

## Injuries in Youth Football: A Prospective Observational Cohort Analysis Among Players Aged 9 to 13 Years

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- **Objective:** To determine the risk of injury in youth football games.

- **Subjects and Methods:** Nine hundred fifteen players aged 9 to 13 years on 42 teams participated, including 10 teams in each grade from grades 4 through 6 and 6 teams each in grades 7 and 8. The study was conducted in the fall of 1997. Injury incidence, prevalence, and severity were calculated for each grade level and player position. Additional analyses examined the number of injuries according to body weight.

- **Results:** A total of 55 injuries occurred in games during the entire season (overall prevalence, 5.97%). Most injuries were mild, and the most common type was contusion, which

occurred in 33 players (60%). Four injuries (7%) were severe enough to prevent players from participating for the rest of the season. All 4 severe injuries were fractures involving the ankle physis. The risk of injury increased as players matured in age and grade level. Injury risk for an eighth-grade player was 4 times greater than the risk of injury to a fourth-grade player. A trend was identified for heavier players to be at increased risk, but no significant correlation was evident between body weight and injury.

- **Conclusion:** Our prospective observational analysis showed that most youth football injuries are mild. Older and heavier players appear to be at higher risk.

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Approximately 1.5 million athletes play American football, beginning at the age of 9 years and continuing through high school, college, and occasionally to professional levels. An estimated 1.2 million injuries per year occur as a result of such participation.<sup>1,2</sup> For many years, the sports medicine community has expressed an interest in documenting the risks and mechanisms of injury in football, especially spinal cord trauma and death.<sup>3-6</sup> Available reports range from surveys, which document the absolute numbers of injuries, to prospective cohort analyses, which identify risk factors of injury and suggest preventive measures. The bulk of the literature<sup>7-15</sup> concerning football injuries has focused on athletes of high school age or older. A few studies<sup>15-19</sup> have investigated the risk of participation in football at the youth level (players younger than 14 years). The purpose of this project was to determine the risk of injury in youth football games. This required using a strict injury definition, documenting a specific diagnosis by experienced sports medicine physicians, and recording exposure to injury by tracking the number of plays in each game.

### SUBJECTS AND METHODS

All players younger than 14 years registered with a community youth football association (N=921) in grades 4, 5, 6, 7,

and 8 were invited to participate. Players from each grade level competed in a separate league. There were 42 teams, including 10 teams in each grade from grades 4 through 6 and 6 teams each in grades 7 and 8. All 42 teams and 915 of the 921 players agreed to participate in the study. The parent of each player who agreed to participate signed an informed consent. The study population included 218 fourth graders, 211 fifth graders, 206 sixth graders, 147 seventh graders, and 133 eighth graders.

For the purpose of this study, a game injury was defined as any football-related ailment that occurred on the field during a game that kept a player out of competition for the remainder of the game, required the attention of a physician, and included all concussion, dental, eye, and nerve injuries. Severity of injury (based on time loss) was recorded as mild (no limitations expected and either no time loss or players expected to return to football within 3 days), moderate (athletes returned within 4 to 14 days), or severe (long-term sequelae expected and athletes expected to be out of football longer than 14 days).

Injury prevalence was expressed as the percentage of players injured during the entire season at each grade level (number of player injuries/total number of players at each grade level). Injury incidence was expressed as injuries per 1000 player-games. The number of injuries was divided by number of players (n=22, the sum of the players on the field from each of the 2 teams), and this quotient was multiplied by the number of games in the season times 1000. Injuries per 1000 player-plays were calculated by dividing the number of injuries by the number of players (n=22) times the number of plays during the season times 1000.

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This prospective observational analysis of youth football injuries in games was performed during an entire single season (September 7-October 26, 1997). The principal investigators presented the purpose of the study and the research protocol to the board of directors and all coaches of the youth football association at a preseason meeting. The study documentation tools, which included informed consent, injury report (Figure 1), and game participation and exposure (Figure 2) forms, were distributed. Coaches were instructed on their responsibilities for collecting the roster information and documenting the total number of offensive plays, kickoffs, and punts for their own team during each game. The sum of the plays for the 2 competing teams equaled the total number of plays in each game.

All football games took place at the same location on 8 consecutive Saturdays. Each game was composed of four 10-minute quarters. Coaches were required to rotate players evenly and ensure that each player competed in at least half of every game.

On injury or complaint, the player reported to his coach and then to the medical tent located adjacent to the playing fields. Research assistants checked with the coaches on the field during games to ensure compliance in reporting. A sports medicine physician (orthopedic surgeon) staffed the medical tent at all times during game competition. The physician examined each injured athlete. The injury incident description and a specific diagnosis were recorded at the time of the physical examination (Figure 1). Player age, weight, level of play and position, years of experience, game quarter, weather conditions, time of the season, equipment type, field condition, and game situation were also documented.

Coaches reported any player who was unable to practice on the Monday following each Saturday game to identify the injuries that prevented continued participation or were not recognized on game day. The investigators contacted each individual player to arrange for consultation (free of charge) with a physician (M.J.S.) as necessary. Physical examination and review of radiographs were performed. This ensured that all pertinent information was recorded and that the documented diagnosis was accurate.

A coach from each team completed the game participation and exposure form (Figure 2). The team roster for each game and the playing status of each player were listed on the form. This allowed the calculation of injury prevalence expressed as the percentage of players injured during the season. Additionally, the total numbers of offensive plays, kickoffs, and punts for each team were recorded on the form. In this manner, incidence of injury, expressed as injuries per 1000 player-games and injuries per 1000 player-plays, could be determined (Table 1). A play in

football begins with the player's snap of the ball and ends with the referee's whistle to stop player participation.

Injury prevalence and incidence were calculated for each grade level and player position. Relative risks and 95% confidence intervals were calculated for each grade level based on the injury prevalence data (Table 1). Additional analyses were conducted that examined the number of injuries according to body weight.

## RESULTS

A total of 55 injuries occurred in games during the entire season, with 4 injuries (7%) severe enough to prevent players from participating for the rest of the season. All 4 severe injuries were fractures involving the physis (growth plate), including a Salter-Harris type 4 distal tibia fracture treated with closed reduction and casting.<sup>20</sup> The other fractures were nondisplaced and included a Salter-Harris type 1 distal tibia fracture, a Salter-Harris type 3 distal tibia fracture, and a Salter-Harris type 1 distal fibula fracture, all treated with a cast or walking boot. The remaining 51 injuries were mild, and all of these players returned to play the following week.

The most common injury was contusion, which occurred in 33 players and accounted for 60% of the total injuries. The other injuries were muscle strains in 11 players (20%), ligament sprains in 5 (9%), fractures in 4 (7%), abrasions in 1 (2%), and concussion in 1 (2%). All the muscle strains and ligament sprains were mild. The only concussion was categorized as mild with no loss of consciousness or amnesia and complete resolution of symptoms within minutes after the injury. No lacerations or dislocations were encountered. No player required hospitalization or surgery. No serious or catastrophic head, neck, or back injuries occurred.

The lower extremity was injured most often—the knee in 11 players and ankle in 8. Less frequently involved were the back and arm or wrist in 5 and the shoulder and head or neck in 4, followed by the hand or fingers, lower leg, ribs, and upper leg in 3 each and elbow in 2 (Table 2). Only 2 foot injuries and 1 pelvis or groin injury were identified.

Injuries were categorized according to offensive and defensive player positions. Thirty-one offensive players sustained 36 injuries and 19 defensive players sustained 19 injuries for a total of 55 injuries in 50 players (Table 3). Three players were injured twice, 2 while playing an offensive position on both occasions and 1 while playing offense on 1 occasion and defense on the other occasion. Injuries to offensive players occurred most often to running backs (18 players), followed by quarterbacks (6), receivers (6), and linemen (6). Three injuries occurred to a center, 2 to tackles, and 1 to a guard. Injuries to defensive players occurred most often to linemen and backs (7 players each), followed by linebackers (5). The prevalence rate, incidence rate, and

**1997 ROCHESTER AREA YOUTH FOOTBALL INJURY STUDY REPORT FORM**

One form must be completed for each injury. Definition of injury is any football-related ailment which occurred on the field during a game that kept a player out of competition for the remainder of the game, required the attention of a physician, and includes all concussions, lacerations, dental, eye, and nerve injuries.

Name: \_\_\_\_\_ Date of injury: \_\_\_/\_\_\_/\_\_\_ Study team member: \_\_\_\_\_  
 Age: \_\_\_\_\_ Grade: \_\_\_\_\_ Years of participation: \_\_\_\_\_

Team (check one):                      Position (circle one):  
 Offense                              Position played at time of injury ( C G T E RB QB WR )  
 Defense                                Position played at time of injury ( DL LB DB )

Time of injury:  
 Quarter (circle one)  
 1 2 3 4 OT

Field conditions:     Dry  
                            Wet  
                            Mud  
                            Snow  
                            Ice

Type of injury:                              Body part affected:  
 Contusion                                       Head/neck                                       Pelvis/groin/hip  
 Laceration                                       Shoulder                                         Upper leg  
 Strain     Upper arm                                        Knee  
 Sprain     Elbow     Lower leg  
 Fracture      Lower arm/wrist                                Ankle  
 Dislocation                                       Hand/fingers                                    Foot  
 Concussion                                       Back     Other: \_\_\_\_\_  
                           grades (check one):  
                            Confusion <15 min  
                            Confusion >15 min  
                            Loss of consciousness  
                            Amnesia  
                            Retrograde  
                            Antegrade

Type of play:  
 Run     Punt  
 Pass     Punt return  
 Kickoff     Kickoff return  
 Other: \_\_\_\_\_

How injury occurred:  
 Contact injury                                       Noncontact injuries  
                            Tackling     Cutting  
                            Getting tackled                                       Pivoting/twisting  
                            Blocking     Jumping  
                            Being blocked                                       Other: \_\_\_\_\_  
                            Incidental  
                            Contact with helmet                                       Unclear  
                            Contact with cleats                                       Other: \_\_\_\_\_  
                            Contact with off-the-field obstruction  
                            Coach  
                            Player  
                            Official  
                            Yardsticks  
                            Goalposts  
                            Bench  
                            Fence

Intent to injure (according to injured player):  
 Yes  
 No

Penalty called:  
 Yes    Type: \_\_\_\_\_  
 No

New injury?                                       Yes     No  
 Symptoms prior to game?                       Yes     No  
 Injury history:  
 Preliminary injury diagnosis:  
 Final injury diagnosis:

Return to play?                                       Yes     No

Signature: \_\_\_\_\_ M.D.

Figure 1. Injury report form. Position played at the time of injury: C = center; DB = defensive back; DL = defensive lineman; E = end; G = guard; LB = linebacker; QB = quarterback; RB = running back; T = tackle; WR = wide receiver.

**Game Participation/Exposure Form**

Team: \_\_\_\_\_ Date: \_\_\_/\_\_\_/\_\_\_  
 Coach: \_\_\_\_\_ Phone number: \_\_\_\_\_  
 Grade: \_\_\_\_\_ Opponent: \_\_\_\_\_

Plays per quarter	1	2	3	4
Offensive plays				
Kickoff				
Kickoff return				
Punt				
Punt return				

  

Name	Status*

\*Blank space = player participated in the entire game (not injured, sick, or absent at the start of the game).  
 I = injured (prior to participation)—did not participate.  
 A = absent (noninjury reasons)—did not participate.  
 U = player participated in the game but was unable to continue because of an injury.

Figure 2. Game participation and exposure form. The team roster for each game and the playing status of each player were listed on the form. A coach also tallied the number of each type of play.

relative risk for each player position are presented in Table 3, with the offensive line as the reference group.

The risk of injury was compared for players above and below the mean body weight for all players at each grade level. A trend was evident that heavier players (ie, those whose individual body weight was higher than the group mean body weight) sustained more injuries than lighter players (ie, those whose individual body weight was less than the group mean body weight). However, discriminant function analyses with weight predicting injury revealed no significant relationship between body weight and injury.

The compliance rate for recording the number of offensive plays by coaches was 90%. A total of 12,787 plays were documented during the season. Extrapolation of the existing data to include the missing 10% resulted in a total of 14,913 plays executed during the entire season. The total number of plays multiplied by 22 players on the field for each play yielded 328,086 injury exposures. Prevalence and incidence rates and relative risks at each grade level are presented in Table 1, with the fourth grade as the reference group. The overall prevalence of injury was low (5.97%),

with a gradual increase by grade and an abrupt increase among the eighth-grade players. Examination of injury incidence expressed according to 1000 player-games and 1000 player-plays identified the same pattern. The risk of injury increased according to increasing player grade level and age. Incidence of injury expressed as injury per 1000 player-plays was lowest in the fourth grade (0.09), increased for the fifth, sixth, and seventh grades (0.16, 0.16, and 0.15, respectively), and was highest in the eighth grade (0.33). Football players in the eighth grade accounted for 3 of the 4 fractures and as a group were 4 times more likely to sustain an injury compared with fourth-grade players (relative risk based on injury prevalence).

**DISCUSSION**

Two major limitations to cross-investigation comparisons are the definitions of injury and risk. These definitions are important to sports medicine personnel, coaches, and ultimately parents and children who are making judgments about sports participation. Risk of injury or incidence is determined according to established principles of epide-

Table 1. Injury Prevalence and Relative Risk by Player Position

Position	No. of players at position	No. (%) of injuries	RR (95% CI)*
Offense	11	36 (65)	
Lineman	5	6 (9)	1.00 (reference group)
Quarterback	1	6 (11)	5.00 (4.95-5.05)
Receiver	2	6 (11)	2.50 (2.29-2.81)
Running back	3	18 (33)	5.00 (4.91-5.09)
Defense	11	19 (35)	
Back	3	7 (13)	4.67 (4.63-4.71)
Linebacker	3	5 (9)	3.33 (3.16-3.50)
Lineman	5	7 (13)	2.80 (2.72-2.88)

\*CI = confidence interval; RR = relative risk.

miologic research. The numerator refers to the injury events and the denominator reflects the population at risk.<sup>21,22</sup> Both the numerator and the denominator must be defined and measured in a practical, meaningful, and sport-specific manner. Injury detection by telephone interview or questionnaire is fraught with inaccuracy. Previous investigations of youth football injuries have not analyzed the population at risk but have merely reported the number of participants. The total number of participants used as the denominator fails to account for the time of exposure, which is a key component for a meaningful analysis. Exposure to injury based on exposure time has been examined in other youth sports, such as ice hockey. Stuart et al<sup>23-25</sup> investigated the epidemiology of ice hockey injuries and documented the incidence of injury per 1000 player-practice and player-game hours across various levels of competition. These studies better reflect the risk of injury for participation in a specific sport. It is difficult to compare injury incidence data from continuous participation sports, such as hockey, to noncontinuous participation sports, such as football. Interruption of competition between plays in football makes injury risk assessment according to player-games and player-plays more pragmatic than player-hours. The actual playing time during a 40-minute youth football game (four 10-minute quarters) in our analysis was measured at approximately 8 minutes. Strengths of this study include a clear definition of injury, standardized forms, strict record keeping, and an orthopedic sports medicine physician on site to provide accurate diagnoses. These epidemiologic principles foster injury identification with minimal detection and recall bias along with simultaneous measurement of injury exposure.

The available literature provides diverse conclusions, and few studies have addressed the risk of injury during football game participation. High school athletes who played football were not at higher risk for injury when compared with students participating in other activities, according to Moretz et al.<sup>12</sup> However, the risk of injury for

football players was 18 times higher in a game when contrasted with a practice. DeLee and Farney<sup>9</sup> determined that high school football players were 6 times more likely to have knee surgeries compared with the general population. Goldberg et al<sup>17</sup> did not identify a correlation between injury risk and age in youth football players. Linder et al<sup>15</sup> examined the relationship between sexual maturity (Tanner stage) and the incidence of injury in junior high school football players. In the study by Linder et al, the coach recorded an injury if a player was removed from a practice or a game. An overall injury rate of 16% was reported for 2 seasons. No serious or permanently disabling injuries occurred. Ten fractures, including 5 physal injuries, were diagnosed. Injuries were more prevalent in the older players who were also more physically mature (Tanner stages 3, 4, and 5). The authors admit that no direct conclusions can be drawn since no individual exposure data were collected.

Our study analyzed the risk of injury in youth football by calculating injury incidence according to injuries per 1000 player-games and injuries per 1000 player-plays.

Table 2. Injuries by Anatomic Region (n=55)

Anatomic region	Frequency, No. (%)*
Knee	11 (20)
Ankle	8 (15)
Back	5 (9)
Arm or wrist	5 (9)
Shoulder	4 (7)
Head or neck	4 (7)
Hand or fingers	3 (5)
Lower leg	3 (5)
Ribs	3 (5)
Upper leg	3 (5)
Elbow	2 (4)
Foot	2 (4)
Pelvis or groin	1 (2)
Unknown	1 (2)

\*Percentages do not total 100% due to rounding.

Table 3. Injury Prevalence, Incidence, and Relative Risk by Grade Level

Grade	No. of players	Injury prevalence (% of players injured per season)	Injury incidence		RR (95% CI)*
			Injuries per 1000 player-games	Injuries per 1000 player-plays	
4	218	2.73	3.80	0.09	1.00 (reference group)
5	211	5.67	7.86	0.16	2.07 (1.43-2.71)
6	206	6.31	8.74	0.16	2.31 (1.59-2.74)
7	147	6.00	8.20	0.15	2.19 (1.56-2.83)
8	133	11.28	15.45	0.33	4.13 (3.49-4.77)
Overall	915	5.97	8.47	0.17	...

\*Based on injury prevalence. CI = confidence interval; RR = relative risk.

Risk increases with level of play (grade in school) and player age. Potential contributing factors include increased size, strength, speed, and aggressiveness. Analysis of body weight indicated that lighter players were not at increased risk for injury, and in fact heavier players had a slightly higher prevalence of injury. Running backs are at greatest risk when compared with other football positions.

To make an informed decision about selection and participation in a particular sport, risk must be reliably identified among the various activities. Comparison of injury incidence is difficult because of sport-specific variations, nonuniform injury definitions, and different exposure estimation. Roser and Clawson<sup>18</sup> concluded that junior league organized football was safer than free play based on an analysis of 70 teams. The retrospective data collection technique may have underreported the number of injuries. According to our data on athletes in the fourth through eighth grades, the risk of injury in youth football does not appear greater than other recreational or competitive sports.

## CONCLUSION

Our prospective cohort, observational analysis showed that youth football injuries are uncommon. Most injuries are mild, and the most common type is contusion. The ankle physes (distal tibial and fibular growth plates) are vulnerable. A trend was identified for heavier players to be at increased risk, but no significant correlation was evident between body weight and injury. Older players in the higher grades are more susceptible to football injuries. The risk of injury for an eighth-grade player was 4 times greater than the risk of injury for a fourth-grade player.

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