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An epidemiological study of pediatric sports and recreational injuries reporting to the emergency room in Grand Forks, ND

Carly Bertsch
University of North Dakota

Lucas Dolan
University of North Dakota

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AN EPIDEMIOLOGICAL STUDY OF PEDIATRIC SPORTS AND RECREATIONAL INJURIES REPORTING TO THE EMERGENCY ROOM IN GRAND FORKS, ND

by

Carly Bertsch, SPT
Bachelor of General Studies
University of North Dakota, 2016

Lucas Dolan, SPT
Bachelor of Science in Biology
Dakota State, 2014

A Scholarly Project Submitted to the Graduate Faculty of the

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in partial fulfillment of the requirements for the degree of

Doctor of Physical Therapy

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This Scholarly Project, submitted by Carly Bertsch and Lucas Dolan in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

[Signature]
(Graduate School Advisor)

[Signature]
(Chairperson, Physical Therapy)
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ABSTRACT

PROBLEM: The purpose of this research study is to evaluate the emergency room records from Altru Health System in Grand Forks, ND from 2011-2015 to find trends in pediatric injuries from the ages of 0-19. The justification for the study is to provide Grand Forks with information about the frequency and distribution of pediatric sports and recreational injuries. No injury surveillance system has been implemented to monitor youth injuries, but his study is a continuation of a previous 10-year study and the combining of the two time frames would result in a 15-year compilation of data. By using descriptive data from Altru Health System, the magnitude of the injury problem can be determined as well as the population affected, when and where injuries occur, and what the outcomes are. An understanding of the potential cause of injury is needed so that an educated approach can be taken when developing injury prevention strategies.

PROCEDURE/METHODS: A review of the literature will be completed using multiple research databases (DynaMed, PubMed, CINAHL, etc.) to formulate an idea of what types of injuries and by what mechanism the pediatric population is sustaining injuries. This information will guide the research process and allow the current literature to be compared and correlated with the research findings. The design of this study is a retrospective case series study in which emergency department records will be obtained from the Altru Hospital Emergency Room for injuries sustained during pediatric sports and recreational activities from January 1, 2011 - June 30, 2015 for children aged 0-19. Altru will provide access to the medical records and the documentation of the medical information will be done under Altru personnel.

RESULTS: It is anticipated that the completed project will be implemented in the care of current and future pediatric clients by finding measures of how to prevent sports and recreational injuries from occurring. The results of this project should give insight to healthcare professionals and to the community of Grand Forks, ND about the prevalence and type of injuries that are sustained in the pediatric population in this geographic area. The hope is that with the increased awareness about the incidence of pediatric sports and recreational injuries is that there are fewer injuries and more preventative measures to limit injuries sustained by children aged 0-19. This information can be shared with all healthcare professionals and the members of the community of Grand Forks, ND.
CHAPTER ONE
BACKGROUND AND PURPOSE

Introduction

According to Access Journal of Sports Medicine, 45 million children play in at least one organized sport in the United States.\(^1\) Child engagement in sports and recreation offers many health benefits but also exposure to injury risks. During the years 2001-2008, an estimated 2,566,178 children ages 1 to 18 years were seen in US emergency departments for recreation injuries. That means there are about 320,722 pediatric cases reported to the emergency department per year or about 37 pediatric sport and recreational injuries treated per hour in the US. Typically, children have been seen in the emergency departments for organized sports and more frequently in recent years children are sustaining injuries in both recreation activities and organized sports.\(^2\) In 2010, 8.6 million children were treated for unintentional injuries in American emergency departments.\(^3\) Overuse or repetitive trauma injuries represent approximately 50% of all pediatric sport-related injuries, and it is speculated that more than half of these injuries may be preventable with simple approaches. The major objective in managing repetitive or training injuries in athletes of any age should be to determine risk factors for injury and identify steps to prevent the occurrence of these injuries. Epidemiologic studies in specific environments in pediatric populations would add greatly to the understanding of the risk associated with sport activities.\(^4\) Furthermore, it has been found that overuse is one of the most common etiological factors that lead to injuries in the pediatric athlete. Many children are participating in sports year-round and sometimes on multiple teams simultaneously; this
overtraining can lead to burnout which may have a detrimental effect on the child participating in sports as a lifelong healthy activity\textsuperscript{5}. Overall, injuries at a young age in development can have adverse long-term effects on their later life.\textsuperscript{6} Research has shown that following an injury during the pediatric years will decrease their level of physical activity, which can lead to other health concerns such as becoming overweight or developing other risk factors for future conditions at a young age. This leads to the importance of identifying the reasons why children are becoming injured, the type of injuries they are sustaining, and what steps can be taken to prevent pediatric injuries from occurring so often.

The purpose of this literature review is to evaluate hospital-based records of children 0 to 19 years of age who have reported to emergency rooms with injuries related to sport and recreation activities. By performing this literature review, there can be inferences made about the types of injuries reported and the age at which children were sustaining these injuries. The literature review was performed using the CINAHL, PubMed and Clinical Key search engines and included data from the past 25 to 30 years. The search terms utilized included: pediatric, emergency room, children, injury, epidemiology, prevention, obesity, sport, and specialization.

The purpose of this research study is to identify the epidemiology of sports-related injuries in the pediatric population in the community of Grand Forks, ND. Due to the decreased information in the literature relating specifically to the area of Grand Forks, ND, the data from the literature review collects data based on the general pediatric population of the United States to make inferences about the pediatric injuries in Grand Forks. General data could be collected from the surrounding areas, but no specific emergency room data from the Grand Forks, ND community was identified. It will be important to the study to identify injuries that may be specific to the area of Grand Forks, ND due to the climate and geography of the area. Grand
Forks, ND experiences winter and colder temperatures for several months out of the year, so there may be a correlation with type of injury and climate because many youth will participate in more winter or indoor sporting activities. Furthermore, Grand Forks has very warm summer temperatures during the months of June to August, therefore giving rise to injuries at the outdoor swimming pools, while biking on the bike paths, and also through horseback riding which is a common recreational activity in this area of the country.

PEDIATRIC POPULATION AFFECTED

Organized Sports Related to Injury

Participation in sports is on the rise, with young athletes training year-round and specializing at earlier ages, predisposing them to sports-related injuries. There are approximately 35 million children aged 5 to 18 years participating in organized sports in the US. As participation is on the rise, the frequency of sports-related injuries has risen as well. The three most common sports-related injuries across development, in order, are basketball, football, and soccer. Other sports included, but did not incur as many injuries are baseball, gymnastics, swimming, softball, hockey, volleyball, and track. Team sports, such as basketball, football, and soccer have emerged as activities causing more injuries in later childhood and adolescent years as compared to injuries occurring in the earlier ages of development. The three most common sports-related injuries are similar in the fact that there are few injuries in early childhood, followed by a sharp increase in injuries around age 8 or 9 years, peaking in the middle teenage years, and then falling off sharply at 17 to 18 years. Furthermore, boys incurred more than 85% of baseball and football injuries and girls incurred more than 85% of gymnastics, cheerleading, and softball injuries. This is likely because these are gender-preferred sports and a correlation
can be made between these gender-preferred sports and what ages and genders could be seen in emergency departments for pediatric injuries.

A common injury that is underreported by pediatric and adolescent athletes is concussion in which the sport of football has the highest incidence of concussion. Although football has the highest incidence rate, girls have higher concussion rates than boys do in similar sports. A clear understanding of the injury is necessary to recognize it and rule out more severe intracranial injuries because concussion can cause symptoms that interfere with a child’s growth and participation in sports. Head injuries are one of the most common injuries in pediatrics and adults, and they can lead to symptoms with acute, subacute, and chronic phases following a concussion. These symptoms following a head injury are labeled “post-concussion syndrome” (PCS) which there is limited research about this area, but has been sparking interest around the world. Headaches are the most common complaint or PCS with children following a head injury.

Concussions are directly related to a brain injury caused by direct or indirect head trauma causing neurological disruption. Most of concussion symptoms are recovered within a few days or weeks, but some can have prolonged symptoms. A meta-analysis was looking at 12 sports found three sports with the highest incidence of concussion was rugby, hockey, and American football, and the lowest incidence rates were volleyball, baseball, and cheerleading. When looking at a few studies done by Barlow we are starting to understand concussion more in the pediatric population. Adolescents are at higher risk for prolonged symptoms following TBI than pre-adolescent children, and that high school athletes have longer recovery time than college athletes. The mid-range pediatric age range is showing to have longer PCS then younger ages, and older age ranges. This shows that there is an elevated risk for children between the ages of 13 to 18 for having prolonged symptoms and headaches following a concussion. With the
increase awareness and concern for pediatric population there is more studies being done to avoid potential consequences from a concussion. The most important defense for this young age range is continuing education on this important topic to families, schools, students, and athletic sporting organizations.

The Grand Forks community is a location with a higher interest for youth in the sport of ice hockey. A study completed compared patterns of injury among pediatric ice hockey, lacrosse, and field hockey players. Between the years 1990 to 2003, an estimated 321,237 pediatric participants in these sports presented to US emergency departments. The injured patients were primarily male (75%) and aged 10-18 (95%). Ice hockey accounted for more injuries (53%) than lacrosse (26%) or field hockey (20%). Furthermore, children aged 2 to 9 years sustained twice the proportion of head and face injuries (53%) as children aged 10 to 18 years (23%). Males incurred a higher proportion of shoulder and upper arm injuries (14%) than females (3%), but in all sports, the ball or puck caused a greater proportion of face injuries in females than in males.12 These results display that when comparing similar, yet different sports, there are differences by age and sport, and within each sport, by gender.

Non-Organized Sports Related to Injury

Aside from organized sports participation, the two most common sources of injury for children and adolescents are bicycling and playing on playgrounds.3 Playground injuries peak in the early elementary ages and then drop off slowly, and bicycling injuries peak in the preteen years but are a common cause of injury throughout childhood and adolescence. An interesting point from the research study was that both biological and sociocultural factors influence the developmental aspects of pediatric sport and recreational injury risk. Biological factors include changes in perception, cognition, and motor control which may influence injury risk.
Sociocultural factors include making decisions about which sport and recreational activities to engage in and determining how much risk taking occurs while engaging in those activities might influence the risk of injury. With these factors in mind, it is important to know that although bicycling and playgrounds are the two most common non-organized activities, there are other activities that cause injury such as: skateboards, trampolines, scooters, roller skating, horseback riding, sledding, go-carts, and winter activities. The years with the most peaks of sport and recreational activity injuries were the middle teenage years, with 6 activities peaking in frequency at age 14 years and 9 activities peaking at age 15 years. Playground and trampoline injuries were most prominent throughout early and middle childhood but were then replaced by team sports, especially baseball. An interesting point is that from the ages of 1 to 7, playground and bicycle injuries dominated the number of injuries that children were sustaining. In each age year, there was a minimum of 2500 children presenting with injuries related to bicycling and playgrounds. As the children became older, there was less injury in these areas, and organized or team sports began to present with more injuries. With the total amount of children sustaining injuries, non-organized sports and recreation activities did present with a moderate amount of injuries, particularly in the younger-aged children, but organized sports injuries dominated. This is a good aspect of the research to notice because even though the amount of children sustained more organized sport-related injuries, there are many children becoming injured through recreation, so prevention strategies and safety will be important for the population of children involved in recreation activities.
INJURY DISTRIBUTION

Type of Injury

The number of pediatric injuries continues to grow with the number of participants and up to 25% of the injuries are fractures. Males sustain fractures twice as often as females and the highest number of fracture-related injuries occur in bicycling, basketball, football, and roller sports. Furthermore, the rate of falls in playground games is highest in the 1 to 4-year-old group and the rates of unintentional injuries, such as being struck by an opponent in sports activity or with bicycling, are highest in the 10 to 19-year-old range, which increases the risk of a fracture-type injury. This risk of fractures increases because at this age children are becoming more competitive and potentially more specialized in a sport, which means they will perform better and play more physically during contact sports. As far as unintentional biking injuries, children at this age may be taking more risks, may be biking more often to school or with friends, and may not be wearing a helmet, which are risks for potential injuries, especially fractures if falling to the ground. Another common type of injury is caused by overtraining which results in overuse injuries. A well-known example is children competing in running activities or the sport of cross country. Between the years 2008 to 2009, there were 429,000 young athletes competing in cross country and many sustained overuse injuries. Overuse injuries are related to repetitive stress on the musculoskeletal system without sufficient recovery time, which overwhelms the normal reparative process. The youngest age group with reliable data is high school cross country runners and this population had a high rate of injuries compared with other high school sports. Compared with boys, girls had a higher rate of injury and were more likely to sustain an injury that resulted in greater disability during the season. The most common site of injury was the shin in girls and the knee in boys. Furthermore, once runners were injured, they had a 4 to 5-fold
likelihood of re-injury at the same site.\textsuperscript{14} Typical injuries that overtraining can induce, especially in the growing athletes are apophyseal disorders, Osgood-Schlatter Disease, Osteochondritis Dissecans, Patellofemoral Syndrome, shin splints, and stress fractures. Each condition presents with a different clinical presentation and varies from stress to the bone to muscle imbalances to inflexibility which can cause damage to the bony structures and muscle tissue. Depending on the sport or injury mechanism can help to determine which type of injury the child may have sustained. Most overuse injuries present as stress fractures or changes to the epiphyseal plates which can be detrimental to the child’s health because it can lead to decreased bone development in the future or difficulty growing as the child ages. Sprains and strains are less common in children, as more injuries are bone-related and most likely due to inflexibility, but they do occur. As with Osgood-Schlatter Disease and Patellofemoral Syndrome, there is muscular imbalance and growth disturbances that can lead to pain and decreased performance in sports activities.

Location of Injury

One of the most common types of pediatric injury are fractures in which 90\% of fractures involve the upper limb including the distal radius, hand, elbow, and clavicle. Other common injured areas are the ankle, knee, and shin, but occur less frequently than upper limb injuries.\textsuperscript{13} There is a significant difference in the location of injury based on gender. Female athletes sustained more injuries to the lower extremity and spine whereas male athletes had a greater percentage of injuries to the upper extremity. The type of hip and pelvis injuries differed greatly where females sustained more overuse and soft tissue injuries where males suffered injuries that were more traumatic and bony in nature.\textsuperscript{15} This may be because males were participating in more team and collision sports at the time and females were participating in sports with less of a risk of contact in sports.
Severity of Injury and Risk Factors

Some risk factors that have been identified are age, gender, weight, and early specialization in sports. Each risk factor has a different effect on the type, location, and severity of an injury that a child or adolescent may sustain. Some risk factors are modifiable, such as weight, which may have an impact on the higher incidences of pediatric injuries. Other risk factors such as age and gender are non-modifiable, but pose their own differences in the patterns of pediatric injuries.

A study completed by Stacciolini et al\textsuperscript{16} evaluated sports injuries sustained in very young children (5 to 12 years) versus their older counterparts (13 to 17 years) regarding the type and location of injuries, severity, and diagnosis. In the 5 to 12-year-old category it was found that children sustained injuries that were more often traumatic in nature and more commonly of the upper extremity. They were diagnosed more often with fractures, including physeal fractures, apophysitis, and osteochondritis dissecans. In the 13 to 17-year-old category, injuries were more likely to occur to the chest, hip and pelvis, and spine. A greater proportion of the older children were treated for overuse injuries, as compared with their younger counterparts, and a much larger proportion of these injuries were classified as soft tissue injuries as opposed to bony injuries.\textsuperscript{16} A study completed by Jordan et al\textsuperscript{13} looked at epidemiology of pediatric fractures and found differences based on age. Children aged 0 to 9 years had the lowest rate of injury with a gradual increase until a drop off at age 15 years for boys and 12 years for girls. Furthermore, prepubescent children theoretically sustain fewer significant blunt-force injuries because their bodies are smaller than those of their older counterparts and they are less likely to generate the same speed and strength. Younger children have softer and more porous bones with relatively...
stronger tendons; therefore, they are more likely to sustain fractures, especially at the growth plates.13

There is evidence supporting that a high body mass index has been associated with an increased risk of sports injuries, and some evidence that overweight sports participants do not have an increased injury risk compared with normal weight sports participants.17 Even with the differing evidence, it is still important that children participate in physical activity to promote growth and development and secondarily to decrease the risks and prevalence of obesity. According to Pomerantz et al18, two of the most prevalent problems facing the youth in the US are injury and obesity. Obesity increases the risk of injury, prolongs recovery time, and increases morbidity among injured children. They recorded 23,349 patients where the mean age was 8 years and 62% were male and obese children represented 16.5% of the study population. Overall, their study concluded that obese and non-obese children had the same percentage of upper extremity injuries but obese children were significantly more likely to have lower extremity injuries.18 A study completed by Ezzat et al19 examined adolescents aged 12 to 19 to determine the association between overweight or obesity and sport injury. Majority of adolescents were categorized as healthy weight (78.5%) with 16.3% and 5.2% in the overweight and obese categories. In examining the odds of sport injury, overweight compared with healthy weight was not found to be associated with increased odds of sport injury, yet obesity was seen to decrease odds of sport injury by 33%. Their study was further supported by a study completed in the Netherlands in which the odds of sport injury were 27% less for overweight participants. This was contrary to their original hypothesis that obesity would further cause injuries. Previous studies suggested that adiposity causes increased musculoskeletal strain and impaired postural control in youths with a disproportionately large body mass. An interesting point is that obese
youths who play on a sports team may not have the skill, confidence, or fitness to engage in aggressive situations, therefore avoiding physically demanding situations and escaping injuries, which may be a protective effect. Lastly, a study completed by Ryan et al evaluated the hypothesis that pediatric forearm fractures from ground-level falls are associated with increased weight status (> 95th percentile). Children aged 0 to 17 were treated for isolated forearm fractures in emergency rooms where 929 forearm fractures were treated, and of those, 226 were ground-level falls and 54 were due to major trauma. Identifiable and preventable factors, such as weight status and bone health, may contribute to forearm fracture risk in children, particularly for fractures sustained from low-energy falls. The authors concluded that forearm fracture after a ground level fall was significantly associated with increased weight status. Overweight children fall with a greater force that may exceed the protection afforded by their relatively increased bone mineral density. Cheron et al argues that being overweight is causing additional stress to the body which is dangerous because the injuries are occurring at a vulnerable stage in the child’s life. An example is that the epiphyseal plates have not closed which means there is room for damage to occur. As seen, there is conflicting evidence about whether obesity has an effect on the prevalence or severity of injuries. An important takeaway is that all children should be engaging in physical activity every day, whether that is in organized sports or in recreational activities. Just by participating in physical activity each day increases an individual’s risk of sustaining some form of injury, but with the proper warm-up, education, or protective equipment, the risk will decrease. So despite conflicting evidence on the effect of obesity on youth injuries, all children are encouraged to participate in daily activity because the positive benefits far outweigh the negative consequences of obesity.
An increasing number of youth are specializing in single sports at younger ages and engaging in repetitive, intensive activity. Single sport specialization has been shown to be detrimental both physically and emotionally, especially when the child is growing because the body is structurally at risk for injury.\textsuperscript{22}

**Prevention**

When looking at all types and areas for sports injuries being able to understand what is happening within the pediatric sports programs and what injuries are occurring is very important. Being able to find ways to prevent these injuries is a top concern. Research has shown that starting resistance training at an early age is beneficial and prevents injuries if done properly.\textsuperscript{23} Being mindful that resistance training at young ages needs to be done correctly because there can be adverse effects from lifting. Being able to understand the biological and sociocultural factors that influence these injuries is a good way to help prevent them and allow for healthier individuals in the pediatric population.\textsuperscript{3}

One specific area of prevention that is important for pediatric sports-related injuries is in conjunction with overuse injuries. As stated previously, more children and adolescents are specializing into sport-specific activities at a younger age, which makes them more prone to overuse injuries in the future. There is little research to support causative factors, but overuse injuries may be caused by training errors, improper techniques, excessive sport training, inadequate rest, muscle weakness and imbalance, and early specialization. A study completed by Valovich et al\textsuperscript{4} has developed recommendations regarding the prevention of overuse injuries in pediatric athletes including children (6 to 12 years) and adolescents (13 to 18 years). The recommendations are for injury surveillance, pre-participation physical examination, identification of risk facts, coach education and medical supervision, sport alterations, training and conditioning
programs, and delayed specialization. Each of these recommendations has been well-researched with evidence to provide specific preventions for overuse injuries in the pediatric population.4

Summary and Conclusions

The results of this review showed that there are a significant amount of pediatric injuries occurring each year across the United States. The three most common sports with pediatric injuries occurring are basketball, football, and soccer. Males sustain more injuries in basketball, football, and baseball, whereas females sustain more injuries in cheerleading, soccer, and softball; which could be due to the gender-specific sports. Most injuries occur starting around the ages of 8 to 9, peak in the middle teenage years, and decrease around 17 to 18 years. Typical injuries include fractures, sprains/strains, and concussions. Fractures are more common in the upper extremities and concussion is most common in the sport of football. Outside of the realm of sports injuries, children are sustaining injuries by biking and playing on the playground. Children are falling and sustaining injuries that could potentially be prevented, such as with helmets or adults supervising on the playground.

With more knowledge about the incidence, type, and severity and pediatric injuries, there have been prevention strategies and more education given to coaches and trainers to reduce amount of injuries experienced by active youth. Specifically, in the Grand Forks community, there is the Safe Kids organization which has taken an active role to promote safety and encourage safe physical activity for children and adolescents. Their organization evaluates bike and helmet safety and active participation for youth in sports-related activities to promote a healthy lifestyle. This organization has been a great addition to the Grand Forks community because it has expanded the community’s knowledge about the incidence of pediatric injuries and what measures can be taken to prevent bicycle and motor-vehicle related injuries.
CHAPTER TWO
METHODS

Study Design

The research study was a continuation of the thesis work completed by Tom Schuch at the University of North Dakota in 2011. The design of this study was a retrospective case series study in which emergency department records were obtained from the Altru Hospital ER for injuries sustained during pediatric sports and recreational activities from January 1, 2011 – June 30, 2015. The study followed the 9th Edition of the International Classification of Diseases, using the ICD-9-CM cause of injury codes, or E-codes to identify injuries specific to the study.

Setting Description

The emergency room records from the years of 2011-2015 have been stored and filed at Altru Hospital in Grand Forks, ND. For this study, computers in the Altru computer lab were used to gain access to the medical records for the pediatric population being researched. Altru gave the students badges which would allow access to the computer lab at any time. The computers were in a locked space in which only Altru employees can grant access to utilize, therefore protecting the confidentiality of every patient and his or her medical record. The records were maintained on a flash drive that only Mark Romanick, PT and the students had access to. The records were saved from the flash drive onto the students’ computers for ease of transferring the information necessary from the Altru computers. Once the research was completed, the records were permanently deleted from the students’ computers.
Sampling Procedures

Altru’s emergency department records were queried for E codes that designate specific sports and recreational injuries. The E codes that were used included E001.0-010.9 and E826.1-917.5. Each code identified a category of injuries related to physical activity. For example, code E007 represented activities involving other sports and athletics playing as a team or group. This code was then broken into subcategories that represent a specific activity, code E007.1 represented American tackle football injuries, code E007.2 represented rugby injuries. Each category included nine subcategories. Once queried, the data was printed off on sheets that only gave the medical record number and the date of injury. The hard copies were contained in a locked cabinet in the physical therapy office at the University of North Dakota. The medical record number and date were used to look up patient records in Altru’s computer data base. The details of each incident were recorded on a Microsoft Excel spread sheet. The medical record number, date of injury, and patient’s name were not included on the spread sheet. The items that were recorded included the age, gender, location of injury, type of injury, admitted/not admitted, duration of stay in hospital, name of sports or recreational activity, month the injury took place, and severity of the injury. Although the month of injury will be included, it will be coded to make it unrecognizable to anyone outside of the research group. If any of the details were missing, except for severity, the case was not included in the study. The search of Altru’s data base was done under the supervision of Altru personnel.

Participants

For this student research study, the participants that were included were male and female children between the ages of 0-19 who presented to the Emergency Department of Altru Hospital in Grand Forks, ND. The subjects that were included in the study were those that suffered a
sports or recreational-related injury. The data was collected between the dates of January 1, 2011- June 30, 2015 and consent of the participants was not required because we submitted a waiver of authorization to bypass the need for consent. In order for the study to begin, IRB approval from the University of North Dakota and Altru Institutional Review Boards needed to be granted. The IRB requirements include: project overview, protocol description, risk identification, subject protection, benefits of the study, and participant consent. Direct access to the medical records was obtained from Altru Hospital by completing the requirements as they related to working within the facility as students. Those requirements included the signing of a confidentiality statement of understanding stating the primary investigator will be held to and abide by the standards as set forth by Altru Health System. IRB approved the study on 6/26/17. Patient confidentiality was maintained because the names of subjects and social security numbers provided by the Altru data base were not recorded. The only pertinent information was using an identification code to further identify the pediatric patients with sports and recreational injuries.

Statistical Analysis

The data was analyzed and was compared via different variables to assess the relationships of various factors that were evaluated in the research study. The descriptor combinations tested were age and gender; this was done to see how injury patterns by maturity differ by gender. Age and type of sport was looked at to investigate how different age groups were affected in each sport. Age and month of injury was done to see if a specific month was responsible for the majority of injuries. Gender and location of injury was looked at to identify differences in the anatomical location of injury between males and females. Gender and type of injury was investigated to identify differences between the types of injuries affecting each gender. Gender and type of sport was looked at to see which sports are related to the most
injuries by gender as well to see how the patterns compare to national trends. Gender and month of injury was compared to see if females are injured more frequently in a different month than males so potential causes can be further researched. Type of injury and type of sport were investigated to see what types of injuries were occurring in which sports. Type of injury and month of injury were evaluated to see what time of year different types of injuries were taking place. Type of sport and month of injury was investigated to determine what time in the year and point in the season injuries related to sports were taking place.
CHAPTER THREE

RESULTS

Age

During 2011 to 2015 a selected group of 66 pediatric patients presented to Altru Hospital emergency department in Grand Forks, ND. They were reportedly involved in sport or recreation rated injuries.

Distribution by Age

Of the total 66 patients injured in this study their ages ranged from 2 to 17 years old. Understanding different age ranges is important, because age specific physiological changes happen to the body. Specific ages are related to specific injuries and pathology concerns. Figure 1 illustrates the distribution of injuries by ages of all 66 patients in this study. In this study the highest amount of injuries occurring at 7 years old with a total of 11 patients. In comparison to the 7-year olds, 12-year olds had with the second highest prevalence of injuries. There were similarities between ages 4 to 15 with amount of injuries ranging from 7 to 12 with 90% of all injuries within this age range. Children’s ages were grouped into three different sets to determine where the largest amount of injuries occurs. The three groups are ages from 1 to 9, 10 to 15, and 15 to 19. The highest amount of injuries transpires in the 1 to 9 age ranges with 59% of all injuries. The next highest injuries occurred in the 10 to 14 age group with 30%, and only 11% in the 14 to 19 age range. Figure 2 demonstrates the findings of distribution of injury by their age group.
Figure 1: Distribution by Age

Figure 2: Distribution of Injury by Age Group
Gender

Past research has speculated that females are at higher risk for injuries. This study shows a gender comparison to note the differences between male and female. Figure 3 shows amount of injuries per gender and the percent within each gender. Females had 60% of the injuries with 40 total injuries, and 40% male with 26 injuries. Figure 4 demonstrates number of injuries by gender and ages.

Anatomical Location

Anatomical location of injury was studied to determine the highest prevalence of affected injuries to the body. The distribution of injury by anatomical location is shown in figure 5. The highest amount of injuries happens at the arm with 24 of the 66 injuries. The next two highest areas of injuries were the face (n = 19) and head/neck (n = 18). These injuries take place because the most common mechanism of injuries was related to falls. Other body areas that were studied were chest, torso, leg, ankle, foot, and hand. The combined total of six other areas was only 26% of all location. Figures 6 and 7 demonstrate location of injury by age and by gender, respectively. Females had a higher amount of total injuries overall in this study, but with amount of arm injuries females were at 64% of total arm injuries, almost double that of males.

Sport and Recreation Injuries

The type of sports and recreational activities is important to study to determine which activities have the highest potential for causing an injury. This allows parents and coaches to be more aware of these high-risk injuries. The distribution of injury by sport or recreational activity at the time of injury is shown in Figure 8. Out of the total 66 injuries a majority (n=31; 47%) of them were associated with other recreational activities. When comparing all sport-related injuries
Figure 5: Location of Injury

Number

Head/Neck | Face | Chest | Arm | Torso | Leg | Ankle | Foot | Hand
---|---|---|---|---|---|---|---|---
11 | 11 | 2 | 16 | 2 | 3 | 3 | 3 | 3

Location of Injury

Figure 6: Location of Injury by Age

Number

Head/Neck | Face | Chest | Arm | Torso | Leg | Ankle | Foot | Hand
---|---|---|---|---|---|---|---|---
11 | 3 | 2 | 9 | 2 | 3 | 3 | 3 | 3

Location of Injury

- 1 to 9
- 10 to 14
- 15 to 19
Figure 7: Location of Injury by Gender

Figure 8: Injury by Sport/Recreation
(n=15) with other recreation activities, recreation-related injuries more than double sport related. The next highest location venue of injuries was found to be on playgrounds with 30% of all injuries. The most significant finding connected with playground injuries was that, a majority of injuries were linked to the monkey bars. Figure 9 shows the location venue of injury with specific age groups. Children age 1 to 9 years old had a higher likelihood of being injured on the playground or during other recreational activities. Children 10 to 14 and 15 to 19 were found to be more injured in organized sports, and continued to decrease injuries on playgrounds and during other recreational events. Figure 10 shows location of injuries by gender. Females were at a higher risk of getting injured in other recreational activities and on the playground. There was no major significant difference between male and females within sports. Males had the only football injury and 2 out 3 hockey injuries. Baseball had one male injured and one female injured playing softball.

Year of Injury

When looking at the number of injuries seen in a year, trends can be determined over time to see were problems are developing during that time frame. The distribution of injuries by year is shown in figure 12. Throughout the five-year time frame the amount of injuries slowly decreased from 2011 till 2015. In this study 20 of the total 66 subjects were injured in 2011, 16 in 2012, 11 in 2013 and 2014, and 8 in 2015. Figure 13 demonstrates injuries per year categorized into the three age groups (1 to 9, 10 to 14, and 15 to 19). The date shows no significant increases by ages during the five tested years. As the total amount injured in that year was followed by the same amount of patients age ranges. 1 to 9-year olds, showed a gradual decrease from 12 in 2011, 9 in 2012, 8 in 2013, and 5 in both 2014 and 2015. In the year 2015 there was only half the amount cases filed which will directly impact the total amount of children
Figure 9: Number of Injury in Sports by Age

Figure 10: Number of Injuries in Sports by Gender
Figure 11: Total Number of Injuries in Each Year

Figure 12: Number of Injuries per Year by Age
injured in this year. This was similar for 10 to 14-year olds, 8 to 6 to 2 from 2011-2013, and slight increase from 2 to 4 in 2014, and none in 2015. Fifteen to 19-year olds were the only ones to show an increase throughout the years starting with 1 patient in 2012 and 2013, to 2 in 2014 and 3 in 2015. Figure 13 displays the injuries through the years by gender. There was no consistent pattern between males and females between the years. There were equal injuries between genders in 2011. Females were higher 75% and 82% of injuries in 2012 and 2013, respectively. Males were slightly higher in 2014 with 6 males and 5 females, and they were equal 4 to 4 in 2015.

Month of Injury

The distribution of injury by month is shown in Figure 14. Perusal on this figure shows that the highest frequencies of injuries occurred during the warmer months of the year, during April through September, with the greatest amount of injuries happening in July. Figure 15 shows the three different age groups distribution of injuries per month. With the age group 1 to 9 having a majority of the total amount injured, also represents higher amount of them injured in the warmer months of the year. The 10 to 14 age group also represents that as well except during the month of June when there was no reported injury. The age group 15 to 19 was more focused to the spring months starting in March and ending in July for their injury time. When looking at gender-related injuries by month Figure 16 breaks down when each gender was injured during the months of the year. Females have the majority of the total injuries in this study, but these injuries were more likely to happen during the summer months. From April to September females were almost double the amount of injuries than males. During the month of July females were 8:1 when compared to males. During March males represented all the injuries, with no
Figure 13: Number of Injuries per Year by Gender

![Bar chart showing the number of injuries per year by gender for the years 2011 to 2015.](chart13)

Figure 14: Total Number of Injuries per Month

![Bar chart showing the total number of injuries per month, with months from January to December.](chart14)
Figure 15: Number of Injuries per Month by Age

Figure 16: Number of Injuries per Month by Gender
females being injured. This was the only month where there were more males injured than females.

Types of Injuries

Knowing the type of injury being sustained by youth will help develop and implement safety strategies to prevent injuries and allow medical staff to be better prepared to treat these injuries.

Figure 17 shows the distribution of injuries by five specific groups. The five different groupings are: soft tissue, laceration, sprain, closed head injury, and fracture. Lacerations were the most common type of injury over all, accounting for 33 cases, 50% of all injured. The next closest two groups were closed head injury and soft tissue. Closed head injury (n = 14) accounted for 21%, soft tissue (n = 13) 20% of the total amount injured. Sprains and strain and fractures were the same with each having 7 injuries, each accounting for 11% of this study.

Figure 18 breaks down the type of injury with each of the three age groups. The 1 to 9 age group reported the highest amount injured with a laceration (n = 17), and also high amounts of injury connected with fractures and soft tissue damaged each having 11 cases. The 1 to 9 year olds had no sprains/strains. The sprains and strains were more common with the older ages 10 to 14 (n = 6) and 15 to 19 (n = 2). There were no lacerations with the 15 to 19 age group, which was more connected to the closed head injury (n = 4). Figure 19 demonstrates the type of injury by gender. Males represented more closed head injuries then females, which was the only group that males had a higher amount of injured then females. There were more females injured by laceration, fractures, soft tissue, and sprains.
Figure 17: Total Number of Injury Types

![Bar graph showing the total number of different types of injuries. The injuries include Soft Tissue, Laceration, Sprain, Closed Head Injury, and Fracture. The number of each type is indicated by a bar with a specific number on it.]  

Figure 18: Type of Injury by Age

![Bar graph showing the type of injury by age group. The injuries include Soft Tissue, Laceration, Sprain, Closed Head Injury, and Fracture. The number of each type is indicated by a bar with a specific number on it, and the bars are color-coded to represent different age groups (1 to 9, 10 to 14, 15 to 19).]
Figure 19: Type of Injury by Gender

<table>
<thead>
<tr>
<th>Type of Injury</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft Tissue</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Laceration</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Sprain</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Closed Head Injury</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Fracture</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>
Severity of Injury

Understanding the severity of an injury helps to determine which sports and activities are more dangerous than others. Knowing this can allow the implement of safety methods to prevent the more serious injuries.

The severity score was given by the ER personal at the moment when the patient reported to the ER. The score was based on an injury rating system that Altru hospital used to assess severity. The severity was constancy found in the ER physician documentation. The injuries were rated Mild, Moderate, and Severe which were normal documented by physician in the electric medical record at the time of injury. Figure 20 demonstrates the three groups of severity. The highest amounts of ER visits were mild (n =38) with 58% of the total. Moderate was (n =23) 35%, and only 7% (n =5) were classified as severe.

Mechanism of Injury

By looking at the mechanism of injury the cause can be better determined and ways to prevent these injuries can be developed.

Figure 21 divides the mechanism into three groups: collided, hit with object, hit with object, and fall. Fall represented the vast majority of injuries with (n =58) 88% of the injuries. There were no injuries with hit with object, and only 2 injuries with hit by object. There were 6 injuries that happened with colliding. Figure 22 breaks the injuries into the three age groupings. The two injuries classed by hit by object were in the 15 to 19 age group, and the rest of them were in the fall group. The 1 to 9 group were mostly associated with falls having 36 cases, and only 3 collided injuries. The 10 to 14 group also had a majority of falls with 19 cases, and only 2 collided injuries.
Figure 20: Severity of Injury

- Mild: 38
- Moderate: 23
- Severe: 5

Figure 21: Total number of Mechanisms

- Collided: 6
- Hit with Object: 2
- Hit by Object: 2
- Fall: 58
Figure 22: Distribution of Mechanism by Age

- Collided
- Hit with Object
- Hit by Object
- Fall

Mechanism of Injury

- 1 to 9
- 10 to 14
- 15 to 19
CHAPTER FOUR
DISCUSSION
Age

Knowing the ages of children affected by sports and recreational injuries helps health care providers and researchers to determine what physiological factor might be predisposing children in sports or in general active activities to certain injuries. These injuries can be linked to types of sports or the environmental aspects associated with the injury. At some age specific children are at a higher likelihood of being injured or linked to certain pathologies. Types of sports or activities place children at higher risk, in addition to age related physical changes such as coordination, knowledge, and skill.

Based on the number of children that presented to the emergency department for sports or recreation-related injuries, the majority affected children between the ages of 4 to 15 years, which accounted for 91% of the total injuries. When evaluating the incidence of injuries, the greatest amount of injuries occurred to those children in the range of 7 to 12 years. This tendency might be linked to the fact that children are very active during these stages of life and are experiencing rapid changes in growth which could lead to an increased risk of injury. Furthermore, children might be playing harder during sports or taking more risks in general activities around home or at school. As children age, their bodies are developing which can lead to better performance in sports such as increasing their speed, strength, and agility. Along with
development, children become taller and gain weight which requires the body to change its mechanism of movement to prevent predispositions to injury.

By evaluating the distribution of injuries by age groups, the majority (59%) of injuries occurred between the ages of 1 to 9 when compared to the 10 to 14 and 15 to 19 age groups. For the 1 to 9 age group, many of the injuries were due to recreational activities as compared to organized sports. A major contributor to the injuries in this age category were due to playground accidents that involved falling from the playground equipment. In comparison to the other age categories, this age group might have had more total injuries because it was the largest range of ages in the fact that it covered nine years, compared to the other groups which covered only five years. Research supports that most pediatric injuries occur between the ages of 10 to 14. The 10 to 14 age range accounted for 30% (n = 20) of all the injuries. Children in this category experienced more injuries related to sports as compared to recreation activities. This may be because this is the period in which children begin competing competitively in sports and are able to join sports teams that have a regular practice schedule. This can contribute to an increased risk of injury because of the increased frequency of sports-related activities and practices. Furthermore, children in this age group are continuing to experience growth spurts and some may be entering puberty which comes with a whole host of bodily changes that requires adaptation to prevent injury. Based solely on age, the conclusions that can be made about injuries are that children in younger age categories (1 to 9) experience more recreation-related activities and as children age, more injuries are seen due to organized and non-organized sports.

Gender

Males and females differ in anatomy and physiology and are therefore subject to different types of injuries.\textsuperscript{24} Identifying certain injury trends by gender is essential to developing certain
risk identifiers and prevention strategies for male versus female children. By being able to identify who may be at a higher risk and at what age they are presenting with injuries can give insight for preventative measures to decrease the amount of injuries.

According to the CDC, males aged 1 to 19 are generally at a higher risk of injuries than their female counterpart. Reports believe that males are more prone to injuries because they take more risks than females and are less likely to take extra precautions. On the other hand, a study was conducted which stated that female athletes are at a higher risk of injury due to certain vulnerabilities in their anatomy and biology. This study found that females had a higher rate of injury (n = 40), owing to 60% of the total injuries. The majority of the injuries sustained by children in this study were due to playground accidents and recreational activities such as horseback riding. Because of these mechanisms of injury, females may be more likely to participate in recreational activities and may have an increased likelihood of injury on the playground due to unsafe play. Another important area of development to acknowledge is puberty. Females tend to reach puberty earlier than males, which causes hormonal and bodily changes which could lead to increased risk for injury if the body does not adapt to the changes immediately. As seen by this study, more females were becoming injured between the ages of 10 to 12 and males experienced injury between the ages of 12 to 15 which correlates to general puberty time periods. Another important factor for gender differentiation may be based on geographic location. This study was completed in Grand Forks, ND and reported on the injuries that presented to its emergency room. Based on the population, there may be more females that participate in activities pertinent to the area, such as horseback riding, and more injuries were common in the summer months which can give rise to more females becoming injured on the playground. Furthermore, organized and non-organized sports such as softball, cheerleading, ice
skating, and board sports may be more appealing to females in this area. Based on gender, there are several factors that could lead females or males to be more prone to injury, but in this study, females were injured more often than males.

Anatomical Location

Identifying the location of injury is useful in determining where the injury occurs and how it can be related to the sport and mechanism of injury. Children are sustaining injuries more often, and anatomical location can be an important factor to determine if there are any trends based on sport, mechanism, gender, or age to cause a specific impaction on a certain area of the body. If trends can be found, prevention strategies could be put in place to limit the amount of injuries sustained by children in organized sports and recreational activities.

When evaluating the anatomical location of injury, it is important to note the mechanism of injury to the affected structure. The majority of injuries occurred at the arm (n = 24) and were largely connected to falls. The next most common area was the head and neck (n = 19), followed by the face (n = 18). Combining these two very similar anatomical locations would account for the majority of injuries when assessing the location with a total of 37 injuries (56%). Contrary to the study findings, research supports lower extremity injuries are the most frequently sustained by children. From the findings in this study a total of 7 injuries occurred in the lower extremities, compared to 26 injuries from the upper extremities. In addition, there was a total of 8 injuries that affected the chest and torso. It is important to note that many children who presented to the emergency room did have multiple injuries, therefore affecting different locations on the body. For example, a child may have fallen off the monkey bars which resulted in a broken arm and a laceration to the face. Another important correlation is to compare the location of injury with the age of the child. Many of the injuries affecting the younger population
occurred at the arm, head and neck, and face. The 1 to 9 age group had 16 injuries of the upper extremity, and 11 in both head/neck and face locations. This was most likely because the mechanism of injury most common in this age group was falling. Falls place the upper extremity as the most vulnerable point of injury and the face at the next highest.\textsuperscript{28} Therefore, it may be important to assess safe play strategies for children and caregivers when on the playground to aid in the decrease or prevention of falls and subsequent upper extremity injuries.

An area of this study compared gender and location of injury. A recent study evaluated head injuries by gender and concluded that males are 80\% more likely to suffer a head injury than females.\textsuperscript{29} In this study, males and females were about equal for injuries to the head and neck, with females slightly higher. This could be because the sample size found that more females were injured than males, and by the activities that children were participating in. For the other areas of the body, females had higher rates of injury to the face, chest, arm, torso, and leg. Interestingly, there were two males in the study that had injuries to the hand and no one presented with an ankle injury. This could be related to the small size and the minimal records for data collection, but overall many of the injuries were confined to the head/neck, face, and arm which is supported by research.

Sports and Recreation Injury

This study evaluated injuries that occurred in both organized sports and recreational activities. Based on the results of this study, more than half of the presented injuries were due to recreational activities, such as playing on the playground or horseback riding. There are many children in the area of Grand Forks that do play organized sports, but according to the small sample of data collected, there were more recreational-related injuries.
Recreational activities were a majority of the injuries found in this current study with 31 cases. Playground accidents were associated with most of the recreational activities, especially by the mechanism of falling from the monkey bars. Monkey bars have not been deeply researched, but some organizations are taking steps to minimize the injuries that are occurring on playgrounds. For example, Kids Health has evaluated playgrounds in various areas to address how safe they are. The organization has evaluated playground surfaces, design and spacing, maintenance and inspection, and has educated children and families about playground safety, safe equipment guidelines, and specific equipment safety.\textsuperscript{30} This research may be beneficial to the Kids Health organization and other pediatric organizations around the country for safer play for children. By providing Kids Health with additional research and information they have the opportunity to make further changes to equipment and to implement safety protocols to school and other recreation facilities to reduce playground injuries. This is important because making the equipment as safe as possible is one of the most important areas to allow children to stay physically active and safe at the same time.

When evaluating specific sport-related injury, there was no sport that stood out between the others. There were 3 hockey related injuries, which is a common sport in the Grand Forks community. There are more hockey programs and teams in North Dakota in the Northern Plains region of the country, which would increase the likelihood of injuries in this sport.\textsuperscript{31}

**Time Frame of Injury**

The five-year period (2011 to 2015) captured by this study showed a steady decline in injuries with the highest amount of injuries in 2011. This decrease in injuries could be due to the small sample group that was given by Altru Health for this current study. The age groups were
consistent with the decline in injuries throughout the years, and females had a spike in amount of injuries during 2012 and 2013 with more than double the amount of injuries sustained by males.

When evaluating the incidence of injuries by month, the month with the greatest frequency of injuries was July. This was closely followed by April, May, June, and August. In the Grand Forks area, these are usually the warmest months of the year, which can be an explanation as to why these months had the highest incidence of injuries. Had this study collected more data, there may have been more winter sports injuries accounted for, but based on the results of this study, the majority of injuries were due to activities and sports played during the warmer months of the year.

Overall, a complete understanding of the time of the year in which most injuries occur is important to help determine the potential causes and risk factors for injury prevalence. Due to the small sample size of this study, the data did not provide a complete list of all injuries sustained by children over the five-year period, but the conclusion that can be made is that most injuries occurred during the warmer months of the year. This is important to know when making preventive recommendations and enforcing safety precautions for children engaging in activities.

Injury Type

This study evaluated the type of injury that children were sustaining during sports and recreational activities. By dividing the types of injuries into categories, there is a better picture of how children are sustaining injuries, and what could be the potential causes for injuries. This could help decide which prevention strategies could be most beneficial to decrease certain types of injuries from occurring.
For this study, the categories of injury were as follows: soft tissue injury, laceration, sprain/strain, closed head injury, and fracture. Many of the children that presented to the emergency room typically sustained more than one type of injury. As stated earlier, a child may have presented with a fracture and a laceration. Therefore, this would count as two injuries for the child since he or she sustained two different types of injury. The most frequently seen injury in this study were lacerations. This could be due to the fact that many of the presenting injuries were caused by falls, therefore resulting in some laceration to a part of the body. Also, the most common age group were those children between the ages of 1 to 9, and they were more common to get minor scrapes due to accidental falls. In the initial phase of this study performed by Tom Schuch, it was determined that fractures were the most common type of injury, which is different from the results found from the current phase of the study. Fractures were one of the least common forms of injury found, which could be due to the small sample size of the data collected, or there were better preventative measures in place to reduce the number of fractures seen in children. Another important point is that there are more children who more obese than those in the past, and previous research has shown that more body weight may have protective effects and better bone density. The second most common injury were closed head injuries which is a major concern. This is concerning because of the risk of concussions and the potential for chronic traumatic encephalopathy. Head injuries can be connected with prolonged symptoms and lifelong physiological changes to the brain and body, which makes this a top priority in injury prevention. Of the 11 patients who suffered a closed head injury 4 of them where in the 15 to 19 age group, which can be related to sporting activities. This is important to note because this could provide solid evidence that there needs to be more protective strategies for those athletes at risk in their sports for concussions and head injuries. Even though this study did not have
adequate evidence about more sports-related injuries, such as football, baseball, and soccer, there is proof that head injuries do occur, even in a small sample size. One of the main goals in sporting activities is safe play and to minimize the risk of injuries for athletes, so prevention strategies for those athletes at risk will be an important addition for teams across the country. Soft tissue injuries were the third most common injury and provide little evidence toward mechanism of injury. Many of the children who presented with soft tissue injuries were those that were not “injured enough” to have a fracture, sprain, or laceration. These were children that had minor bumps and bruises and would follow general pain management protocols for their injury to heal in a short amount of time. For the purpose of this research study, it was important to note the less severe injuries, such as those with soft tissue injuries, to see those mechanisms of injury and why some children may have had more severe injuries in comparison to those that had a less severe reaction.

Severity of Injury

For this research study, the injuries were scored as minor, moderate, and severe. This is important to determine whether the injury was severe enough to require hospital admission, or if it was minor and only required typical recovery management strategies. This is beneficial to note because without the severity indicator, there would be no definition of how intense the injury was based on its mechanism of injury.

The results of the study showed that most of the injuries were scored as mild (58%), followed by moderate (35%), and severe (7%). Because most of the presenting injuries in this study were lacerations, it is common that they would be considered mild as some patients required stitches, but were given a good prognosis and short recovery time. Out of the 66 subjects for the study, only 5 children required hospital admission for a duration of 1 day,
therefore showing that a small amount of the injuries were severe. These types of injuries were those that resulted in closed head injuries, or fractures that required surgical intervention.

Overall, most of the injuries were classified as minor, meaning that children spent a few hours in the emergency room and were able to return home the same day. Having more minor injuries as compared to severe injuries is a good sign for future preventative strategies. Injuries are not something that should happen, but it is easier to make predictions and formulate strategies to help prevent these minor injuries from occurring, such as safe play protocols, more adult supervision, and educating the public on what injuries are most common and what steps can be taken to minimize the risk of injury.

Conclusion

Overall, this study was able to evaluate the emergency room records of Altru Hospital in Grand Forks, ND to determine the various mechanisms of injury, types of injury, severity of injury, and the population of children affected between the ages of 1 to 19. There were several limitations to this study that could be prevented for future continuation of the study. First, not all records from Altru Hospital were obtained for the research study. The data that was collected over the five year time period included only a couple hundred subjects, and from previous research, there should have been thousands of records to evaluate. Because of this limitation, there was not a clear picture as to what the true mechanisms of injuries were, the population affected, and what conclusions or trends could be made regarding injuries. A second limitation was the limited amount of time for data collection. There was a delay from Altru Hospital in this research study which hindered the amount of time for research to be conducted. It came to the point where only one batch of subjects were evaluated, when thousands more files could have been looked through. This was a downfall of the study because had there been more time for data
collection, there could have been more results for more concise trends in pediatric injuries. The last limitation to the study was geographic location. When performing the literature review, there were few studies that evaluated injuries that pertained to the area of North Dakota, and even more specifically, Grand Forks. Most of the research pertained to the entire country and did not have many specifications for certain areas of the country. It would have been beneficial to the research study to have had research about specific injuries at least in the midwestern part of the country to aid in the development of injury trends which could have lead to specific prevention strategies.

To summarize, the point of this research study was to evaluate the incidence of pediatric injuries that reported to the emergency room in Grand Forks, ND. This has allowed for trends to be made about types of injury and the population of children affected, in hopes of forming prevention strategies to minimize the incidence of injuries. A study was completed to evaluate risky play and children safety, which is a perfect correlation to this study. Children were made to have fun and engage in play activities, and sometimes finding the correct formula to keeping children safe is very difficult. Not letting kids be kids with play could decrease their overall physical level and increase a sedentary lifestyle which is connected to a poor quality of life and an increased risk of comorbidities. At the same time, keeping kids safe by avoiding dangerous injuries that can be life treating or life changing is also a main concern with increasing injuries in this pediatric population. To keep children safe and active is important to promote their creative minds and maintain a healthy lifestyle. Because of this reason, the focus for play activities is where the focus needs to be for prevention strategies.32
Future Research

In continuation of this study, future research could be done for further prevention of injuries, types of practices and training schedules for those children and adolescents in sports with a higher risk for injury, and studies about the types of injuries seen most commonly in the Grand Forks community. Research has begun for prevention of injuries, but with the diversity of sports and types of children engaging in activity, there are many factors into finding the golden answer for the best mechanism of preventing injuries. Furthermore, in sports with a higher risk of injury, such as those with frequent cutting, starting and stopping and contact, it is important to evaluate how practices and training schedules are structured to evaluate the risk of over-training, under-training, or not enough focus on stretching and strengthening. Lastly, there has not been much data collected on the frequency and types of pediatric sports injuries in Grand Forks, ND. In this area, there are specific sports more common such as hockey, football, and soccer and more research is necessary to evaluate the mechanisms of injury and types of injury sustained through these sports since many children engage in these sports in Grand Forks.
REFERENCES


