The Epidemiology of Overuse Conditions in Youth Football and High School Football

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by

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Abstract

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The Epidemiology of Overuse Conditions in Youth Football and High School Football

Director of Thesis: Chad Starkey

**Background:** Higher intensity of sports training have led to an increase risk for overuse conditions at the pediatric level. Youth athletes are more susceptible to overuse conditions due to their immature musculoskeletal systems. Limited epidemiological studies have examined overuse conditions in football. **Purpose:** The purpose of this study is to examine the rates, risks, and distributions of overuse conditions in youth football and high school football. **Methods:** Participants were previously collected by Datalys through the Youth Football Safety Study and the National Athletic Treatment Injury and Outcomes Network injury surveillance programs. **Results:** High school football had a higher injury rate and injury risk for overuse conditions than youth football. **Conclusion:** Overuse conditions are not a primary concern in youth and high school football. However, high school football presents an increase risk of sustaining an overuse injury than youth football.
Preface

Chapter 3 contained within the thesis document serves as a prepublication manuscript. This manuscript has been formatted to meet the guidelines set forth by the *Journal of Athletic Training* and Thesis and Dissertation Services at Ohio University.
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Chapter 1: Introduction

Player safety has been a growing concern in youth sports. David Satcher, co-chairman of the National Council on Youth Sports Safety states “because of the reports of injuries, more and more parents are cautious of having their children participate.”1(p 1) A national survey of 1511 parents revealed that 87% of respondents were worried about the risk of injury in youth sports and over 82% of respondents considered keeping their child out of football for fear of injury.2,3

Injuries can be debilitating to the individual and a costly expense for the family. Youth sports-related injuries cumulatively cost approximately $448 million a year.4 These injuries represent nearly 20% of all emergency departments (ED) visits.4 Football-related injuries are a common cause for presenting to EDs, particularly in youth; in 2012, approximately 394,000 football-related injuries in athletes 19 years and under presented to EDs.5 Over 50% of pediatric injuries reporting to the sports medicine clinics were deemed overuse conditions.6–8

Overuse Conditions

Overuse conditions are the result of repeated stresses to an area without adequate rest to occur for structural adaptation.6 These injuries can be detrimental to pediatric athletes, especially when the bony epiphysis is affected.9 Adolescents with immature skeletal systems are less resistant to tensile and compressive forces applied during physical activity, thus making them more vulnerable to growth plate injuries and potentially causing long term consequences on growth and development.6,10,11.
There are various intrinsic (within the body) and extrinsic (outside the body) risk factors for overuse conditions in sports (Table 1). These risk factors become more apparent in athletes specializing in one sport, also known as sports specialization. Sports Specialization is the “intensive year round training in a single sport at the exclusion of all other sports.” The repetitive motions performed over the course of a year is theorized to lead to a higher risk of overuse injuries.

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**The Development of Injury Epidemiology**

The physical and financial burden of sports injuries has led to an increase emphasis on player safety. Healthcare professionals have promoted player safety through the interpretation and application of injury epidemiology. The Institute of Medicine defines injury epidemiology as the study of injury distribution and causation of injuries. Injury epidemiology is categorized as descriptive, analytic, or both depending on the variables being measured. Descriptive epidemiology pertains to identifying the prevalence and incidence of an injury in a specified population, whereas
analytic epidemiology examines the causes of injuries in a given population. Athletic trainers (AT) have used injury epidemiological studies to better understand patterns of injury incidence in the sports with which they work, assist their return-to-play decision making, and limit the risk of re-injury in athletes.

Sports injury epidemiology evolved from the pioneering work of William Haddon. Haddon expanded on the standard epidemiology approach by adding a time sequence to emphasize the event leading up to the injury. The addition of a time sequence led to the creation of Haddon’s Matrix, a conceptual model used to create ideas for the prevention of various injuries (Figure 1). Haddon’s Matrix is divided into three time-phases: the pre-event, event, and post-event. Each phase adds to the potential likelihood that an injury will occur due to the predisposing factors leading up to the injury (pre-event), the type of event in which the injury arises (event), and the consequences that transpire after the injury occurs (post-event).

**Figure 1.** Haddon’s Matrix.
The growth of injury epidemiology has progressed as a result of injury surveillance systems. The National Athletic Injury/Illness Reporting System (NAIRS) was one of the first national injury surveillance systems. In 1975 NAIRS began collecting high school and collegiate sport-related injury data. Two years later, the National Center for Catastrophic Sport Injury Research (NCCSIR) was founded. The NCCSIR accumulated non-fatal football injuries and expanded data collection to all sports in 1982. Coinciding with the NCCSIR, the National Electronic Injury Surveillance System (NEISS) started gathering consumer-related injury data from designated hospitals in 1971. After an expansion of the system in 2000, NEISS affiliated hospitals began collecting data on sports injuries. In 2005, an internet-based data collection tool, High School RIO™, examined time-loss injuries in US high school athletes. Data from RIO was used in the National High School Sports-Related Injury Surveillance Study.

In 2010 The Datalys Center for Sports Injury Research and Prevention designed two programs to track non-time loss and time-loss injuries in youth and high school sports. The first program implemented was the National Athletic Treatment and Injury Outcomes Network (NATION) that tracks injury data for 26 high school sports. Datalys also designed the Youth Football Safety Study (YFSS), which collects all injuries from a sample of youth football leagues across the country. These injury surveillance systems have been used in a wide array of football injury epidemiological research. Injury epidemiological studies serve as a tool for healthcare professionals to incorporate evidence into creating effective injury prevention programs.
Statement of the Problem

Numerous injury epidemiology studies have been conducted on youth and high school football.\textsuperscript{29–62} Overuse conditions have been examined in several of these studies, although a majority of them describe overuse injuries under the category “other” or as a mechanism of injury.\textsuperscript{62,63} The incidence of overuse injuries in sports has also been undervalued in the literature.\textsuperscript{9} Studies that have examined the incidence of overuse injuries in sports have defined injury as only requiring time-loss in participation.\textsuperscript{9}

Purpose

The purpose of this study is to calculate and compare the number of overuse conditions in youth and high school football. Both time-loss and non-time loss overuse conditions will be calculated using the injury rate, injury rate ratio, risk, and risk ratio. Distributions of body part, time loss, and injury diagnoses will also be compared in youth and high school football.

Significance of the Study

Prior to the recent establishment of the YFSS, limited research has been conducted on youth football injuries. While there have been numerous studies that describe overuse conditions, no study has specifically included non-time loss injuries in their evaluation of overuse injuries in sports. This thesis will compare overuse conditions between two groups: youth football and high school football. Comparing overuse conditions between the two levels of competitions assists in determining injury patterns and trends in each group. Due to increase physical demands placed on high school athletes, it is beneficial to understand the risks associated with sustaining an overuse
injury as an athlete progresses from youth football to high school football. Also, because the YFSS and NATION both collect non-time loss injuries, this study will better ascertain the breadth of overuse conditions managed by ATs in youth football and high school football. This thesis will hope to provide evidence-based research on overuse conditions in youth football and high school football in order to target and create effective injury prevention programs designed to reduce the number of overuse conditions.

**Research Questions**

The research questions pertaining to this thesis are:

1. **What is the percentage of injuries that are overuse in youth football and high school football?**
   
   $H_{01}$: The percentage of injuries that are overuse in youth football and high school football do not differ.

2. **What is the injury rate of overuse injuries in youth football and high school football?**
   
   $H_{02}$: The overuse injury rates for youth football and high school football do not differ.

3. **What is the injury risk of overuse injuries in youth football and high school football?**
   
   $H_{03}$: The overuse injury risk for youth football and high school football do not differ.

4. **What is the distribution of overuse injury time loss outcome measures in youth football and high school football?**
H04: The distributions of injury time loss outcome measures in youth football and high school football do not differ.

5. What is the distribution of overuse injuries by body part location in youth football and high school football?
   H05: The distributions of body part location in youth football and high school football do not differ.

6. What is the distribution of overuse injuries by injury diagnosis in youth football and high school football?
   H06: The distributions of injury diagnosis in youth football and high school football do not differ.

**Delimitations of the Study**

1. YFSS data were collected from 2012-13 to 2013-14; NATION data were collected from 2011-12 to 2013-14.

2. Football players from youth football leagues (~5-14 years of age) and high school football teams (~14-18 years of age) will be included in the study.

3. Only overuse conditions will be examined in this study.

**Limitations of the Study**

1. The sample from the YFSS and NATION are convenience samples. Although they were collected from multiple sites across the United States, these data may not be generalizable to all youth football leagues and high school football programs in the country.
2. A clinical definition for overuse conditions has yet to be discovered. Overuse conditions were filtered out of the data sets by the researcher. Overuse conditions were defined as those that were recorded by ATs as having a basic injury mechanism of “overuse/gradual onset” and/or being a chronic injury.

3. The reporting and quality of the data collected was contingent on the specific athletic trainers that collected data. Variations in reporting and data quality may exist.

4. The validity of the reported data was depended on the truthfulness on the athlete.

5. The experience level of the data collectors differed by team and level of competition.

Definition of Terms

Athlete exposure. One athlete participating in one organized practice or competition.\textsuperscript{28}

Athletic trainer (AT). Health care professionals who collaborate with physicians to provide preventative services, emergency care, clinical diagnosis, therapeutic intervention and rehabilitation of injuries and medical conditions.\textsuperscript{18} ATs are certified by the Board of Certification, Inc. and are regulated in most states.

Football-related injury. An injury that occurred during an organized practice or competition, and requires medical attention by a medical professional.\textsuperscript{38}

Injury epidemiology. The study of patterns of injury distribution and causation of injuries in a respected field.\textsuperscript{7,8}
**Injury incidence.** The number of new cases of injuries in a population over a given period of time.\(^{64}\)

**Injury rate.** The number of injuries/1000 athlete exposures.\(^{65}\)

**Injury rate ratio.** Injury rate of group a/injury rate of group b.\(^{53}\)

**Injury risk.** The proportion of athletes who have at least one incident of injury during a fixed period of time.\(^{17}\)

**Injury risk ratio.** Injury risk of group a/injury risk of group b.\(^{53}\)

**National Athletic Treatment, Injury, and Outcomes Network.** An injury surveillance system that gathers data from athletic trainers in public high schools.\(^{28}\)

**Non-time loss injury.** Any injury that was evaluated or treated by an AT, physician, or other health care professional, but did not result in restriction from participation beyond the initial day the injury was reported.\(^{28}\)

**Overuse injury.** Repeated stresses to an area without adequate rest to occur for structural adaptation.\(^{9}\)

**Time-loss injury.** Injuries resulting in a restriction from participation for at least 24 hours past the initial day the injury was reported.\(^{28}\)

**Youth football.** Athletes ages 5-14 playing in organized football before the high school level.\(^{66}\)

**Youth Football Safety Study.** A comprehensive injury surveillance study conducted by Datalys and USA Football to examine player safety in youth football across the nation.\(^{27}\)
Chapter 2: Literature Review

The aim of this chapter is to describe the current literature pertaining to injury epidemiological data in youth and high school football. This chapter will discuss the various injury surveillance systems, participation trends, and injury epidemiology studies in this population.

Epidemiological Research

Epidemiology is “the scientific study of the distributions of diseases and injuries in populations, and their causes and risk factors.”\(^6\)\(^7\)\(^4\) Epidemiological research has been conducted by statisticians, sociologists, psychologists, and physical and biological scientists.\(^6\)\(^7\) A theoretical model conducted by infectious disease epidemiologists attempts to convey the core concepts of epidemiology: recognizing the host, (the person injured), the agent that causes the injury, and how the agent was created.\(^6\)\(^7\)

**Injury epidemiology.** Injury epidemiology is a specific branch of the broader epidemiology model.\(^7\) The Institute of Medicine defined injury epidemiology as the study of patterns of injury distribution and injury causation in a respective field.\(^1\)\(^8\),\(^6\)\(^8\) Introduced by William Haddon, injury epidemiology was built on the standard epidemiological approach by adding a time sequence (epoch) to highlight the event leading up to the injury.\(^1\)\(^8\) Haddon’s approach is divided into three phases: (the pre-event), predisposing factors leading up to the injury, (event), how the injury arises, and (post-event), the consequences that transpire after the injury occurs.\(^1\)\(^8\) Injury epidemiological studies are often used to determine the occurrence and severity of injuries.\(^1\)\(^8\)
The need for injury epidemiological research. Injury epidemiological research can be used to determine the effectiveness of injury prevention policies and practices at reducing the incidence and severity of injuries.\textsuperscript{67} Epidemiologic principles are used when incorporating evidence-based research into clinical practice.\textsuperscript{69} One epidemiologic study concluded that the data obtained from the study underscore a need for the development, implementation, and evaluation of targeted evidence based injury prevention programs.\textsuperscript{34} The statistics accumulated from these studies will help athletic trainers create safer return-to-play decisions.\textsuperscript{44}

Epidemiology Statistics

Injury rate. Injury rate is a broad statistic that can be calculated in numerous ways. When calculating the injury rate in a sport, an important criteria to clarify is the numerator must be a representation of the denominator.\textsuperscript{54} In a study investigating the injury rates in female youth hockey, the injury rate was calculated by the number of injuries/1000 player-hours.\textsuperscript{65} Another study defines injury rate as the number of fractures per 10,000 athletic exposures.\textsuperscript{3}

Injury rate ratio (IRR). Injury Rate Ratio (IRR) compares the difference between the injury rates of two groups.\textsuperscript{53} Injury rates can be compared within a single team, (practices and games) and between levels of competition, (youth football and high school football.) The formula for IRR = Rate\textsubscript{a}/Rate\textsubscript{b}. Rate\textsubscript{a} represents that value for group 1 and Rate\textsubscript{b} represents the value for group 2. In high school football, the concussion rate in games and practices were 2.01 and 0.66/1000 AEs respectively.\textsuperscript{53} Thus, the game-to-practice IRR was 3.03.\textsuperscript{53}
**Injury risk.** Injury risk refers to “the proportion of athletes who have at least one incident of injury during a fixed period of time, as well as the probability an individual subject will sustain an injury.” Risk can be expressed either as a decimal or a percentage. For example, the risk of sustaining an ankle injury over a 1-week basketball camp can be recorded as .15 or 15%. Individuals may vary in injury risk depending on other variables such as flexibility, exposure time, etc.

**Injury risk ratio.** Risk ratio (RR) compares the injury risk between two groups. The formula for $RR = \frac{Risk_a}{Risk_b}$, where $Risk_a$ describes the risk of one group and $Risk_b$ describes the risk of another group. This statistic determines the difference in magnitude of sustaining at least one injury in one group compared to another. One study expressed the RR of concussions in youth football vs. high school football as .35 in 2012. Since the RR value was less than 1, the risk decreases, meaning there is a 65% decrease in risk of sustaining a concussion in youth football compared to high school football.

**Injury Surveillance Systems for Youth Sports**

**The National Athletic Injury/Illness Reporting System (NAIRS).** The NAIRS is a national injury surveillance system that has collected injury data from a variety of high school and collegiate sports since 1975. It was created to provide a mechanism to continuously collect and analyze sport-related injury data. NAIRS includes 53 high school football teams and 148 college and universities football teams. Sports-related injuries are defined by NAIRS as an injury that results in a loss of participation for at least 1 day after the injury. NAIRS ceased data collection in 1983.
Between 1975-1977, NAIRS collected sport-related injury data from more than 1600 athletes. The injury rate for high school football was approximately 8 per 1000 athlete-exposures. Injuries resulting in a time-loss of more than a week occurred nearly 2 per 1000 athlete-exposures. These injury rates for a team size of 50 players would expect around 32 injuries with about 8 being classified as significant.

**National Center for Catastrophic Sport Injury Research (NCCSIR).** The NCCSIR is a systematic data reporting system on catastrophic injuries and illness at the collegiate, high school, and youth sport levels. Catastrophic injuries are defined as a fatal event, non-fatal (permanent severe functional disability), or serious (no permanent functional disability but severe injury), that occurred during an organized practice or competition. The data collection system began reporting non-fatal football injuries in 1977. Under the direction of Frederick O. Mueller the program expanded to include all injuries in 1982. The decision to expand the NCCSIR to all sports was concentrated on increasing awareness and overall player safety, and providing more information on sport-related injuries in all sports, specifically women’s sports injuries.

During the 2013-14 academic year, the NCCSIR collected 80 catastrophic sport-related injuries that occurred in high school and collegiate sports. The majority of the catastrophic cases occurred at the high school setting (78%). Football had the highest incidence of catastrophic injuries (53%), followed by basketball (18%), wrestling (8%), and cross country (6%). The most common type of catastrophic injury was cardiac arrest (30%), brain trauma (16.3%), fractures (11.3%), and heat-related illness (11.3%).
**Reporting Information Online (RIO).** RIO is a multifaceted internet-based injury surveillance system developed by Dawn Comstock. RIO is the data collection tool used in the National High School Sports-Related Injury Surveillance Study. The purpose of RIO is to “describe the rates, patterns, and trends of high school sport-related injuries.” A sample of 100 U.S high schools from across the country were used to track the injury statistics of 22 sports. Injury surveillance areas that RIO researches include high school sports-related injuries, injuries and illness at summer camps, high school rugby-related injuries, and women’s professional football-related injuries.

Athletic trainers are the primary data reporters for RIO, however when athletic trainers were not present, coaches, directors, and other medical providers were responsible for reporting the injury data. For instance, summer camp injuries were reported by camp physicians, nurses, first aid providers, and camp directors. A study conducted by Comstock compared injury data reporting between athletic trainers (ATs) and coaches. Of the 18 high schools that participated, all 18 (100%) ATs entered at least one report into RIO, whereas only 34 of the 79 (43%) participating coaches entered at least one report into RIO. The study also examined the number of injury reports submitted. Athletic Trainers submitted 586 injury reports over the course of the academic year, while coaches submitted 74 injury reports. The authors concluded that athletic trainers should be the primary data reporters, and in high schools without access to an athletic trainer, methodological modifications and compensating coaches will likely be necessary when studies use coaches as reporters.
**National Electronic Injury Surveillance System (NEISS).** Developed by the Consumer Product Safety Commission (CPSC) in 2000, NEISS is a national injury surveillance sample of hospitals in the US and its territories. This system collects patient information from every hospital participating in NEISS. Approximately 100 hospitals were randomly selected in this surveillance system to represent the 5,000+ hospitals with emergency departments in the United States. Unlike other injury surveillance systems, NEISS incorporates all youth injuries reporting to the emergency department, not just sport-related injuries. Injury data from NEISS can be sorted by numerous variables including age, sex, and location of injury.

One of the fields measured by NEISS is recreational or competitive football-related injury. The NEISS reported 11,645 football related injuries in 2014. From this sample, it was estimated that approximately 400,000 football related injuries were evaluated in hospital emergency rooms nationwide. Among age levels, 5-14 year olds had the most football related injuries with just over 200,000 injuries.

**Youth Football Safety Study (YFSS).** The YFSS is a national injury surveillance study conducted by Datalys and USA Football to examine player safety in youth football. Currently, it is the only injury surveillance study examining youth football athletes. The YFSS was conducted over a 2-year period from 2012-13 to 2013-14. Over 4000 athletes ages 5-14 years old from 6 states representing 13 youth football leagues and 118 teams were included in this study. Athletic Trainers were present for all practices and games and reported injuries using a standardized web-based injury
surveillance system. Athlete exposures also collected to calculated determine injury rates.

The YFSS had four endpoints of interest in their studies: (1) an injury or illness that had to be evaluated by an AT, (2) time loss injuries, defined as any injury seen by an AT that resulted in a loss of participation of at least 24 hours from the date of injury, (3) non-time loss injury, defined as any injury seen by an AT that resulted in no time loss, and (4) concussions. The purpose of the YFSS is to promote safer playing standards by examining new ways to increase player safety and lessen injury risks in youth football.

**National Athletic Treatment, Injury, and Outcomes Network (NATION).**

NATION is an injury surveillance system that gathers data from athletic trainers (AT) in public high schools. ATs capture both time-loss and non-time loss injuries from student athletes and record them in one of 3 software applications: Athletic Trainer System (ATS), Injury Surveillance Tool (IST), or Sports Injury Monitoring System (SIMS). From 2011-12 to 2013-14, athletic trainers collected data for 27 high school sports in 147 high schools in 26 states. A total of 163 football teams participated in the 3-year study.

The purpose of the program is to identify time loss and non-time loss injuries in the high school setting, describe the importance of athletic trainers at the secondary level, and evaluate the health-outcomes of athletes who were provided care by athletic trainers.
Overuse Conditions

Overuse conditions represent a number of pathologies that occur due to a repetitive submaximal loading on the body where adequate rest does not take place for structural adaptation to occur.\(^9,77-80\) There are several definitions and interpretations of overuse injuries.\(^30-34,39,43,52,55,60,63\) Studies have labeled overuse conditions as a diagnosis, mechanism of injury, or both.\(^63\) When “overuse” is used as a mechanism of injury, authors refer to the causation of the injury, whereas a diagnosis of “overuse” signifies a group of injuries with the same general characteristics.\(^63\) The Centers for Disease Prevention and Control (CDC) state “the majority of youth sports injuries are the result of overuse [conditions] and are preventable.”\(^81(p.1)\)

Various etiological factors contribute to overuse injuries in sports. These factors are broken down into intrinsic (within the body) and extrinsic (outside the body) (see Table 1). Intrinsic factors for overuse injuries include: biomechanical malignancies, muscle imbalance, muscular weakness, hypermobility of joints, and lack of flexibility.\(^13\) Extrinsic factors consist of: training errors, environmental conditions, footwear, and equipment.\(^13\)

The National Athletic Trainer’s Association (NATA) position statement on the prevention of pediatric overuse injuries have provided evidence based recommendations to limit the risk of overuse injuries in youth sports.\(^6\) Recommendations are graded from A (high quality of evidence) to C (low quality of evidence).\(^6\) One A-rated recommendation listed affirmed “preseason and in-season preventive training programs focusing on
neuromuscular control, balance, coordination, flexibility, and strengthening of the lower extremities are advocated for reducing overuse injury risk.  

**Participation**

**Youth football.** Participation rates in youth sports have dropped since 2008. In 2013, the Sports & Fitness Industry Association conducted a study measuring sports participation trends, identifying youth sports participation rates among athletes ages 6-12 decreased by 4.5%. The downward trend in youth sports participation has affected Youth Football in particular. USA Football reported the number of participants ages 6-14 year olds dropped by approximately 6.7% between 2010-11 to 2011-12. Among 7-14 year olds, USA Football estimates that approximately 3 million children play tackle football in the United States in 2010. Pop Warner, the largest youth football program in the country, saw the football participation rate decrease 9.5% between 2010 to 2012.

**High school football.** While youth sports participation have been consistently decreasing over the past few years, high school sports participation is at an all time high. For the 26th consecutive year, high school sports participation has increased. According to the National Federation of State High Schools Associations, over 7.8 million athletes participated in organized sports during the 2014-15 academic year. This is an increase of 11,000 participants from the previous year. Football is the most popular high school boys sport with 1,083,617 participants in 2014-15. Yet, the number of high school football participants has diminished in recent years. The NFHS reported a decrease of 9,617 football participants between 2013-14 to 2014-15.
Sport specialization

Declining participation rates in youth sports are influenced by various factors. One factor Pop Warner officials believe the decline in sports participation is based on is the trend for athletes to participate only in one sport, known as sport specialization.\(^{85}\) Sport specialization occurs across all sports and levels.

Sports specialization is defined as “a rigorous, year round training in a single sport to develop and master sport specific skills early on in their athletic career with the goal of excelling in higher levels of athletics.”\(^{14}\) As the number of students forgo school-sponsored programs such as football in favor of year-round travel leagues, the larger the reduction in football participation rates.\(^{14}\)

The rate of athletes participating in sports before the age of 6 has increased in the past 15 years. In 1997, approximately 9% of children participated in organized sports, whereas in 2008, the participation rate grew to 12%.\(^{14}\) As athletes get older, the rate of sports specialization increases exponentially.\(^{14}\) A study on junior tennis players indicated the majority of tennis players surveyed began specializing in tennis at an average age 10.4 years.\(^{14}\) At the high school level, athletic directors have seen an increase in sports specialization, with over 77% of athletic directors surveyed reporting an increasing trend in sports specialization.\(^{89}\)

Those who specialize at an early age are at an increase risk for injury. One study analyzing 500 athletes over a decade found that those who specialize in one sport had a 50% higher chance of sustaining a knee injury.\(^{15}\) Another study examined injury prevalence in 1200 youth athletes.\(^{90}\) The researchers concluded that sports specialization
is the strongest predictor of injury in youth sports.\textsuperscript{90} Specialized athletes who participated in the study were 70-93\% more likely to sustain an injury relative to non-specialized athletes.\textsuperscript{90} Recent literature has contemplated the reasons why sports specialization increases the risk of injury.\textsuperscript{14,15} One study theorized the repetitive nature of playing the same sport year-round leads to an increase in overuse injuries.\textsuperscript{15} Another proposed rationale for increased risk of injury in specialized athletes is exposure rates.\textsuperscript{14} Among 2721 high school athletes, increased exposure was the most significant risk factor for injury.\textsuperscript{14} A significant risk of injury develops when training volume exceeds 16 hours per week.\textsuperscript{14} It is recommended that youth athletes take time off between sports or follow the recommended guidelines for the amount of hours per week of physical activity.\textsuperscript{6,16}

**Youth and high school football injury epidemiology**

Because of the high incidence of injuries in youth and high school football, injury epidemiological research have frequently focused on football.\textsuperscript{29-62} Studies have been conducted using injury data collected by various injury surveillance systems such as: RIO, NEISS, NATION, and YFSS. The distinct methods of each injury surveillance system produce a variance of injury statistics that can be used to compare and contrast certain variables.

**Total injuries.** Player safety in youth sports has been a growing concern in recent years. The National Safe Kids Campaign reported over 3.5 million youth athletes ages 5-14 are injured while participating in sports each year.\textsuperscript{91} Among athletes 19 and under, more than 1.35 sport-related injuries are treated in emergency room departments in 2011.\textsuperscript{5} Football had the most injuries with approximately 394,000 injuries.\textsuperscript{5} Football also
contributed the most injuries at the secondary level with just over 600,000 of the estimated 1.4 million sport-related injuries that occur annually. The NEISS reported 11,645 football related injuries in 2014. From this sample, it was estimated that approximately 400,000 football related injuries were evaluated in hospital emergency rooms nationwide. Among age levels, 5-14 year olds had the most football related injuries with just over 200,000 injuries.

**Overuse injuries.** A systematic review of overuse injuries in high school sports found numerous articles that address overuse injuries in some manner. Schroeder et al. used the National High School Sports-Related Injury Surveillance System, High School RIO study to examine the epidemiology of overuse injuries in high school athletes. Overall, 2834 overuse injuries were reported through the duration of the study. The overuse injury rate for all sports was 1.50 per 10 000 AEs, higher than the overall overuse injury rate for boys football, 1.27 per 10 000 AEs. This football injury rate is concurrent with another RIO study on overuse injuries in high school sports, 1.34 per 10 000 AEs. The proportion of overuse injuries to acute injuries ranged from 45.9% to 54%. Overuse injuries were most likely to be reported in practice (79.7%) compared to competition (16.5%). The highest percentage of overuse injuries in football occurred in the lower back, spine, and pelvis, (15.8%) and lower leg (15.6%).

Common overuse diagnoses in high school sports include: muscle/tendon strain (33%), tendinopathy (25%) and stress fracture (8%). Over 53% of the overuse injuries resulted in less than 1 week time-loss, and 7.7% resulted in more than 3 weeks’ time loss. Fernandez et al. studied the epidemiology of lower extremities among U.S high
school athletes. Overuse injuries occurred in 22.4% of all boys lower extremity injuries.\textsuperscript{31} Other studies have examined overuse MOI based on body part location. Overuse MOI made up 6.4\% of ankle injuries,\textsuperscript{33} 25.4\% of knee injuries,\textsuperscript{32} and 4.6\% of shoulder injuries.\textsuperscript{43} When body mass index (BMI) is factored in, the prevalence of have an overuse MOI decreases as BMI goes up.\textsuperscript{39}

\textbf{Tendinopathy.} Over the past 2 decades, the physical demands placed on athletes have increased, exerting more stress and force on the tendons.\textsuperscript{12} The higher force demands has led to an increase in tendon injuries. Prevalence rates for tendinopathy conditions differ based on competition level and body part. In boys middle school athletes, tendonitis comprised 13.94\% of the total injuries.\textsuperscript{49} Among ankle injuries, less than 5\% of injuries are classified as tendonitis.\textsuperscript{33} Football consisted of 8\% of the total Achilles tendon injuries in sports.\textsuperscript{92} Over 19\% of knee injuries in boys sports are tendinopathy injuries.\textsuperscript{32} A similar knee injury epidemiology study revealed 16.5\% of patella/patellar tendon injuries are the result of tendonitis.\textsuperscript{52} Tendonitis was also categorized under “other” along with other diagnoses such as: inflammation, tendon strain, stress fracture, infections, and torn cartilage in a study comparing new vs. recurrent injuries. These injuries were classified as new in 31\% of the total football injuries and recurrent in 29.5\% of injuries.\textsuperscript{58}

\textbf{Stress fractures.} The risk for stress fractures increases with intensive training, weight lifting, and a poor diet.\textsuperscript{93} Stress fractures are one of the more serious overuse conditions due to prolonged recovery required for the bone to fully heal.\textsuperscript{93} Approximately 32\% of stress fractures result in a time-loss of more than 3 weeks.\textsuperscript{94} In males, football had
the second highest percentage of stress fractures in high school sports (23%). A comparable study found 16.5% of stress fractures occur in football. The lower leg consisted of the most stress fractures (40.3%), followed by the foot (34.9%), and lower back/lumbar spine/pelvis (15.2%). The highest proportion of stress fractures in football occurred to the foot (34.4%).

**Time-loss injuries.** The prevalence of football related injuries can be observed in various injury surveillance systems. During the 2014-15 academic year, RIO reported over 9000 time-loss injuries in the 22 participating sports. Time-loss injuries are “all injuries that (1) were evaluated or treated (or both) by an athletic trainer, physician, or other health care professional; (2) restricted the student-athlete from participation for at least 24 hours past the day of injury; and (3) occurred during a sanctioned practice or competition.” The injury rate across all 22 sports was 1.80/1000 AEs. Football had the most reported time-loss injuries, 3620 (40%), and the highest injury rate, 3.94 injuries/1000 athlete exposures (AEs). Badgeley et al. calculated a similar injury rate in a study describing injuries in high school football during the 2005-06 to 2009-10 academic year, 4.08 injuries/1000 AEs. Football also had the highest prevalence of time-loss injuries of any sport participating in NATION, 3709(45%) as well as the highest injury rate, 3.35/1000 AEs. Likewise, a recent study examining the injury rates in two playing standard conditions conducted by the YFSS reported a time-loss injury rate of 3.1 injuries/1000 AEs. Greater injury rates were seen in a couple youth football studies. One study on middle school athletes indicated the injury rate for football was
8.486/1000 AEs, whereas another youth football study computed an injury rate of 7.4/1000 AEs.\textsuperscript{45,49}

**Non-time loss injuries.** NATION collected 38,765 non-time loss injuries, defined as “injuries that (1) were evaluated or treated (or both) by an athletic trainer, physician, or other health care professional; (2) did not restrict the student-athlete from participation for at least 24 hours past the day of injury; and (3) occurred during a sanctioned practice or competition.”\textsuperscript{28(p 863)} Overall, non-time loss injuries among participating sports was 7.95/1000 AEs.\textsuperscript{28} The Non-time loss injury rate for football was 11.94/1000 AEs.\textsuperscript{28} Football also had the highest reported non-time loss injuries of any sport, 13,222 injuries (34%).\textsuperscript{28} When examining different playing standard conditions in youth football, the injury rate drops to 7.2 injuries/1,000 AEs.\textsuperscript{46} Multiple studies acknowledge Non-time loss injuries occur more often than time-loss injuries.\textsuperscript{45,48,49,95} Non-time loss injuries happen approximately 55-70% of the time in football.\textsuperscript{45,48,49,95}

**New vs. recurrent injuries.** Swenson et. al. conducted a study examining the number of recurrent injuries in high school sports during the 2005-2008 seasons.\textsuperscript{34} The injury rate for new injuries across all sports was 2.19/1000 AEs, while the recurrent injury rate was .26/1000 AEs.\textsuperscript{55} Football had a substantially higher new injury rate, 3.85/1000 AEs, as well as a higher recurrent injury rate, .44/1000 AEs.\textsuperscript{55} The study concluded recurrent injuries occur less often than new injuries in high school sports.\textsuperscript{55} Approximately 89.5% of the injuries were classified as new.\textsuperscript{44,46–50,52–55} The proportion of new vs. recurrent injuries remain unchanged in RIO’s 2014-15 convenience sample report, 90% new injuries.\textsuperscript{25}
**Concussion.** Several articles outlined concussion injury rates in youth and high school football.\(^{37,46,53,58,95,96}\) Overall, competition concussion rates were higher than practice concussion rates across both levels of football.\(^{37,46,53,58,95,96}\) The study used the Youth Football Safety Study (YFSS) and National Athletic Treatment and Injury Outcomes Network (NATION) injury surveillance systems to track the number of concussions at the respected competition levels.\(^{53}\) Through the two year period, 936 concussions were reported: 141 (15.1%) in youth athletes, and 795 (84.9%) in high school athletes.\(^{53}\) Out of all the injuries reported in the YFSS and NATION programs, concussions comprised 9.6% and 4% of the total injuries reported respectively.\(^{53}\) Other high school football epidemiological studies computed concussion prevalence rates to be between 4% and 17% of the total reported injuries.\(^{29,30,37,38,42,44,53,58,75,96}\)

**Ankle injuries.** The ankle is one of the most common body parts injured in sports. The National High School Sports-Related Injury Surveillance Study determined approximately 15.5% of injuries are to the ankle in 2013-14, with competition ankle injuries occurring slightly more often.\(^{33}\) This was lower than a previous study on the prevalence of high school sport-related ankle injuries in 2005-06, 22.6%.\(^{33}\) Ankle sprain/sprain arise in roughly 92% of ankle injuries.\(^{25}\) A comparable study revealed 83.4% of ankle injuries were ligament sprains.\(^{33}\) Of the ankle ligaments, the anterior talofibular ligament is the highest sprained structure.\(^{25}\)

Football-related ankle injuries comprised 30% of the total ankle injuries in high school sports. The ankle (13%) is the 3rd most common body structure injured in boys football behind the knee (15.2%) and head/face(28%).\(^{25}\) The proportion of ankle
sprains/strains to total ankle injuries is similar in football, 91.8%, compared to all sports, 92.5%.\textsuperscript{25}

Nelson et al conducted a study investigating ankle injuries in high school sports during the 2005-06 school year. Nine of the most popular high school sports were selected for this study. Across the study period, 905 ankle injuries and 730,764 AEs were submitted into RIO, an injury rate of .523/1000 AEs.\textsuperscript{33} Football accumulated 281 ankle injuries (31%) and 431,242 AEs, an injury rate of .652/1000 AEs.\textsuperscript{33}

Ankle injuries had the highest proportion of injuries in numerous studies.\textsuperscript{30,33,38,42,55} The breakdown of ankle injuries varied by body part and other variables. Among recurrent injuries, the ankle was the most diagnosed body site, 28.3%.\textsuperscript{52} Slightly less recurrent ankle injuries were seen in football, 20.6%.\textsuperscript{55} Football ankle injury severities were consistent with estimated football ankle injury prevalence rates.\textsuperscript{45} Nearly 25% of mild injuries (1-6 days) 25% of moderate injuries (7-21 days) and 13% of severe injuries (> 21 days) were to the lower leg, ankle and foot.\textsuperscript{40} Player to player contact contributed 21.9% of ankle/foot injuries in high school sports.\textsuperscript{42} Football had marginally fewer ankle injuries caused by player-player contact, 13.6%.\textsuperscript{42} Youth football studies all had relatively comparable prevalence of ankle injuries.\textsuperscript{45,47,49} Between 12-16.5% of youth sport injuries were in the ankle.\textsuperscript{45,47,49} Leg/foot injuries were also similar between age groups reporting to emergency rooms with a football-related injury.\textsuperscript{50} Over 23% of 7-11 year olds sustained an leg/foot injury, whereas 27% of 12-17 year olds reported a leg/foot injury.\textsuperscript{50}
Knee injuries. A high percentage of injuries in high school sports occur in the knee. Around 13.8% of high school sport-related injuries were located in the knee.²⁵ One of the most common injury diagnosis in the study was knee sprain/strain, 7%.²⁵ The anterior cruciate ligament (ACL) is one of the most sprained ligaments among all knee injuries, 20.6%.²⁵ This finding is supported by Joseph et. al. study on ACL injuries in high school athletes. The study reported 20.5% of all knee injuries were ACL sprains.³⁶ Numerous studies confirmed knee injuries occur more often in competition than practice.²⁵,³⁰,³²,⁴⁹,⁵⁵

Of the total knee injuries in sports, 39% were committed in football.²⁵ Football-related knee injuries totaled 13.9% of all football injuries.²⁵ Other studies calculated the prevalence of knee injuries in high school football between 14-16%.²⁹,³⁰,³⁵ Knee sprains/strains were diagnosed in approximately 8% of football injuries, which is similar to the proportion of knee sprains/strains across all high school sports.²⁵ Knee sprains also made up 8% of hospital treated injuries.⁴⁴

A descriptive injury epidemiology study on knee injuries was conducted using injury data collected by RIO.³² A total of 1383 knee injuries were reported in the study.³² Football sustained 645 (46.6%) out of the 1383 knee injuries.³² The injury rate for knees injuries in boys sports was .429/1000 AEs.³² This is consistent with the knee injury rate of middle school athletes This finding was lower than the knee injury rate for football, .691/1000 AEs.³² The most common diagnosis for football knee injuries was ligament sprains, 42.6%.³² Contact with another person made up 52% of the knee injuries in sports.⁵² A larger percentage of player to player contact happened in football, 71.5%.⁵²
**Upper extremity injuries.** Although football comprises a high percentage of ankle and knee injuries, upper extremity body sites such as: the shoulder, elbow, and wrist/hand contain a large proportion of the injuries sustained in football. In the 2014-15 academic year, upper extremity injuries totaled 23.5% of football-related injuries. This is higher than the proportion of upper extremity injuries among all sports, 18.3%. Among specific body sites, the shoulder amassed 10.1% of football-related injuries, whereas the hand/wrist accumulated 9.6% and the arm/elbow 3.8%. Other literature studies indicated 12% of football injuries are to the shoulder. The proportion of shoulder and elbow injuries drop to approximately 5-6% in youth sports.

During the 2005-06 to 2011-12 academic year, football accumulated the most shoulder injuries of all sports. Of the 2798 total shoulder injuries reported, 1707(61%) occurred in football. This compares to another study that examines shoulder injuries in high school football, 59% of the total sport-related shoulder injuries. Shoulder injuries had an injury rate of .486/1000 AEs. The rate was higher in competition, 1.64/1000 AEs than practice, .25/1000 AEs. A similar study showed similar injury rates in competition, 1.62/1000 AEs, and practice, .27/1000 AEs. This is different in youth sports where the rate of shoulder injuries is lower, .231/1000 AEs in practice, .255/1000 AEs in games. Amid shoulder injuries, sprains/strains was recognized as the most prevalent type of shoulder injury occurring between 38-40% of shoulder injuries.
Chapter 3: The Epidemiology of Overuse Conditions in Youth Football and High School Football

Context: Higher intensity of sports training at the youth level has led to an increase risk for overuse conditions. Limited research has examined overuse conditions in youth sports.

Objective: To examine the rates, risks and distributions of overuse conditions between youth football and high school football.

Design: Descriptive epidemiologic study.

Setting: Youth football and high school football teams.

Participants: The Youth Football Safety Study (YFSS) included youth football athletes ages 5-14 years old. The National Athletic Treatment, Injury, and Outcomes Network consisted of high school football athletes ages 14-18 years old.

Data Collection and Analysis: Data was previously collected by Datalys Center for Sports Injury Research and Prevention during the 2012 and 2013 seasons. All data were manually checked for inclusion by the primary investigator. The injury rates, risks, distributions were analyzed through SAS Enterprise Guide software version 4.3 (Indianapolis, IN).

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1 This chapter represents a prepublication. Authors' manuscript to be submitted to the Journal of Athletic Training (August, 2016 are: Kevin W. Morris, AT (School of Applied Health Sciences and Wellness, Ohio University, Athens); Zachary Y. Kerr, PhD, MPH (Datalys Center for Sports Injury Research and Prevention, Inc, Indianapolis, IN), Janet Simon, PhD, AT (School of Applied Health Sciences and Wellness, Ohio University, Athens); Dustin Grooms, PhD, AT, CSCS (School of Applied Health Sciences and Wellness, Ohio University, Athens); and, Chad Starkey PhD, AT, FNATA (School of Applied Health Sciences and Wellness, Ohio University, Athens).
Results: During the study period, 1488 injuries were reported to the YFSS, of which 53 (3.6%) were overuse conditions. NATION reported 12,013 injuries, of which 339 (2.8%) were overuse conditions. High school football athletes had a 6% higher injury rate than youth football [Injury rate ratio (IRR) = 1.06; 95% confidence interval (CI): 0.79-1.41], as well as 1.5x greater injury risk than youth football athletes (IRR = 2.53; 95% CI: 1.84-3.47). A greater proportion of non-time loss injuries [Injury proportion ratio (IPR) = 1.24; 95% CI: 1.07-1.43] and overuse injuries to the lower extremity (IPR = 1.48; 95% CI: 1.32-1.65) were seen in youth athletes compared to high school athletes.

Conclusions: Although overuse conditions do not present a primary concern in youth and high school football, numerous overuse patterns and differences exist between the two levels of competition. Athletic trainers can use the statistical information from this study to target overuse conditions at either level. Additional research on the incidence of overuse conditions across all youth and high school sports is needed.

Key Words: injury rate, injury risk, time-loss injury, non-time loss injury, injury body part, injury diagnosis, sports.

Key Points

• A low incidence of overuse conditions was reported in youth football and high school football.

• High school football athletes had a higher overuse injury rate and injury risk than youth football athletes.
Over 60 million youth athletes (ages 5-18 years old) participated in organized athletics.\textsuperscript{1} Sports provide many valuable life skills including social and leadership development, as well as promote a healthier lifestyle through active exercise.\textsuperscript{2} The trend in sports participation has evolved from recreational play for enjoyment to intense sport-specific skill development.\textsuperscript{3–5} To obtain a competitive advantage athletes may begin specializing in a single sport at an earlier age.\textsuperscript{3} The higher intensity of training and repetitive motions performed over the course of a year is thought to lead to a higher risk of overuse conditions.\textsuperscript{3,6,7}

Overuse conditions are the result of repeated stresses to an area without adequate rest to occur for structural adaptation.\textsuperscript{8} Youth athletes are more susceptible to overuse conditions because their tissues are less resistant to the tensile and compressive forces applied during physical activity.\textsuperscript{9} Some estimates suggest that over 50% of youth sports injuries are overuse conditions, and half of these injuries are easily preventable.\textsuperscript{9–11}

Several studies have monitored injuries in youth and high school football, however limited research has studied the overall incidence of overuse conditions in this population.\textsuperscript{12–45} These studies have only included overuse conditions that accounted for time-loss, potentially underestimating their prevalence.

The purpose of this study is to compare the rates, risks, and distributions of overuse conditions between two levels of competition: youth football and high school football. This information can be used to identify any patterns or differences between the two levels of competition and associated age group.
METHODS

Design

This descriptive injury epidemiology study used data that were collected from the Datalys Center for Sports Injury Research and Prevention (Indianapolis, IN) through two comprehensive injury surveillance programs: the Youth Football Safety Study (YFSS), and the National Athletic Treatment, Injury and Outcomes Network (NATION).

Participants

The YFSS comprised more than 4000 athletes ages 5-14 years old from 6 states, 13 youth football leagues, and 118 teams. The two-year study was completed over the 2012 and 2013 football seasons. The NATION injury surveillance system included 14-18 year old football players from 96 secondary school football programs, encompassing 163 team-seasons. Injury data were collected over a 3 year period: 2011-2012 through 2013-2014. Both these programs use the same data fields and methods, with minor adjustments based on the level of play.

Instruments

Three software applications are certified to export injury data to NATION: the Athletic Trainer System, (ATS; Keffer Development Services, LLC, Grove City, PA), Injury Surveillance Tool, (IST; Datalys Center, Indianapolis, IN) and Sports Injury Monitoring System, (SIMS; FlanTech, Inc, Iowa City). The YFSS uses only the Injury Surveillance Tool in their study. Each injury record was deidentified with a unique injury-event number and ran through a quality control process. Data quality control
staff check the data for accuracy and completeness before it is entered into the research database.\textsuperscript{47}

\textbf{Injury Definitions}

For an injury to be reported in the NATION-SP or YFSS, it must have been evaluated or treated by either an athletic trainer, physician, or other health care professional.\textsuperscript{47} Injuries resulting in a restriction from participation for at least 24 hours following the onset of injury was classified as a time loss (TL) injury.\textsuperscript{47} A non-time loss (NTL) injury characterized any injury with the exclusion of all fractures, concussions, and dental injuries, that did not result in restriction from participation beyond the initial day the injury was reported.\textsuperscript{47}

\textbf{Athlete-Exposure Definition}

An athlete-exposure (AE) was expressed as 1 player participating in 1 high school/youth football-scheduled practice or competition in which they were subjected to the possibility of a sport-related injury.\textsuperscript{47}

\textbf{Outcome Variables}

Injury time-loss was divided into five groups: < 24 hours (non-time loss), 1-6 days loss, 7-13 days loss, 14-29 days loss, and 30+ days loss. Injured body parts were separated into 5 different regions: head/face/neck, upper extremity, trunk, lower extremity, and other. Injury diagnoses were listed alphabetically by their injury group code name.
Data Selection Procedure

Data included in this study originate from football data from the YFSS and NATION during the 2012 and 2013 seasons. The primary investigator worked with Datalys to filter data to only include overuse conditions. Illnesses, general medical conditions, and concussions were excluded from the study. The data was filtered for injuries reported by ATs as: (1) having an injury mechanism of “overuse/gradual onset” and/or (2) being a chronic injury, as well as all pathologies that were most likely to be classified as an overuse condition (Table 2). Any injuries that met the above criteria were manually checked for inclusion by the primary investigator relative to the injury diagnosis, and basic mechanism.
Table 2. Chronic Inflammatory Conditions From the YFSS and NATION Injury Surveillance Programs

<table>
<thead>
<tr>
<th>Chronic Inflammatory Condition ID Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 = Arthritis/Chondromalacia</td>
</tr>
<tr>
<td>3 = Avascular Necrosis</td>
</tr>
<tr>
<td>6 = Bursitis</td>
</tr>
<tr>
<td>7 = Capsulitis</td>
</tr>
<tr>
<td>9 = Cartilage Injury</td>
</tr>
<tr>
<td>10 = Compartment Syndrome</td>
</tr>
<tr>
<td>16 = Dislocation</td>
</tr>
<tr>
<td>17 = Effusion</td>
</tr>
<tr>
<td>19 = Entrapment/Impingement</td>
</tr>
<tr>
<td>21 = Exostosis</td>
</tr>
<tr>
<td>23 = Fracture (Stress)</td>
</tr>
<tr>
<td>30 = Inflammation</td>
</tr>
<tr>
<td>33 = Myositis Ossificans</td>
</tr>
<tr>
<td>36 = Osteochondritis</td>
</tr>
<tr>
<td>42 = Strain</td>
</tr>
<tr>
<td>44 = Subluxation</td>
</tr>
<tr>
<td>45 = Synovitis</td>
</tr>
<tr>
<td>46 = Tendinosis</td>
</tr>
<tr>
<td>47 = Tendonitis</td>
</tr>
<tr>
<td>48 = Tenosynovitis</td>
</tr>
<tr>
<td>99 = Miscellaneous</td>
</tr>
</tbody>
</table>

Statistical Analysis

Descriptive statistics were performed in SAS Enterprise Guide software, Indianapolis, IN. These statistics were reported with 95% CIs.

Injury rates were calculated for overuse conditions in youth football and high school football. Injury rates were calculated using the formula: IR = (# of injuries/athlete exposures * 10 000). Our rate was based on 10 000 AEs to allow comparison across several studies using the same denominator. Injury rate ratios (IRRs) compared the difference between IR (eg, youth football vs. high school football), IRR = Rate_a/Rate_b,
where $\text{Rate}_a$ is the injury rate for the first group and $\text{Rate}_b$ is the injury rate for the second group.\textsuperscript{36}

Injury risk is the proportion of athletes who have had at least one injury during a fixed period of time.\textsuperscript{48} For this study, we examined pooled one-season injury risks, that is, the proportion of athletes sustaining at least one injury within one football season.

The number of athletes comprising the denominator for the risk was calculated in the YFSS from the number of athlete-seasons. For NATION, we did not have information on the exact number of athlete-seasons per year. Thus, we utilized football team participation statistics from the National Federation of State High School Associations (NFHS). Risk ratios compared risks between youth football and high school football.\textsuperscript{48}

RESULTS

During the 2012 and 2013 seasons, 1488 injuries were reported to the YFSS, of which 53 (3.6\%) were overuse conditions. The NATION reported 12,013 injuries, of which 339 (2.8\%) were overuse conditions (Table 3).

Rates

Youth football accumulated 142,536 AEs, leading to an overuse condition injury rate of 3.72 per 10,000 AEs (95\% CI: 2.72-4.72) (Table 3). High school football accumulated 8,625,023 AEs, leading to an overuse condition injury rate of 3.93 per 10,000 AEs (95\% CI: 3.51-4.35). The overuse condition injury rate was slightly higher in high school than youth, but was not significant (IRR = 1.06; 95\% CI: 0.79-1.41).
Table 3. Injury Rates in Youth and High School Football

<table>
<thead>
<tr>
<th>Level</th>
<th>Injury Count</th>
<th>% of All Injuries in Dataset</th>
<th>AE</th>
<th>Rate per 10 000 AE (95% CI)</th>
<th>Rate Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Youth</td>
<td>53</td>
<td>3.7%</td>
<td>142 536</td>
<td>3.72 (2.72-4.72)</td>
<td>1.00</td>
</tr>
<tr>
<td>High School</td>
<td>339</td>
<td>2.8%</td>
<td>8 625 023</td>
<td>3.93 (3.51-4.35)</td>
<td>1.06 (0.79-1.41)</td>
</tr>
</tbody>
</table>

Abbreviation: AE, athlete-exposure; CI, confidence interval.

Risk

During the 4092 youth athlete seasons, 43 athletes reported overuse conditions, yielding a risk of 1.05% High school athletes were estimated to have accumulated 11 957 athlete-seasons, during which 318 athletes reported overuse conditions (risk = 2.66%). The one-season risk of overuse conditions in high school football had a statistically significant greater risk than youth football (RR = 2.53; 95% CI: 1.84-3.47, P < .05).

Time-Loss

Most overuse condition injuries were non-time loss injuries (< 24 h) in both youth football (n = 44; 83%) and high school football (n = 227; 67%) (Table 4). The proportion of overuse condition injuries that were non-time loss was statistically significantly lower in high school than youth football (IPR = 0.81; 95% CI: 0.70-0.93). There were no statistically significant differences in any time-loss injury proportions between youth and high school football.
Table 4. Injury Time-Loss in Youth and High School Football

<table>
<thead>
<tr>
<th>Injury Type</th>
<th>Youth</th>
<th>High School</th>
<th>IPR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;24 hours (NTL)</td>
<td>44 (83.0)</td>
<td>227 (67.0)</td>
<td>1.24 (1.07-1.43)*</td>
</tr>
<tr>
<td>1 to 6 days</td>
<td>6 (11.3)</td>
<td>38 (11.2)</td>
<td>1.01 (0.45-2.27)</td>
</tr>
<tr>
<td>7 to 13 days</td>
<td>1 (1.9)</td>
<td>25 (7.4)</td>
<td>3.91 (0.54-28.24)</td>
</tr>
<tr>
<td>14 to 29 days</td>
<td>1 (1.9)</td>
<td>12 (3.5)</td>
<td>1.88 (0.25-4.02)</td>
</tr>
<tr>
<td>30+ days</td>
<td>1 (1.9)</td>
<td>34 (10.0)</td>
<td>5.32 (0.74-38.02)</td>
</tr>
<tr>
<td>Missing</td>
<td>0</td>
<td>3 (0.9)</td>
<td>---</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>53 (100.0)</td>
<td>339 (100.0)</td>
<td>1.00 (1.00-1.00)</td>
</tr>
</tbody>
</table>

Abbreviation: NTL, non-time loss; IPR, injury proportion ratio.
• \( P < .05 \).

**Body Part**

A statistically significant smaller proportion of overuse condition injuries were to the lower extremity in high school (212; 62.5%) than youth football (49; 92.5%) (IPR = 0.68; 95% CI: 0.60-0.76) (Table 5). The proportion of overuse condition injuries to the upper extremity upper extremity overuse conditions was significantly higher in high school (74; 21.8%) than youth football (2; 3.8%) (IPR = 5.78; 95% CI: 1.46-22.86).
Table 5. Injury Body Part in Youth Football and High School Football

<table>
<thead>
<tr>
<th>Body Part</th>
<th>Youth</th>
<th>High School</th>
<th>IPR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head/face/neck</td>
<td>0</td>
<td>13 (3.8)</td>
<td>---</td>
</tr>
<tr>
<td>Head/face</td>
<td>0</td>
<td>1 (0.3)</td>
<td>---</td>
</tr>
<tr>
<td>Neck</td>
<td>0</td>
<td>12 (3.5)</td>
<td>---</td>
</tr>
<tr>
<td>Upper extremity</td>
<td>2 (3.8)</td>
<td>74 (21.8)</td>
<td>5.78 (1.46-22.86)*</td>
</tr>
<tr>
<td>Shoulder</td>
<td>0</td>
<td>51 (15.0)</td>
<td>---</td>
</tr>
<tr>
<td>Arm/elbow</td>
<td>1 (1.9)</td>
<td>11 (3.2)</td>
<td>1.72 (0.23-13.05)</td>
</tr>
<tr>
<td>Hand/wrist</td>
<td>1 (1.9)</td>
<td>12 (3.5)</td>
<td>1.88 (0.25-14.13)</td>
</tr>
<tr>
<td>Trunk</td>
<td>2 (3.8)</td>
<td>40 (11.8)</td>
<td>3.13 (0.78-12.56)</td>
</tr>
<tr>
<td>Vertebral/Paraspinal</td>
<td>2 (3.8)</td>
<td>3 (0.9)</td>
<td>4.26 (0.73-24.93)</td>
</tr>
<tr>
<td>Abdominothoracic</td>
<td>0</td>
<td>37 (10.9)</td>
<td>---</td>
</tr>
<tr>
<td>Lower extremity</td>
<td>49 (92.5)</td>
<td>212 (62.5)</td>
<td>1.48 (1.32-1.65)*</td>
</tr>
<tr>
<td>Hip/Pelvis</td>
<td>1 (1.9)</td>
<td>76 (22.4)</td>
<td>11.88 (1.69-83.64)*</td>
</tr>
<tr>
<td>Thigh/upper leg</td>
<td>1 (1.9)</td>
<td>16 (4.7)</td>
<td>2.50 (0.34-18.47)</td>
</tr>
<tr>
<td>Knee</td>
<td>21 (39.6)</td>
<td>54 (15.9)</td>
<td>2.49 (1.65-3.76)*</td>
</tr>
<tr>
<td>Lower leg/Achilles</td>
<td>16 (30.2)</td>
<td>43 (12.7)</td>
<td>2.38 (1.45-3.91)*</td>
</tr>
<tr>
<td>Ankle</td>
<td>0</td>
<td>5 (1.5)</td>
<td>---</td>
</tr>
<tr>
<td>Foot/toes</td>
<td>10 (18.9)</td>
<td>0</td>
<td>---</td>
</tr>
<tr>
<td>Total</td>
<td>53 (100.0)</td>
<td>339 (100.0)</td>
<td>1.00 (1.00-1.00)</td>
</tr>
</tbody>
</table>

* P < .05.

Injury Diagnosis

The distribution of injury diagnoses varied between youth and high school football. The most common injury diagnoses in youth football were tendinopathy (18; 34%), general inflammatory conditions (11; 20.8%) and knee pain (6; 11.3%) (Table 6). The most common injury diagnoses in high school football were strains (174; 51.3%), general inflammatory conditions (24; 7.1%), and tendinopathy (21; 6.2%).
Table 6. Injury Diagnoses in Youth Football and High School Football

<table>
<thead>
<tr>
<th>Injury Diagnosis</th>
<th>Youth</th>
<th>High School</th>
<th>IPR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arthritis/Chondromalacia</td>
<td>0</td>
<td>6 (1.8)</td>
<td>---</td>
</tr>
<tr>
<td>Bursitis</td>
<td>3 (5.7)</td>
<td>5 (1.5)</td>
<td>3.84 (0.94-15.59)</td>
</tr>
<tr>
<td>Capsulitis</td>
<td>0</td>
<td>2 (0.6)</td>
<td>---</td>
</tr>
<tr>
<td>Compartment syndrome</td>
<td>0</td>
<td>5 (1.5)</td>
<td>---</td>
</tr>
<tr>
<td>Effusion</td>
<td>0</td>
<td>4 (1.2)</td>
<td>---</td>
</tr>
<tr>
<td>Entrapment/Impingement</td>
<td>0</td>
<td>6 (1.8)</td>
<td>---</td>
</tr>
<tr>
<td>Exostosis</td>
<td>1 (1.9)</td>
<td>2 (0.6)</td>
<td>3.20 (0.30-34.66)</td>
</tr>
<tr>
<td>General inflammatory conditions</td>
<td>11 (20.8)</td>
<td>24 (7.1)</td>
<td>2.93 (1.53-5.63)</td>
</tr>
<tr>
<td>General joint instability</td>
<td>1 (1.9)</td>
<td>30 (8.8)</td>
<td>4.69 (0.65-33.67)</td>
</tr>
<tr>
<td>Knee pain</td>
<td>6 (11.3)</td>
<td>1 (0.3)</td>
<td>38.38 (4.71-312.51)</td>
</tr>
<tr>
<td>Low back pain</td>
<td>2 (3.8)</td>
<td>12 (3.5)</td>
<td>1.07 (0.25-4.63)</td>
</tr>
<tr>
<td>Lumbar facet syndrome</td>
<td>0</td>
<td>2 (0.6)</td>
<td>---</td>
</tr>
<tr>
<td>Lumbosacral disc injury</td>
<td>0</td>
<td>3 (0.9)</td>
<td>---</td>
</tr>
<tr>
<td>Nervous system</td>
<td>0</td>
<td>2 (0.6)</td>
<td>---</td>
</tr>
<tr>
<td>Osteochondritis</td>
<td>0</td>
<td>1 (0.3)</td>
<td>---</td>
</tr>
<tr>
<td>Patellofemoral pain syndrome</td>
<td>1 (1.9)</td>
<td>2 (0.6)</td>
<td>3.20 (0.30-34.66)</td>
</tr>
<tr>
<td>Scapulothoracic dysfunction</td>
<td>0</td>
<td>1 (0.3)</td>
<td>---</td>
</tr>
<tr>
<td>SI dysfunction</td>
<td>1 (1.9)</td>
<td>6 (1.8)</td>
<td>1.07 (0.13-8.68)</td>
</tr>
<tr>
<td>Spasm</td>
<td>0</td>
<td>2 (0.6)</td>
<td>---</td>
</tr>
<tr>
<td>Sprain</td>
<td>0</td>
<td>6 (1.8)</td>
<td>---</td>
</tr>
<tr>
<td>Strain</td>
<td>4 (7.5)</td>
<td>174 (51.3)</td>
<td>6.80 (2.64-17.55)*</td>
</tr>
<tr>
<td>Stress fracture</td>
<td>1 (1.9)</td>
<td>13 (3.8)</td>
<td>2.03 (0.27-15.22)</td>
</tr>
<tr>
<td>Synovitis</td>
<td>0</td>
<td>1 (0.3)</td>
<td>---</td>
</tr>
<tr>
<td>Tendinopathy</td>
<td>18 (34.0)</td>
<td>21 (6.2)</td>
<td>5.48 (3.13-9.59)*</td>
</tr>
<tr>
<td>Other</td>
<td>4 (7.5)</td>
<td>8 (2.4)</td>
<td>3.20 (1.00-10.25)</td>
</tr>
<tr>
<td>Total</td>
<td>53 (100.0)</td>
<td>339 (100.0)</td>
<td>1.00 (1.00-1.00)</td>
</tr>
</tbody>
</table>

* P < .05.

DISCUSSION

This study is the first to our knowledge to compare the rates, risks and distributions of overuse conditions between youth football and high school football. It is also the first study to include non-time loss injuries into the estimation of overuse conditions in football. Prior studies limited overuse conditions to those resulting in a
time loss from participation, as well as tracked overuse conditions by a specific body part.\textsuperscript{13–18,22,26,35,38,43,45,49} This study found numerous overuse patterns and differences between the two levels of competition.

**Rates**

The rates between youth football (3.72 per 10 000 AEs) and high school football (3.93 per 10 000 AEs) were not significantly different. This lack of difference may be a result of the number of youth athletes that suffered more than 1 overuse condition (10; 19%) compared to high school athletes (21; 6%), allowing for a higher injury count in youth football. Our overuse rate in high school football (3.93/10 000 AEs) was significantly higher than Roos et al, 2015 (1.35/10 000 AEs) and Schroeder et al, 2015 (1.27/10 000 AEs).\textsuperscript{18,45} This is likely attributed to the inclusion of non-time loss injuries into our study.

**Risks**

Our findings suggest that, high school football athletes have an approximate 150% greater risk of sustaining an overuse condition than youth football athletes (RR, 2.53; 95% CI: 1.84-3.47). Prior studies theorized that participating in a higher level of competition increases the risk of overuse conditions because the intensity of sports training is greater.\textsuperscript{13,45} Higher-level athletes typically have additional years of sports participation, resulting in more exposures to repetitive stresses as well as more diagnosed injuries.\textsuperscript{7,45}
**Time-Loss**

Our results found a higher percentage of non-time loss injuries in youth (83%) compared to high school football (67%) (IPR = 1.24 (1.07-1.43). High school football reported more severe injury diagnoses, i.e. stress fractures and joint instability (43; 10.9%) than youth football (2; 3.8%) resulting in a greater amount of time-loss injuries. Also, youth football teams practice on average 1-2 times per week, whereas high school football teams usually practice throughout the week. The increase time-off between practices may affect the number of youth athletes reporting a time loss injury of at least 1 day. Our proportion of non-time loss overuse conditions in youth football (83%) was significantly higher than the proportion of overall non-time loss injuries in Dompier et al, 2007 (58.6%) and Beachy et al, 2014 (61%). However, our proportion of high school NTL overuse conditions (67%) was considerably lower than the overall estimates of NTL injuries in NATION’s injury surveillance programs (82%).

**Body Part**

Our data showed more overuse conditions occurred to the lower extremity in youth athletes (92.5%) than high school athletes (62.5%). This is likely attributed to the proportion of upper body overuse injuries in high school football (21.8%) compared to youth football (3.8%). It is speculated that high school football has more upper body injuries than youth football because of the intensive style of play leading to more upper body collisions in high school, and a greater emphasis on upper-body strength training at the high school level. The percentage of high school football overuse conditions to the lower extremity was marginally smaller than lower extremity overuse conditions across
all sports (70.4%). Overuse lower extremity injuries were significantly higher in both levels than the overall proportion of lower extremity injuries in youth football (38.3%) and high school football (46.9%). As a result, a greater emphasis on reducing repetitive lower body motions in practice is needed.

**Injury Diagnosis**

At the youth level, tendinopathy (34%) injuries were the most occurring overuse injury diagnosis, while the most frequent injury diagnosis at the high school level was muscle strain (51.3%). The higher proportion of tendinopathy injuries in youth football may be a result of a higher risk for tendon related growth plate injuries such as Osgood Schlatters and Severs Disease in youth athletes. These pathologies occur when the growth plate is still open (up to 15-16 years old in males) and can be misdiagnosed as tendinopathy.

Our results revealed a large percentage of overuse conditions were reported as strains (51.3%) in high school. The percentage of high school overuse strains in our study was larger than Roos et al, 2015 study (33%) and Shankar et al, 2007 (16.5%). However, these studies examined all high school sports while our study just factored in high school football. A higher proportion of muscle strains in high school athletes is theorized to be due to the higher level of sports training, leading to greater rates of muscle fatigue, which is a risk factor for muscle strains.

**Clinical Implications**

Although the incidence of overuse conditions was low, numerous overuse injury patterns and differences exist between the two levels of competition. ATs working in the
high school setting can expect a higher risk for overuse conditions than ATs working in the youth level. A previous study revealed that football had a higher proportion of acute injuries (89%) than overuse injuries (11%). This shows that overuse conditions do not present a primary concern in football relative to other sports. Still, the etiology of certain acute injuries may stem from underlying overuse mechanisms (stress, fatigue, chronic overload), thus warranting a need for ATs to create and implement overuse injury preventative strategies.

**Limitations**

Our study had several limitations. Currently, there is no standardized clinical definition for overuse conditions. Studies have defined overuse injuries as a mechanism of injury, injury diagnosis, or both.⁴⁹ The lack of a standardized clinical definition has allowed for variations of reporting overuse conditions to possibly occur. Also, the level of experience of ATs differed by team and level of competition. This may have contributed to the reporting and quality of the data collected. Another limitation was how the sample of high schools and youth football programs were included into the injury surveillance programs. Although they were collected from multiple sites across the United States, this data may not be generalizable to all youth football leagues and high school football programs in the country. The frequency of overuse conditions across the two levels of competition may have been influenced by several factors. The style of gameplay between the two levels may have perpetuated a higher risk for overuse conditions. Also, high school athletes may report more injuries to a medical professional because they have more experience recognizing an injury.
Future Research

Further research should examine overuse conditions for all youth and high school sports. These findings may allow for injury prevention strategies to target those sports with a high risk for overuse conditions. Additional research could also examine the role etiological risk factors such as: anatomic malignancies, flexibility, overscheduling, and poor fitting equipment have on the risk for overuse conditions.

Conclusion

Overuse conditions are not a primary concern in youth and high school football, however there is a greater risk for overuse conditions at the high school level than the youth level. This is likely attributed to the higher intensity of sports training at the high school level, as well as more years of sports participation, accumulating more repetitive stresses and more diagnosed injuries compared to youth athletes. The statistics reported in this study will provide healthcare professionals the information needed to create overuse injury preventative strategies at the youth and high school football level.
References


Chapter 4: Conclusion

Though the proportion of overuse injuries in youth and high school football was low, this study discovered that as an athlete transitions from youth to high school football, a significant risk of overuse conditions ensues. Prior studies theorized that the higher intensity of sports training and more exposures to repeated stresses contribute to the increase risk for overuse conditions at the high school level. Pediatric athletes are more susceptible to overuse conditions because they’re less resilient to the tensile and compressive forces applied during physical activity.

With the inclusion of non-time loss injuries, our study is the most comprehensive study on overuse conditions in football. It is also the only epidemiological study examining overuse conditions in youth football. Prior studies that have examined overuse conditions in youth sports have underestimated the frequency of overuse conditions by only accounting for injuries resulting in a time-loss from participation. Our study provides data on overuse conditions in youth football and high school football. The information collected can be used by healthcare professionals to develop overuse injury prevention programs.
References


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82. Emery CA, Cassidy JD, Klassen TP, Rosychuk RJ, Rowe BH. Effectiveness of a home-based balance-training program in reducing sports-related injuries among


85. Fainaru S, Fainaru-Wada M. Youth football participation drops.


86. National Federation of State High Schools Association. High school sports participation increases for 26th consecutive year.


Appendix A: Specific Aims

Over 60 million athletes participate in organized youth sports across the country.\textsuperscript{109} Sports provide valuable life skills including social and leadership development, as well as promote a healthy lifestyle through exercise. Unfortunately youth sports injuries are rising and with it decreasing youth sports participation. Pop Warner, the largest youth football program in the country, saw football participation rate decrease by 9.5\% between 2010 to 2012.\textsuperscript{85} A recent survey revealed that 87\% of respondents were worried about the risk of injury in youth sports and over 82\% of respondents considered keeping their child out of football for fear of injury.\textsuperscript{3,110}

Next to traumatic brain injuries, one of the biggest concerns facing youth sports today are the rise in overuse conditions. Studies have estimated over 50\% of youth sports injuries are overuse conditions, and more than half of these injuries are considered easily preventable.\textsuperscript{6–8} These conditions are the result of repeated stresses to an area with adequate time for rest to occur.\textsuperscript{6} Youth athletes are more susceptible to overuse conditions due to their immature musculoskeletal systems.\textsuperscript{103}

Numerous epidemiological studies have examined injuries in youth and high school football, however limited research has studied the overall incidence of overuse conditions in sports.\textsuperscript{29–62} The only published studies on overuse conditions in high school football computed an overuse injury rate of 1.35 per 10 000 AEs and 1.27 per 10 000 AEs.\textsuperscript{35,62} However, these studies have underestimated the magnitude of overuse conditions by only accounting for injuries resulting in a time-loss from participation. This study will examine the rates, risks, and distribution of overuse conditions in youth football and high school football.

It is important to compare overuse conditions across different levels of football to determine any patterns or differences between the two levels of competition and associated age group. This study will hope to provide data on overuse conditions in youth football and high school football that can be used to develop overuse injury prevention programs.

This study aims to calculate and compare:

1) The proportion of injuries that are overuse in youth football and high school football.
2) The injury rate of overuse injuries in youth football and high school football
3) The injury risk of overuse injuries in youth football and high school football
4) The distribution of injury time loss in overuse injuries in youth football and high school football
5) The distribution of overuse injuries by body part location in youth football and high school football
6) The distribution of overuse injuries by injury type in youth football and high school football
Appendix B: Data Collection Letter of Support

Letter of Support:

October 13, 2015

Chad Starkey, PhD, AT, FNATA Professor, Athletic Training Division Coordinator School of Applied Health Sciences and Wellness College of Health Sciences and Professions Ohio University E146 Grover Center Athens, OH 45701

Dear Dr. Starkey:

This letter is to confirm the support of the Datalys Center for Sports Injury Research and Prevention for the project, tentatively titled: Overuse and Inflammatory Conditions in Youth and High School Football, submitted by Mr. Kevin Morris, a graduate student in your department. It is our understanding that Dr. Simon and you will supervise Mr. Morris on this project with external collaboration from Dr. Zachary Kerr from the Datalys Center.

We think this research will ultimately be of benefit to the scientific community and help the Datalys Center’s mission to promote health and physical activity through safer sports. Please note, the methods used to collect these data have been previously ruled exempt from review for the protection of human subjects by the Western Institutional Review Board, of Puyallup, WA. I have included a copy of the letter of determination for your convenience.

If you have any additional questions, please do not hesitate to contact me at (317) 275-3664. Best,

Thomas P. Dompier, PhD, ATC

[Signature]
Appendix C: IRB Exemption Letter

Thomas P. Dompier, PhD
Datalys Center for Sports Injury Research and Prevention
Suite 500
401 West Michigan Street Indianapolis, Indiana 46202

Dear Dr. Dompier:

SUBJECT REGULATORY OPINION IRB EXEMPTION

Protocol Title: National Athletic Trainers' Association Secondary School Injury Surveillance and Outcomes System (NATA NATIONAL)

Project One: Time Loss and Non-Time Loss Injuries in Secondary School Sports

Investigator: Thomas P. Dompier, Ph.D., ATC

This letter is in response to your request for an opinion as to whether your research, "National Athletic Trainers' Association Secondary School Injury Surveillance and Outcomes System (NATA NATIONAL); Project One: Time Loss and Non-Time Loss Injuries in Secondary School Sports," would constitute human subject research requiring IRB review. This opinion is based on federal regulation 45 CFR 46 and associated guidance.

In accordance with the regulation and guidance, the use of coded information is not research involving human subjects and thus does not require IRB review. The following is the basis for this opinion.

Federal regulation 45 CFR 46.102(f) defines a human subject as-

Human subject means a living individual about whom an investigator (whether professional or student) conducting research obtains

(1) Data through intervention or interaction with the individual, or (2) Identifiable private information.

In guidance entitled, Guidance on Research Involving Coded Private Information or Biological Specimens, OHRP explains when research involving coded private information or biological specimens would not be considered to involve human subjects.
For example, OHRP does not consider research involving only coded private information or specimens to involve human subjects as defined under 45 CFR 46.102(f) if the following conditions are both met:

(1) the private information or specimens were not collected specifically for the currently proposed research project through an interaction or intervention with living individuals; and

Western Institutional Review Board

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Office: (360) 252-2500 I Fax: (360) 252-2498 I www.wirb.com

Thomas P. Dompier, PhD August 18, 2011

(2) the investigator(s) cannot readily ascertain the identity of the individual(s) to whom the coded private information or specimens pertain because, for example:

(a) the investigators and the holder of the key enter into an agreement prohibiting the release of the key to the investigators under any circumstances, (note that HHS regulations do not require the IRB to review and approve this agreement);

(b) there are IRB-approved written policies and operating procedures for a repository or data management center that prohibit the release of the key to the investigators under any circumstances, until the individuals are deceased; or

(c) there are other legal requirements prohibiting the release of the key to the investigators, until the individuals are deceased.

This protocol meets these requirements. First, the information that would be involved in this research was not collected specifically for the currently proposed project; rather the information was collected as part of the normal practices of trainers and schools. Second, you have confirmed that the investigators and the holder of the key to the coded samples have entered into an agreement prohibiting the release of the key to the investigators under any circumstances. Therefore WIRB has determined this is not research involving "human subjects."

This determination that this research does not involve human subjects can apply to multiple sites, but it does not apply to any institution that has an institutional policy of requiring an entity other than WIRB (such as an internal IRB) to make such determinations. WIRB cannot provide a determination that overrides the jurisdiction of a
local IRB or other institutional mechanism for making such determinations. You are responsible for ensuring that each site to which this determination applies can and will accept WIRB's determination.

Please note that any future changes to the project may affect its status as research that does not involve human subjects, and you may want to contact WIRB about the effect these changes may have on the status before implementing them. WIRB does not impose an expiration date on its determinations of research that does not involve human subjects.

If you have any questions, or if we can be of further assistance, please contact WIRB Regulatory Counsel, Troy M. Brinkman, J.D., M.A. at 360-252-2837, or e-mail RegulatoryAffairs@wirb.com.

Sincerely,

Troy Brinkman, J.D., M.A

WIRB Regulatory Counsel

TMB:jmgg

Coded Data - Exemption-Dompier (08-18-2011)