccer 0.23 (0.18-.28); and Girls Volleyball 0.02 (0-0.03). From these data, the study also estimated that 60,000 concussions occur among high school athletes each year.[14] More recent data published by Gessel et al. and collected during the 2005-2006 school year suggests the overall incidence of concussion to be 0.23 per 1000 athlete-exposures (A-Es). No confidence intervals were presented in this study with the exception of when rate ratios were computed. Gessel et al reported the following incidence rates per 1000 A-Es for high school sports: Football 0.47; Boys Soccer 0.22; Girls Soccer 0.36; Girls Volleyball 0.05; Boys Basketball 0.07; Girls Basketball 0.21; Wrestling 0.18; Baseball 0.05; and Softball 0.07. The sports above are some of the most common as participants often receive direct blows to the head and face. In these sports, sudden accelerations of the head often also occur.

The Gessel et al study estimated the number of concussions in high school sports annually to be above 135,000 which is more than double the number suggested in the Powell and Barber-Foss study. These studies are two of the largest studies to examine the epidemiology of concussion across the United States in an attempt to make national estimates about concussion. However, these studies have many limitations. Both studies only included schools with access to an AT and many of the findings may not be generalizable to schools without an AT. The definition of concussion across the two studies may also pose an issue. The Powell and Barber-Foss study defined concussion as "a mild head injury identified by a Certified Athletic Trainer which required cessation of play for evaluation before returning to play in the current session or after". This definition included no signs and symptoms and left the identification solely up to the AT, which may lead to bias and variability across concussions and schools. Gessel et al defined concussion as an injury occurring during an athletic practice or game requiring medical attention by the team AT or physician, and resulted in cessation of play for 1 or more days. Again, this definition left the identification solely up to the AT with no clear guidelines as to what was and was not a concussion. The sample in this study is also not nationally representative, despite attempts to increase generalizability. Only after ATs volunteered their high schools to participate were the schools placed in the strata across the country with varying numbers of schools in each strata. The Powell and Barber-Foss study included a greater number of schools and had more strict inclusion criteria in an effort to create a cluster sample representing high schools with different sized student enrollments. The requirements to participate included: the AT work directly with high schools sports programs on a daily basis, work within a geographic distribution among the 50 states, and fit a broad representation from different sized schools

from varying parts of the country. All schools that volunteered were not selected to participate. In the Gessel study all who volunteered where selected to participate. Also, all ATs with a valid email address were invited to participate, which may have limited selection from the initial contact, introducing more bias to the sample selected. Neither of these large-scale studies included cheerleading, lacrosse, or ice hockey, which have been suggested to have a relatively high incidence of concussion. An additional study estimated the incidence of concussion in boys lacrosse to be 0.28 per 1000 A-Es and the incidence in girls lacrosse to be 0.21 per 1000 A-Es.[66] The incidence of concussion among cheerleaders as been estimated to be as high as 0.09 (0.02-0.17) per 1000 A-Es.[67] The incidence of concussion in ice hockey is thought to be one of the highest across all sports. Despite this high incidence, few studies address concussions at the high school level. In 1987, Gerberich[68] reported that concussion may account for over 10% of injuries in hockey which is higher than other sports. Despite these limitations, both studies provide important information related to concussion in high schools sports.

Although college athletes also have a relatively high incidence of concussion, high school athletes are of particular concern as their brain is in an earlier stage of development than college or professional athletes. These young athletes also have the potential for a greater number of exposures than college or professional athletes creating an increased risk for recurrent concussion and cumulative effects. Guskiewicz et al suggested that high school athletes may have a higher incidence of concussion per total 1000 A-Es (1.03) than division I (0.49), division II (0.69), or division III (0.68) collegiate athletes.[62] A more recent study contradicts these findings suggesting collegiate athletes may have a higher incidence of concussion (Rate Ratio 1.82; 95% CI: 1.63, 2.12).[26] Guskiewicz et al had a fewer number of

schools included, but a more specific definition of concussion. The collegiate data was actually also collected in the study along with the high school data. The more recent study used data collected by the National Collegiate Athletic Association to make these comparisons. Most importantly, concussions are occurring at the high school level and need to be managed properly.

These young athletes also have a higher incidence of catastrophic head injury than collegiate athletes.[69] If an athlete chooses not to report and injury and play, a more catastrophic injury may occur. Although rare, catastrophic events such as second impact syndrome may result when an athlete continues to play while concussed following an initial blow to the head. This phenomenon is isolated to younger athletes and should be a reason to treat younger athletes more conservatively. This incidence of catastrophic injury has decreased over the past 30-50 years with increased awareness, rule changes, and new equipment technology, but nonetheless is still significantly higher in the high school athletic population as an increase in these injuries as been seen in 2008. [69, 70]

2.2.3 Impact of Concussion

According to the CDC an estimated 2 million injuries, 500,000 doctor visits, and 30,000 hospitalizations annually are attributed to high school sport-related injuries.[71] Concussion is an injury of particular concern in high school athletes as an estimated 1.6 million to 3.8 million sport-related brain injuries occur each year.[1] Concussion accounts for approximately 10% of injuries in sport; however among high school athletes it is between 5% and 6% of all injuries.[14, 62] As mentioned, a high incidence of concussion, specifically among contact sports is well documented in the literature.[68, 72-75] In addition, other sports such as basketball, soccer, and women's lacrosse also have a relatively high incidence of

concussion.[1, 62, 68, 69, 72, 75-78] Severe consequences such as second impact syndrome may also be a concern for the young athlete. [12]

2.2.4 Risk Factors

Few prospective risk factor studies concerning concussion have been conducted in sport. One of the few identified concussion history, participation in contact sports, and being in the bottom quintile of study athlete body mass indexes to be some of the strongest predictors of concussion rate.[67] Zemper et al also conducted a 2-year prospective study to examine the relative risk of a second concussion among individuals with a concussion history compared to individuals with no previous history of concussion in high school and college athletes. This study suggested that the risk of sustaining a concussion was 5.8 times greater for individuals with a history of previous concussion (95% CI: 4.8-6.9).[10] This study only used data from football players from 42 colleges and 33 high schools over the course of two seasons. However, it does provide epidemiological insight into the risk associated with a previous history of concussion. Anecdotal speculations exist about other possible risk factors for concussion ranging from neck strength, other physical characteristics to location and cumulative magnitude of impacts; however, little to no empirical data exists concerning these factors.

2.2.5 Sex Differences

Some recent studies have also suggested that females may be more at risk for concussion than male athletes, specifically among female soccer and basketball athletes.[26, 76] From these findings, many have made the assumption that overall females are at greater risk. However, caution should be observed with this assumption as this risk is only identifiable among specific sports and when grouped as a whole (with football excluded), the risk for

females is similar to that of that of males. Schulz et al. conducted one of the few prospective studies examining injury rates in high school athletes and found injury rate per 100,000 athlete practices was 4.01 (95% CI: 1.25-6.77) for females and 5.81 (95% CI: 3.30-8.31) for males. The only gender difference observed in this study was between male (2.67/100,000 A-Es) and female (7.94/100,000 A-Es) soccer athletes. Very few explanations for these gender/sex differences have been examined. However, with the possibility of a large number of concussions going unreported, this finding is difficult to generalize. Medical and health related research has shown that females are more likely to seek medical care and report symptoms of many medical conditions than males.[27, 79, 80] These studies are largely focused on more severe health problems and chronic pain, which may not directly translate to athletic injury.

One recent study specifically related to TBI in individuals of all ages found no difference in gender seeking care for concussion. Many of these individuals were older and some had more severe brain injuries.[81] This behavior of increased reporting may contribute to the increased apparent incidence among females reported in the literature. Covassin et al[76] also inferred that female athletes sustain a higher percentage of concussions during games than males with Gessel et al[26] observing that the rate of concussion being higher in practice. Gender differences concerning reporting of concussion are not well understood or studied.

2.2.6 Issues in the Epidemiology of Concussion

Because concussion is such an individual injury that often requires the athlete to actually report the injury, quality epidemiologic data can be difficult to obtain. One of the major issues involves the definition of concussion in many studies. Many of the first and early epidemiologic studies only included concussions resulting in loss of consciousness

which gave estimates as low as 300, 000 sports-related brain injuries each year.[82] Some other studies such as Gessel et al[26], define injury overall more broadly leaving less control over what would be considered a concussion. Much of this difference in definition comes as a result of the lack of agreement among the medical community, which reflects the issue of no gold standard diagnosis technique for concussion. In many cases, specifically milder concussions, these injuries must be reported by the athlete, which may only occur in around 50% of individuals who experience a concussion[15]. Also, much of the information pertaining to the epidemiology has come from schools with access to a Certified Athletic Trainer (AT), which may also influence results of these studies. Individuals, who have access to an AT, may be more likely to report the injury, as there is someone there to manage the injury. Lastly, identifying concussion can be difficult as many of the signs and symptoms may overlap with other conditions and may be influenced by hydration level, fatigue, and time in season.[83-85]

2.3 Pathophysiology of Concussion

The pathophysiology of concussion may be one of the reasons concussion is so difficult to assess and understand. It is a diffuse injury resulting in a variety of signs and symptoms that often differ with each individual concussive incident. This diffuse injury is functional and not structural in nature, leading to issues in developing a gold standard for diagnosis. Concussion does not result in abnormal neuroimaging on standard measures[86, 87] such as magnetic resonance imaging (MRI) and Computed Tomography Scans (CT). As a result, concussion is often undiagnosed by traditional measures. This diffuse injury of concussion often results from accelartion-decelaration forces transmitted through the brain.

From these forces coup (same side) and/or contrecoup (opposite side) injury may result. According to the coup-contrecoup pressure phenomenon, contrecoup injury may produce the majority of deficits in closed head injury.[88] This phenomenon is based on the hypothesis that cerebral spinal fluid (CSF) is denser than the brain itself; therefore, when the skull receives an impact or is suddenly accelerated, the denser CSF moves toward the location of impact with the brain tissue being displaced in the opposite direction. The forces transmitted through the tissue can be compressive, tensile, or rotational in nature. These forces cause a functional disruption in the brain that produces transient neurological deficits.[89] In more severe brain injury, these forces can produce skull fracture and intracranial hemorrhaging.[69, 90] It has been posited that rotational forces result in more severe brain injury and produce increased dysfunction as rotational forces cause increased shearing of the tissue within the brain. However, recent preliminary research has found no relationships between concussive injury and impact magnitude or location.[36-38] More severe brain injury may also often occur as a result of increased force in a focal location but can be a result of a whiplash type of injury. These forces may produce subdural and/or epidural hematomas, subarachnoid hemorrhages, and/or diffuse axonal injury (DAI).[90]

For both severe and mild brain injury, the adult and child/youth brain respond very differently to the forces transmitted through the brain. In an infant, it takes two times as much force to elicit closed head injury compared to an adult brain; however, to elicit skull fracture, it only takes half as much force to cause the skull of an infant to fail compared to an adult. [90] Although the difference is not as much in adolescent or youth, evidence is suggesting more required force to elicit closed head injury including concussion and mild-severe DAI compared to that of an adult.[90] Speculative reasons behind the greater force

required in infants and youth is that the skulls in this age group are not fully fused and developed leading to more attenuation of force in the skull prior to reaching the brain tissue itself. The greater threshold for injury may also be the result of the resiliency of younger individuals to resist injury. However, no empirical studies have confirmed the reasoning behind these findings.

These forces described above produce a complex neurometabolic cascade of events leading to a variety of signs and symptoms of concussion. The cascade is characterized acutely following injury as an abrupt indiscriminant release of neurotransmitters and unchecked ion influxes. There is then further neuronal depolarization with an efflux of potassium and an influx of calcium which all lead to ionic shifts resulting in changes in cellular physiology. During this time the sodium potassium pump works overtime, which requires increased ATP. This increases triggers a dramatic jump in glucose metabolism. This occurs in the setting of decreased cerebral blood flow, and the disparity between glucose supply and demand triggers an energy crisis. This mechanism is thought to be the cause of the post-concussive vulnerability.[89]

Following this, the concussed brain then goes into a phase of depressed metabolism. Increases in calcium may impair cell function and worsen the energy crisis. Unchecked calcium accumulation may also lead to cell death. Although the majority of what is known regarding the neurophysiology of concussion comes from animal studies, new functional imaging techniques are giving insight and paralleling these findings in humans.[91-93] Little is known about the differences in this pathophysiology between adults and youth. One possible reason for the differences may be more diffuse and prolonged cerebral swelling that can occur in the developing brain. Also, the developing brain may be significantly more

sensitive to glutamate N-methyl-D-aspartate (NMDA) excitotoxic brain injury which may cause the developing brain to be more susceptible to the ischemic and injurious effects of excitatory amino acids after brain trauma.[94 95, 96 97] These differences reveal the importance of effectively and promptly managing brain injury in the young athlete and reinforce the need for athletes to report possible brain injuries.

2.4 Signs and Symptoms of Concussion

The most common symptom of concussion is headache, occurring in up to 96% of concussed individuals.[9, 62, 98] Headache is common in non-concussed and various types of headache such as migraine can result is other signs and symptoms similar to those of concussion, making it often difficult to identify the source of headache in an athlete.[99-101] The major determining factor is often a mechanism of injury that could result in a concussion. Second to headache, dizziness, and confusion are the most common of the post-concussion symptoms.[50]

Many post-concussion symptoms resemble conditions such as depression[85], fatigue[102], and dehydration[84]. The base-rates of many post-concussive symptoms are relatively high in healthy, normal individuals.[103] Some of the most frequently endorsed items including headache, fatigue, longer time to think, poor concentration, sleep disturbance, and irritability.[83, 104] With many individuals experiencing these symptoms in the absence of concussion, determining the source of the symptoms may be difficult. Athletes may have a hard time associating these signs and symptoms with a concussive injury. It may also be that more "severe" concussions (increased symptom presence, severity, and duration) are reported more often than concussions presenting with fewer, less severe, and shorter lasting signs and

symptoms. Many of the signs of concussion are also not as visible as signs of other injuries. There are often not many immediate changes in the outward appearance of a concussed individual, making it more difficult to identify and manage.

The signs and symptoms may present in a variety of combinations and may change in presence and severity during the recovery following a concussive injury. In approximately 20% of concussed individuals, there is a delayed onset of symptoms in which symptoms increase in number endorsed and severity around 48 hours post-injury.[2] Because many of these symptoms are often associated with other issues, athletes may overlook or minimize the presence of many symptoms. Also, athletes with the delayed onset may be more likely to report the concussion when the symptoms worsen and not initially. This can be alarming as more severe brain injury, such as a subdural hematoma, may also present in this manner and continuing to compete with a possible brain injury may place an athlete for a second and possibly more severe, even deadly injury.[69, 105]

2.5 Assessment and Recognition of Concussion

Assessment of concussion can be a difficult task as there are many things to consider and many symptoms are based on self-report from the athlete. Current literature and experts suggest a comprehensive approach using a clinical evaluation, symptom assessment, balance assessment, and neurocognitive assessment. Broglio et al[106] found that using a combination of a symptom checklist, balance assessment, and neuropsychological testing yields sensitivity over 90% while neuropsychological testing alone is only around 79%, symptom assessment 68%, and balance assessment only 62%. Although important, this study is limited by the timing of the test following injury and from baseline. Both of these time

frames varied across subjects. The definition of concussion, which was defined as 1 standard deviation change from baseline performance, may also have lead to some injuries not being included. Using this compilation of assessment tools may lead to a better picture of what the patient/athlete is experiencing and my in turn help clinicians make better, more informed decisions surrounding management and return to play.

2.5.1 Symptom Assessment

A symptom checklist is one of the most commonly used clinical measures in the assessment of concussion. Approximately 75% of certified athletic trainers (AT) employ some form of a symptom checklist in evaluation of concussion.[107] The symptom checklist has been used in various studies and has been shown to be a valid and reliable clinical tool.[108-111] Studies suggest it to be reliable and valid when administered by the clinician and across age groups from children to adults.[108, 111] These symptom checklists typically include symptoms such as headache, fatigue, neck pain, and drowsiness. These symptoms are commonly experienced on a regular basis by healthy individuals.[83] This reinforces the need for an accurate assessment of symptoms both pre- and post-injury. Having other objective measures to use in the assessment of concussion may also assist in identification and management, as these checklists are all self-report by the athlete. The athlete may not always be truthful regarding symptom presence and severity.

2.5.2 Neurocognitive Assessment

Neurocognitive assessment has risen to the forefront of concussion evaluation over the past 15 years[48, 50, 60, 112-115], by providing objective assessments of cognitive function for clinicians to use. Recent literature questions the utility of many of these tests and batteries due to low reliability and limited psychometric research.[116-118] The research that has been

done on reliability is limited by the time between test sessions. The testing environment of the athlete also often limits many studies related to neuropsychological performance. Nonetheless, these tests can give us valuable information following possible injury. Many consensus statements have recommended the use of some form of neurocognitive assessment into the evaluation of concussion.[34, 35, 39] Some of the most common simple cognitive tasks include 3 word recall, delayed recall, serial 7s, and months of the year backwards. One other quick cognitive tool is the Standardized Assessment of Concussion[119, 120] that was designed as a side-line assessment tool of mental status. Although it is not a neuropsychological test, it can give a more objective measure of cognitive functioning than the simpler task mentioned above. There is a lack of use of objective measures in athletic situations where no AT or other medical professional is on the sideline, which may contribute to the problem of under-reporting among high school athletes.

2.5.3 Balance Assessment

Balance assessment has also been recommended as a component in a concussion assessment program. Like neurocognitive testing, there are many ways to assess balance from a simple Romberg test to computerized forceplate measures.[50, 121] There is also a clinical field test, the Balance Error Scoring System (BESS) that offers a cheap, objective way to assess balance on the field following a possible concussive injury. The athlete performs six trails consisting of 3 different stances done on both a firm and a foam surface. The stances include double leg, single leg (on the stance leg), and tandem (with the stance leg in the back). Errors are recorded if the individual lifts hands off of their iliac crest, abducts or flexes their hip to greater than thirty degrees, steps, stumbles or falls, opens eyes, lifts their toes, or remains out of the testing position for greater than five seconds. A higher score

indicates a greater deficit in postural stability. Due to individual variability, baseline measures are important to determine the severity of deficit following injury. [122] Baseline measures provide an individual normative value which is often more useful in interpretation of change in scores following an injury. Fatigue has also been shown to play a role in decreasing postural stability and should be taken into account upon evaluation.[102] The BESS has also been shown to elicit a practice effect after repeat administrations [123] There are significant correlations between the BESS and force-platform sway measures established using normal subjects on single-leg stance-firm surface, tandem stance-firm surface, double leg stance-foam surface, single leg stance-foam surface, and tandem stance-foam surface. Intertester reliability coefficients range from 0.78-0.96.[124] Again, although the BESS and/or other postural stability tests provide a valuable piece of information regarding deficits following a concussive injury, it should be used in conjunction with other clinical assessment measures.

2.5.4 Comprehensive Assessment

Although these individual measures provide some useful information the combination of tests including symptom assessment, neurocognitive assessment, and balance assessment is most useful.[106] Individually, these measures are only around 60% sensitive to concussion. If measures are not used in combination, many concussions may go unrecognized, which could be a contributing factor to the large number of unidentified concussions in the high school athletic population. Also, individuals who report no symptoms, may have other deficits resulting from the concussive injury. A recent study found that 38% of athletes reporting no symptoms still displayed deficits on at least 1 neurocognitive measure, again reinforcing the need for a comprehensive assessment.[60] This study was however a

preliminary study and only included 21 concussions most of which were mild in nature resolving within 5 days. Despite these limitations this study is one of the first to report that other deficits may be present in the absence of the athlete reporting symptoms. This finding further suggests the importance of using more objective tools in the assessment of concussion.

2.6 Recovery from Concussion

2.6.1 Short Term Recovery

Most studies examining recovery following sports-related concussion have examined short-term recovery on symptoms, balance, and/or neurocognitive measures.[17, 50, 98, 115, 125] Many of these studies compare subjects to their own baseline measures and/or to a control group, in order to investigate the time period of recovery from concussion. From the combined results of these studies, most individuals return to baseline symptom levels, baseline neurocognitive performance, and baseline balance performance within 7-10 days post-injury.[2] Balance typically recovers between days 3 and 5 post-injury[50, 126, 127], with symptoms often returning to normal between 7-10 days. [50, 51] Neurocognitive measures also reveal recovery time frames in this range. However, one recent study demonstrated that 38% of individuals in the sample still displayed deficits in at least 1 neurocognitive area once reporting asymptomatic following a concussion.[60] These recovery times may be affected by a variety of things including age[17, 18], previous concussion history[6, 9], and management of previous injuries.

It is also within this first week following injury, that many repeat injuries occur. Giza and Hovda[89] proposed the reason for many injuries occurring in this time period is the ongoing energy crisis occurring within the brain which leads to increased vulnerability.

Given the evidence of this related physiology and the clinical evidence of most repeat concussions occurring within one week of the initial injury, it is imperative that the initial injury be reported and managed properly. However, despite this evidence, many individuals choose to not report concussions leaving these athletes in vulnerable and even dangerous situations on the playing field.

2.6.2 Long Term and Cumulative Effects

Little research has focused on the long-term effects and outcomes following concussion. Some studies conducted using retired professional football athletes suggests that clinical depression, mild cognitive impairment, and overall decreased quality of life may all be consequences of multiple concussions, especially 3 or more.[7, 8] In high school athletes, individuals with a history of multiple concussion have been reported to have decreased grade point averages[18] and increased on-field severity of subsequent injuries.[6] Headache presence on a regular basis has also been shown to be associated with previous history of concussion with high school and college athletes with a history of 3 or more concussions being over 3 times more likely to experience headache on a regular basis.[98] Although these studies are important, as they indicate the risks of sustaining multiple concussions, many of them were based on a small number of repeat injuries. Despite the limitations, all of these consequences can lead to a decreased quality of life at a young age as a result of decreased school success and possible lasting symptoms. Many individuals may not realize these consequences and continue to choose to not report possible concussions to someone in an authoritative position as younger athletes may feel they are invincible to these effects as a result of being so young.

One of the few prospective studies to follow people for 5-7 years following concussion found that individuals who had suffered concussion reported more

postconcussive symptoms and decreased health related quality of life even 7 years after the brain injury itself than age and sex mAThed controls with not history of concussion.[128] Although many of these subjects were between the ages of 30-40, this study reveals possible long-term effects of even mild concussion. Current literature also suggest that overall outcome may be related to the individual's perception of the negative consequences of the concussion and symptoms.[129] Ettentopher et al suggested however, that a single concussive incident may have little to no effect on overall outcome.[130] This finding is consistent with the sport concussion literature suggesting a significant difference in recovery between individuals with 3 or more concussions, compared to those with 1-2 or no previous history.[6-9]

One prospective survey design study using children and adolescents suggested that concussion resulted in no decline in the children's health outcome after injury; however this study had a very small, non-representative sample in a wide age range.[131] This study also did not assess number or severity of the concussions in subjects. These findings should be viewed with caution. It has also been suggested that children with complicated concussion (bleed, etc) may be more likely to experience mild neuropsychological impairment throughout life compared to adults who experience the same injury. This study also suggested the greatest predictors of long-term neuropsychological outcome were: length of post-traumatic amnesia (PTA) and EEG activity within 24 hours of injury.[132] In extreme cases of a second impact occurring while the brain is in a more vulnerable conditions, second impact syndrome (SIS) may result. Second Impact Syndrome occurs when the brain looses auto-regulation of blood flow, extreme intracranial bleeding occurs and results in 50% mortality and 100% morbidity.[95, 133, 134] Second Impact Syndrome is not agreed upon across the medical community, as some clinicians and researchers question the diagnosis.[135, 136]

Another term used for this type of even is Malignant Cerebral Edema.[135] The argument behind this terminology is that a second impact does not have to occur for this type of lack of autoregulation of blood flow leading to catastrophic outcomes to result.[135] However, a growing number of cases are suggesting it to be a rare, but realistic phenomenon isolated to young athletes. [134, 137] The possible long-term outcomes following concussion can range from mild to severe. It is important for athletes experiencing a possible concussion to report it to someone so the injury can be evaluated and managed properly.

2.7 Athlete Knowledge and Attitude Surrounding Concussion

2.7.1 Adolescent and Athletes Values

When considering behaviors of athletes, the values and quality of life issues among high schools athletes must also be examined. These values may contribute to behaviors and environmental factors relating to the issue of recurrent concussion.

High school athletes' values are similar to the values of other adolescents including relationships with peers[32, 138], their relationship with their parents[28, 139] and success in school. [140] Athletes also value "toughness"[141, 142], their relationship with their team including their coach and teammates, [28, 33] and athletic performance.[29, 140, 142] Toughness is often defined among athletes as the ability to play through pain and adversity. There is limited information on values of high school athletes. Therefore, inferences must be made from values and behaviors of collegiate athletes. Both athletes and coaches often attribute "Toughness" to athletic success. Toughness is best defined as playing through "adversity" and "pain" both physically and mentally. Although toughness can be a good attribute (staying focused and giving 100%), it can also lead to risky behaviors and underreporting of injuries.[143-145] These

two factors are particularly alarming as the CDC reports a leading cause of death among adolescents is unintentional injury. This risky attitude also leads to other health issues common among adolescents including a higher prevalence of alcohol usage, not wearing seatbelts [143] and perhaps even poor nutritional behaviors leading to eating disorders. [144-146] These "risky" attitudes and behaviors may carry over into sport with athletes choosing not to report possible injuries and to play while injured. Many other psychological factors may interact with these to result in decisions made by athletes concerning injury.

2.7.2 Influence of Teammates

Little is known about the influence of teammates on athletic injury and recovery. However, peer acceptance is extremely important in the adolescent population. When playing sport, teammates are immediate peers. McCrea et al.[15] found that of the 963 individuals with a possible concussion, over 50% did not report the injury, and 22% of those who did not report the injury, did not do so because they did not want to let their teammates down. This study is the only study to examine specific reasons for choosing not to report concussion and although self-report, brings important points to the forefront of discussion in an attempt to begin addressing the behavior of not reporting possible concussions. Other sports injury literature has also indicated that when injured (any injury), athlete report feeling guilty, frustrated, alienated, lonely, and sad over letting their team down and not having normal daily interaction with teammates. [147] This culmination of reasons may serve as a major factor in the under-reporting of concussion among high school athletes.

2.7.3 Psychology of Injury

Psychology of injury may also play an important role in reporting of concussion and continuing to play with a possible concussive injury. Many pre-injury factors may affect an

athlete's response to being injured. The factors often include personality, history of stressors, and coping resources. All of these pre-injury factors may also be influenced by the athletes previous history of concussion and how that concussion was managed, time lost to the injury, and the effect of the injury on athletic performance.[148, 149] Following injury there are many psychological stressors including athletic identity, self-esteem, and body image.[150] Many of these psychological stressors align with the values of this age group. There are also sociologic stressors that may play a large role, specifically in reporting of a possible injury. These include, sport environment, sporting network influence, parents, coaches, and teammates. The opinions and actions of individuals in the social network may play a large role in the response and action an athlete take following a possible injury. Many of these factors can be classified as personal or situational (behavioral and environmental). **Table 3.6** lists the personal factors and situational factors leading to a behavioral and emotional response. Many of the listed factors such as level of play, gender, time in season, practice vs. game, and type of sport are also known to be influential on incidence of injury in sport. With so many possible factors it may be impossible to differentiate the exact cause of under-reporting of concussion; however, it is possible to use these as a guide to understand which ones of these may be most influential in the behavior of not reporting concussion in high school athletics.

2.7.4 Knowledge and Attitude Concerning Concussion

Few studies have directly assessed knowledge and attitude concerning concussion among athletes. Studies indicate that over 50% of concussions go unreported and that an equal number of high school and college athletes continued to participate, while experiencing symptoms associated with concussion. Many of these athletes failed to recognize common

symptoms associated with concussion, and also reported not knowing that their injury could have been a concussion.[3, 5, 15, 69] Reasons for athletes choosing to not report a concussion included, not thinking it was serious enough to report, did not want to leave a game, did not know it was a concussion and did not want to let teammates down[15] all of which tie into the values of the athletic population. The only other study to specifically examine knowledge and under-reporting, examined these characteristics in collegiate athletes and was never published in full article form. This study suggested that 80% of concussions may go unreported, and that knowledge of concussion may increase if an AT gave the concussion information. In this study 73% did not report the injury because they did not think it was serious enough to report.[151] Despite the overwhelming problem of under-reporting of concussion, few studies have addressed knowledge, attitudes, and behavior of high school athletes concerning concussion.

2.8 Coach Knowledge and Attitude Concerning Sports Related Concussion

2.8.1 Coach Values and Attributions to Success

Current and past research suggests strong influences of coaches on their athletes' attributions to success, sportsmanship and overall attitude in sport. These studies reinforce the influence of a coach on the overall decisions and behaviors of their athletes. With this mind, it is apparent that perception of coaches' attitudes and coach behaviors may directly influence reporting of concussion, especially in high school athletes. Studies also suggest a strong relationship between coaches' attribution to success and athletes attribution to success in youth and high school athletes in that what coaches believe brings success (toughness, etc), his/her athletes also believe.[28, 152] These studies were limited by self-report; however,

subjects did not complete the questionnaire in the presence of their coach. This unique relationship between coach and athlete brings a powerful dynamic to reporting of injury and makes it even more essential that a coach and his/her athletes discuss responses and management of possible concussions prior to the incident occurring, leading to possible increased reporting and better management of injuries.

2.8.2 Coach Knowledge and Attitude Concerning Injury and Concussion

Limited research has focused on the coaches' role in reporting and management of concussion in athletes. The coaches' primary role is to help increase the team's performance and ultimately to win. This may present a conflict of interest when an athlete reports and injury. One of the few studies to examine coach knowledge suggested that youth sport coaches shared many common misconceptions about concussion and only recognized an average of 9-10 out of 16 common concussive symptoms. However, this study also found that coaching education was predicative of a coach's ability to recognize signs and symptoms of concussion.[5] Little is known about the influence of the coach on athletes reporting of injury. There have been initiatives aimed at educating coaches, including a tool-kit for coaches disseminated by the Centers for Disease Control.[71] Although coaches who used the tool-kit reported finding it helpful, little to no research has been conducted to assess how coaches' views may affect athlete behavior. Because the coach is often on the field when injuries occur, it is essential to determine their role, knowledge, and attitudes surrounding concussion high school athletics. The only study to examine influence of coach knowledge and attitude on athlete reporting suggested a significant correlation between these characteristics[151], reinforcing the possible influence of the coach.

2.9 Concussion Intervention and Education Programs

Despite advances in interventions concerning injury prevention and education, little has been done to examine these types of programs specifically related to concussion in sport. The concepts surrounding other types of injury prevention may also be applied to concussion. Limitations surrounding these other injury programs are also issues for concussion prevention programs. Few programs exist regarding prevention of concussion. Existing programs are based on limited empirical evidence and expert opinion. The most popular of these are the tool-kits disseminated by the Centers for Disease Control. There are three main tool-kits: 1) Heads Up: Concussion in High School Sports and 2) Heads Up: Concussion in Youth Sports 3) Heads Up: Brain Injury in Your Practice. The high school tool-kit is aimed at coaches and contains a guide for coaches, a symptom assessment card for coaches, a clip board sticker, an athlete fact sheet, a parent fact sheet, a video for coaches to show athletes, and information on access to the CDC's website. Research available on the dissemination of the high school tool-kit suggested that coaches who used the tool-kit found it useful and easy to understand. [41] However, no information is known about how many coaches across the country used the tool-kit and how coaches' implementation of the tool-kit may change athlete behavior regarding concussion.

The youth sports tool-kit includes a fact sheet for coaches on concussion, a fact sheet for athletes on concussion, a fact sheet for parents on concussion, a clipboard with concussion facts for coaches, a magnet with concussion facts for coaches and parents, a poster with concussion facts for coaches and sports administrators, and a quiz for coaches, athletes, and parents to test their concussion knowledge. The medical professionals tool-kit includes information for the physician (letter, management information and fact sheet) and

information for patients (letter and fact sheet), The youth and the medical professional tool-kits only recently become available to the public and little to no research exist on the dissemination or the effectiveness of these tool kits. There are numerous other videos and independent concussion awareness programs. These are not evidenced based and no information on their effectiveness in changing athlete behavior or prevention of concussion exists.

This lack of empirical evidence for intervention and evidence based programs demonstrates the need for research investigating athletes' and coaches' knowledge, attitudes, and behaviors concerning concussion as well as the problem of under-reporting in the athletic population, specifically younger athletes. The lack of multi-level interventions, or interventions addressing more than knowledge alone, also reveals a need for further empirical evidence surrounding prevention and reporting of concussion. Public health literature indicates that interventions involving community values and opinions are often more effective and lead to better compliance.[44, 46] This model is seldom followed in the sports-medicine community and has potential for great influence concerning sport-related concussion.

2.10 Review of Literature Related to Methods

2.10.1 Justification for Subject Population

There are over 7 million high school athletes with only approximately 40% of these athletes having access to an AT.[13, 21] These athletes are not as physically mature as their college and professional counterparts. High school athletes take longer to recover following concussion and are at risk for sustaining more concussions over their lifetime than older

athletes.[17, 18] High school athletes also have a significantly higher incidence of catastrophic head injuries compared to older athletes, often a result of mismanagement of a prior injury resulting in a possible second impact syndrome.[12, 52, 133, 134] These athletes are also students who have much of their lives in front of them and improper management of concussions and/or multiple concussions could leading to long term problems including decreased quality of life and issues such as memory problems and depression.[6-9] These possible complications make it all the more important for high school athletes to report possible concussions to someone in an authoritative position and for these authorities to ensure proper referral and management of any possible concussive injury

2.10.2 Applying Theories of Reasoned Action and Planned Behavior to Concussion Reporting

The theory of reasoned action (TRA) was first developed in 1967 and refined in 1975. It is addresses the relationships between beliefs, attitudes, intentions, and behavior. The theory itself was developed by Fishbein[44] in efforts to explain the relationships between attitude and behavior. This theory also places a significant value on social referents which is very important in athletics. The constructs central to TRA related to attitude and social normative perceptions that determine behavioral intention and the effects behavioral intention on behavior.[153] In his theory, Fishbein distinguished between attitude toward an object and attitude toward a behavior with respect to that object. His early work also demonstrated that attitude toward a behavior is a much better predictor of that behavior than attitude toward the target at which the behavior is directed. An example related to reporting of concussion would be an athletes' attitude about concussion compared to an athletes' attitude toward reporting a concussion, with attitude toward *reporting concussion*

theoretically being a better predictor of athletes likely to report a concussion to someone in authority. This theory has often been used in addressing exercise behaviors and adherence to exercise programs.[154-158]

The theory of planned behavior (TPB) is not an independent theory but an extension of TRA. The TPB includes constructs concerned with perceived control over the performance of the behavior. Both the TPB and the TRA assume that demographics, the environment, and other factors operate through the theoretical constructs, not independent of these constructs. **Figure 3.1** is a schematic representation of the TRA and TPB. **Table 3.7** includes the constructs and definitions from both theories.

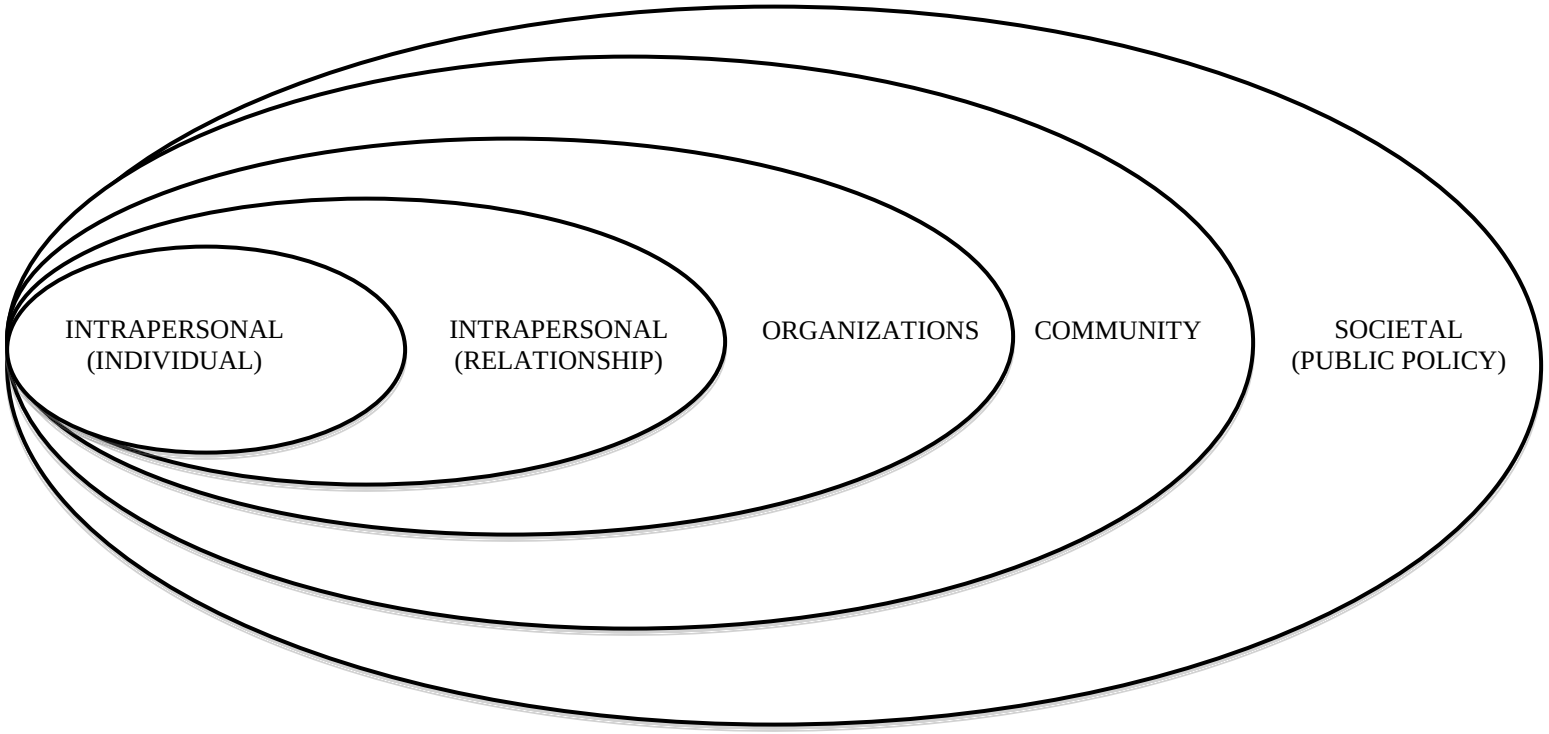
2.10.3 Applying the PRECEED Planning Model to Concussion

Through applications of the PRECEDE planning model, quality of life issues pertaining to high school athletes and behavioral and environmental determinants that contribute to the prevalence and incidence of recurrent concussion in high school athletics will be identified and prioritized. With these determinants in mind, we will assess and prioritize pre-disposing, reinforcing, and enabling factors that may influence the prioritized determinants. We will also identify political, economic, historical and/or structural barriers to addressing our prioritized determinants, factors, and health outcomes. The information obtained from the PRECEDE planning model will then be used to make recommendations for a multi-level intervention concerning the reporting and prevention of recurrent concussion. **Figure 3.3** displays the model used in the PRECEDE planning process.

2.11 Summary of Rationale for the Study

Concussion is a complex injury that can result in a variety of signs and symptoms that may often be confused with other conditions or injuries. It is an injury to the brain and should be recognized and treated as such by athletes, parents, coaches, and medical professionals. Because of the lack of a gold standard for diagnosing concussion, ambiguity over the medical definition has trickled down to athletes and coaches alike leading to a misunderstanding of the injury and the consequences of concussion. To date, no study has concurrently examined knowledge, attitudes, and behaviors of high school athletes and coaches in an effort to understand how to address concussion reporting and management in this young athletic population. In addition, most concussion prevention efforts have been focused on one level of the socio-ecological framework, mainly intrapersonal. Figure 2.1 illustrates this framework. This study aimed to identify targets at various levels of the frame work in order to make recommendations for a multi-level intervention as the more levels of this framework addressed, the more potential success for change. Despite the efforts of organizations to put out educational programs and materials, none of these materials are based on empirical and population evidence leading to anecdotal based prevention and educational programs. This study attempts to bridge the gap pertaining to knowledge, attitude, and behaviors concerning concussion in high school athletics and hopefully inform the future development of interventions concerning concussion.

Figure 2.1 The Socioecological Framework



CHAPTER III

METHODS

3.1 Research Design

A clustered, cross-sectional study design was used to assess the knowledge, attitudes, and behaviors of high school athletes and coaches concerning concussion. The athlete survey instrument was developed via experts and the guidelines for the Theory of Reasoned Action and Planned Behavior (TRA-TpB) **(Figure 3.1)**. The coach survey instrument was developed via experts and pilot testing. High school athletes and coaches for football, boys/girls soccer, boys/girls lacrosse, and cheerleading at 25 high schools completed separate survey instruments **(Appendix 3 and Appendix 4)**. Coaches and athletes completed the survey instrument on their own time following a study recruitment meeting run by the principal investigator or the designated school contact at the respective schools. Completion of the survey instrument by athletes and coaches involved the subjects answering questions concerning concussion. Knowledge questions were centered on knowledge of concussive symptoms, management of concussion, and consequences of concussion. Attitude related questions addressed attitudes concerning concussion education and reporting of concussion. Behavioral questions examined reporting of concussion in athletes and management of concussion by coaches.

The *main outcome measures* of interest were coach and athlete knowledge scores calculated from responses on the survey instrument (total number correct), the coach and

athlete attitude score calculated from answers on the survey instrument (totaling the attitude Likert score answers), and the proportion of concussions athletes indicated as reported and not reported across different reporting variables. Sections 1.8 and 1.9 provide a clear description of the independent and dependent variables for each aim. Leading up to the main portion of the study, in-person elicitation interviews were conducted with high school athletes and coaches to better inform the survey instrument and results.

Figure 3.2 illustrates the conceptual framework for the study. For research question 1, the average of the knowledge and attitude outcome scores of coaches at each school were used to assess correlations between coaches and their athletes' responses. **Table 3.1** lists the constructs for the athlete and coach questionnaires that were used to calculate these scores for Research Question 1. Information surrounding concussion reporting was obtained from the athletes' self-report concussion history portion of the questionnaire. **Table 3.2** lists the independent and dependent variables for each aim.

3.2 School Selection Procedures

Thirty-seven high schools were selected using a convenience sample. A total of 28 high schools participated in the study and survey data was returned from 25 or the 28 schools. These high schools were selected by conducting a targeted search in the 9 states of interest for both private and public high schools. **(Table 3.3)** Schools and school districts in these areas were then contacted via email regarding the study and approval. After all necessary school district and/or school approvals were obtained, the individual school contacts were sent an email **(Appendix 7).** Schools responding yes and following through with the initial study requirements were chosen as study participants. The 28 participating

schools were from 9 different states (Arizona, Colorado, Florida, Connecticut, Maryland, North Carolina, South Carolina and Virginia). The schools in each state were in close geographic proximity to each other. Seventeen of the 28 schools had daily access to an AT and 11 had no access to an AT. Of the 25 schools with returned data, 15 had daily access to an AT and 10 ha not access to an AT. **Table 3.3** includes the clusters included in the study by state. Access to an AT was defined as the school's athletes having access to an AT on a daily basis.

3.3 Participants

The study population of interest was high school students and coaches participating in/coaching varsity football, boys' soccer, girls' soccer, boys' lacrosse, girls' lacrosse, and cheerleading. These sports were selected as they each have a relatively high incidence of concussion and with the exception of football, little data exists on management and incidence of concussion for these sports in the high school setting. A total of 167 athletes and 59 coaches completed and returned the questionnaire (8% and 24% respective return). Athletes and coaches (head coaches and assistants) participating in or coaching varsity football, boys' soccer, girls' soccer, boys' lacrosse, girls' lacrosse, and/or cheerleading were included. Other than participation in, or coaching of these varsity sports, the only additional inclusion criteria was that athlete subjects be 14-18 years old. Participation in sport was defined as being on the roster as an athlete or a coach.

3.4 Instrumentation

3.4.1 Description of Instrumentation

Two interview scripts, 1 for athletes **(Appendix 5)** and 1 for coaches **(Appendix 6)** served as the instrumentation used in the personal interviews to further develop the Theory of Reasoned Action and Planned Behavior questions on the athlete survey instrument. These interview scripts contained questions concerning perceptions of concussion in high school sports. These scripts were developed using expert opinion, and previous literature. The interview information was used to inform the survey instrument and results.

Two separate survey instruments, 1 for athletes **(Appendix 3)** and 1 for coaches **(Appendix 4)** served as the primary instrumentation. These survey instruments were pre-tested for face validity by 3 content experts and by 50 high school athletes and 26 coaches at 5 area high schools in North Carolina. The agreement across test times for all items to be used on the questionnaires was at least Kappa=0.5. For Likert Scale questions, the mean difference was lower than 0.4 for all items on both questionnaires. The overall description of pre-test data results including means is included below. These survey instruments assessed coach and athlete knowledge and attitudes concerning concussion, and behavior patterns surrounding reporting of concussion.

3.4.2 Pre-Test Data Initial KAB Questions (Athlete and Coach)

At the time of study initiation, no validated instruments assessing knowledge, attitudes, and behaviors concerning concussion concurrently in high school athletes and coaches. To determine the reliability of our instrument, we pilot-tested the questionnaire at 4 high schools. Athlete subjects participated in boys' lacrosse, girls' soccer, or boys' ice

hockey. Coach subjects were from a variety of sports including football, lacrosse, soccer, baseball, and track/field.

We secured 50 high school athletes (21 males, 29 females) from 53 recruited to pilot the athlete survey instrument and secured 30 high school coaches out of 50 to pilot the coach survey instrument. Twenty-six (21 males, 5 females) completed the survey instrument both times. These coaches and athletes were from a variety of sports with the only inclusion criteria being participating in or coaching a high school sport at time of test administration during the Spring of 2008.

Athletes were given the survey instrument by a member of the research team during a team meeting and took the survey instrument two times approximately 20 minutes apart. Coaches also took the survey instrument two times 20 minutes apart but on their own time. The questions during the second administration were in varying category orders (knowledge, attitude, behavior) for athletes and coaches. The decision to have both test times on the same day was to minimize the influence of acquired knowledge and discussion among subjects between administrations.

For the coach and athlete data, Kappa tests of agreement were run to assess agreement across test session for categorical responses. The purpose of the Kappa statistic is to adjust for agreement that is due to chance alone. If there was a possibility for multiple responses to questions, each response was treated as a separate variable. For Likert scale questions, the mean difference for each question response was calculated. A paired samples t-test was also used to assess if there was a significant difference in responses across the two test sessions. Demographic responses were not included in the pilot analyses.

All coach questions **(Appendix 4)** with a categorical response displayed at least moderate agreement with a Kappa of 0.60 or higher. Many of the questions revealed very high agreement with a Kappa of 0.81 or higher. All Likert scale questions revealed no significant difference between test 1 and test 2 with $p > 0.30$ on all questions. Significant correlations between test 1 and test 2 were also observed with a high, observed correlation (0.70) for all questions and mean differences of less than .2 across the two test sessions. No Kappa values were computed for questions in which the response was the same for all participants in test 1 and this same response was given in test 2. In addition, no Kappa values were computed when there was no variation in a response among participants within and between test sessions on the questions pertaining to consequences of multiple concussions and returning to play while symptomatic. In these cases, all participants responded the same across test sessions.

For athlete data on the questionnaire **(Appendix 3)**, all categorical responses yielded a Kappa statistic of 0.35 or higher, which indicates at least fair agreement. The only item with a Kappa less than 0.5 (moderate agreement) was "chest pain" on the symptom recognition and this question was not included in the final questionnaire. No Kappa values were computed for questions 5 and 6 of Section 1, Part 4 as all participants responded the same across test sessions or the second responses did not yield a response that was indicated in the first; however for each variable in questions 5 and 6, Spearman correlations between response 2 and response 1 were assessed with correlations being $\rho > 0.6$ for all items. All but 2 of the Likert scale questions (Section 1, Part 5) yielded no significant mean difference across test session. The two Likert scale questions yielding a significant mean difference between response 2 and 1 were questions 1 and 5 on Section 1, Part 5; however, the mean

difference for question 1 on Section 1, Part 5, surrounding symptoms following a blow to the head was only 0.4±0.70. For question 5 on Section 1, Part 5, surrounding concussion education the mean difference was only 0.31±0.71 which are both clinically insignificant. No mean difference for any Likert scale question exceeded 0.4.

For coaches, we found that respondents consistently reported the test responses across two administrations of the instrument on the same day. However, there was more variability in the athlete responses across the two administrations of the instrument. As a result, we elected to delete the question involving chest pain as a symptom of concussion as this question had a Kappa below 0.50. All remaining questions have Kappa values above 0.50 for both players and coaches or significant correlations across test sessions. Ordering of the questions did not affect responses for either coaches or players.

3.4.3 Pre-Test Data TRA-TpB Questions

Following the required elicitation interviews described below in section 3.5.1, all interview data was analyzed using Atlas T.I. (ATLAS.ti GmbH, Cologne, Germany) for common themes throughout the interview. These results yielded common behavioral, normative, and control beliefs about reporting of concussion as well as relevant referent individuals and groups regarding concussion reporting. **Table 3.4** illustrates these elicited responses. Based on these responses, questions for the athlete survey instrument were developed following the guidelines of TRA-TpB. Following the development of these questions the complete TRA-TpB instrument was piloted on 9 male high school athletes with 6 of these individuals repeating the questionnaire 10-14 days following the initial completion time. For the second completion, the order of questions was different than the first. Cronbach's alpha was calculated for internal consistency of direct measures of TRA-TpB.

Paired samples t-test were run comparing mean differences across time for all concepts both direct and indirect per the guidelines of TRA-TpB. **Table 3.5** includes the consistency and mean difference values for all constructs and the questions used to assess each construct. Mean differences were used to assess consistency across time as only 6 athletes completed the questionnaire during a second test session. No significant mean differences were observed. Each construct consisted of 3-5 questions. For clarity regarding mean differences, all items were calculated using a 1-7 Likert response. For the actual questionnaire, 3 of the constructs, as indicated in **Table 3.5,** were scored using a semantic differential scale.

3.5 Procedures

This dissertation project involved 4 phases. The *first phase* took place November 2008 – April 2009 and involved personal elicitation interviews with athletes and coaches. *Phase 2 (July 2009 –February 2010)* involved school recruitment. The *third phase of the study (September 2009-February 2010)* consisted of subject recruitment and data collection. The *fourth and final phase* involved final data analysis and completion of the project.

3.5.1 Phase 1- Personal Elicitation Interviews

Prior to initiation of the project, institutional review board approval was obtained. In January-April 2009, the research team identified 17 high school athletes and 10 high school coaches (Raleigh, Durham, and Chapel Hill) to participate in personal interviews. The personal interviews consisted of varsity football, cheerleading, boys'/girls' soccer, and boys'/girls' lacrosse athletes and coaches. A script of the personal interview questions for athletes is in **Appendix 5**. An interview script for the coaches is in **Appendix 6.** The interviews were in person and in depth and lasted approximately 15 minutes. The interview

consisted of both open and closed ended questions addressing: reporting of concussion, perceptions of coach and teammates attitudes towards reporting of concussion, reasons for not reporting concussion, and overall knowledge and attitude surrounding concussion. These interviews were audio recorded, transcribed, and analyzed using univariate statistics for closed ended questions and content analysis for the open-ended questions. The primary purpose of these interviews was to gather information used in the development of additional questions for the survey instruments. Specifically to develop questions aimed at assessing concepts embedded in the TRA-TpB via eliciting behavioral, normative, and control beliefs about reporting of concussion as well as relevant referent individuals and groups regarding concussion reporting. The TRA-TpB calls for this type of interview in order to develop appropriate questions. In addition the interviews were used to elicit factors that may enhance or impede athletes' abilities to report concussion. This information is discussed descriptively and assisted in the inventory and prioritization behavioral and environmental factors in the PRECEDE planning model.

3.5.2 Phase 2 School Recruitment

In July 2009 – February 2010, the research team recruited schools from all 9 states to participate in the survey instrument portion of the study using the methods described in section 3.2. Prior to this period research approval was obtained from each school or school system used in the study. Once identified, the research team contacted **(Appendix 7)** the athletic director at each school to assign someone serve as the school contact (athletic director, faculty member, or athletic trainer) and to determine if the school employs the services of a certified athletic trainer on a daily basis. Permission was obtained from school administration to conduct the study and information was obtained on the procedures for each

school concerning research protocols and students and employees serving as research subjects within the school. This information was obtained by the school contact at each school and the appropriate procedures followed. Each school contact completed a research ethics training form and an incentive form as a part of the study. These school contacts were asked to complete these forms prior to receiving any possible incentive for assistance and prior to any materials being mailed to the site. A school information sheet was also completed by the school contact to obtain information about sports, number, of athletes, and demographic information concerning the school. **(Appendix 8)** For schools with AT access, a separate form was completed by the AT to gain information on concussion education programs and sport coverage **(Appendix 9).** During this phase, the school contacts also set up a recruitment and distribution meeting date with the PI. If it was too difficult to get all athletes and coaches at a school together, the study materials were delivered to the school contact and the school contact ran the recruitment and distribution meeting at the school. Every effort was made for PI to conduct these meetings. The meeting was always conducted using a specified script in order to maintain standard instructions **(Appendix 10).**

3.5.3 Phase 3- Subject Recruitment and Data Collection

Data collection was conducted from September 2009 – February 2010. The PI visited each school (15 Schools) on the arranged date or the school contact held a meeting (13 Schools) to explain the study and distribute study packets using the specified script **(Appendix 10).** The athlete packet contained a postage paid return envelope, a manila envelope (for section 1) the survey instrument, instruction letter, parental consent, an adult consent and an adolescent assent. The instruction letter indicated which form the athlete/parents should complete based on the athletes age. The coach packet included the

same materials. The potential athlete and coach subjects were asked to review the packet information and return it at their earliest convenience using the postage paid envelope in the packet. The instruction letter was very specific, especially the athlete letter as this survey instrument contained 2 sections. The athlete letter instructed athletes to complete section 1 of the instrument first and then seal this portion. Consent forms were placed in the manila envelope provided. Athletes then completed the second section and placed this along with the sealed manila envelope in the postage paid envelope and returned directly to the PI. Coaches also completed the questionnaire (only 1 section) and placed it in the postage paid envelope and returned it directly to the PI from the subjects or delivered it to the school contact in sealed envelopes and then returned to the PI in an effort to increase return. Only questionnaires with valid consent documents were included in the study dataset. March 24th, 2010 served as the cut-off day for receipt of questionnaires.

A member of the research team contacted the school contacts via email 3 times following the study meeting to promote increased participation and cooperation. School contacts were asked to email coaches and parents reminding them of the study to increase return both prior to and following the meeting at the school. The school contact received a $100 incentive for assistance with the study after all forms were completed and the subject recruitment/study explanation meeting was scheduled. After the data collection meeting at the school, the school's participation in the study was complete.

3.6. Data Analysis

All data were analyzed us SAS v9.1. *A priori* alpha level was set to 0.05 for all analyses. Descriptive statistics (means, standard deviations, and frequencies) were calculated

and reported for all demographic data, independent variables, and outcome variables. **Table 3.2** lists the analyses and comparisons by research question and levels of analyses for each research question. Data for *Research Questions 1 and 4* were analyzed using linear regression models with Generalized Estimating Equations (GEEs). To investigate the association between coach responses to athlete responses for question 1, only the constructs from **Table 3.1** were used to calculate the knowledge and attitude outcome scores. For *Research Question 2* binomial regression models with and without GEEs were used. *Research Questions 3a-b* were analyzed using linear regression models. *Research question 3c* and all *ancillary* reporting analyses were analyzed using binomial regression models. For each part of *Research Questions 2a-f, 3c, and ancillary reporting analyses* the following reporting outcomes were used: 1) people reporting 50% of *concussion* events, 2) people reporting 50% of *bell ringer* events, 3) proportion of *concussion/bell ringer* events in games, 4) proportion of *concussion/bell ringer* events in practices, 5) proportion of *concussion* only events reporting, 6) proportion of *bell ringer* only events, 7) people indicating participating in *games* while experiencing concussion symptoms, and 8) people indicating participating in *practices* while experiencing concussion symptoms. When the binomial regression model could not be run a logistic regression model was used. For the *ancillary analyses* involving the direct/indirect constructs association with behavior, logistic regression models were used for the following: 1) direct attitude and proportion of bell ringers reporting, 2) indirect perceived behavioral control and game events reporting, 3) indirect subjective norm and recalled concussion only events reported, 4) and indirect perceived behavioral control and recall of bell ringer only events reported. Information obtained from these analyses and

previous literature was then used to develop a PRECEDE model following the guidelines in **Figure 3.3**.

Table 3.1 Comparison Questions Between Coaches and Athletes

Area	General Construct
Knowledge	Symptoms of concussion
	Loss of consciousness and concussion
	Asymptomatic return to play
	Injured structure
	Complications of multiple concussions
	Complications of returning to play too soon
Attitude	Seriousness of symptoms following MOI
	Importance of not returning to play when symptomatic
	Importance of reporting concussion
	Agreement surrounding education about concussion
	Overall Attitude

Table 3.2 Data Analyses Table

Aim	Variables	Analysis
1) To assess the relationship between coaches' and athletes' outcomes on questions of knowledge and attitudes concerning concussion – ***CHAPTER 4***	IVs: Coach knowledge and attitude outcome scores DVs: Athlete knowledge and attitude outcome scores	Linear Regression model with Generalize Estimating Equation (1 for knowledge, 1 for attitude) *Levels (for all)* 1. Coach 2. Athlete
2) To determine the factors associated with potential under-reporting of possible concussions among high school athletes ***MANUSCRIPT 1*** a. Gender b. Athlete knowledge c. Athlete attitude ***CHAPTER 4*** d. Coach knowledge e. Coach attitude f. Access to an AT	IVs: Factors associated with concussion reporting DVs: a. - f. Proportion of people indicating > 50% reported recalled concussive events and proportion of reported recalled concussive events (high school years)	a.-c.: Binomial regression d.-f.: Binomial Regression with Generalized Estimating Equation *Levels* a. Athlete b. Athlete c. Athlete d. Athlete/Coach-School e. Athlete/Coach-School f. Athlete/School
3. To determine the factors associated with intention towards concussion reporting and the behavior of reporting (Theory of Reasoned Action/Planned Behavior) – ***MANUSCRIPT 2*** a. Direct Measures and Intention b. Indirect Measures and Intention c. Intention and Behavior	IVs: a.- b: Attitude, Subjective Norm, Perceived Behavioral Control (Direct and Indirect) c. Intention DV: a. and b. Intention c.: Proportion of people indicating > 50% reported recalled concussive events and proportion of reported recalled concussive events (high school years)	a. – b. Linear regression models c. Binomial Regression models (when these would not run properly, a logistic regression model was used as indicated in Chapter 3 and in the results tables)
4) To examine the association between access to an AT and concussion knowledge and attitude – ***CHAPTER 4***	IV: Access to AT DVs: a. Coach knowledge scores b. Coach attitude scores c. Athlete knowledge scores d. Athlete attitude scores	a. – d. Linear Regression models with Generalize Estimating Equation *Levels* a-b. School/Coach c-d. School/Athlete

Table 3.3 School Clusters

Cluster	State	Total # of Schools	AT Access	
			YES	NO
1	Alabama	2	0	2
2	Arizona	1	1	0
3	Colorado	1	1	0
4	Connecticut	1	1	0
5	Florida	1	1	0
6	Maryland	6	3	3
7	New Hampshire	1	1	0
8	North Carolina	12	6	6
9	Virginia	3	3	0
TOTALS		28	17	11

Table 3.4 Elicited Responses from Athlete and Coach Interviews

Elicitation Point	Responses
Behavioral Beliefs	1. Lose Play 2. Let Teammates Down 3. Miss out on activities 4. Multiple concussions - Overall health 5. Performance in School
Normative Beliefs	1. What coaches think 2. What teammates think 3. What parents think 4. What AT (if access) thinks
Control Beliefs	1. Coach pressure 2. Teammate pressure 3. Parent pressure 4. Medical Professional Presence
Social Referents	1. Teammates 2. Coaches 3. Parents **4.** AT (if access)

Table 3.5 Reliability and Consistency for TRA-TpB Athlete Questions

Construct Measured	**Question Number**	**Response Format+**	***Pilot* Reliability and Consistency Analysis***	**Internal Consistency Analysis *Total* Sample**
Behavioral Beliefs	S2, P2, Q 8-15	1 to 7	MD=-3.4±3.9	N/A
Outcome Evaluations	S2, P2, Q 22-29	-3 to +3	MD=-1.7±2.2	N/A
Normative Beliefs	S2, P2, Q 30-34	-3 to +3	MD=0.0±2.9	N/A
Motivation to Comply	S2, P2, Q 35-39	1 to 7	MD=-0.3±8.3	N/A
Control Belief Strength	S2, P2, Q 40-43	1 to 7	MD=-1.6±3.4	N/A
Control Belief Power	S2, P2, Q 44-47	-3 to +3	MD=1.7±5.8	N/A
Attitudes, Direct	S2, P2, Q 48 A-G	1 to 7	Chronbach's $\alpha = 0.87$ MD=1.2±7.6	Chronbach's $\alpha = 0.83$
Subjective Norms, Direct	S2, P2, Q 16-19	1 to 7	Chronbach's $\alpha = 0.81$ MD=0.5±1.4	Chronbach's $\alpha = 0.72$
Perceived Behavioral Control, Direct	S2, P2, Q 4-7	1 to 7	Chronbach's $\alpha = 0.89$ MD=-1.7±1.6	Chronbach's $\alpha = 0.71$
Generalized Intention	S2, P2, Q 1-3	1 to 7	Chronbach's $\alpha = 0.67$ MD==6.1±6.1	Chronbach's $\alpha = 0.94$

Table 3.6 Personal and Situational Factors affecting response to sport injury[150]

Personal Factors	Situational Factors
Injury	**Sport**
History	Type
Severity	Level of Competition
Type	Time in season
Perceived cause	Playing status
Individual Differences	Practice vs. game
Self-motivation	**Social**
Motivational orientation	Teammate influence
Pain tolerance	Coach influence
Athletic identity	Family dynamics
Coping skills	Sports medicine team influence
Psychological skills	Sport ethic/philosophy
Demographic	**Environmental**
Gender	Rehabilitation environment
Age	Accessibility to rehabilitation
Prior sport experience	
Physical	
Use of ergogenic aids	
Physical health status	
Disordered eating	

Table 3.7 TRA and TPB Constructs and Definitions [44, 153]

Theory	Construct	Definition
TRA	**Behavior Intention**	Perceived likelihood of performing the behavior
	Attitude	
	Direct Measure:	Overall evaluation of the behavior
	Indirect Measure:	
	Behavioral belief	Belief that behavioral performance is associated with certain attributes or outcomes
	Evaluation	Value attached to a behavioral outcome or attribute
	Subjective Norm	
	Direct Measure:	Belief about whether most people approve or disapprove of the behavior
	Indirect Measure:	
	Normative belief	Belief about whether each referent approves or disapproves of the behavior
	Motivation to comply	Motivation to do what each referent thinks
TPB	**Perceived Behavioral Control**	
	Direct Measure:	Overall measures of perceived control over the behavior
	Indirect Measures:	
	Control belief	Perceived likelihood of occurrence of each facilitating or constraining condition
	Perceived power	Perceived effect of each condition in making behavioral performance difficult or easy

Figure 3.1 Schematic of the Theory of Reasoned Action and Planned Behavior[44, 153]

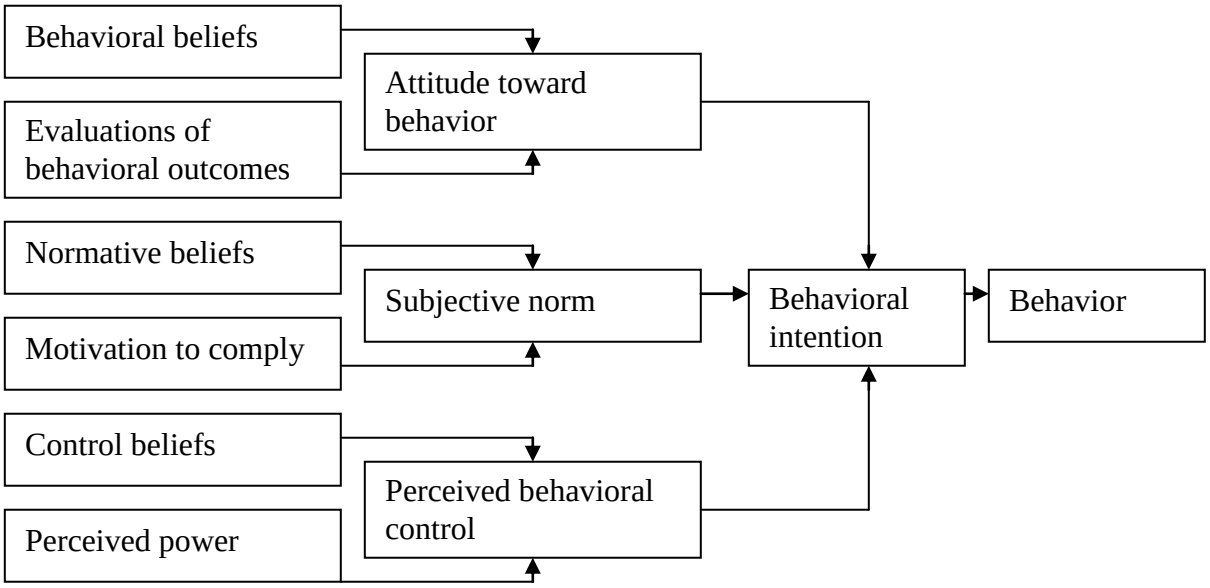
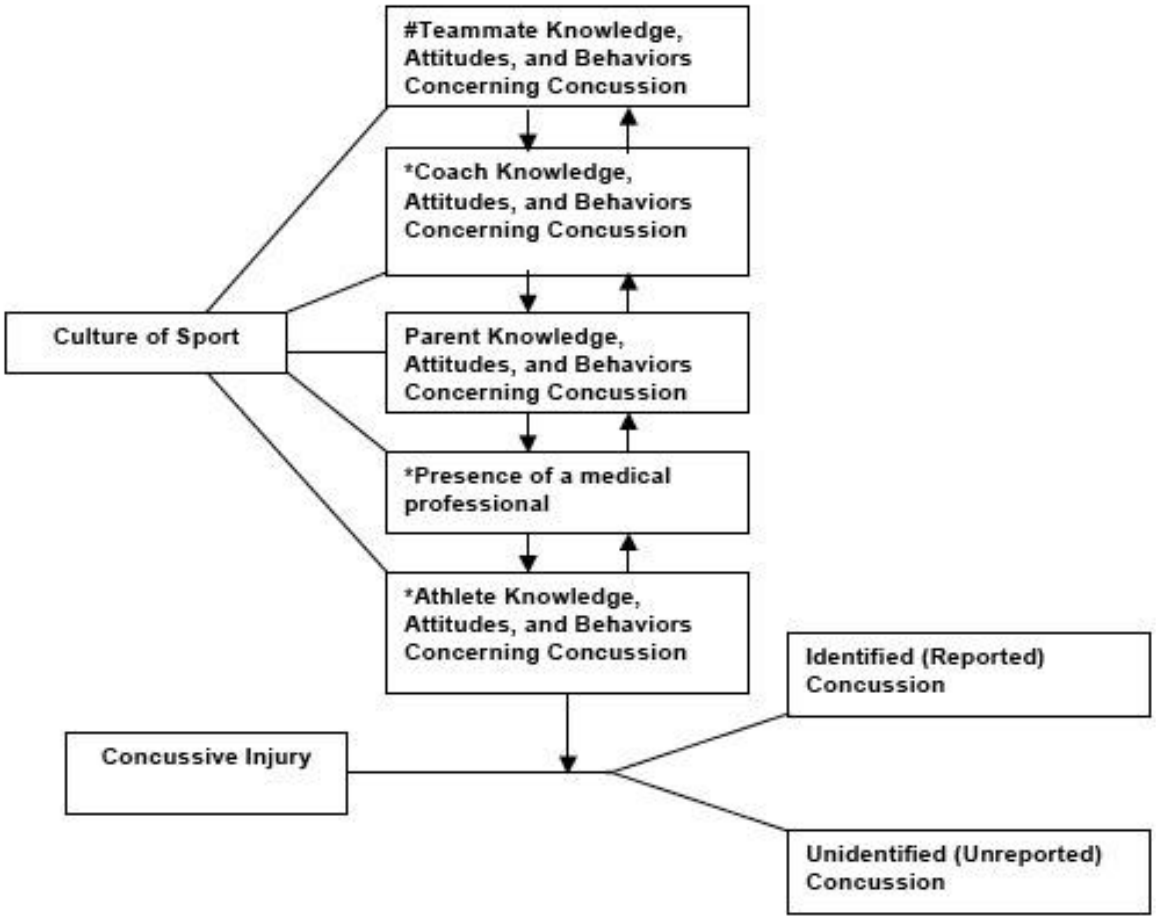
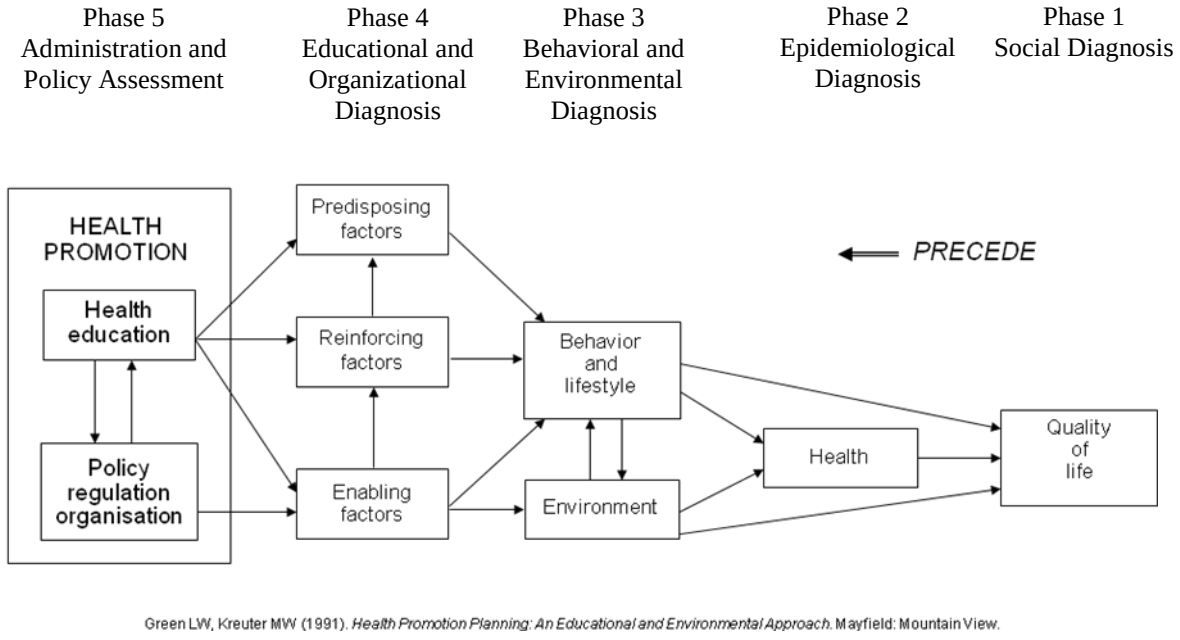


Figure 3.2 Conceptual Model



* Indicates concept used in aims of proposed study
# Indicates concept to be collected from questionnaire but not included in aims

Figure 3.3 PRECEDE Diagram



Green LW, Kreuter MW (1991). *Health Promotion Planning: An Educational and Environmental Approach*. Mayfield: Mountain View.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter includes both results and discussion as it pertains to each of the aims of this study **not included** in Manuscript 1 **(Appendix 1)** and Manuscript 2 **(Appendix 2).** Manuscript 1 **(Appendix 1)** encompasses all results, tables, and discussion for Research Questions 2a-2c examining the influence of gender, athlete knowledge, and athlete attitude on concussion reporting measures. Manuscript 2 **(Appendix 2)** addresses all results, tables, and discussion for Research Question 3 entirely. Included in this chapter are results, tables, and discussion for Research Question 1, Research Questions 2d-2f, and Research Question 4. In addition, this chapter includes results, tables, and discussion for ancillary analyses to support the study research questions, limitations of the entire study, and overall conclusions. Demographic information and descriptive information are duplicated in this chapter and the manuscripts.

It should be noted that there are a different number of subjects included in analyses for 3 reasons: 1) When people reporting concussions or bell ringers are used as the analysis unit, only individuals recalling a concussion or bell ringer event are included; 2) When examining participation in games or practices while symptomatic, all subjects answering the question are included; and 3) In order to be included in the analyses, all questions forming the independent variables and dependent variables had to be answered. **Table 4.1** includes a list of all reporting variables and the sample included for each outcome measure.

For ease of understanding Manuscript 2 **(Appendix 2)**, the following is a brief explanation of Theory of Reasoned Action and Planned Behavior (TRA-TpB) terminology. As explained in Chapter 2, the TRA-TpB was developed around 3 main constructs including attitude, subjective norm, and perceived behavioral control. These 3 main constructs are assessed as direct measures and indirect measures. Direct attitude indicates a person's overall assessment of the behavior. Direct subjective norm indicates how much social pressure a person feels to perform (or not perform) the behavior. Direct perceived behavioral control indicates how much control an individual feels he/she has over the behavior.[44, 155] In the current study, a higher direct attitude score indicates an overall more favorable attitude toward concussion reporting. A higher direct subjective norm score indicates that athletes perceive important referents feel more positive toward reporting of concussion. A higher direct perceived behavioral control score indicates more feelings of control over the behavior of concussion reporting.

Indirect attitude is a product of beliefs about the behavior and the evaluations of these beliefs. A higher score indicates a more favorable attitude. Indirect subjective norm is a product of normative beliefs (beliefs of important social referents) and motivation to comply with the normative beliefs with a higher score indicating more positive influences from social referents. Indirect perceived behavioral control is a product of control beliefs (beliefs "controlling" the behavior and the perceived power of these beliefs) with a higher score indicating a greater feeling of control over reporting.

This study included survey instrument data from varsity athletes (N=167) and coaches (N=59) from 25 high-schools, across nine different states. The return percentage for

athletes and coaches was 8% and 24% respectively. Athlete subjects were from a variety of sports including soccer, football, lacrosse, and cheerleading. More specifically, the athlete sample consisted of 97 males and 55 females with 5 athletes not indicating gender. Athlete descriptive and demographic data are included in **Table 4.2**. Coach subjects were also from a variety of sports including soccer, football, cheerleading, and lacrosse. Coach descriptive and demographic data are included in **Table 4.3**.

4.2 Athlete Knowledge, Overall Attitude, and Theory of Reasoned Action and Planned Behavior (TRA-TpB) Construct Total Scores

Athlete knowledge total scores (out of possible 35) ranged from 20-34 (mean = 27.9 ± 2.8). An overall break down for each knowledge question by frequency responding correctly is presented in **Table 4.4**. Higher knowledge total scores indicate increased knowledge. Athlete's overall attitude total scores (out of possible 98) towards concussion were moderate (mean = 78.3 ± 11.5) with a wide range of 40-98. **Table 4.5** illustrates the mean response to each attitude related question, each attitude question was scored on a 7 point Likert Scale (1-7). Higher attitude total scores indicate a more favorable attitude.

There were also outcomes specifically related to the TRA-TpB. Average direct attitude in the sample was 5.6 ± 1.0 (1-7 possible) indicating a moderate-to favorable attitude. The average direct subjective norm was 5.8 ± 1.3 (1-7 possible) indicating athletes perceive that important referents feel they should report possible concussion symptoms. Average direct perceived behavior control score was 5.8 ± 1.2 (1-7 possible) suggesting that athletes overall feel they have a good amount of control over reporting. **Table 4.6** illustrates overall and question means for all direct constructs.

Average indirect attitude score (product of behavioral beliefs and outcome evaluations) in the sample was 27.1 ± 29.1 (-168 to + 168 possible) again indicating moderately favorable attitude. Average indirect subjective norm score (product of normative belief and motivation to comply) was 41.0 ± 39.7 (-84 to + 84 possible), a relatively high subjective norm score, and average indirect perceived behavioral control (product of control beliefs and control belief power) was 17.8 ± 27.1 (-84 to + 84 possible), which indicates a moderate feeling of control. **Table 4.7** illustrates question and construct means for all indirect constructs.

4.3 Athlete Reporting Behavior Descriptives

All data concerning reporting of recalled concussive events pertains to high school years only. Fifty-three percent (n=89) of the total sample recalled having at least one possible concussive event (*bell ringer or concussion*). Of these 89, only 15 (17.0%) indicated reporting all recalled *concussive/bell ringer* events experienced to a coach or a medical professional. The most common reason cited for not reporting the recalled events to someone in authority was not thinking it was serious enough to report, followed by not wanting to be removed from a game. There were a total of 83 recalled *concussions* among the sample, with only 41 (49%) of these events indicated as reported. In addition, there were a total of 576 recalled *bell ringer* events among the sample with only 72 (13%) indicated as being reported to a coach or a medical professional.

In *games only*, there were a total of 241 recalled *concussion* and *bell ringer* events with only 65 (27%) of these events indicated as reported to a coach or a medical professional. For *practices only*, there were a total of 346 recalled *concussion* and *bell ringer* events, with

only 40 (12%) of these events indicated as reported to a coach or a medical professional. In addition, 40% of the athlete sample (n=63) indicated continuing to participate in a practice or a game at least once, when he/she thought they were experiencing signs and symptoms of a concussion. **Table 4.8** illustrates the reasons for not reporting in those indicating at least 1 *concussion* or *bell ringer* event with not thinking it was serious enough to report being the most common. In addition **Table 4.8** cites the reasons, if they did experience a possible concussive event in the future, they would chose not to report it.

4.4 Discussion: Athlete Descriptives

Athlete knowledge scores were moderate in our study sample; however, with a mean indicating an average of 7 (out of 35) questions missed, there is still a gap in what athletes should know concerning concussion concepts. The most common questions missed were related to less obvious signs and symptoms of concussion such as nausea. Athletes also had difficulty discriminating between other neurological type symptoms such as burning and weakness in neck movements. In addition, the range of attitude scores was wide, illustrating the disparity in perceptions of concussion across the athletic population. Many of the athletes only indicated moderately agreeing that concussions were serious. In addition, many felt reporting concussion may be embarrassing. These issues illustrate some of the attitudes towards concussion and reporting that may need to be addressed.

The disparity concerning concussion issues in the high school athletic setting is further highlighted in our sample by gross under-reporting of recalled concussion events. In addition, a large proportion of the study sample indicated continuing to participate in both games and practices while experiencing concussion signs and symptoms. Earlier studies have

suggested under-reporting to be as high as 50%.[15] Although our study used different methods to investigate and explain this phenomenon, we observed an under-reporting rate approximating 40% for perceived concussions. More strikingly, athletes only indicated reporting 13% of events they considered bell ringers.

The most common reason in this sample for not reporting a possible concussion was not thinking the injury was serious enough to report followed by, not wanting to be removed from a game. These findings are similar to those of McCrea et al[15] which also suggested the most common reason for under-reporting to be not thinking the injury was serious enough to report, followed by not wanting to be withheld from competition. In contrast to McCrea et al, letting teammates and coaches down was prioritized in our sample over awareness of concussion as possible reasons for not reporting. Coupled with results in Manuscript 2 on the influence of social referents and important individuals impacting the decision to report, this finding further illustrates the role of coaches and teammates in concussion reporting. Although reporting in this sample was based on recalled events, it suggests that the behavior of underreporting possible concussive events is prevalent and needs to be addressed.

4.5 Coach Knowledge and Overall Total Scores

Coach total knowledge scores (out of 35 total points) ranged from 21 to 34 with a mean of 29.5 ± 3.3. An overall breakdown of frequency of correct knowledge responses by coaches is presented in **Table 4.9**. Coach overall total attitude scores (out of 98 total points) ranged from 61-98 with a mean of 85.9 ± 7.9. Means for each attitude question and subcomponents of the attitude total score are presented in **Table 4.10**.

4.6 Discussion: Coach Descriptives

The overall coach knowledge and attitude scores in this sample were high, suggesting that they were relatively knowledgeable and had a relatively favorable attitude regarding concussion. This may be in part to the large media and public push concerning awareness and concussion often targeted at coaches, specifically those at the high school level. These findings are similar to those of two recent studies indicating coaches had a relatively high level of knowledge concerning recognition and signs/symptoms of concussion.[159, 160] Prior to the onset of increased attention to sports concussion, some research illustrated major gaps in knowledge and understanding.[5] Recent findings suggest that knowledge and awareness may be increasing among high school coaches. This increase may be the result of public and social attention placed on concussion. In addition, publicized events of mismanagement of concussion by coaches may also be contributing to increased knowledge and awareness. Previous studies have shown that coaches with exposure to concussion education have increased knowledge.[42, 159] Despite this increase, there is still a need for improvement and learning among coaches of young athletes. Concerning attitude questions, coaches may be inclined to answer "appropriately" instead of honestly, which may have influenced attitude totals in this sample. The coach sample in the current study is also small and may not be representative of all high school coaches.

4.7 Research Question 1: Association Between Coach and Athlete Knowledge and Attitude

For each analysis in Research Question 1, a 10-point increase in coach scores was used to estimate differences in athlete scores. This difference in both knowledge and attitude

represents a significant but reasonable change in coach knowledge (28%) and attitude scores (10%) scores and was used in an effort illustrate how this difference in scores may affect athlete scores. Little difference was observed in athlete knowledge total scores as a result of a 10-point increase in school level coach knowledge total scores. **(Table 4.11) Tables 4.3 and 4.8** provide coach and athlete knowledge question and score information. Little difference was also observed in athlete attitude totals based on a 10-point increase in school level coach attitude totals. **Tables 4.5 and 4.10** illustrate coach and athlete attitude question and total means respectively.

4.8 Discussion: Association Between School Level Coach and Athlete Knowledge and Attitude

Although coaches at a given school often have a significant influence on his/her athlete's values and attributions to success[29, 141, 142], information about concussion is rarely communicated to athletes by his/her coach. This may explain the lack of association between school level coach knowledge and athlete's knowledge. In addition, much of the recent information available to the public, such as the CDC's head's up tool-kit for high school coaches, has been targeted at coaches and adults. Although the tool-kit and other measures have a portion to be used with athletes (video, letter, etc), it is often left up to coaches to disseminate this information. Recent studies[41, 42] examining coaches use of the CDC toolkit, found only a small proportion of coaches had actually passed out the athlete materials (7%) , although a large proportion reported planning to do so (76%). There are currently no other studies examining this connection between coach knowledge acquisition and sharing of this acquisition with athletes. In addition, a large number of athletes in our sample (> 20%)

reported no one had ever discussed concussion with them. Concussion is not a simple injury to understand and many facts about concussion may only be known through dissemination of knowledge.

Surprisingly, school level coach attitude was also not associated with athlete attitude total scores. This may best be explained by attitudes of individuals being formed as a result of many sources of input ranging from social referents (teammates, coaches, parents, peers) to personal experience with concussive events.[44] Later discussion in this chapter will focus on the influence of previous number of concussions on attitude. Increased number of concussions negatively influences attitude. This finding yields merit to external sources of input influencing attitude[44] among high school athletes that may override the influence of a coaches' attitude. These results may be limited by only assessing responses at the school level. A large enough coach sample was not obtained to look at these relationships at the team level. The influences of coaches on their own teams may be stronger than just at the school. Athletes also participated in multiple sports providing many coaches to have influence on their behaviors. In addition, the general culture of sport[161] may also be an overriding influence. Similar issues as discussed concerning knowledge may also have lead to this lack of association. Coaches may rarely discuss concepts or feelings about concussion, with athletes.

4.9 Research Question 2c and 2d: Influence of Coach Knowledge and Attitude on Reporting

To estimate differences in reporting prevalence, a 10-point increase in both coach knowledge and attitude score was chosen. This 10-point increase represents a 28% increase in knowledge score and a 10% change in attitude score, which we felt represented significant

changes in these measures. However, the overall findings of association are related to the influence these variables have on reporting. We chose the 10-point change in an effort to see the influence of a relatively large difference in knowledge and attitude on reporting.

4.9.1 People as Analysis Unit

Although not statistically significant, with a 10-point increase in school level knowledge score, the prevalence of people reporting 50% recalled *concussion* and *bell ringer* events was estimated to decrease approximately 30% and 70% respectively **(Table 4.12)**. With a 10-point increase in school level attitude total score the prevalence of athletes reporting of at least 50% of recalled overall *concussion* events remained the same **(Table 4.13).** Alternatively, with a 10-point increase in school level coach attitude total score, the prevalence of athletes reporting at 50% of *bell ringer* events was estimated to decrease by approximately 29% **(Table 4.13)**.

School level coach knowledge **(Table 4.12)** and attitude **(Table 4.13)** were associated with athletes indicating continuing to participate in at least 1 game while experiencing concussion signs and symptoms. For a 10-point increase in each of these scores, it is estimated that the prevalence of individuals engaging in this behavior decreases by 30% and 35% for coach knowledge and attitude total scores respectively. School level coach knowledge although not statistically significant was associated with a decrease (30%) in the prevalence of athletes indicating participating in at least 1 practice while experiencing concussion symptoms when knowledge total score is increase by 10 points. School level coach attitude score was also associated with this behavior as there was an estimated 54% decrease in the prevalence of people indicating continuing to participate with concussion signs and symptoms.

4.9.2 Recalled Events as Analysis Unit

School level coach knowledge scores **(Table 4.12)** were associated with reporting of recalled concussions/bell ringer events in games and practices. The prevalence of reporting these recalled events was estimated to decrease by 56% in games and 90% in practices with a 10-point increase in school level coach knowledge. In contrast, although not statistically significant, the prevalence of reported recalled concussion/bell ringer events during games was estimated to increase by 24% for a 10 point change in school level coach attitude score **(Table 4.13)**. Prevalence of reported recalled *concussion/bell ringer* events during practices was estimated to decrease by 70% with a 10-point increase in school level coach attitude score.

Although not statistically significant, reporting prevalence of recalled *concussion* only events was estimated to decrease by 48% for a 10-point increase in school level coach knowledge total score **(Table 4.12)** and remained similar with a 10-point increase in coach attitude score **(Table 4.13).** School level coach knowledge was not associated with reporting of bell ringer only events. However, a 10-point increase in school level coach attitude resulted in a 65% decrease in the prevalence of these events reported **(Table 4.13)**.

4.10 Discussion: Influence of Coach Knowledge and Attitude on Reporting

Much of the recent push for concussion education and awareness has been aimed at high school coaches. Materials such as the CDC's Coaches Tool Kit and Head's Up programs initially aimed at this group. The coach knowledge scores in our sample suggest an overall moderate to high level of knowledge currently among these coaches. Despite this increase in knowledge, these study results suggest this increase may not positively influence

athlete reporting behavior in the individuals who recall experiencing concussion or bell ringer events. In these individuals who recall concussion/bell ringer events, an increase in coach knowledge decreased the proportion of these events reported in practice and for concussion only events. Athletes participating under coaches with increased knowledge may not report these injuries for fear of more conservative management and again removal from play[15]. However, for athletes in the entire sample, this increase in coach knowledge decreased the proportion of athletes indicating that they continued in games and practices when they thought they were experiencing concussion signs and symptoms.

Overall this increase in coach knowledge may positively influence a large portion of athletes, as these coaches may be more capable of recognizing signs and symptoms of concussion and remove athletes from participation who exhibit these signs and symptoms. Recent literature[159, 160] suggests coaches symptom recognition to be relatively high further highlighting the recognition skills of coaches with increased knowledge. Furthermore, bell ringers were included in the recalled events analysis. It is evident from the overall study sample and in previous literature[4] that many athletes not find these serious enough to report. The questions concerning participation specifically address continuing to play with signs and symptoms of concussion, which athletes in our sample may not have considered bell ringer events.

Concerning school level coach attitude, an increase in coach attitude resulted in increased reporting in games but relate to a decrease in reporting in practices. Although the findings concerning reporting of the recalled events (game events and bell ringer only events) were not statistically significant the change was meaningful and warrants discussion. In spite of a relatively low reporting proportion in games across the sample, coaches with an overall

better attitude towards concussion may provide a more optimal environment for individuals to report. As will be discussed in later sections, coaches are important social referents to athletes. Athletes care significantly about what coaches think of them.[152, 162, 163]

In addition, as previously mentioned, losing play in a game is a significant deterrent from reporting.[15] If coaches have a more favorable attitude, some of the deterrent to reporting may be removed during games, as athletes may be less concerned about letting the coaches down. In contrast, proportion of events reported during practice decreased slightly with this same increase in coach attitude. There are other factors that may contribute to this decrease in reporting such as injury severity. We did not collect severity level of injury. However, data in our sample suggest a significantly decreased proportion of bell ringer events reported than what the athletes perceived as concussion events. An overwhelming majority of the events that occurred during practices were bell ringer events, which may have contributed to the discrepancy in these findings between games and practices.

Alternatively, increases in coach attitude appear to largely decrease the proportion of athletes indicating participating in games and practices while symptomatic from a possible concussion. Again, coaches with a more favorable attitude may create a more optimal environment in which athletes can report, as the fear of letting the coaches down or upsetting the coaches may be decreased. It should also be noted that the coach knowledge and attitude scores included in these analyses were school averages.

4.11 Specific Aim 2b: Influence of Athletic Trainer Access (AT) on Reporting

4.11.1 People as Analysis Unit

Individuals without AT access (13/21, 61.9%) and with AT access (12/22, 54.6%) were equally likely to report at least 50% of recalled *concussion* events. Likewise, athletes without AT access (8/41, 19.5%) and with AT access (9/39, 23.1%) were equally likely to report at least 50% of recalled *bell ringer* events. Individuals without AT access (21/80, 26.3%) were slightly less likely to indicate continuing to participate in at least 1 game while experiencing signs and symptoms of concussion than those with AT access (30/81, 37.0%). Similarly, athletes without AT access (16/77, 20.8%) were slightly less likely to recall continuing to participate in at least 1 practice while symptomatic than those with AT access (25/81, 30.9%). **(Table 4.14)**

4.11.2 Recalled Events as Analysis Unit

Individuals without access (39/166, 23.5%) to an AT were as likely to report recalled *concussion/bell ringer* events during games as individuals with access (33/147, 22.5%), although the model is statistically significant. For recalled *concussion/bell ringer* events during practices, individuals without AT access (16/142, 11.27%) and with AT access (24/204, 11.76%) were equally likely to report. For overall recalled *concussion* events, athletes without (19/37, 51.4%) and with AT access (20/45, 44.4%) reported similar proportions of these events. Concerning over recalled *bell ringer* events, individuals without AT access (36/271, 13.3%) and those with AT access (36/306, 11.8%) again reported similar proportions of these events. **(Table 4.14)**

4.12 Discussion: Influence of Athletic Trainer Access (AT) on Reporting

Little evidence exists on the influence of access to medical care in the athletic setting on injury reporting, specifically concussion. We hypothesized that AT access would improve reporting of recalled concussions, but instead observed the opposite for the 2 outcomes affected. A lower proportion of athletes in this group also indicated participating in games or practices while experiencing signs and symptoms of concussion. Athletes without AT access may have been more inclined to report as a result of knowing there would be little consequence from letting someone know they may be experiencing a concussion. As a result of no AT presence, they may have felt less threatened by loss of playing time[15] in both games and practices.

One of the highlighted reasons in our sample for not reporting was not wanting to be removed from a game, which would support this reasoning. McCrea et al[15] also indicated not wanting to lose playing time in as a major reason for unreported concussions. Further reasoning may also be supported by athletes' overall fear of unpleasant outcomes if the events were reported to the AT (in the AT access group). The ramifications of the consequences of being removed from play extend beyond just not being able to participate. Social issues concerning perceptions of letting teammates and coaches down also play a role.[15, 164] This may have further deterred individuals with access to an AT from reporting these events in games and continuing to participate in games/practices while symptomatic. In addition, athletes with no AT access may also have felt with no one there to identify them as injured, they had to let someone know about the injury. Athletes with access may feel if the injury were severe enough the AT would notice and remove them from activity if needed. These findings also support the notion that concussion problem is multifaceted[39, 165] must be

addressed at many levels of the socio-ecological framework, as just changing factors at one level may not result in the changes expected. It also begins to provide insight towards addressing things not just at the school or policy level, but also among the athletes. In addition, this study occurred at a time when schools began implementing policies concerning no return on the same day of an injury. This may have lead individuals with AT access less likely to report. Reporting was assessed over an athlete's entire high school career, in which many athletes may not have always had access to an AT. In addition, ATs are not always at each event at the high school as many sports are ongoing at the same time. The length of time the athletes had access to an AT was also not collected as part of the study. Recalled events may have occurred when the athlete(s) did not have access to an AT, possibly influencing these findings.

4.13 Specific Aim 4: Association between Athletic Trainer access and Coach and Athlete Knowledge and Attitude Scores

No association was observed between AT access and coach knowledge total scores. The mean knowledge total for coaches with no AT access was 29.3 ± 2.9 and those with AT access had a mean knowledge total of 29.5 ± 3.6. Athletic trainer access also did not influence coach attitude total scores. Coaches without access to an AT had a mean attitude score of 87.5 ± 6.6 and coaches with access had a mean attitude score of 84.9 ± 8.6 (higher represents a more favorable or responsible attitude). **(Table 4.15)**

AT access was also not associated with athlete knowledge totals as athletes without AT access had a mean knowledge total of 27.8 ± 2.9 and those with AT access had a mean total of 29.0 ± 2.7. Athlete attitude total scores were also not associated with AT access.

Athletes without AT access mean attitude total score was (78.7 ± 11.5) which was similar to that of athletes with AT access (78.3 ± 11.6). **(Table 4.15)**

4.14 Discussion: AT Access Influence on Coach and Athlete Knowledge and Attitude

Contrary to our hypothesis, AT access had no association with coach and athlete knowledge and attitude scores in the sample. Although not an aim, we expected most ATs involved in the study would have provided some level of concussion education. However, only 2 of the ATs from the study schools with AT access indicated engaging in any kind of concussion education with their coaches or athletes. Athletic trainer interactions with coaches and athletes are most likely necessary for ATs to influence knowledge and attitude. Given these additional findings of limited education provided by ATs in the study, the role of the AT in concussion reporting may have been diminished. In addition, recent public attention and awareness concerning concussion may have influenced the scores across the entire sample.

Although only in abstract form, one previous study suggested that coach and athlete knowledge increased following education by an AT concerning concussion.[151] This study illustrates the importance of ATs providing some discussion in an effort to influence these characteristics among coaches and athletes. A more recent study suggested that the majority of coaches received information about concussion from conferences and coaching associations[160], not ATs, further highlighting why AT influence may not have been associated with coach knowledge and attitude. No studies have directly addressed the influence a AT may have on knowledge and attitudes concerning concussive injury in coaches or athletes making direct comparisons are difficult. Furthermore, length of time

athletes and coaches had access to the current AT was not collected which may have also influenced these findings.

4.15 Ancillary Analyses

4.15.1 Influence of Intention Group on Reporting

Table 4.16 summarizes these results. When dividing the athlete sample into low intenders and high intenders, similar findings to those in Manuscript 2 concerning intention as a continuous variable, were observed with no difference in prevalence of people reporting at least 50% of *concussion* only events between low intenders (16/28, 57%) and high intenders (6/12, 50%). In addition, reporting of recalled *bell ringer* only events was similar between low intenders (10/46; 21.7%) and high intenders (5/29; 17.3%). The prevalence of athletes indicating continuing game participation while symptomatic was over 150 % greater in the low intention (36/73, 49.3%) group compared to the high intention (14/82, 17.1%) group. Low intenders (32/72, 44.4%) were significantly more likely to continue participating in practice at least one time while experiencing concussion signs/symptoms compared to the high intenders (8/80, 10%).

For recalled events in games, there was not a statistically significant association between intention group and reporting. However, low intenders were (45/177, 25.4%) slightly more likely to report these game related recalled events than high intenders (20/111, 18.0%). Low intenders (26/217, 11.9%) and high intenders (10/89, 11.2%) were also equally likely to report these practice events. Low intenders and high intenders were equally likely to report *concussion* only (Low: 44.3%, High: 50.0%) and *bell ringer* only (Low: 13.2%, High: 11.5%) recalled events.

4.15.2 Influence of Intention Group on Reporting Discussion

These additional analyses were run with intention group using a median split (Median = 6) in order to see if the results differed from using intention as a continuous variable. The findings from these analyses were similar to those looking on intention score alone with no major influence when using only individuals with recalled events, but seeing a significant association when examining participating with signs and symptoms. Manuscript 2 provides more detailed discussion concerning the influence of intention on reporting.

4.15.3 Influence of Direct TRA-TpB Measures on Reporting

Table 4.17 summarizes these results. Direct attitude and direct perceived behavioral control were not associated with reporting of recalled *concussion* only events as a 1 point increase in these measures did not result in a change in the prevalence of people reporting at least 50% of these events. However, direct subjective norm was associated with reporting of the proportion of people reporting at least 50% of these events, with a 27% increase in proportion of people reporting at least 50% of these events for every 1-point increase in subjective norm. None of the direct measures were associated with reporting at least 50% of *bell ringer* only events. All three direct measures were associated with decreases in the prevalence of athletes indicating participating in practice and games while experiencing concussion symptoms **(Table 4.17).**

Only subjective norm was associated with reporting recalled *concussion/bell ringer* events in games with an 18% increase in reporting of these events with a 1-point increase in direct subjective norm score. Both direct attitude (37% increase) and direct subjective norm (31% increase) were associated with increased reporting of *concussion/bell ringer* events in practice. Direct subjective norm was the only direct factor associated with both an increase in

reporting of recalled *concussion* only events and *bell ringer* only events. There was a 30% increase in recalled concussion only event reporting and a 27% decrease in recalled *bell ringer* only event reporting with a 1-point increase in direct subjective norm score. Direct attitude was associated with an increase in odds of reporting *bell ringer* only events **(Table 4.17).**

4.15.4 Discussion: Influence of Direct Measures on Reporting

These discussion points may duplicate some of those used in Manuscript 2 **(Appendix 2).** The only reporting measure not affected by direct subjective norm was the proportion of athletes reporting *bell ringer* only events. Given the culture of sport, and the importance of acceptance by important social referents such as coaches and athletes, it is not surprising that direct subjective norm impacted the most reporting variables. Athletes significantly value what their coaches, teammates, and parents think. In addition, the overall culture of sport including influences from professional and other athletes may play a role in decisions to report injury. However, the strongest of these influences is their coaches and teammates as they are often directly involved in the decision to report to sport. The relationship with the coach is an interesting social referent relationship as it is unique in that the coach has a large amount of control of the athlete's participation. Given that losing participation is a main deterrent to reporting, pleasing a coach and conforming to their belief system on the athletic field is often an inherent characteristic in athletics.[142]

In addition to this unique relationship, teammates take the peer relationship to an additional level, as they are not only peers concerning daily activities but with the added stress of athletic performance.[33] Intertwined with the coach relationship and often parents

wanting their children to perform well, it is inherent that for the behavior of concussion reporting, subjective norm would play a significant role.

Direct attitude towards reporting was associated reporting of *concussion/bell ringer* events during practices, reporting of recalled *bell ringer* events, and decreased prevalence of people indicating continuing in games or practices while symptomatic. Attitude may be associated with behavior as a more favorable attitude is often indicative of individuals overall feelings and beliefs about the behavior. The more positive these feelings are, the more likely the athlete may be to actually perform the behavior.[166-168] However, it should be noted that attitude is not always predictive of behavior. As illustrated in research question 2, other factors may influence behavior. In addition there are interactions among many of these factors, which was beyond the scope of the current study.

The results suggest that increases in perceived behavioral control influence reporting of recalled events in games and decrease the prevalence of athletes indicating continuing in practices and games. In general, the mean direct perceived behavioral control in the sample was high indicating that overall athletes felt control and capability over the behavior of reporting. With an increase in the overall feeling of control over reporting the athletes may be more capable and more likely to report in a game situation. In addition, there is often more medical access and care available during games than practices, which may help to explain this relationship. With increased feeling of control, athletes may also feel more empowered[154, 158, 169] to report possible signs and symptoms to someone in authority. As with other behaviors stronger beliefs of control over a behavior (such as exercise or seeking care) are often correlated with the specific behavior.[154, 170]

4.15.5 Influence of Indirect Measures on Reporting

Table 4.18 summarizes these results. Ten point increases in indirect attitude and indirect perceived behavioral control resulted in an 11% increase and 4% decrease respectively in proportion of people reporting at least 50% of concussion only events. None of the indirect measures were associated with proportion of people reporting at least 50% of bell ringer only events. Only indirect subjective norm was associated with a decreased proportion of people (6% decrease) continuing to participate in a game while symptomatic. A 10-point increase in all measures resulted in decreases in proportion of people reporting continued participation in a practice while symptomatic.

None of the indirect measures were associated with reporting of recalled *concussion/bell ringer* events in games. Increases of 10 points in both indirect attitude (16% increase) and indirect subjective norm (11% increase) resulted in estimated increases of *concussion/bell ringer* events in practices. In addition, none of the indirect measures were associated with reporting of recalled *concussion* only events. Indirect attitude was the only direct measure significantly associated with an increase in proportion of recalled *bell ringer* only events with a 10% increase for every 10-point increase in direct attitude score. However, for every 10-point increase in indirect perceived behavioral control the odds of these events reported was estimated to decrease by 12%.

4.15.6 Discussion: Influence of TRA-TpB Indirect Measures on Reporting

These discussion points may also duplicate some of those used in Manuscript 2 **(Appendix 2).** Indirect attitude encompasses the 2 assumed components of attitude, which are beliefs about the behavior and the judgments about these beliefs (negative/positive). Increases in indirect attitude in turn increase the prevalence of athlete reporting at least 50%

of *concussion* only events, the reporting of practice related recalled events, and the reporting of *bell ringer* only events. Increases in indirect attitude also decreased the prevalence of people reporting participating in practices while symptomatic. Again, attitude measures appear to be influential in affecting many of the reporting measures. This consistent finding provides insight into the importance of changing attitudes. These changes may be accomplished by changes in perspective, education, and again addressing multiple levels of the socioecological framework.[171] The perceptions of outcomes associated with the reporting or discontinuing play, may be driving this finding, which also provides insight into why previous experience with concussion may also influence reporting of possible concussive injuries.

Indirect subjective norm influences reporting of *concussion* events in practices and decreases the proportion of people continuing to participate in practices and games while symptomatic. The high value athletes place on the opinions of coaches and teammates may contribute to this finding. Among the sample, the means for what both coaches and teammates think and how much the individuals in our sample cared what these important individuals think was high. As indirect subjective norm is a product of these 2 factors, the high means in the sample further support this explanation.

Indirect perceived behavioral control does appear to play a larger role with increases actually leading to decreases in proportion of people reporting at least 50% of his/her *concussion* only events, reporting recalled game events, reporting of recalled practice events, and reporting of *bell ringer* only events. This finding may be a result of the types of questions used to determine indirect perceived behavioral control. These questions revolved around pressure from coaches, teammates, and parents and how pressure from these

individuals may influence reporting. In addition, this finding was only observed in 2 of the 8 concussion reporting measures.

4.15.7 Association between Athlete Concussion Number and Reporting, Knowledge and Attitude

Total number of recalled concussion only events is associated with a 68% decrease in proportion of people reporting at least 50% of recalled *concussion* only events, a 49% decrease in the proportion of recalled *concussion/bell ringer* events reported during practices, a 48% decrease in proportion of recalled *concussion* only events reported, and a 38% decrease in proportion of recalled *bell ringer* only events reported for every 3 concussions recalled as experienced. Conversely, an increase of 3 concussions was estimated to result in a 30% increase in proportion of recalled *concussion/bell events* reported during games. An increase in 3 recalled concussion only events was also associated with an increased prevalence of athletes indicating participating in games and practices while experiencing signs and symptoms of concussion **(Table 4.19).** Total number of recalled concussion only events was not associated with athlete knowledge total score (p=0.332). However, total number of recalled concussion only events was significantly associated with athlete attitude total score (p = 0.002) with a decrease in overall attitude total of 7.2 points (95% CI: -12.96, -2.90) for every 3 recalled concussion events indicated.

4.15.8 Discussion: Influence of Previous Concussions on Reporting

Previous experience with recalled concussive events (whether *concussion* or *bell ringer*) appears to negatively affect most aspects of reporting as well as attitude. However, reporting in games was improved in individuals who have experienced more concussions. These individuals may have known the injury to be a concussion, especially if more severe in

nature, and reported the injury. No other study has addressed the issue of how these previous concussion experiences may affect issues related to athlete behavior. These negative effects may be related to being removed from play or letting important social referents such as teammates or coaches down. We did not quantify these reasons for why the previous experiences may directly affect outcomes we examined in this study. We can extrapolate some of our findings of reasons for under-reporting such as fear or removal from play or letting others down.

In addition, many of the decreases may also be attributed to athletes with a previous concussion history, continuing to participate and no major initial consequences resulting. In turn, athletes may choose not to report subsequent injuries. In these cases, with a more cumulative history, underreporting is even more problematic. Recent literature has illustrated many quality of life issues associated with multiple concussions such as depression[8], memory problems[7, 9, 18], and long-term issues such as chronic traumatic encepholpathy.[172] Therefore, the finding that athletes with a more significant concussion history may be less likely to report and seek care is alarming. In many other health related conditions, previous experience with events or conditions often affects responses to subsequent issues related to that condition.[173, 174]

4.16 Commentary on Original Hypotheses Proposed in Chapter 1

For Research Question 1, both original study hypotheses concerning associations between coach knowledge and attitude and athlete knowledge and attitude at the school level (average of coaches at the school) were rejected. We hypothesized that there would be a positive relationship between these variables. No association was observed. Although at the

time of study origination, it seemed intuitive a relationship may exists, the way these variables were examined, may have contributed to this lack of association. Coach influence was examined at the school level and not the team level. Many of the athletes in the current study participated in multiple sports leading to multiple coaches influencing these young athletes. As a result, it was difficult to assess which coach may primarily influence athlete characteristics. Therefore, the school level seemed the most appropriate level of analysis for the variables of knowledge and attitude. Future studies may need to ask questions to gain a better understanding of which coach or set of coaches an athlete most respects. In addition, as mentioned in the discussion for this aim, throughout the study period, it became evident that many coaches do not discuss concussion concepts with his/her athletes. Furthermore, this study occurred at a time when athletes and coaches were inundated by media and social attention to the problem of concussion, which may have also influenced these findings.

Research Question 2 encompassed a variety of factors both intrinsic and extrinsic to the athlete that may influence reporting with various outcomes relative to the original study hypotheses. Originally, context was not factored into these hypotheses, but throughout the study period more thought was given to how this may influence reporting and more specific reporting outcomes were investigated. We initially hypothesized that being female, higher athlete knowledge and attitude scores, higher coach knowledge and attitude scores, and access to a Certified Athletic Trainer (AT) would be positively associated with concussion reporting. Gender was found to be associated with reporting of events during games, practices, and participating while symptomatic during games. Contrary to our original hypothesis males were more likely to report during games. However, females were more likely to report during practices and less likely to participate during games while

symptomatic, which is supportive of our original hypotheses. The other 5 reporting outcome measures were not associated with gender.

In accordance with our original hypotheses, athlete knowledge score was positively associated with reporting during practices and for *bell ringer* only events. As discussed, this may be related to better knowledge allowing athletes to recognize bell ringers as needing to be reported. In addition, the majority of events during practices were *bell ringer* events. However, the other 6 reporting outcomes were not associated with athlete knowledge.

The findings concerning coach knowledge and attitude influence were perplexing upon first review. We observed an estimated decrease in reporting for people reporting 50% of *bell ringer only* events, game events, practice events, and *concussion* only events with increased coach knowledge, which are in contradiction to our original hypotheses. There are multiple plausible explanations for these findings. As mentioned earlier, coach influence was examined at the school level and may not be directly associated with when these athletes reported/did not report these events. Furthermore, athletes with more conservative coaches may be more likely to conceal possible concussive events for fear of being removed from play and more conservative management. In support of our hypotheses higher coach knowledge scores were associated with decreased participation in both games and practices while symptomatic. This may seem contradictory to the previous findings. However, coaches with higher knowledge scores may have recognized the signs and symptoms of concussion in athletes and removed them from play. Perhaps these findings are more of a reflection of coach behavior than athlete reporting behavior. We did not assess coach behavior in this capacity in the current study. Therefore this is only speculation. Only 2 reporting variables were not associated with coach knowledge.

In support of the original study hypotheses, increased coach attitude was associated with increased reporting during games and decreased participation in both games and practices while symptomatic. Contrary to the original hypotheses increased coach attitude was associated with decreased reporting in practice and *bell ringer* only events. These findings may be associated with the fear of removal from activity. As mentioned, the coach variables were at the school level and not assessed for the sport in which the athletes recalled suffering the concussive event, as we did not collect this specific data. To truly understand the influence of coach knowledge and attitude on reporting, the knowledge and attitude of the coach(es) specific to the sport in which the concussive event(s) were experienced would need to be aligned with reporting of these same events. Although the current study may lend some idea to overall coach influence, the reason for some of these perplexing findings may be this lack of alignment between coaches and the concussive event. Future research should focus on reporting at the end of a specific season relative to the coaches of the sport in which the events occurred.

The significant findings concerning AT access were in direct contradiction to the original hypotheses, with individuals with no AT access reporting a greater proportion of game related events, and being less likely to participate in games and practices while symptomatic. The other 5 reporting variables were not associated with AT access. Many factors may have influenced these findings. To begin, AT access was determined by at the time of study the school having daily access to an AT. To truly understand the influence of access to an AT, knowing if at the time of "injury" the individuals had access to an AT would need to be known. Individuals without access may have also been more likely to report and less likely to participate symptomatic as a result of fewer "consequences" related

to reporting. As this study occurred at a time when policies were changing concerning return to play following concussions, many of the schools in our sample both in and outside of North Carolina have implemented policies not allowing athletes to return the same day. In addition, the current attention concerning concussion may have also played a role.

With the exception of indirect perceived behavioral control, the original study hypotheses for Research Question 3a-b were accepted as all 3 direct measures and 2 of the indirect measures (attitude and subjective norm) were found to be positively associated with intention to report. In addition, intention to report was associated with not participating in games and practices while symptomatic. The questions concerning participation with symptoms were more aligned with the questions concerning intention, which may be why these 2 variables were associated with intention and the other 6 reporting variables were not associated. Overall these findings related to the Theory of Reasoned Action and Planned Behavior emphasize the importance of a culture shift concerning the reporting problem among high school athletes.

Both study hypotheses concerning AT influence on coach and athlete knowledge and attitude were rejected with no associations observed. This finding may be the result of many different sources of concussion knowledge, previous experience, and the time in which these individuals had access to an AT. In addition, the current social and media attention to concussion may influence knowledge and attitudes. Furthermore, as mentioned, only 2 of the ATs in the study sample conducted any type of concussion education session with athletes and coaches.

More extensive analyses were done than originally proposed to better understand the many aspects concerning reporting ranging from context to the spectrum (“bell ringer’ vs.

"concussion") of events. Through this examination the variables of participating while symptomatic emerged as 2 of the most meaningful variables as they encompassed the behaviors of the entire sample, not just those 89 individuals who recalled experiencing a "concussive" event. Moreover, the discrepancies across these variables illustrate the many variables, people, and factors that may play a role in concussion reporting among high school athletes. There is not one simple solution to addressing concussion in this population. To better address these issues, multiple facets and people need to be involved.

4.17 Limitations of the Study

The low return among the athlete subjects may present with some response bias. This bias may have resulted in findings not generalizble to all high school athletes participating in the sports included in the study sample. Although the purpose of the study was not to make population estimates, it should still be noted that the sample was a convenient sample. In addition, the behavior assessed in this study (reporting/not reporting) was not observed, but self-report, which may be the best way to understand athletes' perceptions concerning concussion. Because this information was based on self-report and not measured behavior, response bias may have also influenced these findings. Also, a disproportionate percentage of our athlete sample was football athletes (41.5 %) leading to a possible football effect for the study findings. To assess for this affect analyses were run comparing football vs. non-football with minimal differences for knowledge, attitude, and behaviors between the 2 groups. For coaches, we had a lack of racial diversity in response as well as significantly more males (74.1 %) than females (25.9 %). Although we did not set out to assess the effects of race, the lack of diversity may have also lead to some bias. Individuals who recalled more events may also be influencing the variables pertaining to participation with symptoms in the

entire sample as these individuals had more opportunity to choose the concussion reporting behavior. This may be a confounding factor; however, the findings concerning proportion of people engaging in this behavior and the demographics of these individuals provide insight into who clinicians should be aware of when considering concealing of concussion injuries. The current study was also cross-sectional in nature and can only provide insight on the one point in time the survey instruments were completed. We did not assess how changing knowledge, attitude, or environment would influence these factors, which is ultimately the goal of understanding the role these factors may play. This provides a framework for future studies. It should also be noted that time of reporting in proximity to the event was not obtained. During the 18 months in which this study was conducted, there was a significant amount of media attention given to concussion in sport. This may have influenced some of our findings by increasing knowledge and awareness as reflected in the high knowledge scores of both coaches and athletes in our sample. However, the study still provides insight into the behavior of underreporting and the factors surrounding this risky behavior among high school athletes. It is also the first to quantify reporting in addition to knowledge and attitude.

4.18 Future Research

Future research should focus on intervention targets to address the behavior of reporting concussion among high school athletes. These targets should address multiple levels of the socio-ecological framework and include education and possible policy change. The results of this study suggests the educational portions of future interventions should focus on increasing concussion knowledge and conveying the seriousness of possible

concussions to high school aged athletes as this was the primary reason cited for not reporting events. As illustrated by the study findings concerning subjective norm (influence of social referents), conveying this message of the seriousness of concussion to coaches and athletes may provide a more optimal environment for reporting. By involving individuals at various levels of involvement in the reporting process, a shift in overall culture may more likely be achieved. In addition, further research is needed to understand the role of parents in concussion behaviors. The outcomes from current awareness programs and policies should also be examined in an effort to determine if these were successful in changing behaviors and injury patterns concerning concussion in this population.

4.19 Conclusions

The most striking finding of this study was the large proportion of recalled concussive events not reported among this sample of high school athletes. Athletes in the study sample classified the majority of these events as *bell ringers*. The disparity between number of recalled *concussions* and recalled *bell ringers* highlights the misunderstanding concerning the use of this term and athletes' lack of association between this term and concussive injury. We employed this term in our study to examine the number of these events that athletes would classify as occurring. However, the term should not be used in clinical or educational settings as it minimizes the serious nature of a possible concussion. All of these *bell ringer* events may not have been true concussions, but these events should be reported and placed in the hands of clinicians in order to make this decision. If these events are not reported, they cannot be managed, and athletes may continue to play in a vulnerable state. This vulnerable state may set these young athletes up for risk of subsequent or more complicated injury.

Despite these events being self-report, this study provides insight into events athletes recognize as a *bell ringer* or *concussion* that was not reported. The other aims in the study attempted to examine and better understand the factors that may influence the behavior of reporting. Factors that increased reporting included increasing athlete knowledge, intention, and attitude.

Most importantly, the study aimed to identify targets for intervention. **Table 4.20** summarizes the influential factors on concussion reporting. Our results suggest future efforts should focus on increasing athlete knowledge, providing a positive environment for reporting through education, coach discussions, and school policies (affect attitude). In addition, the important individuals (teammates, coaches, parents, medical professionals) who may influence concussion reporting should be involved in the education programs and policies in an effort to begin to address normative beliefs among the important social referents. Increasing coach knowledge appeared to negatively affect reporting. As a result, the study also provides insight into the importance of addressing multiple factors as addressing only 1 may result in negative or unexpected changes.

As future interventions and policies are developed, both barriers and possible outcomes should be considered. Appendix 11 includes a PRECEDE diagram clearly identifying the targets of an intervention aimed at the behavior of concussion reporting. The PRECEDE model calls for careful and through identification of the target population, and the major health problem to be addressed. This is to be followed by behavioral and environmental determinants related to the problem. In addition, predisposing, reinforcing, and enabling factors to these determinants are identified. Lastly, health issues and barriers to action are examined. At each phase of this process issues and factors must be inventoried and

prioritized based on importance and changeability. The inventory and prioritization results from careful and exhaustive review of the literature, community involvement, (Chapter 2) and in this particular process, the results of this dissertation project. This planning model allows for intervention on multiple levels of the socioecological framework.(Figure 2.1) This study is both timely and important and these results have potential to assist in the culture shift in sport concerning sport-related concussion currently underway.

Table 4.1 List of reporting outcomes, analysis unit, and portion of sample included in analyses

Reporting Outcome	Analysis Unit	Portion of Sample Included Analysis
Reporting at least 50% of recalled concussion only events	People	Only those with at least 1 recalled concussion event
Reporting at least 50% of recalled bell ringer only events	People	Only those with at least 1 recalled bell ringer event
Reporting of recalled concussion/bell ringer events in games	Recalled Events	Only those with at least 1 recalled concussion or bell ringer event in a game
Reporting of recalled concussion/bell ringer events in practices	Recalled Events	Only those with a recalled concussion or bell ringer event during practice
Reporting of recalled concussion only events	Recalled Events	Only those with at least 1 recalled concussion event
Reporting of recalled bell ringer only events	Recalled Events	Only those with at least 1 recalled bell ringer event
Participation in game with concussion signs and symptoms	People	Entire Sample
Participation in practice with concussion signs and symptoms	People	Entire Sample

Table 4.2 Athlete Demographic Information

Athlete Demographics	**Frequency (%)***
Gender (5 did not report)	
Male	98 (60.5%)
Female	64 (39.1%)
Race (3 did not report)	
African American	17 (10.4%)
White	138 (84.2%)
Hispanic	5 (3.1%)
Asian	4 (2.4%)
Current Sport (13 did not report)	
Football	66 (41.5%)
Boys Soccer	20 (13.9%)
Girls Soccer	18 (11.8%)
Boys Lacrosse	10 (6.3%)
Girls Lacrosse	9 (6.3%)
Cheerleading	31 (19.0%)
Concussion Education Discussion	
Yes	130 (77.8%)
No	37 (22.2%)
AT access (2 from unknown schools)	
Yes	81 (49.1%)
No	84 (50.9%)
History of "Concussion"	
Yes	44 (26.4%)
No	123 (73.7%)
History of "Ding"	
Yes	81 (48.5%)
No	86 (51.5%)

* Percentages may not add up to 100% because of rounding

Table 4.3 Coach Demographic Information

Coach Demographics	**Frequency (%)**
Gender (1 did not report)	
Male	43 (74.1%)
Female	15 (25.9%)
Coach Type	
Head	25 (42.3%)
Assistance	34 (57.6%)
Race (4 did not report)	
African American	2 (3.6%)
White	52 (94.5%)
Hispanic	1 (1.8%)
Current Sport (3 did not report)	
Football	26 (46.3%)
Boys Soccer	8 (16.0%)
Girls Soccer	7 (14.0%)
Boys Lacrosse	5 (8.9%)
Girls Lacrosse	4 (8.0%)
Concussion Education Discussion	
Yes	36 (61.0%)
No	23 (38.9%)
AT access	
Yes	36 (61.0%)
No	23 (39.9%)
*Certifications/Qualifications**	
None	8 (13.6%)
First Aid	34 (57.6%)
CPR	44 (74.8%)
Coaching Certification	32 (54.2%)
History of Concussion	
Yes	25 (42.4%)
No	34 (57.6%)

*Percentages will not add up to 100% as each row is from the entire sample

Table 4.4 Athlete Knowledge Score: Frequency Answering Correctly by Question

Athlete Knowledge Item	Frequency Answering Correctly (%)
Symptoms	
Abnormal sense of smell	151 (90.4%)
Abnormal sense of taste	153 (91.6%)
Amnesia	94 (56.3%)
Joint Stiffness	152 (91.0%)
Blurred Vision	147 (88.0%)
Black Eye	149 (89.2%)
Bleeding from the ear	130 (77.8%)
Bleeding from the mouth	152 (91.0%)
Bleeding from the nose	145 (86.8%)
Confusion	154 (92.2%)
Fever	157 (94.0%)
Dizziness	148 (88.6%)
Headache	148 (88.6%)
Insomnia	140 (83.3%)
Loss of consciousness	127 (76.1%)
Nausea	107 (64.1%)
Numbness or tingling of arms	113 (67.7%)
Skin rash	167 (100.0%)
Sharp burning pain in neck	113 (67.3%)
Weakness in neck movements	91 (54.5%)
General Knowledge	
Loss of consciousness and concussion *(4 missing)*	15 (9.2%)
Return to play with symptoms *(4 missing)*	15 (9.2%)
Body part injured *(2 missing)*	146 (88.3%)
Complications of Multiple Concussions	
No complications exists	167 (100.0%)
Increased risk of further injury	106 (63.4%)
Brain damage	152 (91.2%)
Joint problems	150 (89.8%)
I don't know	157 (94.0%)
Memory problems	142 (85.0%)
Complications of Returning to Play too Soon	
No complications exists	166 (99.4%)
Increased risk of further injury	145 (86.8%)
Paralysis	92 (55.1%)
Brain damage	145 (88.0%)
Joint problems	147 (88.0%)
I don't know	154 (92.2%)

Table 4.5 Athlete Attitude Means and Totals

Athlete Attitude Question	**Mean (SD)**
Seriousness of symptoms	4.5 ± 1.5
Not participating with symptoms	5.5 ± 1.6
Informed about how concussions happen	5.9 ± 1.4
Informed about prevention	5.9 ± 1.5
Informed about steps to follow	6.3 ± 1.2
Importance of reporting	6.1 ± 1.2
Under-education of Athletes	5.1 ± 1.5
General Attitude Total	39.3 ± 6.9
Cowardly-Brave	5.1 ± 1.6
Embarrassing-Pleasant	4.5 ± 1.7
Harmful-Beneficial	6.2 ± 1.3
Extremely Difficult-Extremely Easy	5.0 ± 1.6
Bad-Good	6.0 ± 1.4
Unimportant-Important	6.1 ± 1.4
Worthless-Valuable	6.1 ± 1.3
Attitude Toward Reporting Total	39.0 ± 7.1

* Scores on a 1-7 Likert Scale

Table 4.6 Mean Responses for Direct TRA-TpB Questions and Constructs

TRA-TpB Questions and Constructs (Direct)	Mean (SD)*
Intention	
I intend to report	5.3 ± 1.9
I plan to report	5.4 ± 1.8
I will make an effort to report	5.4 ± 1.8
Intention Measure (average score)	5.3 ± 1.7
Direct Attitude	
Cowardly-Brave	5.1 ± 1.6
Embarrassing-Pleasant	4.5 ± 1.7
Harmful-Beneficial	6.2 ± 1.3
Extremely Difficult-Extremely Easy	5.0 ± 1.6
Bad-Good	5.9 ± 1.4
Unimportant-Important	6.1 ± 1.4
Worthless-Valuable	6.1 ± 1.3
Direct Attitude Toward Reporting Total (average score)	5.6 ± 1.0
Direct Subjective Norm (referents think should/not)	
People I know think I should/not report	5.5 ± 1.8
People who are important to me think I should/not report	5.7 ± 1.9
It is expect of me to report	5.9 ± 1.5
People who are important would approve of my reporting	5.7 ± 1.9
Direct Subjective Norm Total (average score)	5.8 ± 1.3
Direct Perceived Behavioral Control	
I am confident I could report	5.7 ± 1.6
How much control do you have over reporting (none, complete)	5.9 ± 1.5
I am able/unable to report	5.9 ± 1.5
Direct Perceived Behavior Control Total (average score)	5.8 ± 1.2

* Score on a 1-7 Likert Scale

Table 4.7 Mean Responses for Indirect TRA-TpB Questions and Constructs

TRA-TpB Questions and Constructs (Indirect)	Mean (SD)
Indirect Attitude	
Reporting will improve my athletic performance†	4.6 ± 1.9
Improving my performance is extremely good/bad*	2.7 ± 0.9
Reporting will reduce changes of suffering another concussion†	5.2 ± 1.9
Suffering fewer concussion is extremely good/bad*	2.2 ± 1.6
Reporting will cause me to lose my position on the team†	2.8 ± 2.0
Losing my position is extremely good/bad*	-2.3 ± 1.2
Reporting will cause me to lose playing time†	4.0 ± 2.1
Losing playing time is extremely good/bad*	-1.9 ± 1.4
Reporting will help me maintain my health†	5.8 ± 1.4
Maintaining my health is extremely good/bad*	2.7 ± 0.9
Reporting will cause me to miss out on team activities†	4.2 ± 1.9
Missing team activities is extremely good/bad*	-1.6 ± 1.4
Reporting will help maintain my school performance†	5.1 ± 1.7
Maintaining my school performance is extremely good/bad*	2.6 ± 0.9
Reporting will let my teammates down†	2.9 ± 1.9
Letting my teammates down is extremely good/bad*	-2.1 ± 1.3
Indirect Attitude Toward Reporting Total	27.1 ± 29.1
Indirect Direct Subjective Norm	
How much do you care what your coaches think (not at all, very much)†	5.3 ± 1.9
My coaches think I should/not report*	1.9 ± 1.9
How much do you care what your teammates think (not at all, very much)†	5.3 ± 1.9
My teammates think I should/not report*	1.6 ± 1.8
How much do you care what your parents think (not at all, very much)†	5.8 ± 1.7
My parents think I should/not report*	2.1 ± 1.7
How much do you care what students at your school think (not at all, very much)†	4.5 ± 2.1
Students at my school think I should/not report*	1.6 ± 1.6
Indirect Subjective Norm Total	41.0 ± 39.7
Indirect Perceived Behavioral Control	
I expect my coach to place a lot of pressure on me†	5.3 ± 1.8
The coach pressure makes it much easier/difficult to report*	0.3 ± 1.7
I expect my parents to place a lot of pressure on me†	4.1 ± 1.8
The pressure my parents place on me makes it much easier/difficult to report*	0.9 ± 1.8
I expect my teammates to place a lot of pressure on me†	4.9 ± 1.8
The pressure my teammates place on me makes it much easier/difficult to report*	0.3 ± 1.7
Indirect Perceived Behavior Control Total	17.8 ± 27.1

† Score on a 1-7 Likert Scale *Score on a -3 to +3 Semantic Differential Scale

Table 4.8 Athlete responses for reasons behind not reporting possible concussions

Reason	Frequency Answering Yes (%)
Reasons for not reporting concussions of "dings" during high school (n=89)	
Did not think it was serious enough to report	52 (58.4%)
Did not want to let your teammates down	20 (22.5%)
Did not want to let your coaches down	17 (19.1%)
Did not know at the time it was a concussion	11 (12.4%)
Did not want to be removed from a practice	10 (11.2%)
Did not want to be removed from a game	27 (30.3%)
Reasons athlete subjects reported they would choose not to report (n=167)	
N/A would report it	59 (35.3%)
Would not think it was serious enough to report	94 (56.3%)
Would not want to let your teammates down	41 (24.5%)
Would not want to let your coaches down	42 (25.2%)
Would not know at the time it was a concussion	61 (36.5%)
Would not want to be removed from a practice	30 (17.9%)
Would not want to be removed from a game	59 (35.3%)

Table 4.9 Coach Knowledge Score: Frequency Answering Correctly by Question

Coach Knowledge Item	Frequency Answering Correctly (%)
Symptoms	
Abnormal sense of smell	51 (86.4%)
Abnormal sense of taste	49 (83.1%)
Amnesia	41 (69.4%)
Joint Stiffness	51 (86.4%)
Blurred Vision	47 (79.6%)
Black Eye	49 (83.1%)
Bleeding from the ear	38 (64.4%)
Bleeding from the mouth	43 (89.9%)
Bleeding from the nose	46 (77.9%)
Confusion	51 (86.4%)
Fever	59 (100.0%)
Dizziness	51 (86.4%)
Headache	53 (89.8%)
Insomnia	42 (71.2%)
Loss of consciousness	49 (83.1%)
Nausea	49 (83.1%)
Numbness or tingling of arms	39 (66.2%)
Skin rash	58 (98.3%)
Sharp burning pain in neck	44 (74.8%)
Weakness in neck movements	42 (71.9%)
General Knowledge	
Loss of consciousness and concussion	54 (100.0%)
Return to play with symptoms *(6 missing)*	52 (98.1%)
Body part injured *(4 missing)*	49 (89.1%)
Complications of Multiple Concussions	
No complications exists	59 (100.0%)
Increased risk of further injury	46 (77.9%)
Brain damage	53 (89.8%)
Joint problems	55 (93.2%)
I don't know	58 (98.1%)
Memory problems	50 (84.8%)
Complications of Returning to Play too Soon	
No complications exists	59 (100.0%)
Increased risk of further injury	52 (88.4%)
Paralysis	30 (50.6%)
Brain damage	49 (83.1%)
Joint problems	54 (91.5%)
I don't know	58 (98.3%)

Table 4.10 Coach Attitude Means and Total Scores

Coach Attitude Question	Mean (SD)
Seriousness of symptoms	5.9 ± 1.2
Not participating with symptoms	6.8 ± 0.7
Informed about how concussions happen	6.6 ± 0.9
Informed about prevention	6.5 ± 1.0
Informed about steps to follow	6.9 ± 0.4
Importance of reporting	6.9 ± 0.3
Under-education of Athletes	6.0 ± 1.2
General Attitude Total	45.7 ± 3.9
Cowardly-Brave	5.9 ± 1.8
Embarrassing-Pleasant	4.6 ± 1.8
Harmful-Beneficial	6.6 ± 0.7
Extremely Difficult-Extremely Easy	4.1 ± 1.9
Bad-Good	6.4 ± 1.3
Unimportant-Important	6.5 ± 1.3
Worthless-Valuable	6.5 ± 1.1
Attitude Toward Athlete Reporting Total	40.4 ± 5.8

Table 4.11 Research Question 1: Coach Knowledge (CKT) and Attitude (CAT) Influence on Athlete Knowledge (AKT) and Attitude (AAT) Estimates of Change, Standard Errors, and Confidence Limits

Independent Variable 10-point Increase	Estimate of Change in Athlete Scores	Standard Error	95% Confidence Limits		Chi-Square	P-Value
			Lower	Upper		
RQ 1a. CKT on AKT						
CKT (n=115)	0.18	0.18	-0.18	0.54	0.95	0.331
RQ 1b. CAT on AAT						
CAT (n=114)	1.29	1.39	-1.44	4.02	0.86	0.354

Table 4.12 Research Question 2d: Coach Knowledge (CKT) Influence on Concussion Reporting Prevalence Ratios, Standard Errors, and Confidence Limits

Independent Variable 10-point Increase	Prevalence Ratio	Standard Error	95% Confidence Limits Lower	95% Confidence Limits Upper	Chi-Square	P-Value
RQ 2c. Reporting Recalled Concussion Events† (n=40)						
CKT	0.70	0.22	0.38	1.30	1.23	0.267
RQ 2c. Reporting Recalled Bell Ringer Events† (n=69)						
CKT	0.28	0.23	0.06	1.42	2.33	0.130
RQ 2c. Reporting of Concussion and Bell Ringer Events in Games* (n=61)						
CKT	0.44	0.07	0.31	0.62	21.78	<0.001
RQ 2c. Reporting of Concussion and Bell Ringer Events in Practices* (n=55)						
CKT	0.05	0.07	0.00	0.81	4.46	0.039
RQ 2c. Reporting of Recalled Concussion Events* (n=40)						
CKT	0.52	0.18	0.26	1.03	3.47	0.063
RQ 2c. Reporting of Recalled Bell Ringer Events* (n=69)						
CKT	1.00	1.3	0.09	13.41	0.00	0.956
RQ 2c. Reporting Continuing in a Game while Symptomatic† (n=129)						
CKT	0.79	0.09	0.63	0.99	3.89	0.049
RQ 2c. Reporting Recalled Continuing in a Practice while Symptomatic† (n=128)						
CKT	0.69	0.18	0.42	1.16	1.92	0.170

† = People as the Unit of Analysis *Recalled Events as the Unit of Analysis

Table 4.13 Research Question 2e: Coach Attitude (CAT) Influence on Concussion Reporting Prevalence Ratios, Standard Errors, and Confidence Limits

Independent Variable 10-point Increase	Prevalence Ratio	Standard Error	95% Confidence Limits Lower	95% Confidence Limits Upper	Chi-Square	P-Value
RQ 2d. Reporting Recalled Concussion Events† (n=40)						
CAT	1.05	0.25	0.65	1.69	0.05	0.825
RQ 2d. Reporting Recalled Bell Ringer Events† (n=70)						
CAT	0.71	0.37	0.26	1.97	0.41	0.523
RQ 2d. Reporting of Concussion and Bell Ringer Events in Games* (n=62)						
CAT	1.24	0.17	0.94	1.63	2.37	0.123
RQ 2d. Reporting of Concussion and Bell Ringer Events in Practices* (n=56)						
CAT	0.34	0.26	0.07	1.52	1.98	0.159
RQ 2d. Reporting of Recalled Concussion Events* (n=40)						
CAT	1.02	0.22	0.67	1.56	0.01	0.921
RQ 2d. Reporting of Recalled Bell Ringer Events* (n=80)						
CAT	0.35	0.19	0.12	1.04	3.55	0.059
RQ 2d. Reporting Continuing in a Game while Symptomatic† (n=132)						
CAT	0.65	0.01	0.48	0.87	8.12	0.004
RQ 2d. Reporting Recalled Continuing in a Practice while Symptomatic† (n=130)						
CAT	0.46	0.09	0.31	0.68	14.60	<0.001

† = People as the Unit of Analysis *Recalled Events as the Unit of Analysis

Table 4.14 Research Question 2f : Athletic Trainer (AT) Access Influence on Reporting Prevalence Ratios, Standard Errors, and Confidence Limits

Independent Variable	Prevalence Ratio	Standard Error	95% Confidence Limits Lower	Upper	Chi-Square	P-Value
RQ 2b. Reporting Recalled Concussion Events† (n=43)						
No vs. AT	1.21	0.26	0.79	1.81	0.79	0.372
RQ 2b. Reporting Recalled Bell Ringer Events† (n=80)						
No vs. AT	0.88	0.30	0.44	1.73	0.14	0.705
RQ 2b. Reporting of Concussion and Bell Ringer Events in Games* (n=60)						
No vs. AT	1.31	0.13	1.08	1.60	7.13	0.008
RQ 2b. Reporting of Concussion and Bell Ringer Events in Practices* (n=57)						
No vs. AT	0.90	0.56	0.27	3.07	0.03	0.872
RQ 2b. Reporting of Recalled Concussion Events* (n=43)						
No vs. AT	1.38	0.22	1.02	1.86	4.32	0.378
RQ 2b. Reporting of Recalled Bell Ringer Events* (n=80)						
No vs. AT	0.85	0.43	0.32	2.27	0.10	0.750
RQ 2b. Reporting Continuing in a Game while Symptomatic† (n=158)						
No vs. AT	0.74	0.14	0.51	1.08	2.39	0.122
RQ 2b. Reporting Recalled Continuing in a Practice while Symptomatic† (n=155)						
No vs. AT	0.66	0.15	0.43	1.04	2.26	0.071

† = People as the Unit of Analysis *Recalled Events as the Unit of Analysis

Table 4.15 Research Question 4: Influence of Athletic Trainer (AT) Access on Coach and Athlete Knowledge and Attitude

Label	Mean Difference	Standard Error	95% Confidence Limits		Chi-Square	P-Value
			Lower	Upper		
RQ 4a. AT influence on Coach Knowledge (n=52)						
No AT – Yes AT	-0.33	0.73	-1.78	1.11	0.20	0.652
RQ 4a. AT influence on Coach Attitude (n=48)						
No AT – Yes AT	2.58	2.14	-1.59	6.78	1.47	0.226
RQ 4b. AT influence on Athlete Knowledge (n=143)						
No AT – Yes AT	-0.19	0.29	-0.75	0.38	0.44	0.507
RQ 4b. AT influence on Athlete Attitude (n=140)						
No AT – Yes AT	0.63	1.62	-2.54	3.81	0.15	0.697

Table 4.16 Ancillary: Intention Group and Influence on Reporting Prevalence Ratios, Standard Errors, and Confidence Limits

Independent Variable	Prevalence Ratio	Standard Error	95% Confidence Limits Lower	95% Confidence Limits Upper	Chi-Square	P-Value
RQ 3c. Reporting Recalled Concussion Events† (n=40)						
Low vs. High Intenders	1.14	0.38	0.59	2.19	0.16	0.687
RQ 3c. Reporting Recalled Bell Ringer Events† (n=69)						
Low vs. High Intenders	1.26	0.62	0.48	3.32	0.22	0.635
RQ 3c. Reporting of Concussion and Bell Ringer Events in Games* (n=65)						
Low vs. High Intenders	1.41	0.34	0.89	2.26	2.06	0.151
RQ 3c. Reporting of Concussion and Bell Ringer Events in Practices* (n=62)						
Low vs. High Intenders	1.06	0.37	0.54	2.12	0.03	0.854
RQ 3c. Reporting of Recalled Concussion Events* (n=40)						
Low vs. High Intenders	0.89	0.25	0.41	1.52	0.19	0.659
RQ 3c. Reporting of Recalled Bell Ringer Events* (n=75)						
Low vs. High Intenders	1.14	0.28	0.70	1.86	0.30	0.586
RQ 3c. Reporting Continuing in a Game while Symptomatic† (n=155)						
Low vs. High Intenders	2.89	0.79	1.69	4.91	15.35	<0.001
RQ 3c. Reporting Recalled Continuing in a Practice while Symptomatic† (n=152)						
Low vs. High Intenders	4.44	1.60	2.19	9.00	17.13	<0.001

† = People as the Unit of Analysis *Recalled Events as the Unit of Analysis

Table 4.17 Ancillary: Direct Measures Influence on Reporting Prevalence Ratios, Standard Errors, and Confidence Limits

Independent Variable 1-point Increase	Prevalence Ratio	Standard Error	95% Confidence Limits Lower	Upper	Chi-Square	P-Value
RQ 3d. Reporting Recalled Concussion Events†						
Attitude (n=40)	1.00	0.12	0.80	1.26	0.00	0.965
Subjective Norm (n=37)	1.27	0.16	0.99	1.63	3.69	0.054
Perceived Behavioral Control (n=41)	0.94	0.09	0.79	1.13	0.38	0.541
RQ 3d. Reporting Recalled Bell Ringer Events†						
Attitude (n=71)	1.12	0.28	0.70	1.82	0.23	0.632
Subjective Norm (n=72)	1.12	0.23	0.75	1.67	0.31	0.577
Perceived Behavioral Control	1.30	0.20	0.71	1.51	0.03	0.872
RQ 3d. Reporting of Concussion and Bell Ringer Events in Games*						
Attitude (n=63)	1.07	0.11	0.88	1.31	0.49	0.483
Subjective Norm (n=63)	1.18	0.11	0.99	1.40	3.22	0.073
Perceived Behavioral Control (n=67)	0.89	0.06	0.78	1.02	2.97	0.085
RQ 3d. Reporting of Concussion and Bell Ringer Events in Practices*						
Attitude (n=59)	1.37	0.18	1.06	1.79	5.91	0.015
Subjective Norm (n=60)	1.31	0.16	1.03	1.67	4.84	0.030
Perceived Behavioral Control (n=62)	1.15	0.19	0.83	1.59	0.72	0.396
RQ 3d. Reporting of Recalled Concussion Events*						
Attitude (n=40)	0.96	0.09	0.79	1.17	0.14	0.701
Subjective Norm (n=37)	1.30	0.12	1.10	1.56	9.28	0.002
Perceived Behavioral Control (n=41)	0.92	0.07	0.80	1.07	0.97	0.321

† = People as the Unit of Analysis *Recalled Events as the Unit of Analysis

Table 4.17 Ancillary: Direct Measures and Influence on Reporting Prevalence Ratios, Standard Errors, and Confidence Limits (continued)

Independent Variable 1-point Increase	Prevalence Ratio	Standard Error	95% Confidence Limits Lower	Upper	Chi-Square	P-Value
RQ 3d. Reporting of Recalled Bell Ringer Events*						
Attitude (n=71)	1.43 (odds)	0.17	1.12	1.81	8.46	0.003
Subjective Norm (n=72)	1.27	0.12	1.05	1.53	6.18	0.013
Perceived Behavioral Control (n=75)	1.06	0.11	0.87	1.31	0.42	0.521
RQ 3d. Reporting Continuing in a Game while Symptomatic†						
Attitude (n=144)	0.69	0.06	0.58	0.82	16.82	<0.001
Subjective Norm (n=151)	0.82	0.07	0.68	0.97	5.52	0.019
Perceived Behavioral Control (n=154)	0.81	0.04	0.74	0.88	23.29	<0.001
RQ 3d. Reporting Recalled Continuing in a Practice while Symptomatic†						
Attitude (n=142)	0.60	0.06	0.50	0.72	30.25	<0.001
Subjective Norm (n=148)	0.76	0.78	0.62	0.93	7.00	0.008
Perceived Behavioral Control (n=151)	0.77	0.04	0.69	0.85	25.50	<0.001

† = People as the Unit of Analysis *Recalled Events as the Unit of Analysis

Table 4.18 Ancillary: Indirect Measures Influence on Reporting Prevalence Ratios, Standard Errors, and Confidence Limit

Independent Variable 10-point Increase	Prevalence Ratio	Standard Error	95% Confidence Limits Lower	Upper	Chi-Square	P-Value
RQ 3d. Reporting Recalled Concussion Events†						
Attitude (n=40)	1.11	0.07	0.99	1.25	3.06	0.080
Subjective Norm (n=37)	1.03	0.04	0.97	1.11	1.08	0.291
Perceived Behavioral Control (n=36)	0.96	0.06	0.84	1.11	0.27	0.06
RQ 3d. Reporting Recalled Bell Ringer Events†						
Attitude (n=67)	0.93	0.08	0.78	1.12	0.56	0.462
Subjective Norm (n=67)	0.96	0.07	0.83	1.12	0.23	0.631
Perceived Behavioral Control (n=70)	0.95	0.11	0.77	1.19	0.14	0.704
RQ 3d. Reporting of Concussion and Bell Ringer Events in Games*						
Attitude (n=59)	1.00	0.04	0.92	1.09	0.02	0.891
Subjective Norm (n=59)	0.98	0.03	0.92	1.05	0.23	0.631
Perceived Behavioral Control (n=61)	0.89 (odds)	0.06	0.78	1.04	2.10	0.147
RQ 3d. Reporting of Concussion and Bell Ringer Events in Practices*						
Attitude (n=57)	1.16	0.07	1.03	1.31	6.27	0.011
Subjective Norm (n=57)	1.11	0.05	1.01	1.21	4.62	0.032
Perceived Behavioral Control (n=59)	0.86	0.07	0.74	1.00	3.76	0.052
RQ 3d. Reporting of Recalled Concussion Events*						
Attitude (n=40)	1.04	0.05	0.95	1.15	0.83	0.361
Subjective Norm (n=37)	1.00 (odds)	0.07	0.87	1.14	0.00	0.989
Perceived Behavioral Control (n=36)	0.94	0.05	0.85	1.05	1.28	0.258

† = People as the Unit of Analysis *Recalled Events as the Unit of Analysis

Table 4.18 Ancillary: Indirect Measures and Influence on Reporting Prevalence Ratios, Standard Errors, and Confidence Limits (continued)

Independent Variable 10-point Increase	Prevalence Ratio	Standard Error	95% Confidence Limits Lower	Upper	Chi-Square	P-Value
RQ 3d. Reporting of Recalled Bell Ringer Events*						
Attitude (n=67)	1.10	0.05	1.01	1.20	4.88	0.027
Subjective Norm (n=67)	1.05	0.04	0.98	1.14	2.27	0.132
Perceived Behavioral Control (n=70)	0.88 (odds)	0.06	0.77	1.00	3.63	0.057
RQ 3d. Reporting Continuing in a Game while Symptomatic†						
Attitude (n=138)	0.96	0.04	0.89	1.05	0.68	0.409
Subjective Norm (n=139)	0.94	0.02	0.90	0.97	11.86	<0.001
Perceived Behavioral Control (n=141)	0.97	0.04	0.90	1.06	0.25	0.612
RQ 3d. Reporting Recalled Continuing in a Practice while Symptomatic†						
Attitude (n=135)	0.85	0.04	0.79	0.92	14.08	0.002
Subjective Norm (n=137)	0.94	0.24	0.90	0.99	4.51	0.033
Perceived Behavioral Control (n=138)	0.91	0.04	0.84	1.01	3.20	0.073

† = People as the Unit of Analysis *Recalled Events as the Unit of Analysis

Table 4.19 Ancillary: Influence of Recalled High School Concussion History on Reporting Prevalence Ratios and Associated Standard Errors, and Confidence Limits

Independent Variable 3 Point Increase	Prevalence Ratio	Standard Error	95% Confidence Limits Lower	95% Confidence Limits Upper	Chi-Square	P-Value
Reporting Recalled Concussion Events† (n=40)						
Concussions	0.42	0.18	0.17	1.04	3.60	0.050
Reporting Recalled Bell Ringer Events† (n=69)						
Concussions	0.96	0.50	0.35	2.70	0.00	0.950
Reporting of Concussion and Bell Ringer Events in Games* (n=61)						
Concussions	1.30	0.23	0.92	1.80	2.37	0.130
Reporting of Concussion and Bell Ringer Events in Practices* (n=55)						
Concussions	0.61	0.19	0.32	1.14	2.35	0.120
Reporting of Recalled Concussion Events* (n=40)						
Concussions	0.52	0.13	0.31	0.87	6.73	0.010
Reporting of Recalled Bell Ringer Events* (n=69)						
Concussions	0.62	0.16	0.38	1.04	3.22	0.070
Reporting Continuing in a Game while Symptomatic† (n=129)						
Concussions	1.67	0.22	1.28	2.15	14.94	<0.001
Reporting Recalled Continuing in a Practice while Symptomatic† (n=128)						
Concussions	2.25	0.37	1.63	3.09	24.97	<0.001

† = People as the Unit of Analysis *Recalled Events as the Unit of Analysis

Table 4.20 Reporting Outcome Summary Table

Reporting (Recalled) Outcome	**Gender Boys vs. Girls**	**AT Access No AT vs. AT**	**Coach Knowledge 10-point increase**	**Coach Attitude 10-point increase**	**Athlete Knowledge 10-point increase**	**Athlete Attitude 10-point increase**	**Intention 1 point increase**	**Intention Group Low vs. High**	**Direct Attitude 1 point increase**	**Direct SN 1 point increase**	**Direct PBC 1 point increase**	**Indirect Attitude 10-point increase**	**Indirect SN 10-point increase**	**Indirect PBC 10-point increase**	**Total *Concussions* 3 Concussions**
Concussion Only †										↑		↑		↓	↓
Bell Ringer Only†			↓												
Game Events*	↑ Men		↓	↑		↑		↑ Low		↑	↓			↓	↑
Practice Events*	↓ Men		↓	↓	↑	↑			↑	↑		↑	↑	↓	↓
Concussion Only*			↓							↑					↓
Bell Ringer Only*				↓	↑	↑			↑ odds	↑		↑	↑	↓	↓
Participation in Games with Symptoms†	↑ Men	↓ No AT	↓	↓		↓	↓	↑ Low	↓	↓	↓	↓	↓		↑
Participation in Practice with Symptoms†		↓ No AT	↓	↓		↓	↓	↑ Low	↓	↓	↓	↓	↓	↓	↑

† = People as the Unit of Analysis *Recalled Events as the Unit of Analysis -Shading = association/trend, Arrow = increase/decrease

REFERENCES

1. Langlois JA, Rutland-Brown W, Wald MM. The epidemiology and impact of traumatic brain injury: a brief overview. *J Head Trauma Rehabil.* 2006;21:375-378.

2. McCrea M, Guskiewicz KM, Marshall SW, et al. Acute effects and recovery time following concussion in collegiate football players: the NCAA Concussion Study. *JAMA.* 2003;290:2556-2563.

3. Kaut KP, DePompei R, Kerr J, Congeni J. Reports of head injury and symptom knowledge among college athletes: implications for assessment and educational intervention. *Clin J Sport Med.* 2003;13:213-221.

4. Valovich McLeod TC, Bay RC, Heil J, McVeigh SD. Identification of sport and recreational activity concussion history through the preparticipation screening and a symptom survey in young athletes. *Clin J Sport Med.* 2008;18:235-240.

5. Valovich McLeod TC, Schwartz C, Bay RC. Sport-related concussion misunderstandings among youth coaches. *Clin J Sport Med.* 2007;17:140-142.

6. Collins MW, Lovell MR, Iverson GL, Cantu RC, Maroon JC, Field M. Cumulative effects of concussion in high school athletes. *Neurosurgery.* 2002;51:1175-1179; discussion 1180-1171.

7. Guskiewicz KM, Marshall SW, Bailes J, et al. Association between recurrent concussion and late-life cognitive impairment in retired professional football players. *Neurosurgery.* 2005;57:719-726.

8. Guskiewicz KM, Marshall SW, Bailes J, et al. Recurrent concussion and risk of depression in retired professional football players. *Med Sci Sports Exerc.* 2007;39:903-909.

9. Guskiewicz KM, McCrea M, Marshall SW, et al. Cumulative effects associated with recurrent concussion in collegiate football players: the NCAA Concussion Study. *Jama.* 2003;290:2549-2555.

10. Zemper ED. Two-year prospective study of relative risk of a second cerebral concussion. *Am J Phys Med Rehabil.* 2003;82:653-659.

11. Thurman DJ, Alverson C, Brown D, et al. Tramuatic brain injury in the United States: A report to congress. *Atlanta, GA: National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, US Department of Health and Human Services.* 1999.

12. Buzzini SR, Guskiewicz KM. Sport-related concussion in the young athlete. *Curr Opin Pediatr.* 2006;18:376-382.

13. National Federation of State High School Associations (NFHS). 2005-2006 High School Athletic Participation Survey. 2006.

14. Powell JW, Barber-Foss KD. Traumatic brain injury in high school athletes. *JAMA.* 1999;282:958-963.

15. McCrea M, Hammeke T, Olsen G, Leo P, Guskiewicz K. Unreported concussion in high school football players: implications for prevention. *Clin J Sport Med.* 2004;14:13-17.

16. Rosenbaum AM, Arnett PA. The development of a survey to examine knowledge about and attitudes toward concussion in high-school students. *J Clin Exp Neuropsychol.* 2009:1-13.

17. Field M, Collins MW, Lovell MR, Maroon J. Does age play a role in recovery from sports-related concussion? A comparison of high school and collegiate athletes. *J Pediatr.* 2003;142:546-553.

18. Moser RS, Schatz P, Jordan BD. Prolonged effects of concussion in high school athletes. *Neurosurgery.* 2005;57:300-306; discussion 300-306.

19. Bleiberg J, Cernich AN, Cameron K, et al. Duration of cognitive impairment after sports concussion. *Neurosurgery.* 2004;54:1073-1078; discussion 1078-1080.

20. Cantu RC. Chronic traumatic encephalopathy in the National Football League. *Neurosurgery.* 2007;61:223-225.

21. Secondary School Committee. Position proposal guide for certified athletic trainers in secondary school athletics programs. *National Athletic Trainers' Association.* 2002.

22. Powell JW, Barber-Foss KD. Injury Patterns in Selected High School Sports: A Review of the 1995-1997 Seasons. *J Athl Train.* 1999;34:277-284.

23. Tandon SD, Marshall B, Templeman AJ, Sonenstein FL. Health access and status of adolescents and young adults using youth employment and training programs in an urban environment. *J Adolesc Health.* 2008;43:30-37.

24. Robbins JM, Valdmanis VG, Webb DA. Do public health clinics reduce rehospitalizations?: the urban diabetes study. *Journal of health care for the poor and underserved.* 2008;19:562-573.

25. Merzel C, Moon-Howard J. Access to health services in an urban community: does source of care make a difference? *J Urban Health.* 2002;79:186-199.

26. Gessel LM, Fields SK, Collins CL, Dick RW, Comstock RD. Concussions among United States high school and collegiate athletes. *J Athl Train.* 2007;42:495-503.

27. Dick RW. Is there a gender difference in concussion incidence and outcomes? *Br J Sports Med.* 2009;43 Suppl 1:i46-50.

28. Ommundsen Y, Roberts GC, Lemyre PN, Miller BW. Parental and coach support or pressure on psychosocial outcomes of pediatric athletes in soccer. *Clin J Sport Med.* 2006;16:522-526.

29. Pedersen DM, Manning CL. Attributions of athletes on collegiate sports teams. *Percept Mot Skills.* 2004;99:799-810.

30. Jurimae J, Maestu J, Purge P, Jurimae T, Soot T. Relations among heavy training stress, mood state, and performance for male junior rowers. *Percept Mot Skills.* 2002;95:520-526.

31. Cervello EM, Escarti A, Guzman JF. Youth sport dropout from the achievement goal theory. *Psicothema.* 2007;19:65-71.

32. Hall-Lande JA, Eisenberg ME, Christenson SL, Neumark-Sztainer D. Social isolation, psychological health, and protective factors in adolescence. *Adolescence.* 2007;42:265-286.

33. Ommundsen Y, Roberts GC, Lemyre PN, Miller BW. Peer relationships in adolescent competitive soccer: associations to perceived motivational climate, achievement goals and perfectionism. *J Sports Sci.* 2005;23:977-989.

34. McCrory P, Johnston K, Meeuwisse W, et al. Summary and agreement statement of the 2nd International Conference on Concussion in Sport, Prague 2004. *Br J Sports Med.* 2005;39:196-204.

35. Aubry M, Cantu R, Dvorak J, et al. Summary and agreement statement of the First International Conference on Concussion in Sport, Vienna 2001. Recommendations for the improvement of safety and health of athletes who may suffer concussive injuries. *Br J Sports Med.* 2002;36:6-10.

36. Guskiewicz KM, Mihalik JP, Shankar V, et al. Measurement of head impacts in collegiate football players: relationship between head impact biomechanics and acute clinical outcome after concussion. *Neurosurgery.* 2007;61:1244-1252; discussion 1252-1243.

37. McCaffrey MA, Mihalik JP, Crowell DH, Shields EW, Guskiewicz KM. Measurement of head impacts in collegiate football players: clinical measures of concussion after high- and low-magnitude impacts. *Neurosurgery.* 2007;61:1236-1243; discussion 1243.

38. Mihalik JP, Bell DR, Marshall SW, Guskiewicz KM. Measurement of head impacts in collegiate football players: an investigation of positional and event-type differences. *Neurosurgery.* 2007;61:1229-1235; discussion 1235.

39. Guskiewicz KM, Bruce SL, Cantu RC, et al. National Athletic Trainers' Association Position Statement: Management of Sport-Related Concussion. *J Athl Train.* 2004;39:280-297.

40. Schulz MR, Marshall SW, Mueller FO, et al. Incidence and risk factors for concussion in high school athletes, North Carolina, 1996-1999. *Am J Epidemiol.* 2004;160:937-944.

41. Sawyer RJ, Hamdallah M, White D, Pruzan M, Mitchko J, Huitric M. High School Coaches' Assessments, Intentions to Use, and Use of a Concussion Prevention Toolkit: Centers for Disease Control and Prevention's Heads Up: Concussion in High School Sports. *Health promotion practice.* 2008.

42. Sarmiento K, Mitchko J, Klein C, Wong S. Evaluation of the Centers for Disease Control and Prevention's concussion initiative for high school coaches: "heads up: concussion in high school sports". *J Sch Health.*80:112-118.

43. Theye F, Mueller KA. "Heads up": concussions in high school sports. *Clinical medicine & research.* 2004;2:165-171.

44. Fishbein M, Ajzen I. *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley Publishing Company; 1975.

45. Green LW, Costagliola D, Chwalow AJ. [Educational diagnosis and evaluation of educational strategies (PRECEDE Model): practical methodology for inducing changes in behavior and health status]. *Journ Annu Diabetol Hotel Dieu.* 1991:227-240.

46. Green LW, Kreuter MW. *Health Program Planning: An educational and ecological approach*. Boston: McGraw Hill; 2005.

47. Lovell MR, Collins MW, Iverson GL, Johnston KM, Bradley JP. Grade 1 or "ding" concussions in high school athletes. *Am J Sports Med.* 2004;32:47-54.

48. Collins MW, Iverson GL, Lovell MR, McKeag DB, Norwig J, Maroon J. On-field predictors of neuropsychological and symptom deficit following sports-related concussion. *Clin J Sport Med.* 2003;13:222-229.

49. Lovell MR, Iverson GL, Collins MW, McKeag D, Maroon JC. Does loss of consciousness predict neuropsychological decrements after concussion? *Clin J Sport Med.* 1999;9:193-198.

50. Guskiewicz KM, Ross SE, Marshall SW. Postural Stability and Neuropsychological Deficits After Concussion in Collegiate Athletes. *J Athl Train.* 2001;36:263-273.

51. Erlanger D, Kaushik T, Cantu R, et al. Symptom-based assessment of the severity of a concussion. *J Neurosurg.* 2003;98:477-484.

52. Cantu RC. Return to play guidelines after a head injury. *Clin Sports Med.* 1998;17:45-60.

53. Cantu RC. Posttraumatic Retrograde and Anterograde Amnesia: Pathophysiology and Implications in Grading and Safe Return to Play. *J Athl Train.* 2001;36:244-248.

54. Cantu RC. Athletic concussion: current understanding as of 2007. *Neurosurgery.* 2007;60:963-964.

55. Kelly JP. Loss of Consciousness: Pathophysiology and Implications in Grading and Safe Return to Play. *J Athl Train.* 2001;36:249-252.

56. Gillespie IA. Concussion. *N Engl J Med.* 2007;356:1788-1789; author reply 1789.

57. Pellman EJ, Viano DC, Casson IR, et al. Concussion in professional football: repeat injuries--part 4. *Neurosurgery.* 2004;55:860-873; discussion 873-866.

58. Pellman EJ, Viano DC, Casson IR, Arfken C, Feuer H. Concussion in professional football: players returning to the same game--part 7. *Neurosurgery.* 2005;56:79-90; discussion 90-72.

59. Pellman EJ, Viano DC, Casson IR, Arfken C, Powell J. Concussion in professional football: injuries involving 7 or more days out--Part 5. *Neurosurgery.* 2004;55:1100-1119.

60. Broglio SP, Macciocchi SN, Ferrara MS. Neurocognitive performance of concussed athletes when symptom free. *J Athl Train.* 2007;42:504-508.

61. Collins MW, Hawn KL. The clinical management of sports concussion. *Curr Sports Med Rep.* 2002;1:12-22.

62. Guskiewicz KM, Weaver NL, Padua DA, Garrett WE, Jr. Epidemiology of concussion in collegiate and high school football players. *Am J Sports Med.* 2000;28:643-650.

63. Pellman EJ, Viano DC, Withnall C, Shewchenko N, Bir CA, Halstead PD. Concussion in professional football: helmet testing to assess impact performance--part 11. *Neurosurgery.* 2006;58:78-96; discussion 78-96.

64. Langlois JA, Rutland-Brown W, Thomas KE. The incidence of traumatic brain injury among children in the United States: differences by race. *J Head Trauma Rehabil.* 2005;20:229-238.

65. Rutland-Brown W, Langlois JA, Thomas KE, Xi YL. Incidence of traumatic brain injury in the United States, 2003. *J Head Trauma Rehabil.* 2006;21:544-548.

66. Lincoln AE, Hinton RY, Almquist JL, Lager SL, Dick RW. Head, face, and eye injuries in scholastic and collegiate lacrosse: a 4-year prospective study. *Am J Sports Med.* 2007;35:207-215.

67. Schulz MR, Marshall SW, Yang J, Mueller FO, Weaver NL, Bowling JM. A prospective cohort study of injury incidence and risk factors in North Carolina high school competitive cheerleaders. *Am J Sports Med.* 2004;32:396-405.

68. Gerberich SG, Finke R, Madden M, Priest JD, Aamoth G, Murray K. An epidemiological study of high school ice hockey injuries. *Childs Nerv Syst.* 1987;3:59-64.

69. Boden BP, Tacchetti RL, Cantu RC, Knowles SB, Mueller FO. Catastrophic head injuries in high school and college football players. *Am J Sports Med.* 2007;35:1075-1081.

70. Mueller FO, Blyth CS. North Carolina high school football injury study: equipment and prevention. *J Sports Med.* 1974;2:1-10.

71. Centers for Disease Control. Sports-related injuries among high school athletes--United States, 2005-06 school year. *MMWR Morb Mortal Wkly Rep.* 2006;55:1037-1040.

72. Buckley WE. Concussions in college football. A multivariate analysis. *Am J Sports Med.* 1988;16:51-56.

73. Bruce DA, Schut L, Sutton LN. Brain and cervical spine injuries occurring during organized sports activities in children and adolescents. *Clin Sports Med.* 1982;1:495-514.

74. Cantu RC. Minor Head Injuries in Sports. *Adolesc Med.* 1991;2:141-154.

75. Gerberich SG, Priest JD, Boen JR, Straub CP, Maxwell RE. Concussion incidences and severity in secondary school varsity football players. *Am J Public Health.* 1983;73:1370-1375.

76. Covassin T, Swanik CB, Sachs ML. Sex Differences and the Incidence of Concussions Among Collegiate Athletes. *J Athl Train.* 2003;38:238-244.

77. Cantu RC, Mueller FO. Catastrophic spine injuries in American football, 1977-2001. *Neurosurgery.* 2003;53:358-362; discussion 362-353.

78. Langlois JA, Sattin RW. Traumatic brain injury in the United States: research and programs of the Centers for Disease Control and Prevention (CDC). *J Head Trauma Rehabil.* 2005;20:187-188.

79. Verbrugge LM. Sex differentials in health. *Public Health Rep.* 1982;97:417-437.

80. Verbrugge LM, Wingard DL. Sex differentials in health and mortality. *Women & health.* 1987;12:103-145.

81. Setnik L, Bazarian JJ. The characteristics of patients who do not seek medical treatment for traumatic brain injury. *Brain Inj.* 2007;21:1-9.

82. Thurman DJ, Branche CM, Sniezek JE. The epidemiology of sports-related traumatic brain injuries in the United States: recent developments. *J Head Trauma Rehabil.* 1998;13:1-8.

83. Wang Y, Chan RC, Deng Y. Examination of postconcussion-like symptoms in healthy university students: relationships to subjective and objective neuropsychological function performance. *Arch Clin Neuropsychol.* 2006;21:339-347.

84. Patel AV, Mihalik JP, Notebaert AJ, Guskiewicz KM, Prentice WE. Neuropsychological performance, postural stability, and symptoms after dehydration. *J Athl Train.* 2007;42:66-75.

85. Iverson GL. Misdiagnosis of the persistent postconcussion syndrome in patients with depression. *Arch Clin Neuropsychol.* 2006;21:303-310.

86. Schnadower D, Vazquez H, Lee J, Dayan P, Roskind CG. Controversies in the evaluation and management of minor blunt head trauma in children. *Curr Opin Pediatr.* 2007;19:258-264.

87. Mendez CV, Hurley RA, Lassonde M, Zhang L, Taber KH. Mild traumatic brain injury: neuroimaging of sports-related concussion. *J Neuropsychiatry Clin Neurosci.* 2005;17:297-303.

88. Drew LB, Drew WE. The contrecoup-coup phenomenon: a new understanding of the mechanism of closed head injury. *Neurocritical care.* 2004;1:385-390.

89. Giza CC, Hovda DA. The Neurometabolic Cascade of Concussion. *J Athl Train.* 2001;36:228-235.

90. Ommaya AK, Goldsmith W, Thibault L. Biomechanics and neuropathology of adult and paediatric head injury. *British journal of neurosurgery.* 2002;16:220-242.

91. Chen JK, Johnston KM, Collie A, McCrory P, Ptito A. A validation of the post concussion symptom scale in the assessment of complex concussion using cognitive testing and functional MRI. *Journal of neurology, neurosurgery, and psychiatry.* 2007;78:1231-1238.

92. Lovell MR, Pardini JE, Welling J, et al. Functional brain abnormalities are related to clinical recovery and time to return-to-play in athletes. *Neurosurgery.* 2007;61:352-359; discussion 359-360.

93. Ptito A, Chen JK, Johnston KM. Contributions of functional magnetic resonance imaging (fMRI) to sport concussion evaluation. *NeuroRehabilitation.* 2007;22:217-227.

94. Pickles W. Acute general edema of the brain in children with head injuries. *N Engl J Med.* 1950;242:607-611.

95. Bruce DA, Alavi A, Bilaniuk L, Dolinskas C, Obrist W, Uzzell B. Diffuse cerebral swelling following head injuries in children: the syndrome of "malignant brain edema". *J Neurosurg.* 1981;54:170-178.

96. Snoek JW, Minderhoud JM, Wilmink JT. Delayed deterioration following mild head injury in children. *Brain.* 1984;107 (Pt 1):15-36.

97. Grundl PD, Biagas KV, Kochanek PM, Schiding JK, Barmada MA, Nemoto EM. Early cerebrovascular response to head injury in immature and mature rats. *J Neurotrauma.* 1994;11:135-148.

98. Register-Mihalik J, Guskiewicz KM, Mann JD, Shields EW. The effects of headache on clinical measures of neurocognitive function. *Clin J Sport Med.* 2007;17:282-288.

99. Hart RP, Martelli MF, Zasler ND. Chronic pain and neuropsychological functioning. *Neuropsychol Rev.* 2000;10:131-149.

100. Lake AE, 3rd, Branca B, Lutz TE, Saper JR. Headache level during neuropsychological testing and test performance in patients with chronic posttraumatic headache. *J Head Trauma Rehabil.* 1999;14:70-80.

101. Lane JC. Migraine in the athlete. *Seminars in neurology.* 2000;20:195-200.

102. Wilkins JC, Valovich McLeod TC, Perrin DH, Gansneder BM. Performance on the Balance Error Scoring System Decreases After Fatigue. *J Athl Train.* 2004;39:156-161.

103. Register-Mihalik J, Mihalik JP, Guskiewicz K. Assocation between previous concussion history nd symptom endorsement during preseason baseline testing in high school and collegiate athletes. *Sports Health.* 2009;1:61-65.

104. Iverson GL, Lange RT. Examination of "postconcussion-like" symptoms in a healthy sample. *Appl Neuropsychol.* 2003;10:137-144.

105. Logan SM, Bell GW, Leonard JC. Acute Subdural Hematoma in a High School Football Player After 2 Unreported Episodes of Head Trauma: A Case Report. *J Athl Train.* 2001;36:433-436.

106. Broglio SP, Macciocchi SN, Ferrara MS. Sensitivity of the concussion assessment battery. *Neurosurgery.* 2007;60:1050-1057; discussion 1057-1058.

107. Notebaert AJ, Guskiewicz KM. Current trends in athletic training practice for concussion assessment and management. *J Athl Train.* 2005;40:320-325.

108. Mailer BJ, Valovich-McLeod TC, Bay RC. Healthy youth are reliable in reporting symptoms on a graded symptom scale. *J Sport Rehabil.* 2008;17:11-20.

109. Piland SG, Motl RW, Ferrara MS, Peterson CL. Evidence for the Factorial and Construct Validity of a Self-Report Concussion Symptoms Scale. *J Athl Train.* 2003;38:104-112.

110. Piland SG, Motl RW, Guskiewicz KM, McCrea M, Ferrara MS. Structural validity of a self-report concussion-related symptom scale. *Med Sci Sports Exerc.* 2006;38:27-32.

111. Lovell MR, Iverson GL, Collins MW, et al. Measurement of symptoms following sports-related concussion: reliability and normative data for the post-concussion scale. *Appl Neuropsychol.* 2006;13:166-174.

112. Broglio SP, Ferrara MS, Macciocchi SN, Baumgartner TA, Elliott R. Test-retest reliability of computerized concussion assessment programs. *J Athl Train.* 2007;42:509-514.

113. Cernich A, Reeves D, Sun W, Bleiberg J. Automated Neuropsychological Assessment Metrics sports medicine battery. *Arch Clin Neuropsychol.* 2007;22 Suppl 1:S101-114.

114. Collins MW, Field M, Lovell MR, et al. Relationship between postconcussion headache and neuropsychological test performance in high school athletes. *Am J Sports Med.* 2003;31:168-173.

115. Collins MW, Grindel SH, Lovell MR, et al. Relationship between concussion and neuropsychological performance in college football players. *JAMA.* 1999;282:964-970.

116. Randolph C. Implementation of Neuropsychological Testing Models for the High School, Collegiate, and Professional Sport Settings. *J Athl Train.* 2001;36:288-296.

117. Randolph C. Neuropsychological testing: evolution and emerging trends. *CNS spectrums.* 2002;7:307-312.

118. Randolph C, McCrea M, Barr WB. Is neuropsychological testing useful in the management of sport-related concussion? *J Athl Train.* 2005;40:139-152.

119. McCrea M. Standardized Mental Status Testing on the Sideline After Sport-Related Concussion. *J Athl Train.* 2001;36:274-279.

120. McCrea M. Standardized mental status assessment of sports concussion. *Clin J Sport Med.* 2001;11:176-181.

121. Jansen EC, Larsen RE, Olesen MB. Quantitative Romberg's test. Measurement and computer calculation of postural stability. *Acta Neurol Scand.* 1982;66:93-99.

122. Riemann BL GK. Effects of Mild Head Injury on Postural Stability as Measured Through Clinical Balance Testing. *Journal of Athletic Training.* 2000;35:19-25.

123. Valovich TC, Perrin DH, Gansneder BM. Repeat Administration Elicits a Practice Effect With the Balance Error Scoring System but Not With the Standardized Assessment of Concussion in High School Athletes. *J Athl Train.* 2003;38:51-56.

124. Riemann BL, Guskiewicz KM, Shields EW. Relationship Between Clinical and Forceplate Measures of Postural Stability. *J Sport Rehabil.* 1999;8:71-82.

125. Roebuck-Spencer TM, Yarboro C, Nowak M, et al. Use of computerized assessment to predict neuropsychological functioning and emotional distress in patients with systemic lupus erythematosus. *Arthritis and rheumatism.* 2006;55:434-441.

126. Guskiewicz KM, Perrin DH, Gansneder BM. Effect of Mild Head Injury on Postural Stability in Athletes. *J Athl Train.* 1996;31:300-306.

127. Riemann BL, Guskiewicz KM. Effects of Mild Head Injury on Postural Stability as Measured Through Clinical Balance Testing. *J Athl Train.* 2000;35:19-25.

128. Jakola AS, Muller K, Larsen M, Waterloo K, Romner B, Ingebrigtsen T. Five-year outcome after mild head injury: a prospective controlled study. *Acta Neurol Scand.* 2007;115:398-402.

129. Whittaker R, Kemp S, House A. Illness perceptions and outcome in mild head injury: a longitudinal study. *Journal of neurology, neurosurgery, and psychiatry.* 2007;78:644-646.

130. Ettenhofer ML, Abeles N. The significance of mild traumatic brain injury to cognition and self-reported symptoms in long-term recovery from injury. *J Clin Exp Neuropsychol.* 2008:1-10.

131. Petersen C, Scherwath A, Fink J, Koch U. Health-related quality of life and psychosocial consequences after mild traumatic brain injury in children and adolescents. *Brain Inj.* 2008;22:215-221.

132. Hessen E, Nestvold K, Anderson V. Neuropsychological function 23 years after mild traumatic brain injury: a comparison of outcome after paediatric and adult head injuries. *Brain Inj.* 2007;21:963-979.

133. Baker RJ, Patel DR. Sports related mild traumatic brain injury in adolescents. *Indian journal of pediatrics.* 2000;67:317-321.

134. Cantu RC. Second-impact syndrome. *Clin Sports Med.* 1998;17:37-44.

135. McCrory P. Does second impact syndrome exist? *Clin J Sport Med.* 2001;11:144-149.

136. McCrory PR, Berkovic SF. Second impact syndrome. *Neurology.* 1998;50:677-683.

137. Cobb S, Battin B. Second-impact syndrome. *J Sch Nurs.* 2004;20:262-267.

138. Schutz HK, Paxton SJ. Friendship quality, body dissatisfaction, dieting and disordered eating in adolescent girls. *Br J Clin Psychol.* 2007;46:67-83.

139. Castrucci BC, Gerlach KK. Understanding the association between authoritative parenting and adolescent smoking. *Matern Child Health J.* 2006;10:217-224.

140. Whitehead J, Evans NJ, Lee MJ. Relative importance of success in sport and schoolwork. *Percept Mot Skills.* 1997;85:599-606.

141. Rosenblum S. Psychologic factors in competitive failures in athletes. *Am J Sports Med.* 1979;7:198-200.

142. Van-Yperen NW, Duda JL. Goal orientations, beliefs about success, and performance improvement among young elite Dutch soccer players. *Scand J Med Sci Sports.* 1999;9:358-364.

143. Baumert PW, Jr., Henderson JM, Thompson NJ. Health risk behaviors of adolescent participants in organized sports. *J Adolesc Health.* 1998;22:460-465.

144. Nattiv A, Puffer JC. Lifestyles and health risks of collegiate athletes. *J Fam Pract.* 1991;33:585-590.

145. Nattiv A, Puffer JC, Green GA. Lifestyles and health risks of collegiate athletes: a multi-center study. *Clin J Sport Med.* 1997;7:262-272.

146. Brook U, Tepper I. High school students' attitudes and knowledge of food consumption and body image: implications for school based education. *Patient Educ Couns.* 1997;30:283-288.

147. Podlog L, Eklund RC. A longitudinal investigation of competitive athletes' reutrn to sport following serious injury. *Journal of Applied Sport Psychology.* 2006;18:44-68.

148. Grove JR, Hanrahan SJ, Stewart RM. Attributions for rapid or slow recovery from sports injuries. *Canadian journal of sport sciences = Journal canadien des sciences du sport.* 1990;15:107-114.

149. Petrie TA. Psychosocial antecedents of athletic injury: the effects of life stress and social support on female collegiate gymnasts. *Behavioral medicine (Washington, D.C.* 1992;18:127-138.

150. Wiese-Bjornstal D, Smith A, Shaffer S. An integrated model of response to sport injury: psycholoic and sociologic dynmaics. *J Appl Sport Psychol.* 1998;10:46-69.

151. Sefton JM, Capitao PK, Harackiewicz D, Cordova ML. An examination of factors that influence knowledge and reporting of mild brain injuries in collegiate football (Abstract). *J Athl Train.* 2004;39:S-52.

152. Miller BW, Roberts GC, Ommundsen Y. Effect of motivational climate on sportspersonship among competitive youth male and female football players. *Scand J Med Sci Sports.* 2004;14:193-202.

153. Glanz K, Rimer BK, Lewis FM. *Health behavior and health education: theory, research, and practice*. 3rd ed. San Francisco: Josey-Bass; 2002.

154. Downs DS, Graham GM, Yang S, Bargainnier S, Vasil J. Youth exercise intention and past exercise behavior: examining the moderating influences of sex and meeting exercise recommendations. *Research quarterly for exercise and sport.* 2006;77:91-99.

155. Pender NJ, Pender AR. Attitudes, subjective norms, and intentions to engage in health behaviors. *Nursing research.* 1986;35:15-18.

156. Smith RA, Biddle SJ. Attitudes and exercise adherence: test of the Theories of Reasoned Action and Planned Behaviour. *J Sports Sci.* 1999;17:269-281.

157. Trost SG, Pate RR, Dowda M, Ward DS, Felton G, Saunders R. Psychosocial correlates of physical activity in white and African-American girls. *J Adolesc Health.* 2002;31:226-233.

158. Trost SG, Saunders R, Ward DS. Determinants of physical activity in middle school children. *American journal of health behavior.* 2002;26:95-102.

159. O'Donoghue KM, Onate JA, Van Lunen BL, Peterson CL. Assessment of High School Coaches' Knowledge of Sport-Related Concussions. *Athletic Training and Sports Health Care.* 2009;1:120-132.

160. Guilmette TJ, Malia LA, McQuiggan MD. Concussion understanding and management among New England high school football coaches. *Brain Inj.* 2007;21:1039-1047.

161. Connaughton D, Wadey R, Hanton S, Jones G. The development and maintenance of mental toughness: perceptions of elite performers. *J Sports Sci.* 2008;26:83-95.

162. Jowett S. What makes coaches tick? The impact of coaches' intrinsic and extrinsic motives on their own satisfaction and that of their athletes. *Scand J Med Sci Sports.* 2008.

163. Jowett S, Clark-Carter D. Perceptions of empathic accuracy and assumed similarity in the coach-athlete relationship. *The British journal of social psychology / the British Psychological Society.* 2006;45:617-637.

164. Sagar SS, Stoeber J. Perfectionism, fear of failure, and affective responses to success and failure: the central role of fear of experiencing shame and embarrassment. *Journal of sport & exercise psychology.* 2009;31:602-627.

165. McCrory P, Meeuwisse W, Johnston K, et al. Consensus statement on Concussion in Sport 3rd International Conference on Concussion in Sport held in Zurich, November 2008. *Clin J Sport Med.* 2009;19:185-200.

166. Murnaghan DA, Blanchard CM, Rodgers WM, et al. Predictors of physical activity, healthy eating and being smoke-free in teens: A theory of planned behaviour approach. *Psychol Health.* 2009:1-17.

167. Neighbors C, Larimer ME, Lewis MA. Targeting misperceptions of descriptive drinking norms: efficacy of a computer-delivered personalized normative feedback intervention. *J Consult Clin Psychol.* 2004;72:434-447.

168. Nichols PE, Jonnalagadda SS, Rosenbloom CA, Trinkaus M. Knowledge, attitudes, and behaviors regarding hydration and fluid replacement of collegiate athletes. *International journal of sport nutrition and exercise metabolism.* 2005;15:515-527.

169. Raudsepp L, Viira R, Hannus A. Prediction of physical activity intention and behavior in a longitudinal sample of adolescent girls. *Percept Mot Skills.*110:3-18.

170. Melnyk BM, Small L, Morrison-Beedy D, et al. Mental health correlates of healthy lifestyle attitudes, beliefs, choices, and behaviors in overweight adolescents. *J Pediatr Health Care.* 2006;20:401-406.

171. Hughes R. A socioecological analysis of the determinants of national public health nutrition work force capacity: Australia as a case study. *Fam Community Health.* 2006;29:55-67.

172. McKee AC, Cantu RC, Nowinski CJ, et al. Chronic traumatic encephalopathy in athletes: progressive tauopathy after repetitive head injury. *J Neuropathol Exp Neurol.* 2009;68:709-735.

173. Bayer JK, Peay MY. Predicting intentions to seek help from professional mental health services. *Aust N Z J Psychiatry.* 1997;31:504-513.

174. Corner J, Hopkinson J, Roffe L. Experience of health changes and reasons for delay in seeking care: a UK study of the months prior to the diagnosis of lung cancer. *Social science & medicine (1982).* 2006;62:1381-1391.

APPENDIX 1- MANUSCRIPT 1

Title:
Concussion reporting among high school athletes: Influence of gender, knowledge, and attitude

Potential Journal:
Journal of Athletic Training

ABSTRACT

Context: Many athletes continue to participate with concussion symptoms, potentially predisposing them to subsequent and more complicated brain injuries. However, little is known about factors that influence concussion reporting.

Objective: To examine intrinsic factors that influence concussion reporting in a sample of high school athletes.

Design: Cross-sectional survey

Setting: Subjects completed a survey instrument via mail.

Patients or Other Participants: 167 high school athletes (age = 15.7±1.4) participating in football, soccer, lacrosse, or cheerleading.

Interventions: Gender, athlete knowledge scores, and athlete attitude scores served as separate predictor variables.

Main Outcome Measures: Proportion of athletes who reported continuing to participate in games and practices while symptomatic from concussion and the self-reported proportion of recalled concussion and bell ringer events that were disclosed following possible concussive injury were examined.

Results: Only 40% of *concussion* events and 13% of *bell ringer* events in the sample were reportedly disclosed following possible concussive injury. A trend towards boys being more likely to report in games was observed (PR=1.69, 95% CI: 0.78, 3.66). However, in practices the trend was reversed with boys being less likely to report (PR=0.61, 95% CI: 0.31, 1.19). Boys were more likely to report continuing in a game while symptomatic (PR=1.98, 95% CI: 1.15, 3.41). Increased athlete knowledge of concussion topics (10 point change on a 35 point

scale) was associated with increased reporting prevalence of *concussion* and *bell ringer* events occurring in practice (PR=18.67, 95% CI: 5.38,64.76), and the reporting prevalence of *bell ringer* only events overall (PR=9.40, 95% CI:3.16, 27.98). Athlete attitude scores (10 point change on a 98 point scaled) were associated with decreases in the proportion of athletes reporting that they participated in games (PR=0.76, 95% CI: 0.69, 0.85) and practices (PR=0.71, 95% CI: 0.64, 0.79) while symptomatic from a concussion.

Conclusions: The overwhelming majority of recalled concussive events in our study were not reported. Clinicians should be aware that gender, knowledge, and attitude influence concussion reporting. Clinicians and administrators should make concussion education a priority and encourage a more open and optimal reporting environment.

INTRODUCTION

Cerebral concussion is a functional injury that is difficult to identify and manage. Unidentified concussive injuries carry a risk of additional and more complicated injuries to the brain.[1-3] Thus, it is important to understand the factors influencing concussion reporting in athletes. This is particularly true in high school aged athletes as the brain is continuing to develop. Despite the perception of concussions being "mild", high school athletes with "mild" concussions may experience neurocognitive deficits and symptoms that persist well beyond the day of injury.[4]

Current research suggests that females may be at a greater risk than males for sustaining a concussion.[5] However, since many concussions are possibly not reported this finding may be a result of reporting behaviors.[6] One study that examined reporting[7], suggested that over 50% of concussions go unreported. Reasons for football athletes choosing to not report a concussion included, not thinking it was serious enough to report, did not want to leave a game, did not know it was a concussion, and did not want to let teammates down.[7] All of these reasons tie into the values of the athletic population of "toughness"[8] and peer acceptance[9]. Additionally, recent literature illustrates that many athletes fail to recognize common symptoms associated with concussion, which may also contribute to under-reporting.[7, 10-12]

Few studies have examined the influence of concussion knowledge on reporting. In addition, no studies to date have concurrently examined overall attitudes concerning concussion and reporting of possible concussions among high school athletes. Attitude is often loosely defined as inner feelings expressed by outward behavior. Attitude is an important factor in many behaviors[13], with more favorable attitudes often linked to the

preferred behavior.[14] This is especially true of attitudes toward the behavior itself.[13] Thus, individuals who feel more positive about reporting concussions may be more likely to report. The primary purpose of this study was to examine how intrinsic factors such as gender, knowledge, and attitude influence concussion reporting among a sample of high school athletes.

METHODS

Overview

We conducted a cross-sectional survey study of high school athletes in 6 sports. Insitutional review board approval was obtained prior to study initiation. The survey instrument captured data on athletes' knowledge, attitude, and beliefs regarding concussion. It also asked athletes to recall previous concussion and concussion like events and indicate whether or not they reported the events to a coach or a medical professional.

Sample and Subjects

A convenience sample of 28 high schools agreed to participate in the study, with survey data returned from 25 (from 9 states) of the 28 schools. Fifteen of the 25 respondent schools had daily access to a Certified Athletic Trainer (AT) and 10 had no access. A total of 167 athletes returned the survey instrument for a return of 8%. Demographic information on the subjects is presented in **Table 1**. Inclusion criteria for subjects was being listed as a rostered athlete for varsity football, cheerleading, boys' soccer, girls' soccer, boys' lacrosse, and girls' lacrosse. All subjects were between the ages of 14-18 years old (mean age= 15.7±1.4).

Instrumentation

A single survey instrument served as the instrumentation for the study. This instrument was pre-tested for face validity by 3 content experts. Test-retest agreement was assessed using 50 high school athletes completing the survey instruments at 2 test times (30 minutes apart in a different order). The agreement across test times for all knowledge

(yes/no) items used on the questionnaires was at least Kappa=0.5. For Likert Scale attitude questions, the mean difference was lower than 0.4 (7 max score for each item) on the survey instrument. Chronbach's alpha was calculated for knowledge constructs (Chronbach's $\alpha >$ 0.6) and attitude constructs (Chronbach's $\alpha > 0.6$) on the survey instrument.

Athlete knowledge was assessed by a series of 35 questions concerning symptom recognition, issues with multiple concussions, and general knowledge of concussion. Athlete attitude was assessed using 14, 7-point Likert scale questions addressing overall attitude toward concussion, education, and reporting of concussion. Total knowledge score for athletes was calculated by summing the number of correct answers out of the 35 knowledge questions (possible range = 0-35). Total attitude score was calculated by summing the responses to 14 Likert Score (1-7) attitude questions (possible range = 14-98).

To assess recalled concussive events and reporting, multiple reporting variables were used (**Table 1**). Proportion of athlete reporting concussion and bell ringer events was dichotomized as reporting at least 50% of these events (YES/NO). Athletes were asked about *concussion* events they recalled as experienced and reported during their high school years. Athletes were also asked about *bell ringer* events they recalled as experienced and reported during their high school years. The term bell ringer was employed as a means of assessing when possible concussions occurred. Athletes commonly use the term to describe brief, transient alterations in neurological function. In addition, athletes were asked about ever continuing to participate in practices and games while experiencing concussion signs and symptoms.

Procedures

Approval from each school was obtained prior to initiation of the study. Following school approval, school information forms were completed by a designated school contact (athletic director, Certified Athletic Trainer, or administrator) serving as a research assistant at each school. The school contacts arranged questionnaire distribution meetings for the athletes. The primary investigator (JRM) or the designated school contact conducted these meetings. The meeting was performed using a standardized script to ensure similar instructions for all possible participants. During this meeting, the study was explained and athletes were issued a study packet including an instruction letter, appropriate consent documents, the survey instrument, and a postage paid return envelope. Athletes were asked to take the packet home, complete the survey instrument and return it directly to the primary investigator via mail. Upon return, survey instruments were logged and entered into the study dataset.

Statistical Analyses

General descriptive statistics were used to examine athlete knowledge scores, attitude scores, and concussion reporting behaviors. Reporting was defined as recalled events indicated by the athlete as "reported" to a coach or a medical professional. Separate binomial regression models were used to predict each of the 8 reporting outcomes (Table 1). These predictors included: 1) Gender; 2) Athlete knowledge total (AKT); 3) Athlete attitude total (AAT). A total of 24 binomial regression models were employed (3 predictors X 8 outcomes). Binomial regression models were used to estimate prevalence rations (PRs). The PRs represent the increase in the prevalence of recalled concussion and bell ringer events

associated with gender, athlete knowledge (AKT), and athlete attitude (AAT). To estimate the PRs associated with knowledge and attitude, a 10-point increase in athlete knowledge (35 point scale) and attitude score (98 point scale) was selected. This 10-point increase represents a 28% increase in knowledge score and a 10% increase in attitude score. The 10-point change was selected in an effort to examine the effect of substantial increases in knowledge and attitude on concussion reporting.

There were a different number of subjects included in analyses for variables for 3 reasons **(Table 1)**: 1) When people reporting *concussions* or *bell ringers* are used as the analysis unit, only individuals recalling a concussion or bell ringer event are included; 2) When examining participation in games or practices while symptomatic, all subjects answering the question are included; and 3) In order to be included in the analyses, all questions forming the independent variables and dependent variables had to be answered.

RESULTS

General Descriptive Information

The sample of 167 athletes consisted of 97 males and 55 females, with 5 athletes not indicating gender. Athlete descriptive and demographic data are included in **Table 2**.

Athlete Knowledge and Attitude Descriptives

Athlete knowledge total scores (out of possible 35) ranged from 20-34 (mean = 27.9 ± 2.8). Higher scores indicated increased knowledge. Athlete's overall attitude total scores (out of possible 98) towards concussion were moderate (mean = 78.3 ± 11.5) with a wide range of 40-98. Higher scores indicated a more favorable attitude.

Athlete Reporting Behavior Descriptives

Fifty-three percent (n=89) of the total sample recalled having at least one possible concussive event (*bell ringer or concussion*). Of these 89, only 15 (17.0%) indicated reporting all *concussive/bell ringer* events experienced to a coach or a medical professional. There were a total of 83 recalled *concussions* among the sample, and in only 41 (49%) of these events did the respondent indicate that s/he had reported the event to a coach or a medical professional. In addition, there were a total of 576 recalled *bell ringer* events among the sample with only 72 (13%) indicated as being reported to a coach or a medical professional. Overall, the most common reasons for not reporting concussions or bell ringer events among individuals recalling an event were: not thinking it was serious enough to report (52/89, 58.4%), not wanting to be removed from a game (27/89, 30.3%), not wanting to let teammates down (20/89, 22.5%), and not wanting to let coaches down (17/89, 19.1%).

In *games only*, there were a total of 241 recalled *concussion* and *bell ringer* events and only 65 (27%) of these events indicated as reported to a coach or a medical professional. For *practices only*, there were a total of 346 recalled *concussion* and *bell ringer* events, with only 40 (12%) of these events indicated as reported to a coach or a medical professional. In addition, 40% of the athlete sample (n=63) indicated that on at least 1 occasion they had continued to participate in a practice or a game at least once, when he/she thought they were experiencing signs and symptoms of a concussion.

Influence of Gender

It should be noted that the overall number of recalled events (*concussion and bell ringer)* was significantly less in females compared to males. No association was observed between gender and athletes reporting at least 50% of recalled *concussion* events with 21/36 (58.3%) of males and 5/7 (71.4%) of females reporting at least 50% of these events. In addition, no association was observed between gender and reporting of recalled *bell ringer* events with 15/66 (22.7%) of males and 2/14 (14.3%) of females reporting at least 50% of these events. A significantly greater proportion of males (39/95, 41.1%) than females (13/63, 20.6%) indicated continuing to participate in at least 1 game while experiencing possible concussion symptoms. Similar proportions of males (26/93, 27.9%) and females (14/62, 22.6%) recalled participating in at least 1 practice while experience possible concussion symptoms. **(Table 3)**

Males (67/277, 24.2%) were more likely to report *concussion/bell ringer* events in games than females (6/42, 14.3%). For *concussion/bell ringer* events during practice, males (31/289, 10.7%) were slightly less likely to report recalled events than females (9/51, 17.7%).

It should be noted that although a trend is observed, the findings related to games and practices were not statistically significant. No association was observed between gender and reporting of recalled *concussion* only events with 36/71 (50.7%) male *concussion* events and 5/12 (41.7%) female *concussion* events indicated as reported. Gender was not associated with reporting of *bell ringer* events, as 62/495 (12.5%) of male *bell ringer* events and 10/81 (12.4%) of female *bell ringer* events were indicated as reported. **(Table 3)**

Influence of Athlete Knowledge and Attitude

Athlete general concussion knowledge **(Table 4)** and attitude about concussion **(Table 5)** total scores were not associated with prevalence of people reporting 50% of recalled *concussion* only events. Ten point increases in both scores yielded no association with the prevalence of athletes reporting at least 50% of these recalled events. For recalled *bell ringer* only events, an increase of 10- points in athlete knowledge total score was associated with a 2.65-time increase in the prevalence of athletes reporting at least half of these recalled *bell ringer* only events. While this was not statistically significant, it represents an interesting trend in the data. Little to no difference was observed in prevalence of athletes reporting at least 50% of these recalled bell ringer events with the 10-point change in attitude total score. Athlete knowledge total score was not associated with the prevalence of athletes indicating they continued to participate in a game and/or a practice while experiencing concussion symptoms. Athlete attitude score was associated with a decrease (PR=0.76) in athletes reporting to participate while symptomatic, while the prevalence of athletes reporting that they continued in a practice while symptomatic decreased by (PR=0.11)

Athlete knowledge **(Table 4)** and attitude **(Table 5)** total scores were not associated with reporting of recalled *concussion/bell ringer* events during games. Alternatively, with a 10-point increase in athlete knowledge total score, prevalence of reporting of these recalled events during practice increased by 18.67-times, although this estimate may not be precise. A 10-point increase in attitude total score was also associated with a 1.38-times increased prevalence of recalled event reporting during practice. Athlete knowledge and attitude scores were not associated with reporting of recalled *concussion* only events. Alternatively both athlete knowledge and athlete attitude total score were associated with reporting of *bell ringer* only events as the reporting prevalence of these events increased by over 9 times with a 10-point change in knowledge score and 1.4-times with a 10-point change in attitude score.

DISCUSSION

The most important finding in our study is that the overwhelming majority of recalled concussions sustained by high school athletes in our study were not reported. Although this information is self-report, it suggests that a large proportion of possible concussive events are never reported to a coach or a medical professional. Athletes in the study sample classified the majority of these events as *bell ringers*. The difference between the proportion of athlete recalling *concussions* and *bell ringers* highlights the misunderstanding concerning the use of this term and athletes' lack of association between this term and concussive injury.

We employed this term (bell ringer) in our study to examine the number of these events that athletes would classify as occurring. However, the term should not be used in clinical or educational settings as it minimizes the serious nature of a possible concussion. All of these *bell ringer* events may not have been true concussions, but these events should be reported and evaluated by clinicians in order to make the determination as to whether it was a concussion or not. If these events are not reported, athletes are more likely to continue to play in a vulnerable state. In addition, this study provides insight into the importance of gender, increased knowledge, and increased attitude on the behavior of concussion reporting among high school athletes. Table 6 includes a summary of the influences of these factors on reporting measures included in the study.

Athlete Reporting Behavior

Athlete knowledge scores were moderate-high in our sample; however, with a mean indicating an average of 7 (out of 35) questions missed, there is still a gap in what athletes should know concerning concussion concepts such as common signs and symptoms. The

most common questions missed where those concerning less common symptoms such as nausea. The findings in the sample suggest athletes are relatively knowledgeable about the general signs and symptoms of concussion, which may be a result of recent educational social initiatives to increase concussion awareness.

In addition, attitude had a wide range of scores illustrating the disparity in perceptions of concussion across the athletic population. Many of the athletes only moderately agreed that concussions symptoms were serious as indicated by a mean for this question 4.5/7. In addition, many felt reporting concussion may be somewhat embarrassing (mean =4.5/7). These issues illustrate some of the attitudes towards concussion and reporting in need of attention.

The issues concerning concussion in the high school athletic setting is further highlighted in our sample by gross under-reporting of recalled concussion events. In addition, a large proportion of the study sample indicated continuing to participate in both games and practices while experiencing concussion signs and symptoms. Earlier studies suggests under-reporting to be as high as 50%.[7] Although our study used different methods to investigate and explain this phenomenon, we observed an under-reporting rate approximating 40% for perceived concussions. More strikingly, athletes only indicated reporting 13% of events they considered *bell ringers*. Athletes not reporting these bell ringer events may have continued to participate or returned to participation too early predisposing them to further injury. This illustrates the need for better recognition by clinicians, parents, coaches, and athletes that these mild events be reported and addressed.

The most common reason cited by athletes for not reporting a possible concussion was not thinking the injury was serious enough to report followed by, not wanting to be

removed from a game. These findings are similar to those of McCrea et al[7]. In contrast to McCrea et al, letting teammates and coaches down was prioritized in our sample over lack of awareness concussion awareness as possible reasons for not reporting. Although reporting behaviors in the current study sample were based on recalled events, it suggests that the behavior of underreporting possible concussive events is prevalent. Continuing to participate in the presence of concussive injury is risk given the possible negative outcomes associated with the behavior. Our study highlights the risk taking behaviors of athletes, which has been suggested in other literature.[15]

Gender and Reporting

Little data exists on gender differences concerning concussion reporting. Current literature suggests that females who participate in sports such as soccer, hockey, and basketball may have a higher incidence of concussion than their male counterparts in the same sport.[5, 16] There is some discussion that this increase may due, at least in part, to differences in reporting[6], as with many health issues, females may be more likely to seek medical attention.[17] Recent discussion has centered on males being less likely to report concussive symptoms and events. In the current study, males reported a greater proportion of possible concussive events in games. Despite this observation, there were a relatively small number of female events compared to male events. This finding should be interpreted with caution as a result of males having more opportunity than females to choose to or not to engage in the behavior of concussion reporting.

For recalled events during practices, the proportion of events reported by males was nearly 40% less than that of females. Higher attitude scores were associated with

significantly increased reporting during practices but not games. Females in the sample had a higher attitude score than males, which may help to explain this finding. In addition, although important discussion points, these findings were not statistically significant as a result of the small number of female events and a non-precise prevalence ratio estimate.

Alternatively, when examining the proportion of the sample continuing to participate in a game while experiencing concussion symptoms, nearly double the proportion of males compared to females indicated engaging in this behavior. This finding supports current literature in which females were more likely to report medical symptoms.[17] Males may feel more social pressure in games to repress their symptoms and continue participating. A recent study suggests that males are more likely to report participation in an ego-oriented climate and to display stronger ego orientation.[9] Male athletes, especially during games, may feel that reporting non-visible concussive symptoms causes them to appear weak. An equal proportion of males and females indicated participating with concussive symptoms at least once during a practice.

Together, these findings suggest that context plays a role in reporting as it does with many behaviors.[18] The conflicting finding of male reporting and continued participation during games, may be a factor of the number of athletes included in the 2 different analyses. For the proportion reported during games analysis, only athletes with recalled concussion/bell ringer events were included, which isolated a portion of the sample. These variables evaluated a different sample and provide different information concerning athlete behaviors centered on concussion. The majority of the sample was included in the outcomes pertaining to continued participation while symptomatic. The questions were also different in nature. The two questions concerning participation while symptomatic, were not specific to

reporting the injury to a coach or medical professional. These questions asked about continuing to participate while experiencing signs and symptoms during a game or practice as opposed to indicating reporting/not reporting a concussion or a bell ringer. In addition, boys may have been more likely to tell a coach or medical professional but still continue to play. We did not assess time of reporting or differentiate between reporting to a coach or medical professional in the questionnaire. In addition, boys recalled a greater number of concussion events than females. This provided more opportunity for these individuals to participate with signs and symptoms.

Athlete Knowledge and Attitude Influence on Reporting of Recalled Events

In general, increases in athlete knowledge had a positive effect on reporting as the proportion of people reporting *bell ringer* events, proportion of events reported during practice, and proportion of *bell ringer* events reported was greater with increased athlete knowledge. Increases in knowledge encompass recognition of signs and symptoms. This possible increase in recognition may have resulted in more knowledgeable athletes recognizing the signs and symptoms of these events as needing to be reported since the primary reason for not reporting events in our sample was not thinking the injury was serious enough to report. Increased knowledge may result in athletes recognizing these injuries are possible concussions. Thus, report these injuries to someone in authority. This may also explain why findings related to *concussion* only events and continued participation while symptomatic were not associated with knowledge increases. Valovich McLeod et al[19] found that when asked about concussion history using the terms concussion and bell ringer, a significantly greater proportion of the high school subjects reported having sustained a bell

ringer than having sustained a concussion. Our study further supports these findings underscoring the issue that young athletes often believe that *bell ringers* are not concussions.

Athlete attitude also had overall positive effects on reporting behaviors with increased proportion reported events in games, practices, and *bell ringers* only. Athletes with a more favorable attitude toward reporting may have a better understanding concerning the importance of reporting possible concussion events. Attitude toward a behavior has also been shown to be indicative of certain behaviors. An increase in this attitude score may help athletes to feel more capable of accurately reporting with the increased understanding of the injury.[7, 10]

Limitations

The low return among the athlete subjects is concerning and limits generalizability beyond the study population. Although the purpose of the study was not to make population estimates, it should still be noted that this sample was a convenience sample. In addition, the behavior assessed in this study (reporting/not reporting) was not observed, but self-reported yielding results based largely on athlete perceptions. Also, a disproportionate percentage of our athlete sample was football athletes (41.5%). This may have lead to bias in the sample and many of the findings relative to football. The current study was cross-sectional in nature and can only provide insight on the one point in time the survey instrument was completed. It should also be noted that time of reporting in proximity to the event was not obtained. As a result we do not know if the athletes reported the event immediately following injury or at a later time, which will be important to know in future research. While we acknowledge there are other factors external to the athlete that may influence athlete reporting, this study sought

to investigate the influence of factors at the athlete level. Future research should investigate how these external factors influence reporting of concussion among high school athletes. During the 18 months in which this study was conducted, there was a significant amount of media attention given to concussion in sport, which may have resulted in the relatively high knowledge scores in our sample.

Conclusions

Under-reporting of concussion is a multi-factorial problem as evidenced by the influence of the factors addressed in this study. Gender, knowledge, and attitude all appear to influence reporting behavior. The most striking finding of this study is the large proportion of recalled concussive events not reported among this sample of high school athletes. In addition, this study suggests that increasing knowledge of concussion symptoms, improving the culture of sport, and increasing the understanding of the serious nature of concussion injuries as targets for future interventions.

Clinical Applications

Although this study encompassed only one sample of athletes, the major findings in this study illustrate the importance of increased athlete knowledge, more favorable athlete attitude, and context of reporting of concussion among high school athletes. This study highlights the importance of addressing multiple factors in an effort to increase reporting of possible concussive injuries. In addition this study highlights the need for multi-factorial interventions in the high school setting to change these risky behaviors. Clinicians should make concussion education a priority and address factors to provide a more optimal reporting

environment. In turn, increases in reporting may lead to a decrease in recurrent injuries in this young population. Future research should prospectively address the influence of increasing knowledge and attitude on reporting as well as recurrent concussions.

REFERENCES

1. Collins MW, Lovell MR, Iverson GL, Cantu RC, Maroon JC, Field M. Cumulative effects of concussion in high school athletes. *Neurosurgery.* 2002;51:1175-1179; discussion 1180-1171.

2. Guskiewicz KM, McCrea M, Marshall SW, et al. Cumulative effects associated with recurrent concussion in collegiate football players: the NCAA Concussion Study. *Jama.* 2003;290:2549-2555.

3. Moser RS, Schatz P, Jordan BD. Prolonged effects of concussion in high school athletes. *Neurosurgery.* 2005;57:300-306; discussion 300-306.

4. Lovell MR, Collins MW, Iverson GL, Johnston KM, Bradley JP. Grade 1 or "ding" concussions in high school athletes. *Am J Sports Med.* 2004;32:47-54.

5. Gessel LM, Fields SK, Collins CL, Dick RW, Comstock RD. Concussions among United States high school and collegiate athletes. *J Athl Train.* 2007;42:495-503.

6. Dick RW. Is there a gender difference in concussion incidence and outcomes? *Br J Sports Med.* 2009;43 Suppl 1:i46-50.

7. McCrea M, Hammeke T, Olsen G, Leo P, Guskiewicz K. Unreported concussion in high school football players: implications for prevention. *Clin J Sport Med.* 2004;14:13-17.

8. Connaughton D, Wadey R, Hanton S, Jones G. The development and maintenance of mental toughness: perceptions of elite performers. *J Sports Sci.* 2008;26:83-95.

9. Smith AL, Balaguer I, Duda JL. Goal orientation profile differences on perceived motivational climate, perceived peer relationships, and motivation-related responses of youth athletes. *J Sports Sci.* 2006;24:1315-1327.

10. Kaut KP, DePompei R, Kerr J, Congeni J. Reports of head injury and symptom knowledge among college athletes: implications for assessment and educational intervention. *Clin J Sport Med.* 2003;13:213-221.

11. Valovich McLeod TC, Schwartz C, Bay RC. Sport-related concussion misunderstandings among youth coaches. *Clin J Sport Med.* 2007;17:140-142.

12. Boden BP, Tacchetti RL, Cantu RC, Knowles SB, Mueller FO. Catastrophic head injuries in high school and college football players. *Am J Sports Med.* 2007;35:1075-1081.

13. Fishbein M, Ajzen I. *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley Publishing Company; 1975.

14. Raudsepp L, Viira R, Hannus A. Prediction of physical activity intention and behavior in a longitudinal sample of adolescent girls. *Percept Mot Skills.*110:3-18.

15. Baumert PW, Jr., Henderson JM, Thompson NJ. Health risk behaviors of adolescent participants in organized sports. *J Adolesc Health.* 1998;22:460-465.

16. Covassin T, Swanik CB, Sachs ML. Sex Differences and the Incidence of Concussions Among Collegiate Athletes. *J Athl Train.* 2003;38:238-244.

17. Verbrugge LM. Sex differentials in health. *Public Health Rep.* 1982;97:417-437.

18. Patel DR, Luckstead EF. Sport participation, risk taking, and health risk behaviors. *Adolesc Med.* 2000;11:141-155.

19. Valovich McLeod TC, Bay RC, Heil J, McVeigh SD. Identification of sport and recreational activity concussion history through the preparticipation screening and a symptom survey in young athletes. *Clin J Sport Med.* 2008;18:235-240.

Table 1. List of 8 reporting outcome measures and portion of sample included in analyses

Reporting Outcome	Analysis Unit	Portion of Sample Included Analysis
Reporting at least 50% of recalled concussion only events	People	Only those with at least 1 recalled concussion event
Reporting at least 50% of recalled bell ringer only events	People	Only those with at least 1 recalled bell ringer event
Reporting of recalled concussion/bell ringer events in games	Recalled Events	Only those with at least 1 recalled concussion or bell ringer event in a game
Reporting of recalled concussion/bell ringer events in practices	Recalled Events	Only those with a recalled concussion or bell ringer event during practice
Reporting of recalled concussion only events	Recalled Events	Only those with at least 1 recalled concussion event
Reporting of recalled bell ringer only events	Recalled Events	Only those with at least 1 recalled bell ringer event
Participation in game with concussion signs and symptoms	People	Entire Sample
Participation in practice with concussion signs and symptoms	People	Entire Sample

Table 2. Athlete Demographic Information

Athlete Demographics	**Frequency (%)**
Gender (5 did not report)	
Male	98 (60.5%)
Female	64 (39.1%)
Race (3 did not report)	
African American	17 (10.4%)
White	138 (84.2%)
Hispanic	5 (3.1%)
Asian	4 (2.4%)
Current Sport (13 did not report)	
Football	66 (41.5%)
Boys Soccer	20 (13.9%)
Girls Soccer	18 (11.8%)
Boys Lacrosse	10 (6.3%)
Girls Lacrosse	9 (6.3%)
Cheerleading	31 (19.0%)
Concussion Education Discussion	
Yes	130 (77.8%)
No	37 (22.2%)
AT access (2 from unknown schools)	
Yes	81 (49.1%)
No	84 (50.9%)
History of "Concussion"	
Yes	44 (26.4%)
No	123 (73.7%)
History of "Ding"	
Yes	81 (48.5%)
No	86 (51.5%)

Table 3. Gender Influence on Reporting Prevalence Ratios, Standard Errors, and Confidence Limits

Independent Variable	Prevalence Ratio	Standard Error	95% Confidence Limits		Chi-Square	P-Value
			Lower	Upper		
Gender and Reporting Recalled Concussion Events† (n=43)						
Boys vs. Girls	0.81	0.23	0.47	1.41	0.53	0.471
Gender and Reporting Recalled Bell Ringer Events† (n=80)						
Boys vs. Girls	1.59	1.10	0.41	6.18	0.45	0.400
Gender and Reporting of Concussion and Bell Ringer Events in Games* (n=60)						
Boys vs. Girls	1.69‡	0.66	0.78	3.66	1.80	0.182
Gender and Reporting of Concussion and Bell Ringer Events in Practices* (n=57)						
Boys vs. Girls	0.61‡	0.21	0.31	1.19	2.06	0.151
Gender and Reporting of Recalled Concussion Events* (n=43)						
Boys vs. Girls	1.22	0.44	0.59	2.47	0.30	0.590
Gender and Reporting of Recalled Bell Ringer Events*						
Boys vs. Girls	1.01	0.32	0.54	1.89	0.00	0.961
Gender and Reporting Continuing in a Game while Symptomatic† (n=158)						
Boys vs. Girls	1.98#	0.55	1.15	3.41	6.21	0.012
Gender and Reporting Recalled Continuing in a Practice while Symptomatic† (n=155)						
Boys vs. Girls	1.24	0.36	0.70	2.18	0.55	0.460

† = People as the unit of analysis *Recalled events as the unit of analysis ‡Indicates a trend #Indicates a significant association

Table 4. Athlete Knowledge (AKT) Influence on Reporting Prevalence Ratios, Standard Errors, and Confidence Limits

Independent Variable 10-point Increase	Prevalence Ratio	Standard Error	95% Confidence Limits Lower	Upper	Chi-Square	P-Value
Knowledge and Reporting Recalled Concussion Events† (n=40)						
AKT	1.07	0.65	0.32	3.55	0.01	0.911
Knowledge and Reporting Recalled Bell Ringer Events† (n=67)						
AKT	2.65‡	2.65	0.37	18.88	0.95	0.330
Knowledge and Reporting of Concussion and Bell Ringer Events in Games* (n=58)						
AKT	1.46	0.79	0.51	4.21	0.51	0.475
Knowledge and Reporting of Concussion and Bell Ringer Events in Practices* (n=56)						
AKT	18.67#	11.84	5.38	64.76	21.25	<0.001
Knowledge and Reporting of Recalled Concussion Events* (n=40)						
AKT	0.98	0.52	0.35	2.76	0.00	0.982
Knowledge and Reporting of Recalled Bell Ringer Events* (n=69)						
AKT	9.40#	5.23	3.16	27.98	16.24	<0.001
Knowledge and Reporting Continuing in a Game while Symptomatic† (n=129)						
AKT	0.91	0.39	0.39	2.12	0.04	0.835
Knowledge and Reporting Recalled Continuing in a Practice while Symptomatic† (n=128)						
AKT	0.88	0.44	0.33	2.35	0.02	0.800

† = People as the unit of analysis *Recalled events as the unit of analysis ‡Indicates a trend #Indicates a significant association

Table 5. Athlete Attitude (AAT) Influence on Reporting Prevalence Ratios, Standard Errors, and Confidence Limits

Independent Variable 10-point	Prevalence Ratio	Standard Error	95% Confidence Limits		Chi-Square	P-Value
			Lower	Upper		
Attitude and Reporting Recalled Concussion Events† (n=40)						
AAT	1.07	0.14	0.83	1.39	0.32	0.572
Attitude and Reporting Recalled Bell Ringer Events† (n=69)						
AAT	1.01	0.24	0.63	1.61	0.00	0.961
Attitude and Reporting of Concussion and Bell Ringer Events in Games* (n=61)						
AAT	1.16‡	0.12	0.95	1.42	2.37	0.123
Attitude and Reporting of Concussion and Bell Ringer Events in Practices* (n=55)						
AAT	1.38#	0.20	1.03	1.85	4.46	0.029
Attitude and Reporting of Recalled Concussion Events* (n=40)						
AAT	1.00	0.11	0.80	1.25	0.00	0.964
Attitude and Reporting of Recalled Bell Ringer Events* (n=69)						
AAT	1.40#	0.15	1.13	1.75	9.78	0.002
Attitude and Reporting Continuing in a Game while Symptomatic† (n=129)						
AAT	0.76#	0.04	0.69	0.85	26.99	<0.001
Attitude and Reporting Recalled Continuing in a Practice while Symptomatic† (n=128)						
AAT	0.71#	0.04	0.64	0.79	36.47	<0.001

† = People as the unit of analysis *Recalled events as the unit of analysis ‡Indicates a trend #Indicates a significant association

Table 6. Summary of Study Findings

Reporting (Recalled) Outcome	**Gender Boys vs. Girls**	**Athlete Knowledge 10-point increase**	**Athlete Attitude 10-point increase**
Concussion Only †			
Bell Ringer Only†			
Game Events*	↑ Men		↑
Practice Events*	↓ Men	↑	↑
Concussion Only*			
Bell Ringer Only*		↑	↑
Participation in Games with Symptoms†	↑ Men		↓
Participation in Practice with Symptoms†			↓

APPENDIX 2- MANUSCRIPT 2

Title:
Using the Theory of Reasoned Action and Planned Behavior to understand high school aged athletes' intentions to report concussion

Potential Journal:
Journal of Adolescent Health

ABSTRACT

Purpose: To assess psychosocial determinants of the Theory of Reasoned Action and Planned Behavior.

Methods: The present study employed the Theory of Reasoned Action and Planned Behavior to examine contributors to intention to report concussion symptoms among a sample of 167 high school athletes. Athletes completed the survey instrument via mail. Linear regression models were used to predict intention from the direct and indirect constructs (attitude, subjective norm, and perceived behavioral control) of the Theory of Reasoned Action and Planned Behavior. Binomial regression models were used to predict each of the 8 concussion reporting outcome measures from intention to report.

Results: Direct attitude (χ^2=45.84, P<0.001), subjective norm (χ^2=4.74, P=0.029), and direct perceived behavioral control (χ^2=30.15, P<0.001) were all associated with intention to report in a multivariate model accounting for 58% of the variance in intention. Indirect attitude (χ^2=30.78, P<0.001) and indirect subjective norm (χ^2=15.81, P<0.001) were associated with intention to report in a multivariate model accounting for 37% of the variance in intention to report. As hypothesized, intention was significantly associated with decreased participation while symptomatic from concussion in practices (PR = 0.77, 95% CI: 0.68, 0.85) and games (PR = 0.70, 95% CI: 0.63, 0.79).

Conclusions: Favorable attitudes towards reporting and social referents' (coaches, teammates, parents) beliefs and influence have the greatest impact on intention to report concussion symptoms. Intention to report may also influence reporting behaviors.

Key Words: Brain injury, care seeking, sports

INTRODUCTION

An estimated 1.6 to 3.8 million sports-related traumatic brain injuries occur each year with approximately 1.5 million of these estimated to be cerebral concussions.[1] In the young, adolescent population, traumatic brain injury results in more disabilities and changes in normal healthy people than any other condition.[2] The adolescent brain is continuing to develop and may be perhaps be more vulnerable to injury.[3] Concussion is a complicated injury that often does not present with clear-cut visible signs. Individuals may also conceal symptoms. In some individuals the signs and symptoms may be delayed in presentation.[4] Because of this variability in presentation, and a general lack of understanding of concussion in the athletic community [5-7], many concussions probably go unidentified. Unidentified concussions pose an issue as research suggests long term and cumulative effects of concussion including depression, mild cognitive impairment, risk for subsequent injury, and longer recovery following subsequent injuries.[8-12]

Factors concerning care-seeking behaviors for concussion therefore complicate the management of this injury. These factors include attitudes toward reporting, social referents' influence, and perceived control over reporting a concussion to someone in an authoritative position. Only one published study [13] to date has attempted to examine concussion reporting behaviors concurrently with factors that may contribute to this behavior in adolescent athletes. Although studies have begun to examine knowledge and attitude concerning concussion [5, 7, 14] no studies have examined other factors influencing concussion reporting in high school athletes.

No studies have attempted to apply a health behavior model to understand intentions to perform the behavior of reporting possible concussions to a medical professional or a

coach. The Theory of Reasoned Action and Planned Behavior (TRA-TpB) [15] provides a framework for understanding these factors.

Therefore, the purposes of this study were: 1) to examine the association between attitude, subjective norms, perceived behavioral control and intention to report concussion, 2) to examine the correlation between beliefs and intention to report concussion, and 3) to examine the association between intention to report and the behavior of concussion reporting.

METHODS

Sample and Recruitment

A convenience sample of 25 high schools was recruited to participate in the study. Institutional review board approval preceded any study activities. Approval from each school was obtained. Following school approval, school information forms were completed by a designated school contact serving as a research assistant at each school. A total of 167 high school athletes (98 males, 64 females, 5 not reporting gender; age = 15.7±1.4) completed the questionnaire. Inclusion criteria for subjects was being listed as an athlete on the varsity football, cheerleading, boys' soccer, girls' soccer, boys' lacrosse, and girls' lacrosse. All subjects were between the ages of 13-18 years old.

Development of TRA-TpB Survey Instrument

In the TRA-TpB, individuals' attitudes, perceived social pressures, and perceived control over the behavior are thought to associate linearly to influence behavioral intention:

$$BI = a + b_1Att + b_2SN + b_3PBC$$

where in the current study BI = intention to report concussion, Att = Attitude toward reporting, PBC = perceived behavioral control over reporting. According to the TRA-TpB [15, 16], elicitation interviews were conducted to inform complete development of the TRA-TpB survey instrument. Seventeen high school athletes participated in these interviews. The primary purpose of these interviews was to elicit common behavioral, normative, and control beliefs about reporting of concussion symptoms among high school athletes. The elicited beliefs included:

Following completion and analysis of the elicitation interviews, questions were developed from the elicited concepts and through expert opinion to produce a 48-item TRA-

TpB survey instrument. The instrument was piloted on 12 high school athletes on two occasions, two weeks apart and examined for internal consistency of each TRA-TpB construct and agreement across the two test times. Each direct construct achieved an acceptable internal consistency value of Chronbach's $\alpha > 0.6$.

The behavior of interest for the current study was reporting of concussion during sport participation. Because the initial reporting of concussion is based on symptoms, questions on the survey focused on reporting of symptoms. The survey instrument contained instructions asking athletes to "please answer the following questions related to participation in sports at your high school and your feelings about reporting of concussion, should you experience one". All questions assessing TRA-TpB constructs, involved the phrase "When I experience possible concussion symptoms…"

A higher direct attitude score indicated an overall more favorable attitude toward concussion reporting. A higher direct subjective norm score indicated that important social referents feel more positive toward reporting of concussion. A higher direct perceived behavioral control score indicated more feelings of control over the behavior of concussion reporting. The questions for each of these direct are listed in **Tables 1 and 2**.

Indirect attitude is a product of beliefs about the behavior and the evaluations of these beliefs, with a higher score indicating a more favorable attitude. Indirect subjective norm is a product of normative beliefs (beliefs of important social referents) and motivation to comply with these beliefs. A higher score indicated more positive influences from social referents. Indirect perceived behavioral control is a product of control beliefs and control belief power (beliefs "controlling" the behavior and the perceived power of these beliefs) with a higher

score indicating a greater feeling of control over reporting. The beliefs associated with the indirect constructs are listed in **Table 2**.

Survey Instrument Distribution and Return

The school contacts arranged questionnaire distribution meetings at each school. These meetings were conducted by the study investigator or the designated school contact at the school. The meeting was performed using a standardized script to ensure similar instructions for all possible participants. During this meeting, the study was explained and athletes were given a study packet including an instruction letter, appropriate consent documents, the survey instrument, and a postage paid return envelope. Athletes were asked to take the packet home, complete the survey instrument following appropriate consent, and return it directly to the research team via mail. Upon return, survey instruments were logged and entered into the study dataset.

Statistical Analyses

All data were analyzed using SAS v9.1 with an alpha level set to 0.05 *a priori*. Direct measures were calculated by summing the questions concerning each direct construct and dividing by the number of questions for each construct. **(Table 1)** Indirect measures were calculated by summing the product of the beliefs and the associated weight of these beliefs. **(Table 2)**. Both direct and indirect calculations were performed per the guidelines presented by Francis et al.[17] Linear regression models were used to examine the associations between the indirect measures and their direct counterparts to ensure measurement of similar constructs. Separate multiple linear regressions were used to predict intention from the direct

constructs and the indirect constructs. A 1-point change in each of the direct measures and a 10-point change in each of the indirect measures were used to estimate change in intention. A 1-point change was used for direct measures, as this is the traditional method for analyzing the direct measures. A 10-point change was chosen to estimate influence of the indirect constructs as a result of these constructs using a much larger scale. Binomial regression models were used to estimate prevalence rations (PRs) for each of the 8 reporting outcomes **(Table 4).** The PRs represent the increase in the prevalence of recalled concussion and bell ringer events associated with a 1 point increase in intention score (7 point scale).

RESULTS

TRA-TpB Descriptives

Average direct attitude in the sample was 5.6 ± 1.0 (1-7 possible) indicating a moderate-to favorable attitude toward concussion reporting. The average direct subjective norm was 5.8 ± 1.3 (1-7 possible). This higher direct subjective norm score indicates athletes in the sample believed important social referents (eg: teammates, coaches, parents) had positive views concerning concussion reporting. The average direct perceived behavioral control score was 5.8 ± 1.2 (1-7 possible) suggesting that athletes overall feel they have a good amount of control over concussion reporting. **Table 1** illustrates question and overall means for all direct constructs.

Average indirect attitude score (product of behavioral beliefs and outcome evaluations) in the sample was 27.1 ± 29.1 (-168 to + 168 possible) again indicating moderately favorable attitudes. Average indirect subjective norm score (product of normative belief and motivation to comply) was 41.0 ± 39.7 (-84 to + 84 possible), a relatively high subjective norm score indicating an overall positive influence from social referents. The average indirect perceived behavioral control (product of control beliefs and control belief power) was 17.8 ± 27.1 (-84 to + 84 possible), which indicates a moderate feeling of control. **Table 2** illustrates question and overall means for all indirect constructs.

Reporting Behavior Descriptives

Of the 89/167 individuals recalling at least 1 concussive event, only 15 (17.0%) indicated that they had reported all recalled *concussive/bell ringer* events they experienced to a coach or a medical professional. There were a total of 83 recalled *concussions* among the

sample, but only 41 (49%) of these events were indicated as reported by the respondents. In addition, there were a total of 576 recalled *bell ringer* events among the sample with only 72 (13%) indicated as being reported to a coach or a medical professional.

In *games only*, there were a total of 241 recalled *concussion* and *bell ringer* events with only 65 (27%) of these events indicated as reported to a coach or a medical professional. For *practices only*, there were a total of 346 recalled *concussion* and *bell ringer* events, butonly 40 (12%) of these events were recalled as reported by the respondents to a coach or a medical professional. In addition, 40% of the athlete sample (n=63) indicated continuing to participate in a practice or a game at least once, when he/she thought they were experiencing signs and symptoms of a concussion.

Direct and Indirect Measures Influence on Intention

All indirect measures were associated with their direct counterparts. ($P<0.05$) which indicates these factors were related and addressed similar constructs. There was an association between all direct measures (attitude, subjective norm, perceived behavioral control) and intention to report possible concussive symptoms with each direct construct in a separate model and in a multivariate model when controlling for all three factors. The multivariate model, as called for in the TRA-TpB, accounted for 58% of the variance in intention. A 1-point change in each of the direct measures was used to estimate change in intention. **(Table 5)**

There was also a significant association between all indirect measures (attitude, subjective norm, and perceived behavioral control) when used in separate models to predict intention. However, in a multivariate model controlling for all three factors, only indirect attitude and indirect subjective norm were associated with intention. The combined model

accounted for 32% of the variance in intention. A 10-point change in the indirect measures was used to estimate change in intention to report. **(Table 5)**

Correlation between Beliefs and Intention

The behavioral beliefs that reporting concussion symptoms would improve athletic performance ($r=0.434$, $p<0.001$), reduce chances of another concussion ($r=0.308$, $p<0.001$), maintains health ($r=0.431$, $p<0.001$), and improves school performance ($r=0.264$, $p<0.001$) were all correlated with intention to report. Believing that reporting concussions would let teammates down was weakly correlated with intention to report ($r=-0.175$, $p=0.029$). The behavioral beliefs that reporting concussion symptoms cause loss of position on the team ($r=0.100$, $p=-0.132$), loss of playing time ($r=-0.091$, $p=0.255$), and missing out on team activities ($r=-0.071$, $p=0.357$) were not correlated with intention to report.

The normative beliefs of coaches ($r=0.305$, $p<0.001$), teammates ($r=0.343$, $p<0.001$), parents ($r=-.202$, $p=0.012$), and students at school ($r=0.390$, $p<0.001$) thinking athletes should report were all positively correlated with intention to report. The control belief of having a medical professional present makes it easier to report was correlated with intention to report ($r=0.294$, $p<0.001$). The beliefs concerning coach ($r=-0.059$, $p=0.456$), parent ($r=-0.068$, $p=0.402$), and teammate ($r=0.001$, $p=0.902$) pressure making it easier to report were not correlated with intention to report.

Intention Influence on Reporting of Recalled Events

When examining only individuals with recalled concussive or bell ringer events, intention was not associated with reporting behavior. There was no association between the

prevalence of people reporting at least 50% of *concussion* only events or *bell ringer* only events and a 1-point increase in intention. When including the entire sample, increased intention was strongly associated with a decrease in the prevalence of people indicating participating in games and practices while experiencing signs/symptoms of concussion. For every 1-point increase in intention score there was an estimated 23% decrease in prevalence of athletes indicating this behavior in games. There was also an estimated 30% decrease in prevalence of athletes indicating this behavior in practice. **(Table 6)**

There was no association between a 1-point increase in intention and the prevalence of recalled concussion/bell ringer events reported in games and reported in practices. Increase in intention score was also not associated with proportion of recalled concussion/bell ringer events reported in practice. Lastly, increased intention was not associated with reporting of recalled concussion only or bell ringer only events. **(Table 6)**

DISCUSSION

This study was the first to understand the psychosocial determinants of the Theory of Reasoned Action and Planned Behaivor (TRA-TpB) to sports-related concussion and the behaviors associated with reporting of this injury. This study identified significant contributors to reporting intention including a more favorable attitude, influence of coaches and teammates, and control of the behavior of reporting concussion. These findings suggest important and changeable factors that if addressed among the high school athletic population, would improve concussion reporting in these young athletes.

Direct and Indirect Measures Influence on Intention

Attitude contributed to the largest change in intention. Athletes with a more favorable attitude toward reporting may have a better understanding concerning the importance of reporting possible concussion events. Athletes with more favorable attitudes may also feel more capable of reporting with the increased understanding of the injury.[5, 13] In addition attitudes are often formed by social norms and personal experience.[15, 16] This study did not examine influence of previous concussion experience with concussion, but social norms and opinions of important social referents were found in this study to significantly influence intention. The attitudes of these referents may also be reflected in the attitudes and behaviors of the athletes.[18, 19]

Given the culture of sport (mental toughness, hardiness, etc), and the importance of acceptance by important social referents such as coaches and athletes, it is not surprising that both direct and indirect subjective norm influence intention. Athletes significantly value the opinions of their coaches, teammates, and parents. In addition, the overall culture of sport

including influences from the medial and professional and other athletes, may play a role in decisions to report injury. However, the strongest of these influences is their coaches and teammates as they are often directly involved in the decision to report during sport participation.

The relationship with the coach is unique in that the coach has a large amount of control over the athlete's participation. Given that losing participation is a main deterrent to reporting [13], it is logical to expect social referents who influence playing time and participation to have some influence on concussion reporting among athletes. Pleasing a coach and conforming to their belief system on the athletic field is often an inherent characteristic among athletes.[20] A recent study suggests that coach listening and support may play a role in recovery from injury, further highlighting the importance of coach opinion and support.[21] In addition to this unique relationship, teammates take the peer relationship to an additional level, as the relationship now involves the added stress of athletic performance. [18] The motivations and aspirations of coaches[22], parents[20, 23], and teammates[20] often overlap and compete as athletes value each of these groups' opinions. This combination of factors lends further credit to the significant role social pressures may play in concussion reporting.

The perceived behavioral control in the sample was high indicating that overall, athletes felt moderate control and capability over the behavior of reporting. In addition, as explained below, the only control belief correlated with intention was increased belief that having a medical professional present made it easier to report. Half of the study sample had access to a certified athletic trainer (AT) at his/her school and half did not. This may have influenced control beliefs and the relationships with intention in the study sample. In addition, although athletes believe they have control over reporting, as a result of the

competing concerns such as losing playing time [13] and letting others down [24, 25], athletes may still choose not to report. The behavior of concussion reporting is unique, as it often needs to be reported immediately and in the middle of participations where other competing motivations may persist.

A similar use of TRA-TpB to physically active athletes is exercise behavior. Often in these behaviors, subjective norm does not play a role.[26, 27] However, when examining adolescent reporting of mental health issues, subjective norm and attitude often play the largest roles. This behavior may be more similar to reporting concussion as there is a stigma associated with mental health issues among peers and often times even among family members [28, 29] Our data concerning reporting of concussion symptoms follow a similar pattern. In addition, like concussion, many of the signs and symptoms of mental health issues are often not visible to others. Thus, it is even more difficult for people to understand the problem at hand.

Our data suggest attitude and subjective norm may have the greatest influence on intention. In order to influence the constructs addressed in TRA-TpB changes involving multiple levels of the socio-ecological framework need to be addressed. It should be noted that other factors influence intention. The three direct factors in the current study accounted for 53% of intention variance in intention. Other factors may include coach influence, parental influence, previous experience with concussion, access to overall medical care, and trust in health care may affect intention to report.

Only indirect attitude and indirect subjective norm were associated with intention in the combined model. However, the changes in intention as a result of the changes in the indirect measures were not as strong as the direct constructs. Indirect perceived behavioral

control also appears to play less of a role, most likely as a result of the volitional control individuals have over reporting concussive symptoms. Again, attitude towards reporting (indirect) resulted in the largest change in intention. As with the direct model, other factors influence both intention and behavior.

Correlation between Beliefs and Intention

To further understand the indirect measures' influence on intention and the specific beliefs associated with intention, correlations between each behavioral, normative, and control belief and intention to report were examined. These correlations suggests that increases in the behavioral beliefs of reporting improving athletic performance, reducing chances of another concussion, improving health, and improving school performance increased intention to report. However, with stronger belief that reporting would result in letting teammates down, intention to report may decrease. Concerning normative beliefs, the stronger the belief that coaches, teammates, parents, and students believe individuals should report, the greater the intention to report. Lastly, the only control belief positively correlated with intention to report was having a medical professional present. Alternatively, the stronger the behavioral belief that concussion symptom reporting may let teammates down, the lower the intention to report. Combined with the data suggesting the influence of indirect attitude and indirect subjective norm on intention, these findings illustrate the beliefs that may be driving these associations.

The correlations between the beliefs indentified in this study also illustrate the influence these beliefs may have on intention. Each normative belief (component of subjective norm) assessed was correlated with intention to report. The majority of the

behavioral beliefs assessed were also correlated with intention. This illustrates the influence that athlete beliefs concerning concussion have on intention. These correlations lend further evidence to the factors to be addressed among this age group of athletes in an effort to increase concussion reporting. Decreases in concussion reporting may ultimately decrease occurrence of subsequent injuries as a result of pre-mature return to play.

Intention Influence on Reporting

Intention did not appear to significantly affect overall reporting behavior in individuals who recalled experiencing a *concussion/bell ringer* event. Alternatively, when examining the entire sample, an increase in intention was associated with a decrease in the prevalence of people indicating that they continued in a game and practice when they were experiencing signs and symptoms of concussion. The questions concerning participation with signs and symptoms were constructed in a similar fashion to questions concerning intention to report, which may explain the associations related to these questions. In addition, these 2 variables assessed the proportion in the entire sample, and individuals with a concussion history would have more opportunity to participate while symptomatic than individuals with no concussion history. Individuals who intend to perform a specific behavior are often more likely to actually engage in the behavior.[15, 16] Although intention and behavior are not always aligned, intention can often be used as a proximal measure of behavior. Some physical activity and exercise behaviors are often linked to intention to actually perform these behaviors. [30] The behavior of reporting and intention to report concussive symptoms may be unique as individuals often have complete control over reporting but the decision must be made often in a short amount of time during participation in sport.

Average intention in our sample was 5.3 ± 1.7 (out of 7) which indicates a moderate level of intention. Although some people may intend to report a concussion, this decision must often be made in a small amount of time with many factors influencing the decision to actually engage in the behavior. Removal from competition is a major deterrent to reporting in previous research [13] and in our sample. Although intention may play some role, the importance and intensity of the competition may override that of the athlete's original intention. Influence of the athlete's coach[22] and teammates[31] are also factors that may play into the immediate decision of reporting during a game or practice. In our study sample not wanting to let teammates down was one of the top 3 reasons indicated for not reporting a possible concussive injury. This in conjunction with the findings related to social referent influence illustrates the need for educational programs to emphasize the importance of reporting possible concussions.

The entire team should be included in this approach in efforts to overcome the concern of letting down others when reporting these possible injuries. Teammates and coaches engaged in discussions concerning concussion reporting and promoting reporting of these injuries may help athletes overcome this deterrent to reporting. As indicated in the McCrea [13] study and in our sample, not knowing the injury was serious enough to report is a major deterrent to concussion reporting. If the individuals did not know the signs and symptoms they were experiencing were related to concussion, they may still not report these symptoms, regardless of intention to report.

Limitations

The current study is not without limitations. Although the purpose of the study was not to make population estimates, it should still be noted that the sample was a convenience sample. In addition, the low response from the athlete subjects may have lead to some response bias in the sample making the findings less generalizable. A large number of athletes (41.5%) in this study were football athletes, which may have influenced study findings with football being over-represented. It should also be noted that time of reporting in proximity to the event was not obtained which made it difficult if athlete's reported the concussive event at the time of injury. During the study period, a significant amount of media and medical attention was focused on the concussion problem in sport, which may have influenced the data collection to some degree by increasing knowledge and awareness.

Conclusions

This study highlights the role attitude, social norms, and control over concussion reporting may play in the current issues related to concussion among high school athletes. The Theory of Reasoned Action and Planned Behavior is a useful framework in predicting intention to report concussion symptoms. Moreover, this study is the first to quantify intention to report concussive symptoms and the factors influencing these intentions. The current study provides insight into the importance of addressing the culture of sport in an effort to decrease the risky behavior of choosing not to report possible concussive injuries.

REFERENCES

1. Langlois JA, Rutland-Brown W, Wald MM. The epidemiology and impact of traumatic brain injury: a brief overview. *J Head Trauma Rehabil.* 2006;21:375-378.

2. Thurman DJ, Alverson C, Brown D, et al. Tramuatic brain injury in the United States: A report to congress. *Atlanta, GA: National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, US Department of Health and Human Services.* 1999.

3. Buzzini SR, Guskiewicz KM. Sport-related concussion in the young athlete. *Curr Opin Pediatr.* 2006;18:376-382.

4. McCrea M, Guskiewicz KM, Marshall SW, et al. Acute effects and recovery time following concussion in collegiate football players: the NCAA Concussion Study. *Jama.* 2003;290:2556-2563.

5. Kaut KP, DePompei R, Kerr J, Congeni J. Reports of head injury and symptom knowledge among college athletes: implications for assessment and educational intervention. *Clin J Sport Med.* 2003;13:213-221.

6. Valovich McLeod TC, Bay RC, Heil J, McVeigh SD. Identification of sport and recreational activity concussion history through the preparticipation screening and a symptom survey in young athletes. *Clin J Sport Med.* 2008;18:235-240.

7. Valovich McLeod TC, Schwartz C, Bay RC. Sport-related concussion misunderstandings among youth coaches. *Clin J Sport Med.* 2007;17:140-142.

8. Collins MW, Lovell MR, Iverson GL, Cantu RC, Maroon JC, Field M. Cumulative effects of concussion in high school athletes. *Neurosurgery.* 2002;51:1175-1179; discussion 1180-1171.

9. Guskiewicz KM, Marshall SW, Bailes J, et al. Association between recurrent concussion and late-life cognitive impairment in retired professional football players. *Neurosurgery.* 2005;57:719-726.

10. Guskiewicz KM, Marshall SW, Bailes J, et al. Recurrent concussion and risk of depression in retired professional football players. *Med Sci Sports Exerc.* 2007;39:903-909.

11. Guskiewicz KM, McCrea M, Marshall SW, et al. Cumulative effects associated with recurrent concussion in collegiate football players: the NCAA Concussion Study. *Jama.* 2003;290:2549-2555.

12. Zemper ED. Two-year prospective study of relative risk of a second cerebral concussion. *Am J Phys Med Rehabil.* 2003;82:653-659.

13. McCrea M, Hammeke T, Olsen G, Leo P, Guskiewicz K. Unreported concussion in high school football players: implications for prevention. *Clin J Sport Med.* 2004;14:13-17.

14. Rosenbaum AM, Arnett PA. The development of a survey to examine knowledge about and attitudes toward concussion in high-school students. *J Clin Exp Neuropsychol.* 2009:1-13.

15. Fishbein M, Ajzen I. *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley Publishing Company; 1975.

16. Pender NJ, Pender AR. Attitudes, subjective norms, and intentions to engage in health behaviors. *Nursing research.* 1986;35:15-18.

17. Francis JL, Martin PE, Johnston M, et al. Constructing Questionnaires Based on the Theory of Planned Behavior. In: Centre for Health Services Research UoN, ed2004.

18. Ommundsen Y, Roberts GC, Lemyre PN, Miller BW. Peer relationships in adolescent competitive soccer: associations to perceived motivational climate, achievement goals and perfectionism. *J Sports Sci.* 2005;23:977-989.

19. Ommundsen Y, Roberts GC, Lemyre PN, Miller BW. Parental and coach support or pressure on psychosocial outcomes of pediatric athletes in soccer. *Clin J Sport Med.* 2006;16:522-526.

20. Van-Yperen NW, Duda JL. Goal orientations, beliefs about success, and performance improvement among young elite Dutch soccer players. *Scand J Med Sci Sports.* 1999;9:358-364.

21. Malinauskas R. College athletes' perceptions of social support provided by their coach before injury and after it. *J Sports Med Phys Fitness.* 2008;48:107-112.

22. Jowett S, Clark-Carter D. Perceptions of empathic accuracy and assumed similarity in the coach-athlete relationship. *The British journal of social psychology / the British Psychological Society.* 2006;45:617-637.

23. White SA, Kavussanu M, Tank KM, Wingate JM. Perceived parental beliefs about the causes of success in sport: relationship to athletes' achievement goals and personal beliefs. *Scand J Med Sci Sports.* 2004;14:57-66.

24. Hall-Lande JA, Eisenberg ME, Christenson SL, Neumark-Sztainer D. Social isolation, psychological health, and protective factors in adolescence. *Adolescence.* 2007;42:265-286.

25. Nattiv A, Puffer JC, Green GA. Lifestyles and health risks of collegiate athletes: a multi-center study. *Clin J Sport Med.* 1997;7:262-272.

26. Smith RA, Biddle SJ. Attitudes and exercise adherence: test of the Theories of Reasoned Action and Planned Behaviour. *J Sports Sci.* 1999;17:269-281.

27. Raudsepp L, Viira R, Hannus A. Prediction of physical activity intention and behavior in a longitudinal sample of adolescent girls. *Percept Mot Skills.*110:3-18.

28. Van Voorhees BW, Fogel J, Houston TK, Cooper LA, Wang NY, Ford DE. Attitudes and illness factors associated with low perceived need for depression treatment among young adults. *Soc Psychiatry Psychiatr Epidemiol.* 2006;41:746-754.

29. Bayer JK, Peay MY. Predicting intentions to seek help from professional mental health services. *Aust N Z J Psychiatry.* 1997;31:504-513.

30. Murnaghan DA, Blanchard CM, Rodgers WM, et al. Predictors of physical activity, healthy eating and being smoke-free in teens: A theory of planned behaviour approach. *Psychol Health.* 2009:1-17.

31. Smith AL, Balaguer I, Duda JL. Goal orientation profile differences on perceived motivational climate, perceived peer relationships, and motivation-related responses of youth athletes. *J Sports Sci.* 2006;24:1315-1327.

Table 1. Direct Questions and Constructs Means and Standard Deviations

TRA-TpB Questions and Constructs (Direct)	Mean (SD)*
Intention	
I intend to report	5.3 ± 1.9
I plan to report	5.4 ± 1.8
I will make an effort to report	5.4 ± 1.8
Intention Measure (average score)	5.3 ± 1.7
Direct Attitude	
Cowardly-Brave	5.1 ± 1.6
Embarrassing-Pleasant	4.5 ± 1.7
Harmful-Beneficial	6.2 ± 1.3
Extremely Difficult-Extremely Easy	5.0 ± 1.6
Bad-Good	5.9 ± 1.4
Unimportant-Important	6.1 ± 1.4
Worthless-Valuable	6.1 ± 1.3
Direct Attitude Toward Reporting Total (average score)	5.6 ± 1.0
Direct Subjective Norm (referents think should/not)	
People I know think I should/not report	5.5 ± 1.8
People who are important to me think I should/not report	5.7 ± 1.9
It is expect of me to report	5.9 ± 1.5
People who are important would approve of my reporting	5.7 ± 1.9
Direct Subjective Norm Total (average score)	5.8 ± 1.3
Direct Perceived Behavioral Control	
I am confident I could report	5.7 ± 1.6
How much control do you have over reporting (none, complete)	5.9 ± 1.5
I am able/unable to report	5.9 ± 1.5
Direct Perceived Behavior Control Total (average score)	5.8 ± 1.2

* Scores on a 1-7 Likert Scale

Table 2. Indirect questions and constructs means and standard deviations

TRA-TpB Questions and Constructs (Indirect)	Mean (SD)
Indirect Attitude † Score on a 1-7 Likert Scale *Score on a -3 to +3	
Reporting will improve my athletic performance†	4.6 ± 1.9
Improving my performance is extremely good/bad*	2.7 ± 0.9
Reporting will reduce changes of suffering another concussion†	5.2 ± 1.9
Suffering fewer concussion is extremely good/bad*	2.2 ± 1.6
Reporting will cause me to lose my position on the team†	2.8 ± 2.0
Losing my position is extremely good/bad*	-2.3 ± 1.2
Reporting will cause me to lose playing time†	4.0 ± 2.1
Losing playing time is extremely good/bad*	-1.9 ± 1.4
Reporting will help me maintain my health†	5.8 ± 1.4
Maintaining my health is extremely good/bad*	2.7 ± 0.9
Reporting will cause me to miss out on team activities†	4.2 ± 1.9
Missing team activities is extremely good/bad*	-1.6 ± 1.4
Reporting will help maintain my school performance†	5.1 ± 1.7
Maintaining my school performance is extremely good/bad*	2.6 ± 0.9
Reporting will let my teammates down†	2.9 ± 1.9
Letting my teammates down is extremely good/bad*	-2.1 ± 1.3
Indirect Attitude Toward Reporting Total	27.1 ± 29.1
Indirect Direct Subjective Norm † Score on a 1-7 Likert Scale *Score on a -3 to +3	
How much do you care what your coaches think (not at all, very much)†	5.3 ± 1.9
My coaches think I should/not report*	1.9 ± 1.9
How much do you care what your teammates think (not at all, very much)†	5.3 ± 1.9
My teammates think I should/not report*	1.6 ± 1.8
How much do you care what your parents think (not at all, very much)†	5.8 ± 1.7
My parents think I should/not report*	2.1 ± 1.7
How much do you care what students at your school think (not at all, very much)†	4.5 ± 2.1
Students at my school think I should/not report*	1.6 ± 1.6
Indirect Subjective Norm Total	41.0 ± 39.7
Indirect Perceived Behavioral Control † Score on a 1-7 Likert Scale *Score on a -3 to +3	
I expect my coach to place a lot of pressure on me†	5.3 ± 1.8
The coach pressure makes it much easier/difficult to report*	0.3 ± 1.7
I expect my parents to place a lot of pressure on me†	4.1 ± 1.8
The pressure my parents place on me makes it much easier/difficult to report*	0.9 ± 1.8
I expect my teammates to place a lot of pressure on me†	4.9 ± 1.8
The pressure my teammates place on me makes it much easier/difficult to report*	0.3 ± 1.7
Having a medical professional present makes it easier/difficult to report*	6.1 ± 1.5
The pressure my parents place on me makes it easier/difficult to report†	2.1 ± 1.4
Indirect Perceived Behavior Control Total	17.8 ± 27.1

Table 3. Elicited Beliefs in Rank Order

Elicitation Point	Responses
Behavioral Beliefs	1. Lose Play 2. Let Teammates Down 3. Miss out on activities 4. Multiple concussions - Overall health 5. Performance in School
Normative Beliefs	1. What coaches think 2. What teammates think 3. What parents think 4. What AT (if access) thinks
Control Beliefs	1. Coach pressure 2. Teammate pressure 3. Parent pressure 4. Medical Professional Presence
Social Referents	1. Teammates 2. Coaches 3. Parents 4. AT (if access)

Table 4. Reporting outcomes, analysis units, and portion of sample used in analysis

Reporting Outcome	Analysis Unit	Portion of Sample Included Analysis
Reporting at least 50% of recalled concussion only events	People	Only those with at least 1 recalled concussion event
Reporting at least 50% of recalled bell ringer only events	People	Only those with at least 1 recalled bell ringer event
Reporting of recalled concussion/bell ringer events in games	Recalled Events	Only those with at least 1 recalled concussion or bell ringer event in a game
Reporting of recalled concussion/bell ringer events in practices	Recalled Events	Only those with a recalled concussion or bell ringer event during practice
Reporting of recalled concussion only events	Recalled Events	Only those with at least 1 recalled concussion event
Reporting of recalled bell ringer only events	Recalled Events	Only those with at least 1 recalled bell ringer event
Participation in game with concussion signs and symptoms	People	Entire Sample
Participation in practice with concussion signs and symptoms	People	Entire Sample

Table 5. Direct and Indirect Constructs Influence on Intention to Report Estimates of Change, Standard Errors, and Confidence Limits

Independent Variable 1 Point Increase Direct 10-point Increase Indirect	Estimate of Change	Standard Error	95% Confidence Limits Lower	 Upper	Chi-Square	P-Value
Direct and Intention (individual models)						
Attitude (n=144)	1.14#	0.11	0.94	1.35	117.34	<0.001
Subjective Norm (n=149)	0.63#	0.10	0.44	0.82	41.25	<0.001
Perceived Behavioral Control (n=154)	0.82#	0.09	0.64	0.99	83.94	<0.001
Direct and Intention (all in combined model, n=134)						
Attitude	0.75#	0.11	1.71	2.64	45.84	<0.001
Subjective Norm	0.19#	0.08	0.02	0.36	4.74	0.029
Perceived Behavioral Control	0.48#	0.09	0.31	0.65	30.15	<0.001
Indirect and Intention (individual models)						
Attitude (n=138)	0.26#	0.04	0.17	0.36	30.78	<0.001
Subjective Norm (n=141)	0.18#	0.03	0.11	0.24	27.48	<0.001
Perceived Behavioral Control (n=140)	0.14#	0.05	0.03	0.24	6.60	0.010
Indirect and Intention (all in combine model, n=116)						
Attitude	0.23#	0.05	0.13	0.32	30.78	<0.001
Subjective Norm	0.15#	0.03	0.07	0.22	15.81	<0.001
Perceived Behavioral Control	0.05	0.05	-0.05	0.16	0.81	0.365

#Indicates a significant association

Table 6. Intention Influence on Behavior Prevalence Ratios, Standard Errors, and Confidence Limits

Independent Variable 1 Point Increase	Prevalence Ratio	Standard Error	95% Confidence Limits Lower	95% Confidence Limits Upper	Chi-Square	P-Value
Reporting Recalled Concussion Events† (n=40)						
Intention	1.00	0.07	-0.13	0.14	0.00	0.983
Reporting Recalled Bell Ringer Events† (n=69)						
Intention	1.10	0.14	0.85	1.42	0.54	0.461
Reporting of Concussion and Bell Ringer Events in Games* (n=61)						
Intention	0.96	0.05	0.87	1.08	0.34	0.561
Reporting of Concussion and Bell Ringer Events in Practices* (n=55)						
Intention	1.02	0.09	0.85	1.23	0.07	0.795
Reporting of Recalled Concussion Events* (n=40)						
Intention	0.98	0.06	0.86	1.12	0.05	0.830
Reporting of Recalled Bell Ringer Events* (n=69)						
Intention	1.07	0.07	0.94	1.22	1.10	0.293
Reporting Continuing in a Game while Symptomatic† (n=129)						
Intention	0.77#	0.04	0.69	0.85	27.31	<0.001
Reporting Recalled Continuing in a Practice while Symptomatic† (n=128)						
Intention	0.70#	0.04	0.63	0.79	37.29	<0.001

† = People as the unit of analysis *Recalled events as the unit of analysis #Indicates a significant association

APPENDIX 3 – ATHLETE SURVEY INSTRUMENT

51143

Athlete Questionnaire

****PLEASE USE A PEN TO COMPLETE****

High School ID (office use only) Player ID (office use only)

SECTION 1

Section 1-Part 1

1. Your Age: ☐☐ (years)

2. Your Race:

☐ African-American ☐ White, not Hispanic ☐ Asian ☐ Hispanic ☐ Other: ☐☐☐☐☐☐☐☐☐☐

3. Grade/Class in School:

☐ Freshman ☐ Sophomore ☐ Junior ☐ Senior ☐ 8th Grade or Less

3a. School Name: (do not put "high school" at the end) ☐☐☐☐☐☐☐☐☐☐☐☐☐☐

4. Your Sex/Gender: ☐ Male ☐ Female

5. Of the following, what sport are you playing now OR if the sport is currently not in season, what sport did you most recently play? (CHECK ONLY 1)

☐ Soccer ☐ Football ☐ Lacrosse ☐ Cheerleading

6. What other sports do you play at your high school? (CHECK ALL THAT APPLY)

☐ Soccer ☐ Volleyball

☐ Football ☐ Wrestling

☐ Lacrosse ☐ Softball

☐ Cheerleading ☐ Baseball

☐ Track/Field ☐ Other ☐☐☐☐☐☐☐☐☐☐

☐ Basketball

7. Of the following which do you consider your primary sport?

☐ Soccer ☐ Football ☐ Lacrosse ☐ Cheerleading

8. Has anyone ever discussed concepts concerning concussion with you? (what it is or what to do if you have one, etc)

(CHECK ALL THAT APPLY)

☐ N/A no one has ever discussed it with me

☐ Athletic Trainer

☐ Doctor

☐ Coach

☐ Parent(s)

☐ Other ☐☐☐☐☐☐☐☐☐☐☐☐☐☐

9. In your lifetime, how many concussions have you had? ☐☐

10. In your lifetime, how many concussions have you had caused by sport? ☐☐

Section 1-Part 2

****IF YOU DID NOT PLAY SPORTS IN MIDDLE SCHOOL - SKIP TO PAGE 3 (NEXT PAGE)****

Middle School Concussion History (6th -8th grade)

1.When you were in middle school, how many concussions do you think you experienced:

During games? ☐☐

During practices? ☐☐

2. How many of the possible concussions you experienced in middle school did you report to a medical professional (doctor, athletic trainer, etc) or coach?

During games? ☐☐

put 0 if you did not have any to report or put 0 to the above question

During practices? ☐☐

3. When you were in middle school, how many times did you get your "bell rung" or get "dinged"?

During games? ☐☐

During practices? ☐☐

4. Of the times you got your "bell rung" or got "dinged", how many did you report to a medical professional (doctor, athletic trainer, etc) or coach?

During games? ☐☐

put 0 if you did not have any to report or put 0 to the above question

During practices? ☐☐

5. Check all of the following reasons why you did not report a possible concussion(s) or when you got your "bell rung" or "dinged" when you were in middle school.

- ☐ N/A did not have any concussions/dings OR reported all concussions/dings
- ☐ Did not think it was serious enough to report
- ☐ Did not want to let your teammates down
- ☐ Did not want to let your coaches down
- ☐ Did not know at the time is was a concussion
- ☐ Did not want to be removed from a practice
- ☐ Did not want to be removed from the game
- ☐ Other ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

6. On your middle school athletic teams, did you know anyone who thought they had a concussion but did not tell anyone? ☐ No ☐ Yes ☐ N/A - I did not play sports in middle school

7. When you were in middle school, did you think your coach or teammates would be upset if you had to come out of a game or practice because of a concussion?

☐ No ☐ Yes ☐ N/A - I did not play sports in middle school

51143

Section 1-Part 3

High School Concussion History (9th-12th grade)

1. In your high school years, how many concussions do you think you have experienced?

During games? ☐☐ During practices? ☐☐

2. How many of the possible concussions you experienced in high school have you reported to a medical professional (doctor, athletic trainer, etc) or coach?
put 0 if you did not have any to report or if you put 0 to the above question

During games? ☐☐ During practices? ☐☐

3. In your high school years, how many times have you had your "bell rung" or been "dinged"?

During games? ☐☐ During practices? ☐☐

4. Of the times you got your "bell rung" or were "dinged" in high school, how many have you reported to a medical professional (doctor, athletic trainer, etc) or coach?
put 0 if you did not have any to report or if you put 0 to the above question

During games? ☐☐ During practices? ☐☐

5. Check all of the following reasons why you have not reported a possible concussion(s) or when you got your "bell rung"/"dinged" during your high school years.

- ☐ N/A did not have any concussions/dings OR reported all concussions/dings
- ☐ Did not think it was serious enough to report
- ☐ Did not want to let your teammates down
- ☐ Did not want to let your coaches down
- ☐ Did not know at the time is was a concussion
- ☐ Did not want to be removed from a practice
- ☐ Did not want to be removed from the game
- ☐ Other ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

6. On your current high school athletic team(s), do you know anyone who thought they had a concussion but did not tell anyone? ☐ No ☐ Yes

Answer the next few questions using the following scenario:
During a game, one of your teammates gets up slowly after being hit and falling to the ground just before half time of the game. He/She shakes it off and joins the team for a group meeting at half time. Many of your teammates find his/her behavior funny. As the athlete walks over to be with the rest of the team he/she doesn't seem to be acting like him/herself. The team breaks from the meeting, but the athlete who was hit is slow to react and acts as though he/she doesn't know where to go.

8.Do you think the athlete who was hit has sustained a concussion? ☐ No ☐ Yes

9.Do you think the athlete who was hit should participate in the second half of the game? ☐ No ☐ Yes

10.Would you participate in the 2nd half of the game if you were the athlete who was hit in this scenario ? ☐ No ☐ Yes

11.In high school, how many times has something like what happened to the athlete who was hit happend to you ? ☐☐

12.How many times did you NOT report it to a medical professional or a coach when something like what happened to the athlete who was hit happened to you during your high school years?

During games? ☐☐ During practices? ☐☐

13.Check all of the reasons below why you think it would be okay for the athlete who was hit in the above scenario to play in the second half and not tell a medical professional or a coach how he/she was feeling ?

- ☐ The athlete wanted to help his/her team to win
- ☐ The athlete did not want to let his teammates down
- ☐ The athlete did not want to upset his/her coach
- ☐ The athlete didn't feel it was serious enough to report
- ☐ The athlete had experienced a situation like this before and felt he/she could continue playing
- ☐ N/A the athlete should tell a medical professional or a coach
- ☐ Other ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

51143

Section 1-Part 4

1. Please indicate (by checking the box) which of the following you would consider a sign or symptom of concussion. (Select all that apply)

- ☐ Abnormal sense of smell
- ☐ Abnormal sense of taste
- ☐ Amnesia
- ☐ Joint stiffness
- ☐ Blurred vision
- ☐ Black eye
- ☐ Bleeding from ear
- ☐ Bleeding from mouth
- ☐ Bleeding from the noise
- ☐ Confusion
- ☐ Fever
- ☐ Dizziness
- ☐ Headache
- ☐ Insomnia
- ☐ Loss of consciousness
- ☐ Nausea
- ☐ Numbness or tingling in the arms
- ☐ Skin rash
- ☐ Sharp burning pain in the neck
- ☐ Weakness in neck movements

2. A concussion only occurs if you lose consciousness ("black out"). ☐ True ☐ False ☐ I don't know

3. If you are experiencing any sign or symptom of concussion following a blow to the head or sudden movement of the body, you should not return to play. ☐ True ☐ False ☐ I don't know

4. A concussion is an injury to the _____. (check only one below)

☐ Skull ☐ Neck ☐ Face ☐ Brain ☐ None are correct ☐ I don't know

5. Of the following, what are possible complications of having multiple concussions? (check all that apply)

- ☐ No complications exist
- ☐ Increased risk of further injury
- ☐ Brain damage
- ☐ Joint problems
- ☐ Memory problems
- ☐ I don't know

6. Of the following, what are possible complications of returning to sporting activity while still experiencing posssible concussion symptoms? (check all that apply)

- ☐ No complications exists
- ☐ Increased risk of further injury
- ☐ Paralysis
- ☐ Brain damage
- ☐ Joint problems
- ☐ I don't know

51143

Section 1-Part 5

1. Rate on a scale of 1-7 how serious you think it is when you experience a headache and dizziness following a blow to the head or body.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

not serious moderately serious very serious

2. Rate on a scale of 1-7 how important you think it is, not to participate in physical activity (game or practice) when experiencing signs and symptoms of concussion.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

not important moderately important very important

3. Rate on a scale of 1-7 how important you think it is to be informed about how concussions happen.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

not important moderately important very important

4. Rate on a scale of 1-7 how important you think it is to be informed about how concussions can be prevented.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

not important moderately important very important

5. Rate on a scale of 1-7 how important you think it is to be informed about what to do if you have a concussion.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

not important moderately important very important

6. Rate on a scale of 1-7 how important you think it is to report possible concussion symptoms to a medical professional (doctor, athletic trainer, etc) or your coach.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

not important moderately important very important

7. Rate on a scale of 1-7 your level of agreement with the following statment: In general, athletes are under-educated (don't know enough) about concussions.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

disagree moderately agree strongly agree

8. In your high school years, have you ever continued to play in a game even though you thought you were experiencing signs and symptoms of concussion? ☐ No ☐ Yes

9. In your high school years, have you ever continued to participate in practice even though you thought you were experiencing signs and symptoms of concussion? ☐ No ☐ Yes

10. Check ALL OF THE FOLLOWING REASONS that you would choose not to report a possible concussion to a medical professional or your coach.

- ☐ N/A I would report it
- ☐ Would not think it was serious enough to report
- ☐ Would not want to let your teammates down
- ☐ Would not want to let your coaches down
- ☐ Would not know at the time is was a concussion
- ☐ Would not want to be removed from a practice
- ☐ Would not want to be removed from the game
- ☐ Other

****PLEASE PLACE SECTION 1 (WHICH YOU COMPLETED) IN THE POSTAGE PAID ENVELOPE DO NOT SEAL UNTIL AFTER COMPLETING THE NEXT SECTION). THEN BEGIN SECTION 2.****

51143

SECTION 2

Section 2-Part 1

USE THE FOLLOWING DEFINITION TO ANSWER THE QUESTIONS IN THIS SECTION (SECTION 2)

A concussion is an injury caused by a blow to the head or sudden movement of the body followed by a variety of signs and symptoms that may include any of the following: headache, dizziness, loss of balance, blurred vision, "seeing stars", feeling in a fog or slowed down, memory problems, poor concentration, nausea, or throwing up. Getting "knocked out" or being unconcious does NOT always occur with a concussion.

1. Using the above definition, how many concussions did you have in your middle school years?

During games? ☐☐ During practices? ☐☐

2. How many of the concussions you experienced in middle school (listed in question one above) did you report to a medical professional (doctor, athletic trainer, etc) or coach?

put 0 if you did not have any to report or if you put 0 to the above question

During games? ☐☐ During practices? ☐☐

3. Check all of the following reasons why you did not report a possible concussion(s), based on the definition above, when you were in middle school.

- ☐ N/A did not have any concussions/dings OR reported all concussions/dings
- ☐ Did not think it was serious enough to report
- ☐ Did not want to let your teammates down
- ☐ Did not want to let your coaches down
- ☐ Did not know at the time is was a concussion
- ☐ Did not want to be removed from a practice
- ☐ Did not want to be removed from the game
- ☐ Other ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

4. Using the above definition, how many concussions have you had in your high school years? During games? ☐☐ During practices? ☐☐

5. How many of the concussions you have experienced in high school (listed in question 4 above) did you report to a medical professional (doctor, athletic trainer, etc) or coach?

put 0 if you did not have any to report or if you put 0 to the above question

During games? ☐☐ During practices? ☐☐

6. Check all of the following reasons why you have not reported a possible concussion(s), based on the definition above, when you were in high school.

- ☐ N/A did not have any concussions/dings OR reported all concussions/dings
- ☐ Did not think it was serious enough to report
- ☐ Did not want to let your teammates down
- ☐ Did not want to let your coaches down
- ☐ Did not know at the time is was a concussion
- ☐ Did not want to be removed from a practice
- ☐ Did not want to be removed from the game
- ☐ Other ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

51143

Section 2-Part 2

Player ID

office use only

PLEASE ANSWER ALL REMAINING QUESTIONS RELATED TO PARTICIPATION IN SPORTS AT YOUR HIGH SCHOOL AND YOUR FEELINGS ABOUT REPORTING OF CONCUSSION, SHOULD YOU EXPERIENCE ONE. CHECK THE BOX CLOSEST TO HOW YOU FEEL ABOUT EACH STATEMENT. THE QUESTIONS MAY LOOK SIMILAR, BUT THEY ADDRESS DIFFERENT THINGS SO READ EACH ONE CAREFULLY.*

1. When I experience possible concussive symptoms, I intend to report them to my coach or a medical professional.

Strongly Disagree	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	Strongly Agree

2. When I experience possible concussive symptoms, I plan to report them to my coach or a medical professional.

Strongly Disagree	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	Strongly Agree

3. When I experience possible concussive symptoms, I will make an effort to report them to my coach or a medical professional.

Strongly Disagree	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	Strongly Agree

4. My reporting possible concussive symptoms to my coach or medical professional, when I experience them, will improve my athletic performance.

Strongly Disagree	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	Strongly Agree

5. I am confident that I could report possible concussive symptoms to my coach or a medical professional, when I experience them.

Strongly Disagree	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	Strongly Agree

6. How much control do you believe you have over reporting possible concussive symptoms to a coach or a medical professional, when you expereince them ?

No Control	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	Complete Control

7. It is mostly up to me whether or not I report possible concussive symptoms to my coach or a medical professional, when I experience them.

Stongly Disagree	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	Stongly Agree

8. My reporting possible concussive symptoms to my coach or a medical professional, when I experience them, will reduce my chances of suffering another concussion.

Strongly Disagree	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	Strongly Agree

9. My reporting possible concussive symptoms to my coach or a medical professional, when I experience them, will cause me to lose my position on the team.

Strongly Disagree	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	Strongly Agree

10. My reporting possibe concussive symptoms to my coach or a medical professional, when I experience them, will cause me to lose playing time

Strongly Disagree	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	Strongly Agree

11. I am: **ABLE** ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 **UNABLE**
to report possible concussive symptoms to my coach or a medical professional, when I experience them .

51143

12. My reporting possible concussive symptoms to my coach or a medical professional, when I experience, them will maintain my health.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Strongly Agree**

13. My reporting possible concussive symptoms to my coach or a medical professional, when I experience them, will cause me to miss out on activities with the team.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Strongly Agree**

14. My reporting possible concussive symptoms to my coach or a medical professional, when I experience them, will help maintain my performance in school.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Strongly Agree**

15. My reporting possible concussive symptoms to my coach or a medical professional, when I experience them, will let my teammates down.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Strongly Agree**

16. People I know <u>who are important to me</u> think that:

I Should ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **I should not** report possible concussive symptoms to my coach or a medical professional, when I experience them.

17. People I know think that:

I Should ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **I should not** report possible concussive symptoms to my coach or a medical professional, when I experience them.

18. It is expected of me to report possible concussive symptoms to my coach or a medical professional, when I experience them.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Strongly Agree**

19. People who are important to me would approve of me reporting possible concussive symptoms to my coach or a medical professional, when I experience them.

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Strongly Agree**

20. My teammates report possible concussive symptoms to a coach or a medical professional, when they experience them .

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Strongly Agree**

21.Other athletes I know (not on my team) report possible concussive symptoms to a coach or a medical professional, when they experience them .

Strongly Disagree ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Strongly Agree**

22. Suffering fewer concussions is:

Extremely Bad ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Extremely Good**

23. Improving my athletic performance is:

Extremely Bad ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Extremely Good**

51143

24. Losing my position on my team is:

Extremely Bad ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Extremely Good**

25. Maintaining my health is:

Extremely Bad ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Extremely Good**

26. Missing team activities is:

Extremely Bad ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Extremely Good**

27. Losing playing time is:

Extremely Bad ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Extremely Good**

28. Maintaing my performance in school is:

Extremely Bad ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Extremely Good**

29. Letting my teammates down is:

Extremely Bad ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Extremely Good**

30. My coaches think that:

I should ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **I should not**
report possible concussive symptoms to a coach or a medical professional, when I experience them.

31. My teammates think that:

I should ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **I should not**
report possible concussive symptoms to a coach or a medical professional, when I experience them.

32. My parents think that:

I should ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **I should not**
report possible concussive symptoms to a coach or a medical professional, when I experience them.

33. My athletic traininer thinks that: (IF YOU DO NOT HAVE AN ATHLETIC TRAINER - LEAVE BLANK)

I should ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **I should not**
report possible concussive symptoms to a coach or a medical professional, when I experience them.

34. Other students at my school think that:

I should ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **I should not**
report possible concussive symptoms to a coach or a medical professional, when I experience them.

35. How much do you care whether your coaches think you should report possible concussion symptoms to a coach or a medical professional ?

Not at All ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Very Much**

36. How much do you care whether your teammates think you should report possible concussion symptoms to a coach or a medical professional ?

Not at All ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Very Much**

37. How much do you care whether your parents think you should report possible concussion symptoms to a coach or a medical professional ?

Not at All ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Very Much**

38. How much do you care whether your athletic trainer think you should report possible concussion symptoms to a coach or a medical professional ? (IF YOU DO NOT HAVE AN ATHLETIC TRAINER - LEAVE BLANK)

Not at All ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Very Much**

39. How much do you care whether other students at your school think you should report possible concussion symptoms to a coach or a medical professional ?

Not at All ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 **Very Much**

51143

40. I expect that my coach will place a lot of pressure on me during participation in my sport.

Strongly Disagree	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Strongly Agree**

41. I expect that my parents will place a lot of pressure on me during participation in my sport.

Strongly Disagree	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Strongly Agree**

42. I expect that my teammates will place a lot of pressure on me during participation in my sport.

Strongly Disagree	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Strongly Agree**

43. I expect that there will be a medical professional at athletic events I can report my concussive symptoms to if I experience them during participation in my sport.

Strongly Disagree	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Strongly Agree**

44. The pressure my coach places on me makes it:

Much Easier	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Much more Difficult**

to report possible concussive symptoms to a coach or a medical professional, when I experience them.

45. The pressure my teammates place on me makes it:

Much Easier	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Much more Difficult**

to report possible concussive symptoms to a coach or a medical professional, when I experience them.

46. The pressure my parents place on me makes it:

Much Easier	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Much more Difficult**

to report possible concussive symptoms to a coach or a medical professional, when I experience them.

47. Having a medical professional on-site at athletic events for my sport would make it:

Much Easier	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Much more Difficult**

to report possible concussive symptoms to a coach or a medical professional, when I experience them.

48 A-G. CHECK THE BOX CLOSEST TO THE WAY YOU FEEL ABOUT THE FOLLOWING STATEMENT FOR EACH PAIR OF WORDS LISTED BELOW:

For me to report possible concussive symptoms to a coach or a medical professional, when I experience them is:

Cowardly	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Brave**
Pleasant	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Embarrassing**
Harmful	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Beneficial**
Extremely Easy	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Extremely Difficult**
Good	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Bad**
Unimportant	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Important**
Worthless	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Valuable**

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE! PLEASE PLACE ALL MATERIALS IN THE POSTAGE PAID ENVELOPE, SEAL IT AND RETURN AS SOON AS POSSIBLE. GOOD LUCK WITH ALL OF YOUR FUTURE ACTIVITIES!

PAGE 10

Submit

APPENDIX 4 – COACH SURVEY INSTRUMENT


23795

PLEASE USE PEN TO COMPLETE

High School ID ☐☐☐☐ office use only

Coach ID ☐☐☐☐☐☐☐ office use only

PART 1

Coach Ouestionnaire

1. Your Age: ☐☐ (years)

2.a Your Sex/Gender: ☐ Male ☐ Female

3. Highest academic degree achieved:

- ☐ None
- ☐ High School Diploma
- ☐ GED
- ☐ Bachelor's degree
- ☐ Master's degree
- ☐ Doctoral Degree

2.b. Your Race:

- ☐ African American
- ☐ White, not Hispanic
- ☐ Asian
- ☐ Hispanic
- ☐ Other

4. Of the following, what sport are you coaching right now OR most recently coached if not currently coaching? (CHECK ONLY 1)

- ☐ Boys' Soccer
- ☐ Girls' Soccer
- ☐ Boys' Lacrosse
- ☐ Girls' Lacrosse
- ☐ Football
- ☐ Cheerleading

5. What other sports do you coach at your high school? (CHECK ALL THAT APPLY)

- ☐ Girls' Soccer
- ☐ Boys' Soccer
- ☐ Football
- ☐ Boys' Lacrosse
- ☐ Girls' Lacrosse
- ☐ Cheerleading
- ☐ Track/Field
- ☐ Boys' Basketball
- ☐ Girls' Basketball
- ☐ Volleyball
- ☐ Wrestling
- ☐ Softball
- ☐ Baseball
- ☐ Other ☐☐☐☐☐☐☐☐☐☐

6. Have you ever been formally educated about concussion? (seminar, coach meeting, etc)

☐ No ☐ Yes

7. Which of the folllowing best describes your role on the team you are currently coaching OR most recently coached?

☐ Head Coach ☐ Assistant Coach

8. Overall, how many years have you been a coach including this athletic season? ☐☐

9. In your lifetime, how many concussions have you had? ☐☐

10. Check all of the following sports you have played competitively in your lifetime.

- ☐ N/A- never played competitive sports
- ☐ Soccer
- ☐ Football
- ☐ Lacrosse
- ☐ Cheerleading
- ☐ Track/Field
- ☐ Basketball
- ☐ Volleyball
- ☐ Wrestling
- ☐ Softball
- ☐ Baseball
- ☐ Other ☐☐☐☐☐☐☐☐☐☐

11. From the options below, check all of the certifications you currently hold.

☐ None ☐ FirstAid ☐ CPR ☐ Coching Certification ☐ Paramedic ☐ Emergency Medical Technician

23795

PART 2

1. Please indicate (by checking the box) which of the following you would consider a sign or symptom of concussion. (Select all that apply)

☐ Abnormal sense of smell	☐ Fever
☐ Abnormal sense of taste	☐ Dizziness
☐ Amnesia	☐ Headache
☐ Joint stiffness	☐ Insomnia
☐ Blurred vision	☐ Loss of consciousness
☐ Black eye	☐ Nausea
☐ Bleeding from ear	☐ Numbness or tingling in the arms
☐ Bleeding from mouth	☐ Skin rash
☐ Bleeding from the noise	☐ Sharp burning pain in the neck
☐ Confusion	☐ Weakness in neck movements

2. A concussion only occurs if someone loses consciousness ("blacks out"). ☐ True ☐ False ☐ I don't know

3. If an athlete is experiencing any sign or symptom of concussion following a blow to the head or sudden movement of the body, he/she should not return to play. ☐ True ☐ False ☐ I don't know

4. A concussion is an injury to the _____. (check only one below)

☐ Skull ☐ Neck ☐ Face ☐ Brain ☐ None are correct ☐ I don't know

5. Of the following, what are possible complications of having multiple concussions? (check all that apply)

- ☐ No complications exist
- ☐ Increased risk of further injury
- ☐ Brain damage
- ☐ Joint problems
- ☐ I don't know
- ☐ Memory problems

6. Of the following, what are possible complications of returning to sporting activity while still experiencing posssible concussion symptoms? (check all that apply)

- ☐ No complications exist
- ☐ Increased risk of further injury
- ☐ Paralysis
- ☐ Brain damage
- ☐ Joint problems
- ☐ I don't know

23795

PART 3

1. Rate on a scale of 1-7 how serious you think it is when an athlete experiences a headache and dizziness following a blow to the head or body.

☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
not serious			moderately serious			very serious

2. Rate on a scale of 1-7 how important you think it is for an athlete not to participate in physical activity (game or practice) when experiencing signs and symptoms of concussion.

☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
not important			moderately important			very important

3. Rate on a scale of 1-7 how important you think it is to be informed about how concussions happen?

☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
not important			moderately important			very important

4. Rate on a scale of 1-7 how important you think it is to be informed about how concussions can be prevented?

☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
not important			moderately important			very important

5. Rate on a scale of 1-7 how important you think it is to know the steps to follow if an athlete has a concussion?

☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
not important			moderately important			very important

6. Rate on a scale of 1-7 how important it is for an athlete to report possible concussion symptoms to a medical professional (doctor, athletic trainer, etc) or a coach.

☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
not important			moderately important			very important

7. Rate on a scale of 1-7 your level of agreement with the following statement: In general, athletes are under-educated (don't know enough) about concussions.

☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
disagree			moderately agree			strongly agree

8. Rate on a scale of 1-7 your level of agreement with the following statement: Currently, there is too much attention and focus on concussion in sports.

☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
disagree			moderately agree			strongly agree

9. Rate on a scale of 1-7 your level of agreement with the following statement: A coach should be actively involved in the prevention and return to play decisions following concussion in an athlete.

☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
disagree			moderately agree			strongly agree

23795

PART 4

1. Of the following who is the PRIMARY PERSON responsible for making immediate return to play decisions (in practice or a game) for an athlete following a possible concussive injury.

Check ONLY 1

- ☐ Head Coach
- ☐ Asst. Coach
- ☐ Certified Athletic Trainer
- ☐ Physician
- ☐ Other

2. Of the following who do you refer the athlete to FIRST if you suspect he/she has a concussion ?

Check ONLY 1

- ☐ No Referral Source
- ☐ School Nurse
- ☐ EMT/Paramedic
- ☐ Certified Athletic Trainer
- ☐ Physician
- ☐ Other

3. Check ALL OF THE FOLLOWING symptoms that would cause you to hold an athlete out of activity until further evaluation ?

- ☐ Fatigue
- ☐ Headache
- ☐ Trouble Concentrating
- ☐ Skin Irritation/Itching
- ☐ Dizziness
- ☐ None of the above symptoms would cause me to hold an athlete out of activity

4. Check ALL OF THE FOLLOWING tools you use to help you to recognize a possible concussion and make return to play decisions.

- ☐ N/A - I do not use any tools
- ☐ N/A I do not make return to play decisions
- ☐ Balance Task (standing on one leg, etc)
- ☐ CDC Concussion Tool-kit (Heads Up for High School Coaches)
- ☐ Word Recall (asking athlete to remember and recall a list of words)
- ☐ Symptom Checklist

5. Have you ever heard of the High School Coaches Tool Kit on Concussion entitled: *Heads Up: Concussion in High School Sports* distributed by the Centers for Disease Control? ☐ No ☐ Yes

6. Have you ever used the High School Coaches Tool Kit on Concussion entitled: *Heads Up: Concussion in High School Sports* distributed by the Centers for Disease Control? ☐ No ☐ Yes

23795

PART 4

Answer the questions on this page using the following scenario.

During a game, you observe one of your athletes getting up slowly after being hit and falling to the ground just before half time of the game. He/She shakes it off and joins the team for a group meeting at half time. Many of your athletes find his/her behavior humorous, because as the athlete walks over to be with the rest of the team he/she doesn't seem to be acting like him/herself. The team breaks from the meeting, but the athlete who was hit is slow to react and acts as though he/she doesn't know where to go.

7.Do you think this athlete has sustained a concussion? ☐ No ☐ Yes

8. In the box below explain why you think the athlete does OR does not have a concussion.

9.Do you think this athlete should participate in the second half of the game? ☐ No ☐ Yes

10. Check all of following choices that would help you decide if it was ok for the athlete to play in the second half of the game?

- ☐ If they athlete says he/she is ok
- ☐ Once I think the athlete is ok
- ☐ If the athlete's parents say it is ok for the athlete to play
- ☐ If the athlete is evaluated and cleared by a physician
- ☐ If the athlete is evaluated and cleared by a certified athletic trainer
- ☐ Other

11.Would you allow this athlete to participate in the 2nd half of the game? ☐ No ☐ Yes

12.How many times over the past year has something like the above scenario happened to one of your athletes?

CIRCLE THE NUMBER CLOSEST TO THE WAY YOU FEEL ABOUT THE FOLLOWING STATEMENT FOR EACH PAIR OF WORDS LISTED BELOW:

13 A-G. For an athlete on your team(s) to report possible concussive symptoms to you or a medical professional when they experience them is:

Cowardly	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	Brave
Pleasant	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	Embarrassing
Harmful	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	Beneficial
Extremely Easy	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	Extremely Difficult
Good	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	Bad
Unimportant	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	Important
Worthless	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	Valuable

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE! PLEASE PLACE ALL MATERIALS IN THE POSTAGE PAID ENVELOPE AND RETURN AS SOON AS POSSIBLE.

Submit

APPENDIX 5 – ATHLETE INTERVIEW SCRIPT

ATHLETE INTERVIEW **ID#**
KAB High School Concussion Initiative

Interview Information:

1. **Interview Date** ___/___/___
   1a. Interview Method On-Site
2. **Interviewer ID** _____
3. **Athlete ID** _____
4. **Interviewee's Gender (circle one) Female (1) Male (2)**
5. **Current Sport of Athlete:** _____
6. **Grade in School: Fresh. (1) Sophomore (2) Junior (3) Senior (4)**
7. **Age: 15 (1) 16 (2) 17 (3) 18 (4)**

Instructions to interviewer:

1. **Answer questions 1-5 as best you can before conducting interview. Confirm answers with interviewees if necessary.**
2. **All italicized words should be spoken.**
3. **Please follow all skip patterns.**
4. **Mark your answer with an x in the appropriate box, or circle the number corresponding to the given response.**

Today's interview will be more formal than a regular conversation. I have a series of questions to ask you, and I will need your help to stay on course so that I may ask all of them. Each high school athlete participating in the study will be asked these same questions even if they do not always apply to them. Therefore, it is important that I ask you each question as it is written. Of course, if you do not understand a question, or if you need for me to repeat a question, please let me know.

Thank you for agreeing to talk with me today. This survey will last approximately 30 minutes. I will ask questions about you, your team, and your opinions about how things are handled and how you feel concerning sports-related concussion. <u>There are no right or wrong answers.</u> If there are any questions that you would rather not answer, you are free to decline to answer them. All of your responses will be kept confidential – meaning that only the research team will know your responses. When we summarize the results, we will report them across athletes in the study, and no individual names will be used.
If it's okay with you, let's begin…

START TIME: _____ _____:_____ _____

I will begin with some basic questions about your participation in sport and experience with previous concussion.

file: Athlete_Interview_Script.doc
Last printed 5/5/10 5:11 PM

ATHLETE INTERVIEW ID#

1. *How many years have you participated in your current sport?*

   Num. of years _____ _____ mos. _____ _____
   □ DK (7)
   REFUSED (9)
   □

2. *How many years have you participated in your current sport at this high school?*

   Num. of years _____ _____ mos. _____ _____
   □ DK (7)
   □ REFUSED (9)

3. *How many head coaches have you had with this sport at this school?*

   □ 1 (1)
   □ 2 (2)
   □ 3 (3)
   □ 4+(4)
   □ DK (7)
   □ REFUSED (9)

4. *How many sports do you play at your high school?*

   □ 1 (1)
   □ 2 (2)
   □ 3 (3)
   □ 4+(4)
   □ DK (7)
   □ REFUSED (9)

5. *On average, what is the average percent of each game you typically play ? (percent of game)*

   □ <10%(0)
   □ 10-25% (1)
   □ 26-40% (2)
   □ 41-55% (3)
   □ 56-70% (4)
   □ 71-85% (5)
   □ DK (7)
   □ REFUSED (9)

6. *In your opinion, over the past 12 months, has the number of concussions on your team **decreased**, **increased** or **stayed the same** compared to last year?*

N/A THIS IS MY FIRST YEAR PLAYING → **GO TO QUESTION 10**

- ☐ INCREASED (1)
- ☐ DECREASED (2)
- ☐ STAYED THE SAME (3)

6a. *Please explain why you think the number of concussions has increased or decreased:*

_____
_____
_____
_____
_____

7. In your own words, what is a concussion?

_____
_____
_____
_____

☐

8. What do you think are the signs and symptoms of a concussion?

_____
_____
_____
_____

☐

9. What is the current number of coaches for your team

Number of coaches _____ _____

- ☐ DK (7)
- ☐ REFUSED (9)

10. What is the current number of athletes on your team

Number of athletes _____ _____

- ☐ DK (7)
- ☐ REFUSED (9)

11. Of your coaches how many are female?

Number of females _____ _____

- ☐ DK (7)
- ☐ REFUSED (9)

ATHLETE INTERVIEW **ID#**

Next, I want to read you a series of statements, and I would like for you to tell me the extent to which you agree or disagree with each statement. Your options are Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, or Strongly Agree.

Note to Interviewer: Read response options after each statement

	Do you…					
	Strongly Disagree	*Disagree*	*Neither Agree nor Disagree*	*Agree*	*Strongly Agree*	*N/A*
12. *When you have an injury you can usually count on our teammates to be supportive.*	1	2	3	4	5	6
13. *When you have an injury, you can usually count on your coaches to be supportive.*	1	2	3	4	5	6
14. *When decisions about an athlete returning to play after a possible head injury, coaches take into account the feelings of the athlete.*	1	2	3	4	5	6
15. *Your teammates encourage each other to report possible injuries to someone in authority like a coach or medical professional.*	1	2	3	4	5	6
16. *Your work is valued and respected by your coaches even if you miss a practice because of injury.*	1	2	3	4	5	6
17. *Most of your team would report a possible concussion or head injury to someone.*	1	2	3	4	5	6
18. *Your coaches encourage you and your teammates to report possible concussions and head injuries.*	1	2	3	4	5	6
19. *Your teammates would be upset if you missed practice or a game because of a concussion or a head injury.*	1	2	3	4	5	6
20. *Your coach would be upset if you missed practice or a game because of concussion or a head injury.*	1	2	3	4	5	6
21. *Your parents would be upset if you missed practice or a game because of concussion or a head injury.*	1	2	3	4	5	6

I will now ask you some questions about your comfort level with a couple of different situations on your team.

22. *All in all, how comfortable are you with the way concussions are managed on your athletic team?*

    Very comfortable (5)

    Comfortable (4)

    Somewhat comfortable(3)

    Uncomfortable (2)

    Very uncomfortable (1)

    DK (7)

    REFUSED (9)

23. *All in all, how comfortable are you telling your coach you may have a concussion or head injury?*

    Very comfortable (5)

    Comfortable (4)

    Somewhat comfortable(3)

    Uncomfortable (2)

    Very uncomfortable (1)

    DK (7)

    REFUSED (9)

Now I'm going to read you a series of question about the kinds of information you may have received in the last twelve months.

24. *In the last 12 months, have you been educated about any of the following topics related to concussion and head injury?*

Please answer YES or NO to each question…

		Yes	No	DK	REFUSED
24a.	*Concussion definitions*	1	2	7	9
24b.	*Signs and Symptoms of concussion*	1	2	7	9
24c.	*Reporting of Concussion (telling someone)*	1	2	7	9
24d.	*Management of Concussion*	1	2	7	9
24e.	*Consequences of multiple concussions*	1	2	7	9
24f.	*Continuing to participate with signs and symptoms of concussion*	1	2	7	9
24g.	*Prevention of Concussion*	1	2	7	9
24h.	*Proper technique to prevent head and neck injury (no spearing)*	1	2	7	9

25. *In the last 12 months , has your team participated in any concussion awareness programs? (as a team)*

YES (1)
NO (2)
DK (7)
REFUSED (9)

28.a Could you please describe the type of program and who provided the information?

Organization	**Information**

26. *In the last 12 months , have you participated in any concussion awareness programs?*

YES (1)
NO (2)
DK (7)
REFUSED (9)

26.a Could you please describe the type of concussion information you have provided and who provided the information?

Organization	**Information**

ATHLETE INTERVIEW **ID#**

Now I'd like to ask you about access to medical professionals and concussion assessment

27. *Which of the following medical professionals is available during practices (at our school) for your team 3 more days per week.*

Please answer YES or NO to each one I mention…

	Yes	No	DK	REFUSED
27a1. Certified Athletic Trainer	1	2	7	9
27a2. Doctor/Physician	1	2	7	9
27a3. School Nurse	1	2	7	9
27a4. Emergency Medical Technician (Ambulance)	1	2	7	9

28. *Which of the following medical professionals is available during games (at your school).*

Please answer YES or NO to each one I mention…

	Yes	No	DK	REFUSED
28a1. Certified Athletic Trainer	1	2	7	9
28a2. Doctor	1	2	7	9
28a3. School Nurse	1	2	7	9
28a4. Emergency Medical Technician (Ambulance)	1	2	7	9
31a5. Other (neuropsychological, computer test, etc)	1	2	7	9

29. *Which of the following do your coaches or medical staff use to evaluate concussions?*

Please answer YES or NO to each one I mention…

	Yes	No	DK	REFUSED
29a1. Symptom Checklist	1	2	7	9
29a2. Balance	1	2	7	9
29a3. Memory Test (remember 3 words, count backwards, etc)	1	2	7	9
29a4. Discussion with athlete (with you or teammates about the injury)	1	2	7	9
29a5. Other (neuropsychological, computer test, etc)	1	2	7	9

The next section is about rules and policies on your team:

30. Does your team/school have any formal or informal policies or rules about managing/return to play following concussion or head injuries. You can say you don't know- don't guess.

YES (1)
NO (2) → **SKIP TO Q32**
DK (7)
REFUSED (9)

30a. Please describe the rules or policy:

_____
_____
_____

31. Have the rules about return to play following concussion changed in your team in the last 12 months?

YES (1)
NO (2)
DK (7)
REFUSED (9)

31a. Please describe how the rules or policies have changed?

_____
_____
_____

32. Do you think management of concussion on your team is too lenient, too restrictive or both?

NOT APPLICABLE (0)

TOO LENIENT (1)

TOO RESTRICTIVE (2)

BOTH (3)

DK (7)

REFUSED (9)

32. b Please explain your answer as to how you feel about the management of concussion?

_____
_____
_____

ATHLETE INTERVIEW **ID#**

The next several questions ask your opinion about how you feel about concussion awareness and practices

Please answer on a 4-point scale where 1 means it has not influenced your business at all and 4 means it enhanced your business a great deal.

In your opinion…	SD	DIS	NA/ND	AGREE	SA	DK	REF
33. *In general athletes are undereducated about concussion.*	1	2	3	4	5	7	9
34. *In general coaches are undereducated about concussion.*	1	2	3	4	5	7	9
35. *You should NOT play through signs and symptoms of concussion in games and practices.*	1	2	3	4	5	7	9
36. *You should always report possible signs and symptoms of concussion to someone in authority.*	1	2	3	4	5	7	9
37. *Coaches should encourage their athletes to report concussions to someone in an authoritative position.*	1	2	3	4	5	7	9
38. *What my teammates thinks about me affects some of my decisions about reporting an injury.*	1	2	3	4	5	7	9
39. *What my coach thinks about me affects some of my decisions about reporting an injury.*	1	2	3	4	5	7	9

40. Please describe the reasons you might NOT report a possible concussion:

DK (7)

REFUSED (9)

_____

_____

_____

_____

_____

_____

ATHLETE INTERVIEW **ID#**

Now, I will ask you about some questions about your experience with concussions. Use this definition about concussion to help you answer some of these questions: A ***concussion results from a blow to the head or sudden thrust of the head followed by a variety of symptoms that may include any of the following: headache, dizziness, loss of balance, blurred vision, seeing stars, loss of consciousness, feeling in a fog or slowed down, memory problems, poor concentration, nausea, or throwing up. Getting knocked out or being unconscious does not always occur with a concussion.***

41. *How many concussions have you had since the 6th grade?*

0 (0)

1 (1)

2 (2)

3 (3)

4 or more (4)

DK (7)

REFUSED (9)

42. *How many times have you been dinged or had your "bell rung" since the 6th grade?*

0 (0)

1 (1)

2 (2)

3 (3)

4 or more (4)

DK (7)

Refused (9)

43. *Since 6th grade, have you ever NOT REPORTED a possible concussion or bell ringer/ding?*

*YES -----→ How many*_____

NO

43a. *Please explain why you DID and DID NOT REPORT the possible injury:*

_____
_____
_____
_____
_____

44. *What do you think are some of the most influences affecting athletes' decision athletes to report OR not report a possible concussion? (thoughts, ideas, sport-related things, etc)*

45. *In general describe the steps you think you should take if you think you have a concussion or a head injury.*

46. *What are things you would like to know about concussion and head injury?*

47. *Is there anything else you think we should know about your experience with concussions/head injuries or concussions/head injuries on your team?*

END TIME: _____ _____:_____ _____

TOTAL TIME: _____ _____:_____ _____

INTERVIEWER REFLECTIONS ON THE INTERVIEW

APPENDIX 6 – COACH INTERVIEW SCRIPT

COACH INTERVIEW **ID#**
KAB High School Concussion Initiative

Interview Information:

1. **Interview Date** ___/___/___
   1a. Interview Method On-Site
2. **Interviewer ID** _____
3. **Coach ID** _____
4. **Interviewee's Gender (circle one) Female (1) Male (2)**
5. **Current Sport of Coach:** _____

Instructions to interviewer:

1. **Answer questions 1-5 as best you can before conducting interview. Confirm answers with interviewees if necessary.**
2. **All italicized words should be spoken.**
3. **Please follow all skip patterns.**
4. **Mark your answer with an x in the appropriate box, or circle the number corresponding to the given response.**

Today's interview will be more formal than a regular conversation. I have a series of questions to ask you, and I will need your help to stay on course so that I may ask all of them. Each high school Coach participating in the study will be asked these same questions even if they do not always apply to them. Therefore, it is important that I ask you each question as it is written. Of course, if you do not understand a question, or if you need for me to repeat a question, please let me know.

Thank you for agreeing to talk with me today. This survey will last approximately 30 minutes. I will ask questions about you, your team, and your opinions about how things are handled and how you feel concerning sports-related concussion. <u>There are no right or wrong answers.</u> If there are any questions that you would rather not answer, you are free to decline to answer them. All of your responses will be kept confidential – meaning that only the research team will know your responses. When we summarize the results, we will report them across Coaches in the study, and no individual names will be used.
If it's okay with you, let's begin…

START TIME: _____ _____:_____ _____

I will begin with some basic questions about your participation in sport and experience with previous concussion.

COACH INTERVIEW **ID#**

1. *How many years have you coached your current sport?*

   Num. of years _____ _____
   □ DK (7)
   REFUSED (9)
   □

2. *How many years have you coached your current sport at this high school?*

   Num. of years _____ _____
   □ DK (7)
   □ REFUSED (9)

3. *Are you a head coach or an assistant coach?*

   □ Head Coach (1)
   □ Asst. Coach (2)
   □ DK (7)
   □ REFUSED (9)

4. *How many sports did you play in high school?*

   □ 1 (1)
   □ 2 (2)
   □ 3 (3)
   □ 4+(4)
   □ DK (7)
   □ REFUSED (9)

5. *When you were in high school, would you have reported having your bell rung or having a concussion to someone in authority like a coach, your parents, or a doctor?*

   Yes (1)
   No (2)
   REFUSED (9)

6. *In your opinion, over the past 12 months, has the number of concussions on your team **decreased**, **increased** or **stayed the same** compared to last year?*

N/A THIS IS MY FIRST YEAR COACHING → **GO TO QUESTION 7**

- ☐ INCREASED (1)
- ☐ DECREASED (2)
- ☐ STAYED THE SAME (3)

6a. *Please explain why you think the number of concussions has increased or decreased:*

_____
_____
_____
_____
_____

7. In your own words, what is a concussion?

_____
_____
_____
_____

☐

8. What do you think are the signs and symptoms of a concussion?

_____
_____
_____
_____

☐

9. What is the current number of coaches for your team

Number of coaches _____ _____

- ☐ DK (7)
- ☐ REFUSED (9)

10. What is the current number of athletes on your team

Number of athletes _____ _____

- ☐ DK (7)
- ☐ REFUSED (9)

11. Of your coaches how many are female?

Number of females _____ _____

- ☐ DK (7)
- ☐ REFUSED (9)

COACH INTERVIEW **ID#**

Next, I want to read you a series of statements, and I would like for you to tell me the extent to which you agree or disagree with each statement. Your options are Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, or Strongly Agree.

Note to Interviewer: Read response options after each statement

	Do you…					
	Strongly Disagree	*Disagree*	*Neither Agree nor Disagree*	*Agree*	*Strongly Agree*	***Refused***
12. When an athlete has an injury on the team, his/her teammates are supportive.	1	2	3	4	5	9
13. When an athlete has an injury on the team, they can count on the coaches to be supportive.	1	2	3	4	5	9
14. When decisions are made about an athlete returning to play after a possible head injury, coaches typically take into account the feelings of the athlete.	1	2	3	4	5	9
15. The athletes on your team encourage each other to report possible injuries to someone in authority like a coach or medical professional.	1	2	3	4	5	9
16. You value and respect the work ethic of your athletes even if they miss a practice because of injury.	1	2	3	4	5	9
17. Most of your team would report a possible concussion or head injury to someone in authority (athletic trainer, coach, parent).	1	2	3	4	5	9
18. You and your coaches encourage your athletes to report possible concussions and head injuries.	1	2	3	4	5	9
19. Athletes on your team would be upset if a fellow teammate missed practice or a game because of a concussion or a head injury.	1	2	3	4	5	9
20. You would be upset with an athlete if he/she missed practice or a game because of concussion or a head injury.	1	2	3	4	5	9
21. The majority of parents would be upset if their child missed practice or a game because of concussion or a head injury.	1	2	3	4	5	9

I will now ask you some questions about your comfort level with a couple of different situations on your team.

22. *All in all, how comfortable are you with the way concussions are managed on your athletic team?*

    Very comfortable (5)

    Comfortable (4)

    Somewhat comfortable(3)

    Uncomfortable (2)

    Very uncomfortable (1)

    DK (7)

    REFUSED (9)

23. *All in all, how comfortable are you when an athlete tells you he/she may have a concussion or head injury?*

    Very comfortable (5)

    Comfortable (4)

    Somewhat comfortable(3)

    Uncomfortable (2)

    Very uncomfortable (1)

    DK (7)

    REFUSED (9)

Now I'm going to ask a series of questions about information you may have received in the last 12 months.

24. *In the last 12 months, have you been educated about any of the following topics related to concussion and head injury?* **Please answer YES or NO to each question…**

		Yes	No	DK	REFUSED
24a.	*Concussion definitions*	1	2	7	9
24b.	*Signs and Symptoms of concussion*	1	2	7	9
24c.	*Reporting of Concussion (telling someone)*	1	2	7	9
24d.	*Management of Concussion*	1	2	7	9
24e.	*Consequences of multiple concussions*	1	2	7	9
24f.	*Continuing to participate with signs and symptoms of concussion*	1	2	7	9
24g.	*Prevention of Concussion*	1	2	7	9
24h.	*Proper technique to prevent head and neck injury (no spearing)*	1	2	7	9

25. In the last 12 months , has your team participated in any concussion awareness programs? (as a team)

YES (1)
NO (2)
DK (7)
REFUSED (9)

25.a Could you please describe the type of program and who provided the information?

Organization	**Information**

26. In the last 12 months , have you participated in any concussion awareness programs?

YES (1)
NO (2)
DK (7)
REFUSED (9)

26.a Could you please describe the type of concussion information you were provided and who provided the information?

Organization	**Information**

The next section is about rules and policies on your team:

27. *Does your team/school have any formal or informal policies or rules about managing/return to play following concussion or head injuries. You can say you don't know- don't guess.*

YES (1)
NO (2) → **SKIP TO Q32**
DK (7)
REFUSED (9)

27a. Please describe the rules or policy:

_____
_____
_____

28. *Have the rules about return to play following concussion changed on your team in the last 12 months?*

YES (1)
NO (2)
DK (7)
REFUSED (9)

28a. Please describe how the rules or policies have changed?

_____
_____
_____

Do you think management of concussion on your team is too lenient, too restrictive or both?

NOT APPLICABLE (0)

TOO LENIENT (1)

TOO RESTRICTIVE (2)

BOTH (3)

DK (7)

REFUSED (9)

29. a Please explain your answer as to how you feel about the management of concussion?

_____
_____
_____

COACH INTERVIEW **ID#**

The next several questions ask your opinion about how you feel about concussion awareness and practices

Please answer on a 4-point scale where 1 means it has not influenced your business at all and 4 means it enhanced your business a great deal.

In your opinion…	*Strongly Disagree*	*Disagree*	*Neither Agree or Disagree*	*Agree*	*Strongly Agree*	***Refused***
30. In general athletes are undereducated about concussion.	1	2	3	4	7	9
31. In general coaches are undereducated about concussion.	1	2	3	4	7	9
32. An athlete should NOT play through signs and symptoms of concussion in games and practices.	1	2	3	4	7	9
33. An athlete should always report possible signs and symptoms of concussion to someone in authority.	1	2	3	4	7	9
34. Coaches should encourage their athletes to report concussions to someone in an authoritative position.	1	2	3	4	7	9
35. What an athlete's teammates think about him/her affects the athlete's decisions about reporting an injury.	1	2	3	4	7	9
36. What an athlete's coach thinks about him/her affects the athlete's decisions about reporting an injury.	1	2	3	4	7	9

37. Please describe the reasons you believe an ATHLETE might NOT report a possible concussion:

DK (7)

REFUSED (9)

COACH INTERVIEW **ID#**

Now, I will ask you about some questions about your experience with concussions. Use this definition about concussion to help you answer some of these questions: A ***concussion results from a blow to the head or sudden thrust of the head followed by a variety of symptoms that may include any of the following: headache, dizziness, loss of balance, blurred vision, seeing stars, loss of consciousness, feeling in a fog or slowed down, memory problems, poor concentration, nausea, or throwing up. Getting knocked out or being unconscious does not always occur with a concussion.***

38. How many concussions have you had in the past 10 years?

0 (0)

1 (1)

2 (2)

3 (3)

4 or more (4)

DK (7)

REFUSED (9)

39. How many times have you been dinged or had your "bell rung" in the past 10 years?

0 (0)

1 (1)

2 (2)

3 (3)

4 or more (4)

DK (7)

Refused (9)

40. In the past 10 years, have you ever NOT REPORTED a possible concussion or bell ringer/ding?

YES -----→ How many_____

NO

40a. Please explain why you DID and DID NOT REPORT the possible injury:

_____
_____
_____
_____
_____

41. *What do you think are some of the most significant influences affecting athletes' decisions to report OR not report a possible concussion? (thoughts, ideas, sport-related things, etc)*

42. *In general describe the steps you think an athlete should take if he or she believes they have a concussion or a head injury.*

43. *What are things you would like to know about concussion and head injury?*

44. *Is there anything else you think we should know about your experience with concussions/head injuries or concussions/head injuries on your team?*

END TIME: _____ _____:_____ _____

TOTAL TIME: _____ _____:_____ _____

INTERVIEWER REFLECTIONS ON THE INTERVIEW

APPENDIX 7 - INITIAL RECRUITMENT EMAIL

Dear <<name of AD>>:

We are writing from The University of North Carolina at Chapel Hill to invite your school to participate in a study examining concussion in high school sports. The National Federation of State High School Associations has endorsed the study. Given recent events and the increased number of athletes participating in sport, it is important to understand as much about concussion in these young athletes as possible. The involvement of your school would involve a minimal time commitment. We are interested in administering a questionnaire about concussion to varsity athletes and coaches on the football, cheerleading, boys' soccer, girls' soccer, boys' lacrosse, and girls' lacrosse teams from this 2008-2009 <<2009-2010 for last 3 clusters>> school year. The person assisting us with the study at your school would **receive $100 for their assistance** with the study. Below is a summary of what the study would involve.

1) Designating a school contact to assist us with the study
2) Assisting us at UNC to gain approval from the school administration to conduct the study
3) Arranging/coordinating a meeting with the varsity athletes and coaches from the football, cheerleading, boys' soccer, girls' soccer, boys' lacrosse, and girls' lacrosse teams from this 2008-2009 school year.
    - This meeting would need to be held <<>>. A person from UNC would come out and administer and collect the questionnaires. In the event this is not possible, you may be asked to conduct this meeting.
    - This meeting would only need to last approximately 20 minutes.
5) Once the meeting is complete your school's involvement in the study would be complete.

The questionnaire contains no personal information such as names, addresses, or any other form of contact information and all questionnaire data will be held in confidence by the research team.

We hope that your school will assist us with this important study. Please respond to this email or call Johna Register-Mihalik if you think your school might be interested in the study. We will set up a time to discuss the study further with you an answer any questions you may have. Also, please do not hesitate to contact us if you have any questions.

Study contact information:
Johna Register Mihalik
Principal Investigator
Office: 919-962-2702
Email: johnakay@email.unc.edu

Thank you for your time.
Johna Register-Mihalik
Prinicpal Investigator

APPENDIX 8- SCHOOL INFORMATION SHEET

School Name:		
School Contact Name:		
School Contact Mailing Address: (where study materials are to be mailed if needed)		
School Contact Email:		
School Contact Phone:		
School Contact Alternate Phone:		
Does your school have a certified athletic trainer on a daily basis?	YES	NO
Approximate Number of Students at School:	Students:	
Approximate Number of Varsity Athletes and Varsity Coaches at School (Total):	Athletes:	Coaches:
# of Varsity Football Athletes and Coaches:	Athletes:	Coaches:
# of Varsity Cheerleaders and Coaches:	Athletes:	Coaches:
# of Varsity Boys' Soccer Athletes and Coaches:	Athletes:	Coaches:
# of Varsity Girls' Soccer Athletes and Coaches:	Athletes:	Coaches:
# of Varsity Boys' Lacrosse Athletes and Coaches:	Athletes:	Coaches:
# of Varsity Girls Lacrosse Athletes and Coaches:	Athletes:	Coaches:

Please complete and return by email or fax to Johna Register Mihalik at UNC Chapel Hill.
Email: johnakay@email.unc.edu
Fax: (919) 962-7060

APPENDIX 9- AT INFORMATION SHEET

School Name:	
AT Name:	
AT Certification #:	
Do you travel with Sports:	YES NO
List all sports you travel with:	
Of the listed sports (to the right) prioritize the sports in order of time spent: (1-6)	Football _____ Boys Soccer_____ Girls Soccer_____ Boys Lacrosse_____ Girls Lacrosse_____ Cheerleading_____
Have you ever conducted a concussion education session with the athletes at your school?	YES NO
If yes, describe the information you provided:	

APPENDIX 10: RECRUITMENT SCRIPT

Study Explanation Guide:

The University of North Carolina is conducting a study examining knowledge, attitudes, and practices surrounding sports-related concussion in high school coaches and athletes. The study involves completion of a short concussion information questionnaire. The questionnaire will not ask for your name. This study will help us gain important information on concussion in sports and will hopefully help to make participation in sport safer. We hope you will choose to complete the questionnaire, but you do not have to participate and there is no penalty for choosing not to participate. If you have any questions contact information is provided in the packet and you can contact the people conducting the study at UNC.

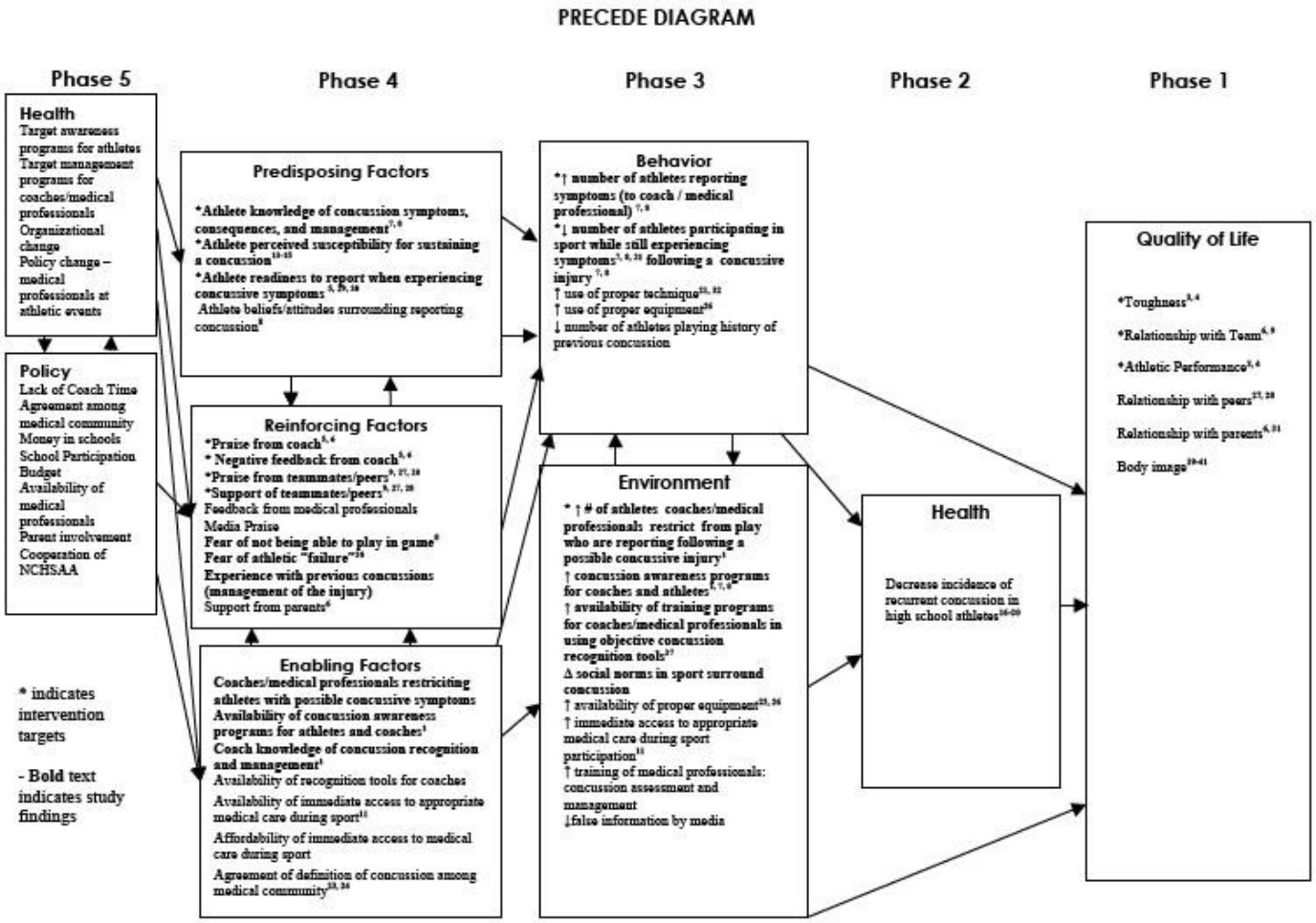
You (both coaches and athletes) will be asked to take a packet containing the questionnaire, appropriate consent forms, and instruction letter, and a postage paid return envelope. There are no right or wrong answers so please give your best effort.

Coaches – your questionnaire only has 1 section. If you decide to complete it – give your best effort and try and answer all questions on the questionnaire.

Athletes- ***you will need to take this packet home and discuss it with your parents***. If you choose to participate, follow the directions on the questionnaire and upon completion, place it in the postage paid envelope and drop it in the mail. No postage is needed as it has already been paid. You will not be contacted again as there is no contact information on the questionnaire. Your only involvement in the study would be completion of the questionnaire. Your questionnaire has 2 sections and you will need to complete section 1, place it in the envelope before beginning part 2. PLEASE BE SURE TO WRITE IN YOUR SCHOOL NAME AND INCLUDE THE CONSENT FORMS IN THE RETURN ENVELOPE THAT YOU MAIL BACK.

APPENDIX 11- PRECEDE

DIAGRAM



1. Valovich McLeod TC, Schwartz C, Bay RC. Sport-related concussion misunderstandings among youth coaches. *Clin J Sport Med.* Mar 2007;17(2):140-142.

2. Pedersen DM, Manning CL. Attributions of athletes on collegiate sports teams. *Percept Mot Skills.* Dec 2004;99(3 Pt 1):799-810.

3. Van-Yperen NW, Duda JL. Goal orientations, beliefs about success, and performance improvement among young elite Dutch soccer players. *Scand J Med Sci Sports.* Dec 1999;9(6):358-364.

4. Miller BW, Roberts GC, Ommundsen Y. Effect of motivational climate on sportspersonship among competitive youth male and female football players. *Scand J Med Sci Sports.* Jun 2004;14(3):193-202.

5. Ommundsen Y, Roberts GC, Lemyre PN, Miller BW. Parental and coach support or pressure on psychosocial outcomes of pediatric athletes in soccer. *Clin J Sport Med.* Nov 2006;16(6):522-526.

6. Kaut KP, DePompei R, Kerr J, Congeni J. Reports of head injury and symptom knowledge among college athletes: implications for assessment and educational intervention. *Clin J Sport Med.* Jul 2003;13(4):213-221.

7. McCrea M, Hammeke T, Olsen G, Leo P, Guskiewicz K. Unreported concussion in high school football players: implications for prevention. *Clin J Sport Med.* Jan 2004;14(1):13-17.

8. Ommundsen Y, Roberts GC, Lemyre PN, Miller BW. Peer relationships in adolescent competitive soccer: associations to perceived motivational climate, achievement goals and perfectionism. *J Sports Sci.* Sep 2005;23(9):977-989.

9. Lyznicki JM, Riggs JA, Champion HC. Certified Athletic Trainers in Secondary Schools: Report of the Council on Scientific Affairs, American Medical Association. *J Athl Train.* Jul 1999;34(3):272-276.

10. Theye F, Mueller KA. "Heads up": concussions in high school sports. *Clin Med Res.* Aug 2004;2(3):165-171.

11. Toft UN, Kristoffersen LH, Aadahl M, von Huth Smith L, Pisinger C, Jorgensen T. Diet and exercise intervention in a general population--mediators of participation and adherence: the Inter99 study. *Eur J Public Health.* Dec 21 2006.

12. Charron-Prochownik D, Sereika SM, Becker D, et al. Reproductive health beliefs and behaviors in teens with diabetes: application of the Expanded Health Belief Model. *Pediatr Diabetes.* Mar 2001;2(1):30-39.

13. Collins MW, Lovell MR, Iverson GL, Cantu RC, Maroon JC, Field M. Cumulative effects of concussion in high school athletes. *Neurosurgery.* Nov 2002;51(5):1175-1179; discussion 1180-1171.

14. Guskiewicz KM, Marshall SW, Bailes J, et al. Association between recurrent concussion and late-life cognitive impairment in retired professional football players. *Neurosurgery.* Oct 2005;57(4):719-726.

15. Guskiewicz KM, Marshall SW, Bailes J, et al. Recurrent concussion and risk of depression in retired professional football players. *Med Sci Sports Exerc.* Jun 2007;39(6):903-909.

16. Guskiewicz KM, McCrea M, Marshall SW, et al. Cumulative effects associated with recurrent concussion in collegiate football players: the NCAA Concussion Study. *Jama.* Nov 19 2003;290(19):2549-2555.

17. Zemper ED. Two-year prospective study of relative risk of a second cerebral concussion. *Am J Phys Med Rehabil.* Sep 2003;82(9):653-659.

18. Boden BP, Tacchetti RL, Cantu RC, Knowles SB, Mueller FO. Catastrophic head injuries in high school and college football players. *Am J Sports Med.* Jul 2007;35(7):1075-1081.

19. Aubry M, Cantu R, Dvorak J, et al. Summary and agreement statement of the 1st International Symposium on Concussion in Sport, Vienna 2001. *Clin J Sport Med.* Jan 2002;12(1):6-11.

20. McCrory P, Johnston K, Meeuwisse W, et al. Summary and agreement statement of the 2nd International Conference on Concussion in Sport, Prague 2004. *Clin J Sport Med.* Mar 2005;15(2):48-55.

21. Cantu RC, Mueller FO. Catastrophic spine injuries in American football, 1977-2001. *Neurosurgery.* Aug 2003;53(2):358-362; discussion 362-353.

22. Collins M, Lovell MR, Iverson GL, Ide T, Maroon J. Examining concussion rates and return to play in high school football players wearing newer helmet technology: a three-year prospective cohort study. *Neurosurgery.* Feb 2006;58(2):275-286; discussion 275-286.

23. Hall-Lande JA, Eisenberg ME, Christenson SL, Neumark-Sztainer D. Social isolation, psychological health, and protective factors in adolescence. *Adolescence.* Summer 2007;42(166):265-286.

24. Schutz HK, Paxton SJ. Friendship quality, body dissatisfaction, dieting and disordered eating in adolescent girls. *Br J Clin Psychol.* Mar 2007;46(Pt 1):67-83.

25. Carey KB, Henson JM, Carey MP, Maisto SA. Which heavy drinking college students benefit from a brief motivational intervention? *J Consult Clin Psychol.* Aug 2007;75(4):663-669.

26. Rooney K, Hunt C, Humphreys L, Harding D, Mullen M, Kearney J. Prediction of outcome for veterans with post-traumatic stress disorder using constructs from the transtheoretical model of behaviour change. *Aust N Z J Psychiatry.* Jul 2007;41(7):590-597.

27. Castrucci BC, Gerlach KK. Understanding the association between authoritative parenting and adolescent smoking. *Matern Child Health J.* Mar 2006;10(2):217-224.

28. Mueller FO, Blyth CS. North Carolina high school football injury study: equipment and prevention. *J Sports Med.* Jan-Feb 1974;2(1):1-10.

29. Rosenblum S. Psychologic factors in competitive failures in athletes. *Am J Sports Med.* May-Jun 1979;7(3):198-200.

30. Nattiv A, Puffer JC. Lifestyles and health risks of collegiate athletes. *J Fam Pract.* Dec 1991;33(6):585-590.

31. Nattiv A, Puffer JC, Green GA. Lifestyles and health risks of collegiate athletes: a multi-center study. *Clin J Sport Med.* Oct 1997;7(4):262-272.

32. Brook U, Tepper I. High school students' attitudes and knowledge of food consumption and body image: implications for school based education. *Patient Educ Couns.* Mar 1997;30(3):283-288.