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Epidemiology of Concussive Injuries in Collegiate Recreational Athletics

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EPIDEMIOLOGY OF CONCUSSIVE INJURIES IN COLLEGIATE RECREATIONAL ATHLETES

by

MADDISON FLOWERS

(Under the Direction of Tamerah Hunt)

ABSTRACT

Background: The epidemiology of concussion in collegiate and high school athletes has been extensively researched. Concussive injury in collegiate recreation, a less supervised sample, is limited. This preliminary study retrospectively examined the incidence and prevalence rates of concussive injuries in intramural and club sports at one institution. Methods: Injury reports were analyzed during the 2016-2019 calendar years. Concussion prevalence, incidence, and odds ratios (reported with 95% CIs) were calculated for intramural and club sports. Results: During the study period, a total of 805 injuries were reported between intramural and club sports with 111 injuries being documented as concussions. Intramural sports concussion prevalence averaged a rate of 2.77 per 1,000 unique participants while the incidence for both intramural and club sports was 13.79%. Females (2.58; 95% CI, 1.623-3.722), club lacrosse (8.923; 95% CI, 0.906-87.84), and club ultimate frisbee (7.83; 95% CI, 1.02-60.114) resulted in having higher odds of sustaining a concussion. Conclusion: Concussion prevalence and incidence was higher in this sample compared to high school and NCAA athletes. The high incidence of concussion paired with lack of medical care may result in poor outcomes in this population. Future research should replicate and expand to ensure increased rates are generalizable.

INDEX WORDS: Intramural sports, Club sports, Collegiate recreation, Concussion

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ATHLETES

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MADDISON FLOWERS

B.S., University of South Carolina, 2019

M.S., Georgia Southern University, 2021

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MASTER OF SCIENCE

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CHAPTER ONE

INTRODUCTION

Interest in recreational sports (i.e., club sports, intramurals) have been on the rise. With the help of organizations such as the National Intramural and Recreational Sports Association (NIRSA), now known as Leaders in Collegiate Recreation, affiliated institutions have been able to serve an estimated 8.1 million students in the United States and Canada combined.¹ While involvement in NIRSA is not a requirement, colleges and universities that are officiated are able to offer educational, developmental, and networking opportunities for their intramural and club sports members as well as their recreational student and professional staff.² Recreation includes both intramural and club sports which are student run organizations but have unique governing bodies, leagues, and tournaments.^{3,4} Club or intramural sports can serve as recreational alternatives to their institution's varsity counterparts. In addition, collegiate recreation can serve as the highest level of competition for sports not supported by collegiate athletics (e.g., ultimate frisbee, quidditch, rugby).³ During the 2014-2015 academic year, Copp et al. reported that the typical NIRSA officiated collegiate institution offered around 20 intramural and 20 club sports.⁵ This resulted in approximately 1,000 games annually.⁵ With this increase in interest and participation, there is an expected increase in injury rates in recreational athletes.⁴

While sports offered by recreational programs are similar to those offered at both the collegiate and high school level, the collegiate recreational population is severely underserved. Most notably, club and intramural sports have limited access to standardized medical supervision and no universal injury surveillance system is used.^{3,5-7} Without oversight of a governing body, recreational programs fail to report the physical presence of healthcare professionals during club and intramural games.³⁻⁴ Only 35% of programs report having access to an athletic trainer.⁶ This

reduced access leaves participants vulnerable and ultimately responsible for their own injury recognition and management. Placing this responsibility in the care of the participant or even a recreational student employee is potentially dangerous considering the background education and knowledge of healthcare clinicians as well as the possibility of underreporting for more complex injuries such as concussions.^{5,8} Many high school and collegiate athletes do not report concussive injuries because athletes may not perceive the injury to warrant medical attention.⁸⁻¹² Not to mention, the athlete may fear being removed from play and ultimately losing playing time.⁸⁻¹² Additionally, Wallace et al. found that high schoolers without access to athletic trainers were more likely to not report concussive injuries for these same reasons.¹⁰ Understanding that athletes are predisposed to underreporting, it is important to understand injury numbers to make comparisons and provide evidence to make appropriate changes.

Given there is no current standardized injury surveillance database, widespread injury rates in college recreation is difficult. While national systems such as the National Health Interview Survey (NHIS) and the National Electronic Injury Surveillance System (NEISS) are helpful, comparisons to collegiate aged individuals is cumbersome because the injury data reported to these systems includes patients from adolescence to adults.^{13,14} Data on injury rates in the collegiate recreational population is very limited. Among the few studies available, club sports resulted in an injury rate of 18.3 injuries per 1,000 sport interactions whereas intramural sports saw 10.28 injuries per 1,000 sport interactions.⁷ Whereas, NCAA sports had 13.79 injuries per 1,000 sport interactions.⁷ Other researchers found, among intramural options (n=8), floor hockey, soccer, basketball, and softball to have higher injury rates.¹⁵ While these studies provide descriptive data on injury rates in the recreational population, these data lack sufficient insight to

type and severity of injury. Their lack of detail creates a challenge when attempting to understand risk of concussions.

As research has developed over the years, the understanding of concussions has evolved as well. While there are multiple variations of the definition of concussions, based upon their training, the healthcare professional chooses what definition is most appropriate for their setting to guide their practice.¹⁶⁻¹⁸ Commonly, athletic trainers look to the National Athletic Trainers' Association (NATA) Position Statement and utilize the following definition: "a trauma induced alteration in mental status that may or may not involve loss of consciousness."¹⁸ Additionally, this position statement can help athletic trainers to determine their next steps including rapid identification, initial care, and conducting an appropriate return to activity protocol.^{16,18-20} When adequately trained healthcare providers are not present, these responsibilities are then placed on the participants and the recreational student workers. While this situation is not ideal, the implications of these actions are unknown due to lack of epidemiological injury information regarding club and intramural sports.

Concussions are complex injuries that have recently been spotlighted in mainstream media. This is coupled with an increased interest from researchers. Collectively, this has led to a need to better track concussive injury in both the collegiate and high school populations. Hootman et al. longitudinally examined 15 NCAA sports over 16 years and found over 9,000 documented concussions. These sports averaged 563 concussions per year and noted an average annual increase in the overall rate of concussions.²¹

Researchers have used high school surveillance to discover that the following sports commonly report the greatest rate of concussions: football, women's rugby, women's soccer, wrestling, women's volleyball, and men's lacrosse.^{19,22-24} It is important to note that the number

of and type of activities offered by both college and high school are similar to those offered by collegiate recreational programs. Research suggests that concussions represent 8.9% of all high school athletic injuries and 5.8% of all collegiate athletic injuries.²⁵ Based upon the lack of accessible data, we would have a similar expectation for collegiate recreational athletic injuries. However, research has begun to examine factors that could influence concussive incidence rates including sex, contact, and sport.

Recently, to identify risk factors for concussion, researchers have focused on participant characteristics such as sex, sport type, and contact levels. Studies have shown that females at both the high school and collegiate level have a higher concussion rate when compared to their male counterparts.^{12,22,26-28} When analyzing sex comparable sports, differences in concussive injury rate has been noted to be as great as 56% higher in females than males.²² These sex comparable sports commonly include soccer, basketball, and ice hockey.²⁶⁻²⁸ While sex is often studied to examine incidence rates across numerous injuries, researchers have found evidence that most sport related concussions as a result of contact either with another player, a playing surface, or an apparatus.^{22,28,29}

In both high school and collegiate studies, player-to-player contact has shown to be the most common mechanism and has accounted for approximately 60 and 70 percent of all concussive injury mechanisms.^{22,29} Additionally, higher concussive injury incidence rates have been attributed to increased intensity and body contact during competition as compared to practices.²⁶ A study conducted by Kerr et al. in youth football players, found that when players were grouped by skill the overall concussion rate was greater than when the players were grouped by physical size.³⁰ Students participating in collegiate recreation will, in theory, have

variable physical size and skill.⁴ Understanding the interaction of these factors will benefit collegiate recreation departments and participants alike.

Current research regarding concussions shows that these injuries can result in long term consequences that can potentially be catastrophic. It is also known that while information regarding the seriousness of concussions have begun to be highlighted by mainstream media and educational initiatives, high school and collegiate athletes commonly underreport concussive injuries for a variety of reasons.⁸⁻¹² While we may assume that concussive injury rates would look similar to those at the high school and collegiate level, little research is available that has shown club sports can result in a higher overall injury incidence rate than NCAA.^{7,25} The level at which these catastrophic injuries are occurring as well as their potential effects remains unknown. The purpose of this preliminary study is to examine incidence and prevalence rates of concussive injuries in intramural and club sports. Secondly, this study will attempt to identify risk according to; sex, sport, and contact level within a University's recreation department.

CHAPTER TWO

REVIEW OF LITERATURE

Introduction

College and university recreation centers across the United States are associated with the National Intramural and Recreational Sports Association, also known as NIRSA, which includes club and intramural sports.² Club and intramural sports are both student run organizations with governing bodies and are sponsored by recreational professionals.^{3,31} Each of these organizations have various opportunities for their participants, but they are severely missing the presence of healthcare professionals.^{3,6} Limited research exists concerning collegiate recreation however, of the few studies conducted, only 35% of campus recreation directors reported having access to an athletic trainer for their club and intramural sport programs.^{3,6} Lack of healthcare access can lead to underreporting as well as a gap in the knowledge concerning injury rates, specifically concussion rates since there is no current national standard for management of sport related concussions for the collegiate recreational population.^{6,11} This becomes especially concerning when considering the diversity of skill and experience of individuals participating in club and intramural sports, potentially resulting in a collective increase of injuries.⁴ The specifics of this impact are unknown due to the gap in knowledge concerning injury surveillance for collegiate recreational sports.

Pierpoint et al. states that injury prevention largely benefits from ongoing monitoring of injury incidence and updated descriptives concerning epidemiology.³² Commonly used surveillance systems are the National Collegiate Athletic Association Injury Surveillance System (NCAA-ISS), the High School Reporting Information Online (HS-RIO), the National Health Interview Survey (NHIS), and the National Electronic Injury Surveillance System (NEISS). The

use of injury surveillance is of utmost importance when examining concussive injuries. While general information regarding sport related concussions is known globally, specifics concerning the collegiate recreational population is limited.¹¹ The limitation concerning concussion occurrence is that patients may not report an injury because they do not recognize their symptoms as an injury.¹² Herring et al. states that it is essential for the team physician and ultimately the healthcare professional closest to the participants to understand a multitude of aspects concerning concussion management from recognition to return to play and prevention.²⁰ These actions become difficult to accomplish when the presence of a healthcare professional is limited. This leaves the collegiate recreational population potentially more at risk because of the lack of healthcare professional presence and guidance to offer proper injury prevention and care especially concerning concussive injuries. This document will examine epidemiological research across multiple populations, relevant systems to complete epidemiological research, the most updated and relevant information concerning collegiate recreational sports as well as epidemiological studies involving concussions will be discussed in order to gain a better understanding for this topic and population.

Recreation

NIRSA, now referred to as Leaders in Collegiate Recreation, offers college and universities recreational alternatives for various sports and activities.² This change in tagline came with the adoption of a new mission statement in 2012.^{1,33} While much has changed since the first intramural conference in 1950, NIRSA remains to be a leader and an advocate for all things recreation, sport, and wellness.^{1,33} Since its founding, NIRSA has grown to serve nearly an estimated 8.1 million students in the United States (U.S.) and Canada combined.¹

Included in these offered activities are both intramural and club sports ². Club sports are defined as “a group of students that voluntarily organized to further their common interests in an activity through participation and competition.”³ Club sports have competitive leagues, governing bodies, as well as their individual national championships. ³ Depending on the institution, some recreation departments can even host the varsity team for traditional sports such as lacrosse and field hockey as well as non-traditional sports such as rugby, ultimate frisbee, and quidditch.³

The term intramural sport refers to “team, dual, or individual activities, tournaments, meets, and special events which are limited to participants and teams who come from within a specific institution.”³⁴ Intramural sports offer in-house leagues consisting of male, female, and co-recreational teams of students.³ These teams are then supported by recreational professionals who hire paid student staff that help oversee daily game operations and procedures.³ Campus recreation departments depend on these student workers to help their programs operate effectively and efficiently.³⁴ In return, these recreational staff students are offered multiple student development and leadership opportunities through various out-of-classroom learning experiences.³⁴ Overall, collegiate recreational sports teams are student run organizations that capture a large number of the campus population’s attention each year.^{4,5}

A 2014-2015 report conducted on 330 NIRSA affiliated schools revealed that on average, a collegiate institution offers approximately 20 intramural sports up to 1,000 games played annually.⁵ Additionally, these same institutions can offer an average of 20 club sports each year.⁵ While the exact number of participations in collegiate recreational sports can be difficult to calculate, NIRSA estimates 8.1 million students on over 700 campuses in both the U.S. and Canada.¹ Additionally, a study conducted during the 2014-2015 academic year discovered that

7.8 million high school students participated in sports.¹¹ From this group of students, only 6.2% would move on to compete on a varsity team at an NCAA institution.¹¹ The remaining individuals who did not move forward only make up a portion of the possible individuals who participate in recreational activities.

While the interest and availability of collegiate recreational sports continues to rise, there are still multiple limitations concerning this population. One limitation of this population is regardless of the league, recreation or competitive, limited regulation exists concerning the discrepancy in size, age, skill, and experience of the players competing against each other.⁴ This means larger individuals can be matched against smaller individuals, older individuals can be matched against younger individuals, and experienced players can be matched against amateurs.⁴ Using Kerr et al.'s study conducted on youth football players for reference where they compared injury rates in leagues grouped by age (skill) and those grouped by age and weight (physical size), these potential matchups can give rise to a dangerous environment ultimately resulting in an increase in patron injuries, especially for concussive injuries.^{4,30} Hootman et al. suggested that variability exists regarding intensity during practices and competitions and the same concepts can be applied to club and intramural sports.²¹ Following this rationale, Hootman et al. explained that the higher intensity of the sport activity was most likely an important factor contributing to higher injury rates in competitions compared to practices.²¹ Additionally, Hootman et al. noted that poorly conditioned athletes may react negatively to high-intensity and high-load activity potentially resulting in an excess of injuries.²¹ Understanding these findings, Arthur-Banning et al. discovered that while their sample of intramural injuries had the lowest rate during games, it can be argued that intensity of activity, level of competition, and participant ability may impact injury rates results.^{7,35} This idea comes from a study conducted by Luiggi et al. who found that

the injury risk associated with an increase in level of play was higher than those related to the hours of athlete exposure or type of sport.³⁵ Depending on the nature of the match-ups, it can be assumed that while intramural injury rates may be lower than that of their club sport counterparts, each sport program can be at high risk for injury.^{7,21} Although this is the assumption, due to the lack of healthcare presence, there is limited injury surveillance information regarding this population.

NIRSA is an organization that supports collegiate recreational programs, but it is still possible for institutions to not be a part of NIRSA and still host campus intramural and club sports.⁷ Keeping this in mind, a study conducted in 2008 found that only 35% of campus recreation directors at NIRSA institutions reported having access to an athletic trainer for their intramural and club sport programs.⁶ While this does include a large population of collegiate institutions, this statistic does not include non NIRSA affiliated schools. Additionally, Stier et al. conducted a survey regarding risk management policies, practices, and procedures for NIRSA affiliated institutions.⁴ Based on this study, researchers discovered only 1% of institutions who responded to the survey noted a requirement of physical examinations of all of their intramurals participants.⁴ This study also showed that both indoor and outdoor intramural sports were physically supervised by intramural student employees ~75% of the time.⁴ Of potential supervisors, there was no mention of physical supervision by certified healthcare professionals, including athletic trainers. This decreased presence of healthcare professionals results in the participants being responsible for any injury recognition, including concussion recognition, since there is no current standardization for injury monitoring and medical supervision or sport related concussion management for the recreational population.^{5,6,11} These combined limitations create

an unknown impact due to the limited information that has been recorded regarding injury epidemiology within the collegiate recreational population.

Epidemiology

Injury surveillance and updated epidemiological data are crucial for understanding and implementing appropriate and effective injury prevention efforts.^{32,36} Today, epidemiology is defined as “the study of the distribution and determinants of health related states or events in specified populations and the application of this study to the control of health problems.”³⁶ Additionally, sports injury epidemiology specifically aims to “examine the incidence and risk factors of and the preventative measures for injury occurring during sport related activities.”³⁶ By gathering this data, programs are able to gain a better understanding of common injury trends and ultimately better anticipate and potentially create policies and procedures to help prevent common injuries.¹⁵

Many different injury surveillance systems exist to collect and analyze data based on different populations.⁷ There are a multitude of injury surveillance systems in use for both research and non-research purposes, the two most commonly used and compared surveillance systems are the NCAA-ISS and the HS-RIO.^{21,37-43} In attempts to be consistent, the surveillance systems use the same definitions when determining injury, athlete exposure, and time loss. The definitions used are as follows; injury: (1) occurred as a result of participation in an organized intercollegiate practice or competition, (2) required medical attention by a team certified athletic trainer or physician, and (3) resulted in restriction of the student-athlete’s participation or performance for one or more calendar days beyond the day of injury. Athlete exposure is defined as (AE): one student-athlete participating in one practice or competition in which he or she was exposed to the possibility of athletic injury, regardless of the time associated with participation.

Time loss is defined as: the time between the original injury and return to participation at a level that would allow competition participation.^{21,37-43}

The NCAA-ISS dates back to 1982 and was created to collect relevant injury and exposure data from a NCAA representative sample.^{21,37} This information is then shared with NCAA sport and policy members in order to create appropriate evidence-based decisions regarding health and safety issues.³⁷ Using this surveillance system, researchers were able to discover that football had the highest rate of injury during competitions with 35.9 injuries per 1,000 AE, followed by wrestling who had 26.4 injuries per 1,000 AE, and baseball having the lowest competition injury rate of 5.8 injuries per 1,000 AE among men's sports.^{21,38,39,42,43} Researchers also found women's soccer, which was fourth overall for highest injury rates, had the highest competition injury rate with 16.4 injuries per 1,000 AE and softball had the lowest with 4.3 injuries per 1,000 AE among women's sports.^{21,39} Additionally, over a 16 academic year time frame from 1988 to 2004, researchers discovered that the greatest number of concussions were observed with fall men's football who reported 4,404 concussions overall, but this was not the sport that reported the highest rate of concussion.²¹ Higher concussion rates were observed with women's ice hockey who reported 0.91 concussions per 1,000 AE, spring men's football who reported 0.54 concussions per 1,000 AE, and women's soccer and men's ice hockey who reported 0.41 concussions per 1,000 AE each.²¹ Over these 16 years, researchers also noted a 7% annual increase of the rate of concussion injuries.²¹ Utilizing data gathered by the NCAA-ISS allows researchers and healthcare personnel to notice commonalities and trends in order to make appropriate decisions regarding athlete and participant safety for the future.

Similarly, the HS-RIO was developed in 2005 and was modeled after the NCAA-ISS to capture injury data from a random sample of high school athletes in the United States.³⁶

Understanding there is a greater number of high school athletes compared to collegiate athletes, it is important to note any injury incidence differences in order to make appropriate recommendations and changes that would best benefit the high school population.³⁶ Using this surveillance system, researchers were able to discover injury rates and trends specific to individual sports.^{23,32,38-42} For example, Pierpoint et al. discovered for high school men's lacrosse, the majority of injuries occurred during competitions and their most common injury was to players' head and face.³² Additionally, Kerr et al. discovered for high school men's soccer, the most common injury during competitions was concussion across all positions, and this injury mostly occurred due to contact with another player.⁴²

Researchers also use these injury surveillance systems to compare injury trends in NCAA sports versus their high school counterparts. Based off of these studies, researchers have discovered that competition injury rates were greater than practice injury rates for both high school and NCAA men's football, men's lacrosse, men's and women's basketball, and men's wrestling.^{32,38,40,41,43} Additionally, researchers are also able to look into injury trends in same sex sports.^{21,32,37-43} These comparisons include men's and women's basketball, soccer, lacrosse, and ice hockey.²¹ Understanding the data gathered from each of these surveillance systems, researchers and policy makers are able to determine the most appropriate, evidence-based decision regarding implementation of health and safety changes.^{21,37}

While NIRSA does not have its own injury surveillance system, a limited number of researchers have either conducted their own surveillance system for their campus' recreational population, or used a pre-existing national survey such as the National Health Interview Survey (NHIS) or the National Electronic Injury Surveillance System (NEISS) in efforts to gain more understanding concerning recreational related injuries.^{7,13-15} The NHIS was originally a face-to-

face health survey conducted by the National Center for Health Statistics.¹⁴ Today, the NHIS is a computer based personal interview system that collects information from an adult member of the family regarding medical injuries and poisoning episodes.¹⁴ Conn et al. utilized the NHIS to examine all the medically attended sports and recreation related injuries.¹⁴ Researchers from this study discovered males were most commonly injured while participating in basketball, football, or cycling while females most commonly reported being injured while participating in exercising, gymnastics/cheerleading, or basketball.¹⁴ Researchers also discovered that sprains and strains were the most frequently diagnosed injury followed by fractures.¹⁴ It is important to note that while this study lays a good foundation for understanding recreational related injuries, the subjects included in this study range from adolescent to adult making direct comparisons for the collegiate aged population difficult thus making it equally as difficult to implement change that would be most beneficial for this population.

Similarly, the NEISS is a product of the US Consumer Product Safety Commission that gathers information on patients who present with injuries to various emergency departments a part of a network of 100 hospitals.¹³ Yard et al. utilized the data within this database specific to rugby related injuries to conduct their study.¹³ From this dataset, researchers discovered that male rugby players resulted in a higher percentage of diagnosed facial injuries while female rugby players resulted in a higher percentage of diagnosed knee injuries.¹³ Additionally, rugby players older than the age of 18 had a higher percentage of facial injuries when compared to players 18 years of age or younger.¹³ Similar to Conn et al.'s study, Yard et al.'s population of rugby players ranged from 3 to 71 years of age thus making a direct comparison to collegiate recreational rugby more difficult.¹³

Although the NHIS and NEISS can be useful for gaining a base understanding concerning recreational sport related injuries, injury studies conducted using a collegiate recreation population are much more beneficial for creating comparisons. Comparison becomes difficult when access to injury rates are limited due to the absence of healthcare individuals, specifically athletic trainers, to diagnose and gather injury data. While this information is limited, one study completed surveillance on nine club sports over a two year academic period.⁷ Using the information collected from the campus' intramural accident reports as well as previously collected NCAA injury information, researchers were able to compare injury rates between the three.⁷ Researchers found that club sports had an injury rate of 18.3 per 1,000 sport interactions which was significantly greater than both NCAA with an injury rate of 13.79 per 1,000 sport interactions and intramural sports with an injury rate of 10.28 per 1,000 sport interactions.⁷ Additionally, researchers discovered that the injury rates for NCAA athletes were lower than the injury rates for club sport participants during competitions.⁷ Researchers suggested that this could be explained by club athletes potentially having less ability, conditioning, and proper intensity compared to NCAA athletes.⁷ Based on the findings from this study, it can be inferred that injury rates may be impacted by the intensity of activity, level of competition, as well as participant ability.^{7,35} These factors can be accounted for in both intramural and club sports. While club sports may participate at a higher level of intensity and competition, participant ability becomes a factor for individuals competing in either club or intramural sports.^{7,35} While global injury rates are important, several injuries and illnesses have recently been highlighted for increasing concern for injuries such as concussions.

Concussion

The numbers of reported concussions appear to vary based upon the definition utilized. Concussion comes from the Latin term *concutere*, which means to strike together.⁴⁴ Since its inception, the definition of concussion has evolved over time from a bruise to the brain to a more recent definition that is more functional than structural in nature.⁴⁴ The most commonly accepted definition of concussion is “a traumatic brain injury induced by biomechanical forces.”¹⁷ It has since been updated to include additional characteristics in order to understand the clinical nature of concussive head injury.¹⁶ These are identified as:

1. “Sports related concussion (SRC) may be caused by either a direct blow to the head, face, neck, or elsewhere on the body with an impulsive force transmitted to the head.
2. SRC typically results in rapid onset of short-lived impairment of neurological function that resolves spontaneously. However, in some cases, signs and symptoms evolve over a number of minutes to hours.
3. SRC may result in neurological changes, but the acute clinical signs and symptoms largely reflect a functional disturbance rather than a structural injury and, as such, no abnormality is seen on standard structural neuroimaging studies.
4. SRC results in a range of clinical signs and symptoms that may or may not involve a loss of consciousness. Resolution of the clinical and cognitive features typically follows a sequential course. However, in some cases symptoms may be prolonged.”¹⁶

After examination of these additional factors, there was a consistent rise in the number of concussions diagnosed, reported, and evaluated.²¹ If a concussion is suspected, rapid identification and initial care is crucial in order to initiate the appropriate management steps that need to be taken.^{16,19,20} These steps include removing the participant from play and conducting

an appropriate return to activity protocol.^{16,19,20} It is imperative that each of these steps be completed by a properly educated healthcare individual in order to offer optimal safety to their patients. The barrier begins to become unclear when these healthcare individuals are not present and patients are expected to take on this role of initiating concussion management for themselves and their peers.

As the understanding of concussions and proper management has evolved, clinicians have had to learn and grow alongside new research and findings. Based upon their expertise and training, the clinician chooses what definition is most appropriate for them in their setting, thus allowing the definition they choose to guide their diagnosis of a concussion.¹⁶⁻¹⁸ This technique becomes flawed in intramural and recreational sports because many programs do not have access to an adequately trained and certified healthcare professional to properly identify and diagnose a concussion.^{4,6} This situation then leaves participants, coaches, or recreational employees in charge of making these decisions.⁴ Not only does this give rise to underreporting and an increase in injury, but athletic trainers are typically responsible for reporting injury data thus creating a gap in knowledge concerning concussion incidence in recreational sports.^{8,9}

While general surveillance information regarding concussions is known due to its increase in presence of research and media, much remains to be understood concerning surveillance, trends, and effects within the recreational community.²⁶ For example, on a national level, Langlois et al. discovered that on average, 1.6 to 3.8 million sports related traumatic brain injuries (TBIs), including concussions, occur each year.⁴⁵ They also found that sports and recreational activities were a major cause of TBIs but suggested that national datasets are severely underestimated.⁴⁵ Narrowing the surveillance scope, Hootman et al. conducted an injury surveillance study of 15 NCAA sports over a 16 year time frame with concussions being one of

the injuries they looked into.²¹ Researchers from this study documented over 9,000 concussions over the 16 years, resulting in an average of 563 concussions a year for their sample.²¹ From this study, researchers were also able to determine which sports had the greatest number of concussions reported, the greatest rate of concussions, and were able to note an average annual increase in the overall rate of concussions.²¹ Similarly, researchers have studied injury surveillance concerning high school athletes with concussions being an injury they included in their exploration.³⁶ As previously mentioned, concussions were the most common injury during competition among all positions for men's soccer.⁴² Bartley et al. discovered that concussions due to player-to-player contact were significantly higher in competition when compared to practice for high school men's football, ice hockey, and lacrosse.⁴⁶ Acknowledging and understanding the prevalence of concussions for each population and how they adhere to generalized national estimates is a vital piece of proper concussion management.

In attempts to understand how concussions affect different populations, many studies have examined the epidemiology of concussive injuries concerning the most commonly reported symptoms, differences within sex-comparable sports, sports more susceptible to concussive injuries, and injury trends during different levels of competitions.^{19,22-24,26,27} In addition to the information gathered from the studies previously mentioned, researchers have found that the most commonly reported symptom to be headache with dizziness and confusion.^{23,25,26} Researchers found that males and females will describe a different chief complaint concerning concussion symptoms, and females are more likely to report concussions when compared to their male sport counterparts.^{23,26,27,29} Similar studies have found that the rate of concussions reported and diagnosed during competition is greater compared to those that occur during practice.^{22,24,27} Commonly, incidence and prevalence rates are obtained utilizing studies involving concussive

injuries. From these studies, researchers found that the following sports reported the greatest rate of concussions; football, women's rugby, women's soccer, wrestling, women's volleyball, and men's lacrosse.^{19,22-24} Understanding the nature of these sports, how incidence rates may vary based on factors such as difference in sex, sport, and player contact, and knowing that they are likely to result in higher rates of concussions can be essential for the healthcare professionals who work closely with these sports.

It is important to note that throughout most concussion studies, researchers relied on healthcare providers, specifically athletic trainers, to recognize, diagnose, and report data on concussive injuries based upon their medical expertise as well the most up to date research concerning concussions.²²⁻²⁴ This task becomes difficult when the sole responsibility of recognition is placed into the hands of untrained participants or recreational staff.⁵ According to the National Athletic Trainers Association's (NATA), the definition of appropriate medical coverage goes beyond the need for an emergency action plan.^{7,47} Other duties must include daily interaction with student athletes to encompass injury prevention, evaluation, care, and rehabilitation along with psychosocial and nutritional interaction.^{7,47} Not only do many studies count the potential for underreporting concussions when considering their study limitations, but Patel et al. conducted a study and found that concussion incidence can be underreported for many reasons.^{15,48,49} These researchers found that two of the most frequent reasons were that athletes and coaches did not recognize the signs and symptoms along with athletes wanting to avoid exclusion from play.⁴⁸ Additionally, Clark et al. conducted a systematic review of studies concerning barriers and facilitators for concussion reporting behaviors.⁹ Common facilitators included being of female sex, increased knowledge of long-term effects from untreated concussions, and having a medical professional present during the time of injury. Common

barriers included the athlete's fear of losing playing time, the belief that their injury was not serious, and they did not want to let their team down or feel "weak" to their teammates or opponents.^{8,9} When student-athletes, coaches, or recreational staff are responsible for concussion recognition and reporting, not only are participants not receiving appropriate medical services, but they are also at risk for underreporting due to their lack of proper knowledge and education as well as prioritizing external or internal factors over what is best for their health and wellbeing.^{6,19}

Conclusion

Presence and interest of recreational sports have continued to rise over the years making programs such as intramural and club sports a prominent figure at collegiate institutions.^{4,5,11} While this population continues to grow, they continue to be underserved when it comes to access to appropriate medical coverage.^{3,6,7} Due to the nature of and the population that participates in recreational sports, there is a potential for greater injury compared to their NCAA or high school counterpart, but this risk goes unknown because of the lack of research concerning intramural and club sports.^{4,7} Absence of healthcare presence cultivates an environment that discourages injury surveillance for this population because there no one is present to properly identify, diagnose, and report. This becomes concerning when considering injuries such as concussion which are known to be common in both NCAA and high school populations and could have catastrophic consequences when not reported and properly managed.^{9,21,29,36,50} In order to make suitable changes and provide appropriate medical coverage for recreational sports, concussion incidence and prevalence must first be explored. In hopes to lay appropriate groundwork for future studies to come, the purpose of this preliminary study is to explore concussive injury incidence and prevalence in collegiate recreational sports.

CHAPTER THREE

EPIDEMIOLOGY OF CONCUSSIVE INJURIES IN COLLEGIATE RECREATIONAL ATHLETES

Introduction

Interest in recreational sports have been on the rise. With the help of organizations such as the National Intramural and Recreational Sports Association (NIRSA), now known as Leaders in Collegiate Recreation, affiliated institutions have been able to serve an estimated 8.1 million students in the United States and Canada combined.¹ The programs offered within typical collegiate recreational facilities, intramural and club sports tend to be commonly popular programs offering approximately 20 different sports for each program and consisting of their individual governing bodies, leagues, and tournaments.²⁻⁴ These sports offered, either club or intramural, can serve as recreational alternatives to their institution's varsity counterparts as well as the varsity team for sports not supported by collegiate athletes including ultimate frisbee, quidditch, and rugby.²

While sports offered by recreational programs are similar to those offered at both the collegiate and high school level, the collegiate recreational population is severely underserved. Club and intramural sports are student run organizations with limited access to standardized medical supervision.^{2,5} This leaves participants vulnerable and ultimately responsible for their own injury recognition and management. Placing this responsibility in the care of the participant or even a recreational student employee.

Beyond recreational programs failing to report the physical presence of healthcare professionals during club and intramural games, information regarding injury rates in the collegiate recreational population is very limited.^{2-3,5} There is no current standardized injury

surveillance database forcing researchers to examine and refine national surveillance systems or utilize their current institution's population to gain a greater understanding of common injuries and trends. Of the few studies available, it has been discovered that when compared, club sports resulted in a larger injury rate (18.3 injuries per 1,000 sport interactions) followed by NCAA sports (13.79 injuries per 1,000 sport interactions) and intramural sports (10.28 injuries per 1,000 sport interactions).⁶ Additionally, one institution found that out of the eight intramural sports offered, floor hockey, soccer, basketball, and softball resulted in higher injury rates.⁷ While these studies provide foundational knowledge concerning injuries in the recreational population, their lack in injury specifics creates a challenge when compared to the injury information available regarding the collegiate and high school populations, specifically for epidemic level injuries such as concussions.

As research has developed over the years, the understanding of concussions have evolved as well. Concussions are complex injuries commonly defined as “a trauma induced alteration in mental status that may or may not involve loss of consciousness.”⁸ Researchers have used high school surveillance to discover that the following sports commonly report the greatest rate of concussions; football, women's rugby, women's soccer, wrestling, women's volleyball, and men's lacrosse.⁹⁻¹² It is important to note that the number of and type of activities offered by both college and high school are similar to those offered by collegiate recreational programs. Research suggests that concussions represent 8.9% of all high school athletic injuries and 5.8% of all collegiate athletic injuries.¹³

Recently, to gain further understanding of the concussion epidemic, researchers have focused on factors such as sex, sport type, and contact levels that may have an effect on concussive injury incidence. Studies have shown that females at both the high school and

collegiate level have a higher concussion rate when compared to their male counterparts.^{9, 14-17} Additionally, in both high school and collegiate studies, player-to-player contact has shown to be the most common mechanism accounting for approximately 60 and 70 percent of all concussive injury mechanisms with higher concussive injury incidence rates being attributed to higher intensity and body contacts during competitive events.^{9, 18} Understanding the impact of these factors and knowing the sports that commonly report greater rates of concussion are especially beneficial for healthcare professionals working with collegiate recreation.

Current research regarding concussions shows that concussions can result in long term consequences that can potentially be catastrophic. While we may assume that concussive injury rates would look similar to those at the high school and collegiate level, little research is available that has shown club sports can result in a higher overall injury incidence rate than NCAA.^{6,13} The level at which these catastrophic injuries are occurring as well as their potential effects remains unknown. Therefore, the purpose of this study is to take a preliminary look into the incidence and prevalence rates of concussive injuries in intramural and club sports; specifically examining sex, sport, and contact level within a Division I recreation department.

Methods

Study Design: This study is a descriptive epidemiological study of a retrospective chart review.

Participants: A convenience sample of injured club and intramural sport participants from a NCAA Division I university in southeastern United States during the calendar years of 2016-2019. Both intramural and club sports were included in the analysis. This internal database contained participant sex, club or intramural sport where the injury occurred, type and location of injury, and the severity of injury-were recorded. Further, the database identified if the participant

immediately returned to play and/or if emergency medical services (EMS) were called.

Participants were coded based upon sex (male/ female), sport played (see Table 1 for list of sports) and contact sports classification (contact versus non-contact: See Table 3). Contact was defined as, “sports where players experience body-to-body contact as a recognized circumstantial part of the game, but purposeful collisions by rule are not allowed” while non-contact was defined as “sports where players experience rare body-to-body contact is rare and is typically an unexpected occurrence.”¹⁹

Procedures: Data was collected as part of the recreation department’s standard post-injury protocol and used by the University for risk management. For the current study, the database was de-identified and consolidated according to the aforementioned inclusion requirements.

Statistical Analyses: Incidence rates were calculated individually for intramural and club sports by dividing the number of concussions by the number of overall injuries. This number was then multiplied by 100 to represent the percentage of incidence of concussions. Prevalence rates were calculated for intramural sports by dividing the number of concussions each semester (spring, summer, and fall) by the number of unique participants for each of these semesters. Each semester was then averaged together to determine the average prevalence rate for each year. These averages were then multiplied by 1,000 to determine the prevalence of concussions per 1,000 unique participants. Odds ratios and logistic regression models were calculated to determine the likelihood of sustaining a concussive injury based on sex, contact level and sport type utilizing SPSS 25.0 (IBM Corp) and statistical significance was set a priori as $P \leq .05$. Sport participation was examined for both individual and team sport participation and participation in a contact sport.

Results

During the calendar years 2016-2019, there were a total of 805 injuries that occurred between intramural and club sports. Overall, these injuries included musculoskeletal, general medicine, and first aid injuries. Most of these injuries were documented as musculoskeletal injuries (n=722), with first aid injuries being the second most common (n=56), and general medicine injuries being the least common (n=24). Club sports accounted for 235 of these injuries while intramurals accounted for the remaining 570 injuries. Throughout these four years, intramurals hosted an average of 1,243 games during a spring semester, 1,025 games during a fall semester, and 42 games during a summer semester.

The sports typically offered by intramurals during these years are listed in Table 1. Of these sports, the following resulted in injuries and were included in this study: basketball, dodgeball, flag football, indoor soccer, soccer, softball, ultimate frisbee, and volleyball. While there is limited demographic and logistical information concerning club sports, the typical sports club activities available to patrons during these years are listed in Table 2. Of these sports listed, aikido, cheer, dance, dodgeball, fencing, lacrosse, mixed martial arts, rugby, soccer, track, ultimate, volleyball, water polo, and wrestling resulted in documented injuries. Due to the nature of medical coverage for sport clubs, in order to accurately represent injury occurrences within these clubs, only injuries from the following sports have been included in this study: lacrosse, rugby, soccer, and ultimate frisbee. Each of these sports were then examined retrospectively for concussive injuries utilizing various statistical calculations. These calculations include prevalence, incidence, odds ratios, and logistic regression specifically analyzing sex differences, contact level, and sport type.

The prevalence of concussions for intramural sports resulted in an average rate of 2.77 per 1,000 unique participants (n=69, average unique participants=6,214) during the four year period. During these years, 2016 observed the smallest rate resulting in 0.92 concussions per 1,000 unique participants (n=9, unique participants=6,645) while 2019 observed the highest rate resulting in 7.27 concussions per 1,000 unique participants (n=24, unique participants=5,378). These findings as well as the average for each year included in this study can be found in Figure 1.

The incidence of concussions for both intramural and club sports resulted in a rate of 13.79% (n=111) and is noted in Figure 2. Individually, intramural sports resulted in a rate of 12.11% (n=69) during these four years while club sports resulted in a rate of 17.87% (n=42). Incidence rate of concussions were calculated for both intramural and club sports separately and together as a whole.

Participants (n=795) were retrospectively analyzed and consisted of 558 males and 237 females. For this specific calculation, 10 participants were excluded because sex was omitted on the intake form. Male participants resulted in a greater absolute number of concussions (n=56) than females (n=51). Females were almost two and a half times more likely to sustain a concussion compared to males (OR: 2.458; 95% CI, 1.623 to 3.722).

Injuries were analyzed utilizing odds ratios based on contact level. Injuries (n=570) were retrospectively analyzed and consisted of 510 injuries during intramural contact sports and 60 injuries during non-contact sports. Injuries that occurred during contact intramural sports resulted in a greater absolute number of concussions (n=60) than non-contact sports (n=9). Individuals participating in non-contact sports are 1.324 times more likely to sustain a concussion (OR: 1.324; 95% CI, 0.620 to 2.822). Of these sports, flag football reported the most concussions for

contact sports (n=25) while softball reported the most concussions for non-contact sports (n=6). For full details of both contact and non-contact sports, see Table 3.

Club sport injuries (n=235) were retrospectively analyzed and consisted of 17 lacrosse injuries, 61 rugby injuries, 30 soccer injuries, and 127 ultimate injuries during the allocated calendar years with the absolute number of 4, 10, 1, and 27 concussions respectively. The odds of sustaining a concussion in lacrosse, ultimate frisbee, and rugby were individually calculated relative to soccer within club sports. Each of these sports resulted in an increased odds of 5-fold or greater for sustaining a concussion when compared to soccer. Lacrosse reported the highest odds followed by ultimate frisbee and rugby reporting 8.92, 7.83, and 5.69 respectively. While lacrosse resulted in the highest odds, ultimate frisbee was the only sport that was statistically significant. For full details of all club sports, see Table 4.

Similarly, intramural sport injuries (n=570) were retrospectively analyzed and consisted of 113 basketball injuries, 5 dodgeball injuries, 224 flag football injuries, 44 indoor soccer injuries, 100 outdoor soccer injuries, 36 softball injuries, 29 ultimate frisbee injuries, and 19 volleyball injuries. During the study period, flag football resulted in the greatest absolute number of concussions (n=25) while dodgeball and ultimate frisbee each resulted in the least (n=0). The odds of sustaining a concussion in each sport were individually calculated relative to outdoor soccer within intramural sports. Each of these sports resulted in a decreased odds of sustaining a concussion comparatively. Specifically, softball and volleyball reported on the higher end, closer to 1.00 reporting 0.976 and 0.915 respectively. While basketball and flag football reported the lowest odds reporting 0.58 and 0.613 respectively. However, none of the sports resulted in statistically significant values. For full details of all intramural sports, see Table 5.

Discussion

Collegiate recreation continues to rise in popularity on college and university campuses nationwide. Given this increase in participation, directors and staff members must consider risk management and the safety of the individuals participating in their offered activities.³ One injury that has recently been highlighted in both literature and mainstream media are concussions. Concussive injuries are costly and can result in long-term cognitive, behavioral psychological impact and even catastrophic results when not appropriately recognized and managed.²⁰⁻²³ Understanding the increase in knowledge and literature concerning concussive injuries in sport, this study begins to lay the groundwork to learn and understand incidence and prevalence of concussion injuries as well as factors that influence concussion rates in collegiate recreation.

Overall, this study examined injuries sustained during the 2016 through 2019 calendar years and found lower than hypothesized prevalence of concussions in intramural sports. However, incidence of concussions for intramurals and club sports were greater than hypothesized and the normal reported averages for both high school and collegiate athletics.^{9,12-13,22-23} Consistent with the literature, factors that influence concussion incidence such as sex and sport participation resulted in females, lacrosse, and outdoor soccer having higher odds of sustaining a concussion.^{9,14-17} However, inconsistent with the literature, it was found that contact sports were less likely to sustain a concussion than non-contact sports. As the first study to examine prevalence, incidence, and odds of sustaining a concussion in intramural and recreation sports, it is not surprising that our discoveries as a whole are not consistent with literature in NCAA collegiate and interscholastic athletics.

Prevalence can be utilized to shape the picture of the effect of concussions on the specific population. Epidemiology literature commonly reports the prevalence calculation in terms of

athlete exposures. The definition for athlete exposure is, “one student athlete participating in one practice or competition in which he or she was exposed to the possibility of athletic injury, regardless of the time associated with that participation.”²⁴ Recreation sports pose a novel environment where the number of participants is high with limited to no staff available to collect real time individual athlete exposures per event. Thereby making large surveillance data with individual athlete exposure difficult to collect. Therefore, institutional intramural sport programs track similar data labeled as participations. The value presented for participations included every time a participant signed into an event for all intramural sports offered that semester.

Unfortunately, there is no way to confirm the individuals who signed into matches or games actually participated in every play or competitive event. In an attempt to present the most accurate representation of the participant population, the number of unique participants for intramural sports were used to compute the prevalence of concussive injuries instead of overall patron participations. This slight change in methodology may have unexpectedly lowered our prevalence rates.

Overall, the average prevalence of concussions for intramural sports was 2.77 per 1,000 unique participants. Ranging from 0.92 per 1,000 to 7.27 per 1,000 unique participants over the four-year period. This finding was significantly lower than the hypothesized 50 per 1,000 unique participants would sustain a concussion. Even though our numbers are consistent with the high school literature that reports prevalence rates ranging anywhere from 0.09 concussions per 1,000 athlete exposures to 9.1 concussions per 1,000, the expected increase due to the nature of recreation sports was not supported.^{9,12,23} In a study examining college athletes with higher volume of participants and number of sports, prevalence rates were 45 concussions per 1,000 athlete exposures.¹⁸ The hypothesis for research question one was driven by the numbers of

participants and intramural sports offered each year. NIRSA estimates that affiliated institutions serve on average 8.1 million students collectively nationwide with each individual campus playing approximately 1,000 intramural games annually.^{1,4} Therefore, the research hypothesis was under the assumption that there would be an equally large number of concussive injuries. Following data collection, it was discovered that not all of the intramural sports offered resulted in the documented injuries.

Sports such as swimming, sand and aqua volleyball, and wheelchair basketball did not report any injuries within our data collection. These sports are considered low risk within the risk matrix created for the institution's recreational facility. This matrix takes probability and severity of injury along with other extraneous factors to determine the level of risk that is inherent in the sport.³ The number of low risk intramural sports make up 75% of the intramural sports offered by the institution, with the remaining 25% consisting of an even 50/50 split of moderate and high risk activities. It's important to keep in mind when considering these calculations, the number of intramural sports offered each year, the number of participants for each sport, and each sports effect on either increasing or decreasing the risk for injury. In addition to understanding the value of prevalence based on population, it is also important to determine what percentage of the injuries that were documented resulted in a concussion.

During the years 2016 through 2019, concussions resulted in 111 of the 805 injuries documented between both intramural and club sports. Together, the incidence of concussions resulted in a rate of 13.79%. This combined rate as well as the individual rates for intramural and club sports (12.11% and 17.87% respectively) were both well above the hypothesized percentage. This finding was supported in literature where concussions have represented a range of 5-18% but is most commonly reported as representing approximately nine percent of all high

school athletic injuries and approximately six percent of all collegiate athletic injuries.^{13,21}

Therefore this sample reports a higher incidence of concussion than both the high school and collegiate settings.^{13,21}

Although there is limited research concerning epidemiology of injuries in collegiate recreation, one study by Arthur-Banning et al. compared overall injury rates of their institutions club and intramural sports to the average injury rates reported by NCAA.⁶ This study found club sports had the highest overall injury rate (18.3 per 1000 athlete exposures), followed by previously reported NCAA data (13.8 per 1000 athlete exposures). The lowest injury rates occurred within intramurals (10.3 per 1000 athlete exposures).⁶ Even though Arthur-Banning examined total injuries instead of concussion, these findings are consistent that club sports resulted in a higher incidence rate of injuries when compared to intramural sports.

In the current study, club sports resulted in an incidence rate almost five percent higher than intramurals. One reason that might explain this finding is that comparatively, the competition level, intensity, and load of activity associated with club sports is greater than that of intramural sports.^{6,21,25} Previous studies have suggested that intensity of activity, level of competition, and participant ability can have an impact on injury rates.^{6,21,25} Luiggi et al. found that increased levels of competition resulted in increases in sport injury percentages. It appears that the greater the competitive context, the greater the number of injuries.²⁵ Level of participant competition and skill level is often unknown within recreational sports. The nature of club sports encourages minimally trained participants to become involved in these activities which would result in a potential increased rate of injuries, in this case concussions, when compared to activities of decreased competition and intensity. While incidence and prevalence provide global

description of injury rates, additional factors may lead to increased rates. Commonly reported factors include sex, contact level, and sport type.

Throughout the four-year time frame observed in this study, males made up 70% (n=558) of the recorded injuries while females made up 20% (n=237). While the sample for this study includes both club and intramural participants, these percentages are similar to a typical year for intramural sports for this institution where males tend to represent 75% of the participants while females represent 25%. Males resulted in a total of 56 concussions compared to females' total of 51. Although males resulted in a greater overall number of documented concussions, when calculated, females were almost two and a half times more likely to sustain a concussion compared to males.

The increased female likelihood of sustaining a concussion is not novel. This finding is consistent with previous literature and supports the hypothesis.^{9,13,16,18} Previous research has reported female odds of sustaining a concussion in high school athletes of 1.56; 95% CI 1.1.34 to 1.81.^{9,16} Related literature tends to report females resulting in an increased concussion risk as well as an increased proportion of all injuries attributed to concussions when compared to males.^{13,16} These studies have attributed the findings to females being more likely to report concussions when compared to their male sport counterparts as well as the physical differences between males and females concerning both size and physical stature and strength of various muscles.^{16,26} Going beyond sex difference, odds ratios were also calculated to determine the effects contact and non-contact sports had on concussion rates.

Contact sports were defined as sports where players experience body-to-body contact as a recognized part of the game, but purposeful collisions were not allowed, while non-contact

sports were defined as sports where players rarely experience body-to-body contact and it is typically an unexpected occurrence.¹⁹ During the four year time period, intramurals documented 69 concussions, 60 which occurred during contact sports, and 9 which occurred during non-contact sports. While contact intramural sports resulted in more overall injuries and documented concussions, individuals participating in non-contact sports ended up being 1.23 times more likely to sustain a concussion. This finding is inconsistent with the literature where the risk of sustaining a concussion is typically higher in contact sports.

Player-to-player contact tends to be the most common risk factor and the most common mechanism for sport related concussions.^{13,18,27} By definition, non-contact sports included those where contact was rare in regards to body-to-body contact deeming dodgeball, softball, and volleyball as non-contact sports.¹⁹ Therefore, this risk and mechanism is not typically seen in non-contact sports. The total number of participants and resultant injuries in the non-contact sports was significantly lower than sports deemed as contact. Although contact sports reported more concussions and injuries overall, the low number of injuries in the non-contact group appears to inflate the influence of concussive injuries. In order to gain a better understanding of how sports, both contact and non, affect concussive rates, odds ratios were computed for each club and intramural sport.

All club sports resulted in increased odds of sustaining a concussion when compared to club soccer. Although lacrosse resulted in the highest odds, ultimate frisbee was the only club sport to produce a statistically significant value. The findings from this study were consistent with previous literature findings that lacrosse has a high prevalence of concussion, typically reporting 1.22 and 1.7 concussive injuries per 1,000 athlete exposures for high school and collegiate populations respectively.^{28,27} However, the sport of soccer typically reports higher

incidences of concussion. Several factors may explain the inconsistent incidence rates. First, studies provide evidence that concussive injury rates tend to be greater during competition than during practice.^{11,18,29-32}

Club sports typically participate in practices, games, and tournaments throughout the year. While all clubs at the institution underwent practices and competitions, some clubs participated in more competitions and tournaments than others. Although soccer did report the greatest number of home games played (n=19), during the study period, ultimate frisbee documented 10 total tournament days resulting in the highest volume of games among club sports. Following soccer, lacrosse documented participating in 12 home matches and rugby documented hosting eight. The high volume of competitions as well as the nature of play for lacrosse, ultimate frisbee, and rugby may explain the increased rate. Another reason for the inconsistent rates may revolve around the intensity of sport. Researchers have reported higher intensities of sport activity could be an important factor contributing to higher injury rates in competitions compared to practice.²¹ The increase in intensity of competitions compared to practices, combined with decreased conditioning and acclimatation to higher intensities of play creates an environment where club sport participants could be predisposed to concussive injuries.^{6,13,33}

Interestingly, the incidence of concussion in club sports does not align with current research. Studies conducted in NCAA collegiate athletics, researchers discovered that soccer, football, and ice hockey tend to have the highest rates of concussion.^{21,27,32,34} While this does not appear consistent, football and ice hockey are not available making lacrosse the club sport with the highest concussion rate of those noted in NCAA studies. However, soccer which is available, when compared to other club sports included in this study, resulted in decreased odds

comparatively. It is unclear why soccer did not have higher odds ratios when compared to other club sports. One factor that has previously been suggested was total competition numbers.^{11,18,29,30-32} After examining the data, it appears that soccer had the most home games to obtain injury data and would not be a limiting factor. It is important to note that of the club sports examined, soccer is more widely played in the region prior to participation within collegiate recreation. This previous familiarity with the sport and potential for increased player skill and physical ability may have potentially given the individuals participating in soccer an unintentional advantage for decreasing their likelihood of concussions.

All intramural sports that documented injuries resulted in a decreased odds of sustaining a concussion when compared to outdoor soccer. Based on these values, it can be inferred that intramural sports tend to align with typical high school and collegiate athletic trends with soccer consistently attributing an increased percentage of their overall injuries to concussions, especially in competition.^{21,34-35} Intramural sports are unique in that their only exposure includes games or matches. While these competition interactions are typically of a lower level of competition compared to club sports, as previously stated, research has commonly discovered that concussive injury rates tend to be greater during competition.^{11,18,29,30-32} With every sport only having exposure to competitive events, the decreased level of overall competition and the typical inconsistency of participant ability and skill, as a whole, the remaining intramural sports may have unintentionally been all within the same level of risk for sustaining a concussion.

While the results and the interpretations from the study appear to align with previous research, this study is not without limitations. First, due to the retrospective nature of this study, incomplete records were excluded since there was no way to determine or verify the missing information. Therefore, researchers worked under the assumption that the individual who

originally gathered the information reported true and factual information regarding the patient, their injury, and the activity during their time of injury. Fortunately, the entire data set was collected by four athletic trainers that received training on concussion assessment from the same faculty and program thus decreasing variability in assessment and accurate reporting.

Additionally, there was limited information collected and stored by the institution regarding club sports that restricted the statistical analysis that could be conducted. Given the information obtained, the large sample size and data collection period provides a representative sample of collegiate intramural and club sports. The absolute data was consistent with previously published research. Lastly, due to the nature of the recreational setting, it is common for multiple events from various recreational programs to happen simultaneously. As such, medical professionals and staff may not be immediately available to evaluate an injury. Therefore, a majority of injury reporting responsibility lies with the participant, potentially creating a limitation that not all injury occurrences may have been documented. Counteracting this limitation, support and athletic trainers were prioritized by injury risk in each sport. While all recreational staff members were CPR and First Aid certified, athletic trainers were prioritized by sports that were considered as high risk for injury.

Conclusion

Literature has shown that interest and participation in club and intramural sports continues to increase across college and university campuses nationwide.^{3,4} While interscholastic and NCAA sports report approximately 7.9 million and 280,000 participants annually respectively, college and university recreational sports boasts 8.1 million participants annually.^{1,36} Accommodating the number of participants and providing a wide variety of opportunities to participate, club and intramural programs typically offer 20 or more sports and

activities annually.⁴ As the number of participants is significantly higher, the amount of support provided to this population is limited.

College and university recreational programs are typically missing the presence of healthcare professionals.^{2,5} During these four years, a total of 805 injuries occurred with 111 documented as concussions. Unlike the majority of institutions with recreational programs that rely on the campus healthcare system, this study is fortunate to employ dedicated certified athletic trainers for campus recreation. This ensures that all 111 individuals diagnosed with a concussion were able to receive proper evaluation, treatment, and education regarding their injury. The same cannot always be said for recreational participants at institutions where healthcare professionals might not be available. Therefore, the findings from this and future studies become essential to aid in advocating for appropriate changes to ensure optimal safety for this population.

The findings from this study not only provide estimates and statistical information for collegiate recreation epidemiology but provide foundational information regarding concussion incidence for collegiate club and intramural sports. It is important to note that based on this study, concussion incidence and prevalence within club and intramural sports is higher than both NCAA and high schools. The increased incidence of concussion paired with the lack of medical care may increase the risk of poorly managed concussion that can potentially lead to catastrophic consequences in collegiate students.

In the future, to ensure that these findings are generalizable to every collegiate recreation population, it is imperative that this study is replicated at different institutions of all sizes and divisions. While this study acts as a beneficial foundation for what program directors, risk managers, and healthcare professionals could expect to experience, these numbers are best

representative of what is to be expected of a Division I recreational center in the southeast United States. Ultimately, the collegiate recreational population tends to have a larger number of participants with less medical access, knowledge, and coverage than traditional settings that employ athletic trainers. Bringing awareness and building an understanding, this study can serve as a catalyst to other institutions to determine the risk of injury in their own programs and validate the need to ensure safety of continued sport participation beyond high school.

Tables and Figures

Table 1: Intramural Sports Offered

4-on-4 Flag Football	Cornhole	Indoor Volleyball
4-on-4 Sand Volleyball	Golf	Kickball
Archery	Dodgeball	Soccer
Archery Tag	Basketball	Spikeball
Basketball	Softball	Tennis
Battleship	Flag Football	Ultimate Frisbee
Bowling	Indoor Soccer	Wheelchair Basketball

Table 2: Club Sports Offered

Aikido	Climbing	Golf	Quidditch
Archery	Dance	Lacrosse	Soccer
Baseball	Disc Golf	Quidditch	Tennis
Bass Anglers (Fishing)	Dodgeball	Rugby	Track and Field
Bowling	Equestrian	Shooting Sports	Water Polo
Cheerleading	Fencing	Ultimate Frisbee	Wrestling

Table 3: Contact and Non-contact Intramural Sports

SPORT	CONTACT	NON-CONTACT
Basketball	X	
Dodgeball		X
Flag Football	X	
Indoor Soccer	X	
Soccer	X	
Softball		X
Ultimate Frisbee	X	
Volleyball		X

Table 4: Club Sport Odds Ratios

SPORT*	VALUE	95% CONFIDENCE INTERVAL		P-VALUE
		LOWER	UPPER	
Lacrosse	8.923	0.906	87.84	0.061
Ultimate	7.830	1.02	60.114	0.048
Rugby	5.686	.692	46.694	0.106

*Soccer served as comparison group

Table 5: Intramural Sports Odds Ratios

SPORT*	VALUE	95% CONFIDENCE INTERVAL		P-VALUE
		LOWER	UPPER	
Softball	0.976	0.35	2.708	0.964
Volleyball	0.915	0.24	3.492	0.897
Indoor Soccer	0.771	0.282	2.11	0.612
Flag Football	0.613	0.315	1.195	0.151
Basketball	0.58	0.262	1.283	0.179
Ultimate	0.0	0.0	-	.998
Dodgeball	0.0	0.0	-	.999

*Outdoor soccer served as comparison group

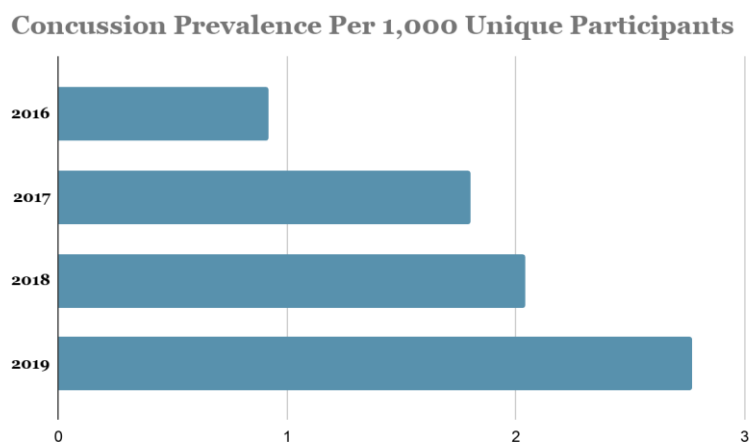
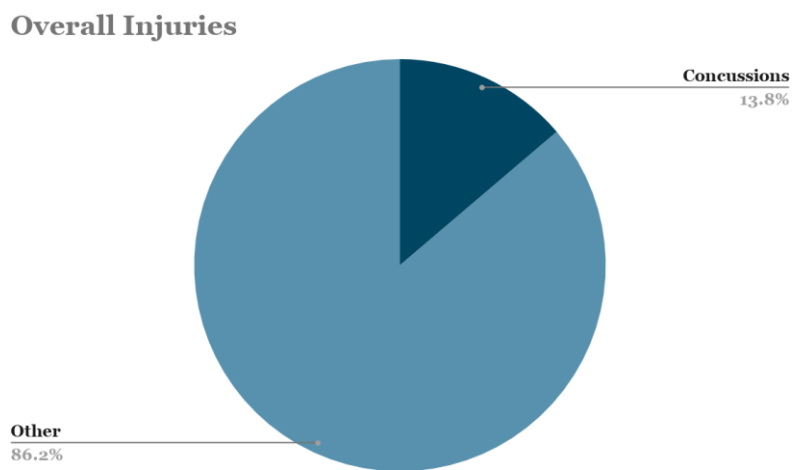
Figure 1: Concussion Prevalence in Intramural Sports

Figure 2: Concussion Incidence



CHAPTER FOUR

GENERAL CONCLUSIONS AND FUTURE DIRECTIONS

Literature has shown that interest and participation in club and intramural sports continues to increase across college and university campuses nationwide.^{4,5} While interscholastic and NCAA sports report approximately 7.9 million and 280,000 participants annually respectively, college and university recreational sports boasts 8.1 million participants annually.^{1,54} Accommodating the number of participants and providing a wide variety of opportunities to participate, club and intramural programs typically offer 20 or more sports and activities annually.⁵ As the number of participants is significantly higher, the amount of support provided to this population is limited.

College and university recreational programs are typically missing the presence of healthcare professionals.^{3,6} During these four years, a total of 805 injuries occurred with 111 documented as concussions. Unlike the majority of institutions with recreational programs that rely on the campus healthcare system, this study is fortunate to employ dedicated certified athletic trainers for campus recreation. This ensures that all 111 individuals diagnosed with a concussion were able to receive proper evaluation, treatment, and education regarding their injury. The same cannot always be said for recreational participants at institutions where healthcare professionals might not be available. Therefore, the findings from this and future studies become essential to aid in advocating for appropriate changes to ensure optimal safety for this population.

The findings from this study not only provide estimates and statistical information for collegiate recreation epidemiology but provide foundational information regarding concussion incidence for collegiate club and intramural sports. It is important to note that based on this

study, concussion incidence and prevalence within club and intramural sports is higher than both NCAA and high schools. The increased incidence of concussion paired with the lack of medical care may increase the risk of poorly managed concussion that can potentially lead to catastrophic consequences in collegiate students.

In the future, to ensure that these findings are generalizable to every collegiate recreation population, it is imperative that this study is replicated at different institutions of all sizes and divisions. While this study acts as a beneficial foundation for what program directors, risk managers, and healthcare professionals could expect to experience, these numbers are best representative of what is to be expected of a Division I recreational center in the southeast United States. Ultimately, the collegiate recreational population tends to have a larger number of participants with less medical access, knowledge, and coverage than traditional settings that employ athletic trainers. Bringing awareness and building an understanding, this study can serve as a catalyst to other institutions to determine the risk of injury in their own programs and validate the need to ensure safety of continued sport participation beyond high school.

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APPENDICES

A. EXTENDED METHODOLOGY

Research Questions

1. What is the prevalence of concussive injuries in intramural sports?
2. What is the incidence of concussive injuries in intramural and club sports?
3. What is the likelihood of sustaining a concussive injury based on sex and type of sport participation?

Hypotheses

1. H₁: Five percent of intramural sport athletes will sustain a concussive injury over the 4-year timeframe.
2. H₂: Concussive injuries will make up approximately 7 percent of overall injuries.
3. H₃:
 - a. Females will be at greater odds for sustaining a concussive injury when compared to their male counterparts.
 - b. Contact sports will have greater odds of sustaining a concussive injury when compared to non-contact sports.
 - c. Flag football, soccer, rugby, and lacrosse will have a greater odds of sustaining a concussive injury when compared to non-contact sports.

Inclusion Criteria

1. Injured recreational patrons during this allotted time frame (2016-2019)
2. Participants must have been injured during an intramural or club sport activity.

3. Participants must have been diagnosed with a concussion by either a certified athletic trainer or another healthcare clinician allowed to diagnose concussions within their scope of practice.
4. Concussion diagnosis properly documented in the initial injury or follow up report.
5. Participants must not have been able to immediately return to play as documented in the original report.

Exclusion Criteria

1. Participants were not injured during a club or intramural sport activity.
2. The original injury report does not include complete injury information resulting in an official diagnosis.
3. Workers Compensation reports
4. Participants were not evaluated by a certified athletic trainer either during the initial or follow up evaluation.

Limitations

There was limited information collected and stored by the institution regarding club sports that restricted the statistical analysis that could be conducted. Given the information obtained, the large sample size and data collection period provides a representative sample of collegiate intramural and club sports. The absolute data was consistent with previously published research. Additionally, due to the nature of the recreational setting, it is common for multiple events from various recreational programs to happen simultaneously. As such, medical professionals and staff may not be immediately available to evaluate an injury. Therefore, a majority of injury reporting responsibility lies with the participant, potentially creating a limitation that not all injury occurrences may have been documented. Counteracting this

limitation, support and athletic trainers were prioritized by injury risk in each sport. While all recreational staff members were CPR and First Aid certified, athletic trainers were prioritized by sports that were considered as high risk for injury.

Delimitations

The current study has delimited data to participants who participated in intramurals or club sports and was injured during either and was evaluated by the recreation department's certified athletic trainers.

Assumptions

Researchers worked under the assumption that the individual who originally gathered the information reported true and factual information regarding the patient, their injury, and the activity during their time of injury.

Definitions

Prevalence: The Centers for Disease Control and Prevention defines prevalence as “the proportion of persons in a population who have a particular disease or attribute at a specific point in time over a specified period.”⁵¹ For this study, researchers utilized the number of unique participants for the population to determine the proportion of people who were diagnosed with a concussion.

Incidence: The Centers for Disease Control and Prevention defines incidence as “the proportion of an initially disease-free population that becomes injured during a specified period.”⁵¹ The current study examined the proportion of the initially injury-free population who became a new case vs the total population at risk.

Injury: The injury was constrained to have resulted in the organized practice or competition of a club or intramural sports. The injury required medical evaluation by a certified athletic trainer or trained healthcare professional and resulted in restriction of immediate return to participation.³⁷

Concussion: Since Athletic Trainers were the clinicians documenting and diagnosing, the following NATA concussion definition was used: “a trauma-induced alteration in mental status that may or may not involve loss of consciousness.”¹⁸

Contact: Intramural sports were categorized by the likelihood of contact. Meehan et al. categorized sport into three categories; collision sports, contact sports, and non-contact sports.⁵² Collision sports are where players experience routine, purposeful body-to-body collisions as a legal and expected part of the game. Contact sports include those where players experience body-to-body contact as a recognized circumstantial part of the game, but purposeful collisions by rule are not allowed. Lastly, non-contact sports include those where players experience rare body-to-body contact is rare and is typically an unexpected occurrence.⁵² For this study, only the definitions for contact and non-contact sports were utilized to categorize intramural sports.

B. INSTRUMENTATION

Accident Report

-Georgia Southern University-
CAMPUS RECREATION AND INTRAMURALS
ACCIDENT REPORT

Date of Injury ___/___/___ Date of Report ___/___/___ Time of Injury ___:___ AM PM

Injured Person Information:

Name _____ Eagle ID # _____
 Local Address _____ Local Phone _____
 Gender: ___Male ___Female Classification: ___Student ___Faculty/Staff ___Other (Specify) _____
 Public Safety Notified: ___Yes ___No EMS Called: ___Yes ___No Time Called: _____
 Program Area: ___Informal ___Intramural Sports ___Aquatics ___Club Sports ___Fitness ___Group Fit ___Southern Adv.
 Location of Activity (Building or Facility and/or Field # or Court #) _____

Describe the injury and Indicate Part of Body Injured (include right or left side of body).

Brief Description of Accident. Please include activity occurring at the time of injury. (Use back if necessary)

Describe care given for the injury. (Band-Aid, Ice, etc.)

Witness Name(s) and Contact Information

Action Taken:

Participant Sent To: ___Home ___Health Services ___Hospital ___Other _____
 Transportation: ___Private Vehicle ___Ambulance ___None ___Other _____

Participant's Signature _____ Date _____
 Trainer/Witness's Name _____ Signature _____ Date _____
 Report Filed By _____ Signature _____ Date _____

Follow-Up Report made by (Print Name): _____
 Date/Time: _____ Person Talked to: _____
 Comments: _____

Revised 7/07

C. IRB APPROVAL

**GEORGIA
SOUTHERN
UNIVERSITY**

RESEARCH INTEGRITY

Institutional Review Board (IRB)Veazey Hall 3000 PO Box 8005 • STATESBORO, GA 30460 Phone:
912-478-5465 Fax: 912-478-0719 IRB@GeorgiaSouthern.edu**To:** Flowers, Maddison; Morigiello, Jenna**Approval Date:** 8/25/2020**Subject:** Institutional Review Board Exemption Determination - Limited Review

Your proposed research project numbered **H21034**, and titled “**Campus Recreation Injury Rates.**” involves activities that do not require full approval by the Institutional Review Board (IRB) according to federal guidelines. **In this research project research data will be collected anonymously.**

According to the Code of Federal Regulations Title 45 Part 46, your research protocol is determined to be exempt from full review under the following exemption category(s):

Exemption 4 Secondary research uses of identifiable private information or identifiable biospecimens, if at least one of the following criteria is met: The identifiable private information or identifiable biospecimens are publicly available; Information, which may include information about biospecimens, is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained directly or through identifiers linked to the subjects, the investigator does not contact the subjects, and the investigator will not re-identify subjects.

Any data use agreement or agreement change required by the data owner must be supplied to the IRB prior to execution for review. This approval is contingent upon researcher compliance with the conditions of the data use agreement (where required) and current institutional data security policy.

Any alteration in the terms or conditions of your involvement may alter this approval. *Therefore, as authorized in the Federal Policy for the Protection of Human Subjects, I am pleased to notify you that your research, as submitted, is exempt from IRB Review. No further action or IRB oversight is required, as long as the project remains the same. If you alter the project, it is your responsibility to notify the IRB and acquire a new determination of exemption. Because this project was determined to be exempt from further IRB oversight, this project does not require an expiration date.*

Sincerely,

Eleanor Haynes Compliance Officer