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Time-Loss and Non–Time-Loss Injuries in Youth Football Players

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Context: Estimates suggest that more than 5.5 million youths play football annually, and 28% of youth football players (age range = 5 to 14 years) are injured each year, resulting in more than 187 000 emergency room visits.

Objective: To analyze time-loss (TL) and non–time-loss (NTL) injury patterns across age groups in youth football players.

Design: Two-year observational cohort.

Setting: Two midwestern communities, including players from the fourth through eighth grades and between the ages of 9 and 14 years.

Patients or Other Participants: A total of 779 players participated, including 296 in grades 4 and 5; 203 in grade 6; 188 in grade 7; and 92 in grade 8. (Players in the fourth and fifth grades participated on the same teams, so we considered them as a single group.)

Main Outcome Measure(s): Injury frequencies and exposures were collected by certified athletic trainers present at each practice and game and used to calculate injury rates with 95% confidence intervals (CIs) for both TL and NTL injuries across age groups.

Results: A total of 474 injuries and 26 565 exposures were identified. Injuries were reported by 36.5% of the players, with 14.4% reporting more than 1 injury in a season. The overall injury rate per 1000 athlete-exposures (A-Es) was 17.8 (95% CI = 16.3, 19.5). The injury rate increased with each succeeding grade from 14.3 per 1000 A-Es (95% CI = 12.1, 16.9) in grades 4 and 5 to 21.7 per 1000 A-Es (95% CI = 17.2, 27.3) in grade 8. A total of 58.6% of all injuries were NTL. Non–time-loss injuries accounted for 70.1% of the injuries reported by fourth and fifth graders, 55.1% by sixth graders, 64.0% by seventh graders, and 33.8% by eighth graders. The cumulative NTL injury rate was 10.5 per 1000 A-Es (95% CI = 9.3, 11.8), and the TL injury rate was 7.4 per 1000 A-Es (95% CI = 6.4, 8.5).

Conclusions: Youth football players sustained more NTL injuries than TL injuries. We recommend that a first-aid–certified coach or league official be present at all games and practices.

Key Words: youth sports, epidemiology, injury incidence

Key Points

- The overall injury rate in youth football players was 17.8 per 1000 athlete-exposures.
- A total of 58.6% of the injuries sustained by youth football players did not require restriction from participation but did require assessment or first aid from a certified athletic trainer.
- First-aid training is recommended for at least 1 coach or league official present at all youth football practices and competitions.

Organized sports are a popular and important form of recreational activity for children. One sport growing in popularity is American football. More than 2.8 million persons over the age of 6 years participate in tackle football each year.[1] Two of the largest youth football organizations, Pop Warner Little Scholars[2] and American Youth Football,[3] boast more than 240 000 and 200 000 annual participants, respectively. Many other local, regional, and state organizations also exist, increasing the total number of participants at risk of injury.

The National Safe Kids Campaign[4] reported that more than 3.5 million children between the ages of 5 and 14 years are injured while participating in sports each year. Burt and Overpeck[5] estimated that more than 2.5 million emergency room visits each year are the result of sports participation.[5] Of these emergency room visits, 207 400 have been attributed to basketball, 187 800 to football, 116 900 to baseball and softball, 76 200 to soccer, and 21 200 to gymnastics.[4] The Campaign[4] also reported that 28% of youth football players between the ages of 5 and 14 years were hurt while playing their sport. Registry data are useful for considering the incidence of injury and the burden on the health care system, but many injured patients are not seen in medical facilities and do not file insurance claims, the typical sources of these data. Registry data also are limited by the lack of exposure and injury detail.

Injury data are limited by the definition of *injury*, and the definition is limited by the data source or collectors available. In one of the first extensive studies to examine injury in high school football players,[6] coaches were surveyed on a weekly basis; thus, their ability to recall injuries was important. To facilitate coach recall and to include only those athletes whose injuries caused significant impairment, injuries were defined as those that required a player to miss the next scheduled session (time loss). The National Athletic Injury/Illness Reporting

Table 1. Subject Demographics by Grade

Grade	n*	Age, y			Height, cm			Mass, kg		
		n	Mean	SD	n	Mean	SD	n	Mean	SD
Fourth and fifth	296	250	10.1	0.7	270	141.2	6.6	271	40.6	10.8
Sixth	203	178	11.4	0.4	185	148.5	7.2	185	45.9	12.3
Seventh	188	175	12.5	0.4	178	155.6	8.2	178	55.3	16.1
Eighth	92	83	13.4	0.4	88	164.0	9.3	88	63.6	17.6
Missing†	0	93	—	—	58	—	—	57	—	—
Total	779	779	11.4	1.3	779	149.4	10.8	779	48.4	15.7

*n indicates the total number of participants included in the injury surveillance.
†"Missing" refers to the participants for whom demographic information was unavailable.

System (NAIRS),[7] using a similar time-loss (TL) definition, sought to improve the quality of data by asking certified athletic trainers (ATs) to report injuries and exposure data. Powell and Barber-Foss[8] studied a variety of high school sports, further defining TL injuries as those that included players removed from the current session and any athletes with fractures, dental injuries, or head injuries. The American College of Sports Medicine Roundtable on Injuries in Youth Sports[9] has supported this definition by recommending that injuries be defined as those events that restrict participation for at least 24 hours. Despite widespread use and support, a TL definition does not include all injuries that require coach, parent, AT, or physician intervention and may underestimate the true burden.

Conditions that do not restrict play still require that a decision be made as to the severity and disposition of the injury. Although few are likely to be serious, some injuries that do not cause immediate impairment may have long-term consequences. This is of particular concern in youth sports, in which trained health care providers typically are unavailable and coaches must make decisions regarding the disposition of players. Many states require first-aid training for high school coaches, but few states have similar requirements for youth sport coaches.[10] Ransone and Dunn-Bennett[11] found that only 36% of high school coaches surveyed could pass a basic first-aid examination, and 8% were lacking current certification despite the state law requirement. More importantly, inconsistent decisions by coaches to return or not return players to games, depending on the situation, demonstrate the need for better understanding of injuries and their potential severity.

Few authors have specifically compared TL and non–time-loss (NTL) injuries in football. In a survey of a variety of high school sports, Beachy et al[12] reported that 61% of the injuries recorded required no time lost from participation, and across all high school sports, 65% of injuries were considered NTL.[12] Powell and Dompier[13] examined TL and NTL injuries in a variety of collegiate sports. Across all sports, 84% of the injuries reported by female athletes and 78% of the injuries reported by male athletes were NTL injuries.[13] When football alone was considered, 76% were NTL injuries.[13] If these proportions are similar in youth football, then the actual number of children injured playing youth football is higher than previously reported.[14–17] Our purpose was to determine the rate and nature of TL and NTL injuries in youth football players.

METHODS

Subjects

Subjects were participants from 2 southern Michigan communities hosting teams in the Mid-Michigan Pony Football League during the 2002 and 2003 football seasons. League rules mandate that participants must be between the ages of 9 and 14 years and must be in the fourth to eighth grades. The fourth graders and fifth graders were grouped together on the same teams and were considered as one group (fourth–fifth). Only 1 of the communities had eighth-grade teams.

These data represent a subset of the injury surveillance data collected as part of a broader study of youth football injury incidence, injury risk, and maturity from 2000–2006.[18] The project was approved by the University Committee for Research Involving Human Subjects and by community officials. Parental consent and child assent were collected from all 779 registered players from both communities at the time of registration each season. This initial consent and assent included them in the injury surveillance portion of the study. Additional parental consent and child assent were obtained at the time of equipment handout, before inclusion in the injury risk and maturity portions. The various sample sizes reported for subject demographics (Table 1) reflect measured data that were collected as part of the injury risk and maturity portions. Some participants who were included in the surveillance portion chose to not participate in the injury risk or maturity portions of the study or may not have been present the day measurements were taken.

Instrumentation

Player stature was measured to the nearest 0.1 cm using a long-arm field anthropometer (GPM Anthropological Instruments, DKSH Management, Ltd, Zurich, Switzerland). The standard error of the measurement of player height (0.14 cm) was well within the range of variability recommended for children.[19] Weight was measured to the nearest 0.2 kg using a digital scale (Taylor Precision Products, Oak Brook, IL). Height was measured on a flat concrete surface while the players wore shorts and a T-shirt. Standardized demographics and injury reporting forms were used to maintain consistency between the communities.

Procedures

At least 1 AT was present at each practice and game field at each community location. An AT was responsible for documenting injuries and exposures and using a standardized injury reporting form; the AT completed an injury report for each contact with an athlete that required assessment or treatment of injury. An *NTL injury* was defined as any injury evaluated by the AT that did not require removal from the current session and subsequent sessions or one that did not meet the criteria of a TL injury.[13] A *TL injury* was defined as any injury

Table 2. Injury Frequencies and Proportions by Grade

Grade	Exposures		Injured Players		Injuries									
					Games		Practices		Non-Time Loss		Time Loss		Total	
	Games	Practices	n	Percentage of Total*	n	Percentage in Grade†	n	Percentage in Grade	n	Percentage in Grade	n	Percentage in Grade	n	Percentage of Total
Fourth and fifth	1697	7898	87	29.4	46	33.6	91	66.4	96	70.1	41	29.9	137	28.9
Sixth	1162	5512	76	37.4	41	32.3	86	67.7	70	55.1	57	44.9	127	26.8
Seventh	1249	5640	78	41.5	37	27.2	99	72.8	87	64.0	49	36.0	136	28.7
Eighth	650	2757	43	46.7	21	28.4	53	71.6	25	33.8	49	66.2	74	15.6
Total	4758	21 807	284	36.5	145	30.6	329	69.4	278	58.6	196	41.4	474	100.0

*Percentage of total for injured players is the proportion of injured players for that age group.
†Percentage in grade is the proportion of total injuries for that age group.

requiring removal from the current session or subsequent sessions or any fracture, dental injury, mild traumatic brain injury, or other injury requiring physician referral or diagnostic procedures.[8,13] Injury data included body location, type, and severity. Time-loss injuries were classified further as minor (less than 8 days lost), moderate (8 to 21 days lost), or severe (more than 21 days lost).[8,12] An *overuse injury* was defined as any injury of insidious onset not included in other categories (eg, tendinitis, apophysitis). Stress fractures were included in the fracture category. Injuries listed as ''other'' were lacking an assessment or location or were conditions such as illnesses that were not included in other categories. Wounds included abrasions, lacerations, and punctures.

An *athlete-exposure* (A-E) was defined as an opportunity to be injured during a coach-directed practice session or game.[8,13] Each player who participated in a practice or game was counted as 1 A-E.[8,13] The AT's count of the number of participants present at each session was cross-matched with the count reported by each coach. Athlete-exposures were recorded by town, grade, and type of session (game or practice).

Analysis

Data analysis was conducted using SPSS statistical software (version 12.0; SPSS Inc, Chicago, IL). Injury risk was calculated as the number of injured athletes/number of athletes at risk[20] and reported as a proportion. Injury rates were calculated as the (injury frequency/A-E) $\times$ 1000 and expressed as the result per 1000 A-Es.[8] Injury rates and injury rate ratios (IRRs) were calculated for TL and NTL injuries and for practice and game conditions.[13] The IRR is a ratio that provides a comparison of the magnitude of difference between the conditions under consideration (eg, game injury rate/practice injury rate). Injury rate ratios and injury rates were reported with 95% confidence intervals (CIs). The null value was set at 1.0. Therefore, an IRR of 1.0 would represent no difference between the conditions, and if the corresponding CIs did not include 1.0, the IRR was statistically significant. Frequencies and proportions for type of injury, injury location, and injury severity were reported also.

RESULTS

Injury Rates and Injury Rate Ratios

Injury and exposure frequencies are reported in Table 2. Of the 779 players, 284 (36.5%) sustained an injury. The fourth-grade and fifth-grade players had the least risk of injury (29.4%), whereas the eighth-grade players had the highest risk (46.7%). The risks of injury for the sixth and seventh graders were 37.4% and 41.5%, respectively. A total of 149 players (19.1%) sustained at least 1 TL injury, and 135 players (17.3%) sustained at least 1 NTL injury. The most TL injuries any one player sustained was 5, and the most NTL injuries any one player sustained was 7 (data not shown). A total of 474 injuries and 26 565 A-Es were documented. Practices accounted for 69.4% of the injuries and 82.1% of the A-Es. Of the total injuries, 58.6% were classified as NTL (Figure 1).

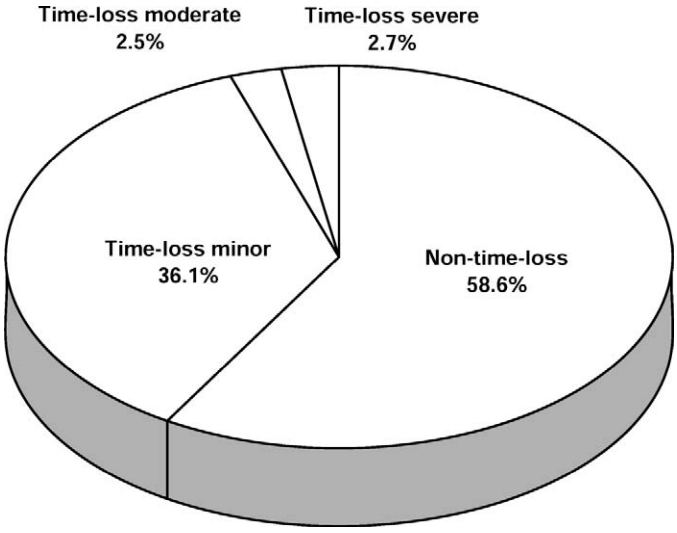

Figure 1. Proportion of non–time-loss injuries and time-loss injuries by severity in youth football players. Players with non–time-loss injuries returned to the current session. Time-loss injury severity categories include minor (<8 days lost), moderate (8 to 21 days lost), and severe (>21 days lost).

Injury rates and the IRRs between TL and NTL and between game and practice injury rates are reported in Table 3. The overall injury rate was 17.8 per 1000 A-Es (95% CI = 16.3, 19.4) per 1000 A-Es. The game injury rate (30.5 per 1000 A-Es, 95% CI = 25.6, 35.4) was significantly higher than the practice injury rate (15.1 per 1000 A-Es, 95% CI = 13.5, 16.7), with an IRR of 2.0 (95% CI = 1.5, 2.9). The overall and practice injury rates increased with each succeeding grade, but the game injury rate was highest in the sixth-grade players (35.3 per 1000 A-Es, 95% CI = 24.7, 45.9). The NTL injury rate (10.5 per 1000 A-Es, 95% CI = 9.2, 11.7) was significantly higher than the TL injury rate (7.4 per

Table 3. Injury Rates and Injury Rate Ratios With 95% Confidence Intervals (CIs) by Grade

	Injury Rates per 1000 Athlete-Exposures										Injury Rate Ratios			
	All Injuries		Games		Practices		Non-Time Loss		Time Loss		Games/Practices		Non-Time Loss / Time Loss	
Grade	Injury Rate	95% CI	Injury Rate	95% CI	Injury Rate	95% CI	Injury Rate	95% CI	Injury Rate	95% CI	Injury Rate Ratio	95% CI	Injury Rate Ratio	95% CI
Fourth and fifth	14.3	11.9, 16.7	27.1	19.4, 34.8	11.5	9.2, 13.9	10.0	8.0, 12.0	4.3	3.0, 5.6	2.4	1.8, 3.5	2.3	1.8, 3.5
Sixth	19.0	15.8, 22.3	35.3	24.7, 45.9	15.6	12.3, 18.9	10.5	8.0, 12.9	8.5	6.3, 10.7	2.3	1.7, 3.4	1.2	0.9, 1.7
Seventh	19.7	16.5, 23.0	29.6	20.2, 39.0	17.6	14.1, 21.0	12.6	10.0, 15.3	7.1	5.1, 9.1	1.7	1.5, 2.5	1.8	1.5, 2.6
Eighth	21.7	16.8, 26.6	32.3	18.7, 45.9	19.2	14.1, 24.3	7.3	4.5, 10.2	14.4	10.4, 18.4	1.7	1.6, 2.6	0.5	0.2, 1.5*
Total	17.8	16.3, 19.4	30.5	25.6, 35.4	15.1	13.5, 16.7	10.5	9.2, 11.7	7.4	6.3, 8.4	2.0	1.5, 2.9	1.4	1.2, 1.9

*Indicates not significant.

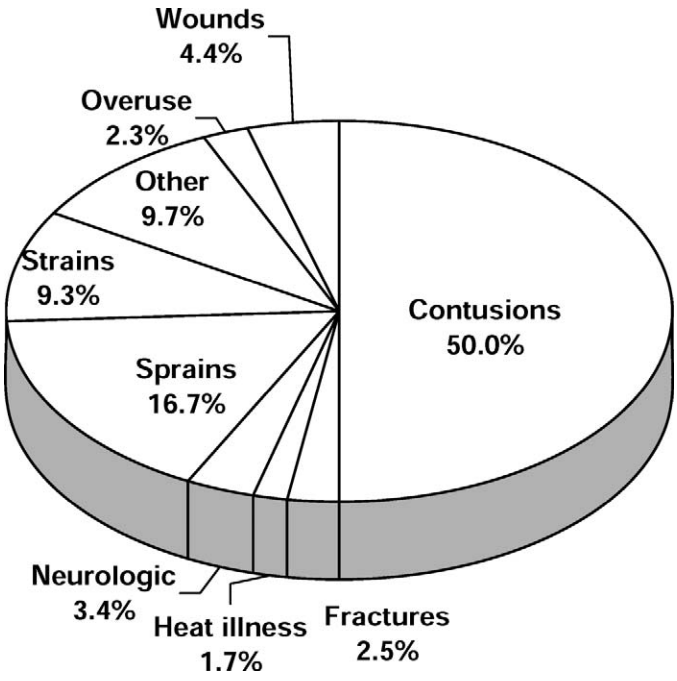

Figure 2. Proportions of injuries by type in youth football players. *Overuse injuries* were defined as any injury of insidious onset not included in other categories (eg, tendinitis, apophysitis). Stress fractures were included in the fracture category. Injuries listed as "other" were those lacking an assessment or conditions such as illnesses that were not included in other categories. Wounds included abrasions, lacerations, and punctures.

1000 A-Es, 95% CI = 6.3, 8.4), with an IRR of 1.4 (95% CI = 1.2, 1.9). Time-loss injury rates also increased with each succeeding grade (range = 4.3 to 14.4 per 1000 A-Es). The IRR was similar across all grades for both comparisons except for the eighth graders. The IRR for eighth-grade NTL/TL injuries was 0.5 (95% CI = 0.2, 1.5), but this value was based on small frequencies of both TL (n = 49) and NTL (n = 25) injuries and had a wide CI, including the null value (1.0), and is, therefore, nonsignificant. The fourth and fifth graders had the highest NTL/TL IRR: 2.3 (95% CI = 1.8, 3.5).

Injury Type and Location

Contusions were the most common type of injury reported, accounting for 50.0% of all injuries (Figure 2). Ligament sprains (16.7%) were the second most common type of injury, with muscle strains (9.3%) the third most common. Fractures accounted for 2.5% of all injuries; 5 (41.7%) of these fractures were suffered by the eighth graders, which constituted 6.8% of all injuries incurred by that group (data not shown). Heat illness was rare, accounting for 1.7% (n = 8) of all injuries. The sixth graders sustained 62.5% (n = 5) of all heat illness cases.

The wrist and hand was the most common location of injury, accounting for 20.3% of all injuries (Figure 3). Injuries to the ankle and foot and the knee were the second most common injury locations, representing 12.7% each of all injuries. A total of 31 head injuries (6.5%) reflected the sixth most common injury site. The youngest group (fourth graders and fifth graders) accounted for 51.6% of all head injuries. The neck and spine sustained 4.6% of all injuries, with the sixth graders reporting the highest proportion (36.4%). Interpretation of the frequency and proportion of neck and spine injuries is tempered by low frequencies and our inability to further differentiate among specific regions of the spine. Grade-specific frequencies are not shown due to low cell counts for most categories.

The proportions and injury rates for the most common sites of specific injuries are reported in Table 4 for all grades combined. Contusions to the wrist and hand (9.9%) were the most common injury sustained by these youth football players. Contusions of the knee (8.4%) and elbow and forearm (7.4%) ranked second and third, respectively. Ankle and foot sprains ranked fourth, accounting for 7.2% of all injuries. Of the 31 injuries to the head, 13 (41.9%) were classified as neurologic (mild traumatic brain injury), whereas 8 were contusions, 3 were wounds, 6 were classified other, and 1 was classified as heat illness. One noncatastrophic fracture was documented for the neck and spine. The remaining injuries to the neck and spine were classified as contusions (10), strains (9), and other (2). The ankle and foot, lower leg, and knee accounted for all overuse injuries.

Injury Severity

Most injuries (94.7%) were classified as NTL and minor TL injuries (Figure 1). Severe injuries were rare, accounting for 2.7% of all injuries. The majority of NTL injuries (55.9%) were classified as contusions (data not shown). The eighth graders sustained 46.2% of the severe and 81.8% of the moderate injuries but only 9.0% of the NTL injuries. Of the 13 injuries classified as severe, 12 were fractures and 1 was a sprain. Most of the moderate injuries (63.6%) were sprains.

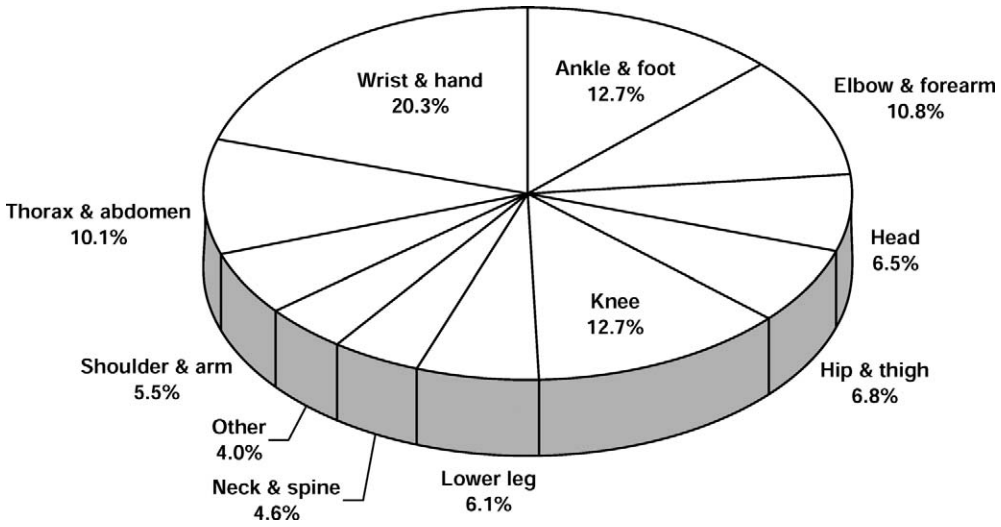

Figure 3. Proportions of injuries by location in youth football players. "Other" included illnesses and any location that was not reported.

DISCUSSION

We are the first to report the difference between TL and NTL injuries in youth football players as young as fourth graders to sixth graders. Beachy et al[12] did report NTL and TL injuries occurring in high school athletes in grades 7 through 12 but did not differentiate among age groups for specific sports. We found that 58.6% of the injuries sustained by youth football players did not require restriction from participation. Youth football players were 1.4 times (95% CI = 1.2, 1.9) more likely to sustain an NTL injury. Fortunately most injuries were not serious, but because coaches and parents make most of the return-to-play decisions at this level, it is critical that one or both parties have a minimal knowledge of basic first aid and injury prevention.

A few important limitations to our study exist. Our study was limited to a convenience sample of participants from 2 youth football seasons in 2 primarily rural Michigan communities. Although data were aggregated across years, normal fluctuations in frequency and rate may limit these results. The inclusion of only 2 communities and the cross-sectional nature of the data also introduce selection bias. In addition, only 1 community sponsored eighth-grade teams, which may account for the inverse distribution of TL and NTL injuries compared with the other grades. The lower frequency of NTL injuries reported by the eighth graders may have lowered the overall NTL injury rate or inflated the TL rate. Care should be taken in any interpretation of the eighth-grade data. Generalizations are limited further by the temperate Michigan climate, particularly regarding heat illness. Low frequencies within some injury location and injury type categories across all age groups also limit generalizations. Finally, these data only represent injuries brought to the attention of the AT on site. Some injuries may not have been reported, but this possibility was tempered by frequent follow-up with coaches, parents, and organization officials. Despite these limitations, we feel the breadth of information provided by these data regarding the nature and burden of injuries sustained by youth football players is unique.

Our study was part of a broader study examining risk factors for injury in youth football players.[18] Observation of the cohort began during the fall of 2000 and continues to the present. Time-loss injury rates (10.4 per 1000 A-Es) previously reported by Malina et al[18] representing the 2000 and 2001 seasons are significantly different from our TL injury rates (7.4 per 1000 A-Es) representing the 2002 and 2003 seasons. Some of this difference may be the result of normal variation; however, notable differences between the data collection periods may have contributed. Between the second and third years, 2 ATs were replaced by 1 new AT and another was added during the 2003 season. In addition, new operational definitions were developed to document both TL and NTL injuries. Although we are only speculating, these differences may illustrate the effect of changing data recorders and definitions during a surveillance program on injury rates.

Other authors have reported NTL and TL injuries in high school[12] and college[13] football players. Our proportion of NTL injuries (58.6%) was similar to the 61% reported by Beachy et al[12] for high school players but considerably lower than that reported for collegiate athletes (76%).[13] In addition, our IRR (1.4) between NTL and TL injuries was less than half the incidence density ratio (3.7) reported by Powell and Dompier,[13] despite use of the same operational definitions. This disparity may be the result of ATs taking a more conservative approach when returning younger players to sport.

In reviewing the literature, we identified only a few studies that included comparisons between TL and NTL injuries in sports other than football. The most comprehensive study of TL and NTL injury patterns to date was reported by Powell and Dompier.[13] Their analysis of injury patterns included a variety of sports at 50 colleges and universities representing all levels of competition. In that study, NTL injury proportions were 84% and 78% for women's and men's sports, respectively.[13] During the 1985 Junior Olympic Games, Martin et al[21] documented 1113 athlete and AT contacts. Of those, 11% were classified as reportable injuries, with 17% requiring cessation of play. Cunningham and Cunningham[22] found that only 34% of the injuries reported at the Australian University Games required removal from participation. Others have noted proportions of NTL injuries between 72% and 95% in sports such as baseball,[23] softball,[24] track and field,[25] volleyball,[26] and wrestling.[27]

Our overall player risk of injury (36.5%) was higher than the values reported previously for youth football players. Previous authors have reported the injury risk to be between 6%

Table 4. Most Common Body Parts and Injury Types for Practices and Games Combined*

Body Part	Injury Type	Frequency	Percentage of All Injuries	Injury Rate per 1000 Athlete-Exposures	95% Confidence Interval
Wrist and hand	Contusion	47	9.9	1.8	1.3, 2.4
Knee	Contusion	40	8.4	1.5	1.1, 2.1
Elbow and forearm	Contusion	35	7.4	1.3	0.9, 1.8
Ankle and foot	Sprain	34	7.2	1.3	0.9, 1.8
Thorax and low back	Contusion	33	7.0	1.2	0.9, 1.7
Wrist and hand	Sprain	31	6.5	1.2	0.8, 1.7
Lower leg	Contusion	20	4.2	0.7	0.5, 1.2
Shoulder and arm	Contusion	20	4.2	0.7	0.5, 1.2
Head	Neurologic	13	2.7	0.5	0.3, 0.8
Thigh	Strain	13	2.7	0.5	0.3, 0.8
Elbow and forearm	Wound	10	2.1	0.4	0.2, 0.7
Knee	Sprain	10	2.1	0.4	0.2, 0.7
Neck and spine	Contusion	10	2.1	0.4	0.2, 0.7
Ankle and foot	Contusion	9	1.9	0.3	0.2, 0.6
Neck and spine	Strain	9	1.9	0.3	0.2, 0.6
Head	Contusion	8	1.7	0.3	0.2, 0.6
Hip	Contusion	8	1.7	0.3	0.2, 0.6
Thigh	Contusion	7	1.5	0.3	0.1, 0.5
Thorax and low back	Strain	7	1.5	0.3	0.1, 0.5
Other†	Heat illness	7	1.5	0.3	0.1, 0.5
Ankle and foot	Overuse	5	1.1	0.2	0.1, 0.4
Knee	Overuse	5	1.1	0.2	0.1, 0.4

*Table includes only those injuries with a frequency of at least 5.
†Includes systemic conditions and injuries for which body part was not listed.

and 28%.[14–17] The researchers reporting lower injury risks used some level of restricted participation as part of the injury definition. Considering only players reporting TL injuries, our player risk was 19.1%, slightly lower than that reported by Zaricznyj et al[17] (28%). The injury definition used in that study was broad and also included NTL events.[17] Specifically included were incidents that required first aid, insurance claims, accident reports, or medical treatments.[17] Linder et al[14] found a 16% risk for TL injuries in junior high school football players when injury required removal from the current or subsequent sessions and the coach reported an injury. In another study of junior high school football players, Turbeville et al[16] reported a 10% player risk when a TL definition was used and both coaches and ATs reported injuries. Stuart et al[15] studied injuries in a community youth football organization, including players between the ages of 9 and 13 years. They found a much lower injury risk (6%) but only considered injuries that occurred in games and those that coaches referred to a centralized location for physician evaluation. Overall, the proportion of injured players in our study was fairly consistent with previous reports.

Injury (incidence) rates provide additional information because they include player exposures to injury. Our overall injury rate was 17.8 per 1000 A-Es. The game injury rate was 30.5 and the practice injury rate was 15.1 per 1000 A-Es. Our youth football injury rates are similar to those of one study except for the practice injury rate. With reports from coaches and a definition of injury that included NTL incidents, Radelet et al[28] found an overall injury rate of 15.0, a game rate of 43.0, and a practice rate of 7.0 per 1000 A-Es. The twofold difference in practice rates may be due to the inability of coaches to recall a large proportion of injuries that occurred during practices, especially if these injuries did not cause subsequent time loss. Turbeville et al[16] reported much lower game (8.8) and practice (1.0) injury rates per 1000 A-Es. During 2 years, only 64 injuries were documented in more than 600 players when the definition of *injury* required the restriction of participation in 1 or more practices. Our TL injury rates were similar for games (10.7 per 1000 A-Es) but much higher for practices (6.6 per 1000 A-Es). This difference may be due to the increased reporting or to the different definitions used in our study.

Most injuries occurred to the wrist and hand and were classified as contusions, followed by ligament sprains and muscle strains. Our data were consistent with previous reports identifying the wrist and hand as the most common sites of injury.[16,29] Stuart et al[15] found the most common site to be the knee, followed by the ankle. Goldberg et al[29] reported the most frequent types of injuries were fractures (35%), sprains (25%), and contusions (17%). Radelet et al[28] reported contusions (54%) followed by sprains and strains (15%) to be the most common types of injuries. Our data are similar because contusions of the wrist and hand are common, but many were unlikely to restrict players from participation in youth football.

Our data are unique in demonstrating the frequency of heat stress and neurologic injuries in youth football players. Fortunately, both heat illness and neurologic injuries were rare in our study. All heat illness cases (1.7% of all injuries) were classified as NTL or minor in nature, reflecting the low incidence of severe heat illness (heat exhaustion or heat stroke) in our sample. This proportion is consistent with that of Powell and Barber-Foss,[8] who found general stress (including heat illness) to account for 2% of all injuries in high school athletes. The heat illness frequency in our study may have been limited by a number of factors. The moderate Michigan climate and league rules restricting all levels except the eighth graders to 2 practices per week are possible mitigating factors. We can only speculate about the reason for the higher proportion of heat illness cases among the sixth graders, but it is a point of interest. Neurologic injuries (concussions and neur-

apraxia) were also rare, accounting for 3.4% of all injuries. Our players' risk of neurologic injury was within the 1% to 10% reported for high school football players.[6,8,30] Although these injuries were rare in our study, low frequencies limit generalizations.

Examining the severity of injury produced unexpected but interesting results. Although tempered by a smaller sample size in the eighth-grade group, it is notable that most of the moderate (81.8%) and severe (46.2%) injuries but only 9.0% of the NTL injuries occurred in this group. From these data, it would appear that the eighth graders either sustained fewer NTL injuries or were less likely to report them to the AT for reasons that only can be speculated. The eighth-grade data also may be unreliable due to the small sample size and limitation of players from 1 community. Care should be taken in the interpretation of these data.

The definition of *injury* varied slightly in the majority of reports, and few included both TL and NTL injuries. A consensus is that the definition of *injury* should include only TL injuries.[9] Time-loss injuries are not only more severe by definition but also have more associated health care costs and disability. In addition, TL injuries are more manageable to report from a recorder's perspective. Based on our proportions of NTL injuries (58.6%) and those reported elsewhere,[13] the added documentation would make the use of an NTL definition impractical for most injury surveillance programs. In addition, few trained health care providers are available at youth sport events, and a coach or parent is much more likely to recall an event that requires an athlete to be removed from or miss subsequent games or practices.

The difference we found between TL and NTL injuries does raise the question of whether or not coaches or league officials should be first-aid certified. First-aid training may provide a safer environment for youth football players but must be updated regularly and compliance must be enforced. Ransone and Dunn-Bennett[11] surveyed coaches in a state in which high school coaches were required by law to be first-aid certified and found that only 36% could pass a basic first-aid examination and 8% were lacking current certification. That study highlights the difficulty of maintaining and enforcing such policies. Coaches of youth football teams are often volunteers and turnover is frequent. Requiring youth football coaches or league officials to maintain first-aid certification while being involved in youth sports would be challenging and may make it more difficult to find volunteer coaches.

SUMMARY

Our study was unique because we called on ATs exclusively to assess and to record both TL and NTL injuries in youth football players. Nearly 59% percent of the injuries incurred by youth football players were NTL in nature but required evaluation and/or treatment by an AT. These data demonstrate that in the absence of trained health care professionals, coaches or parents have to make frequent decisions regarding the injury status of youth football players. This is a concern because if appropriate decisions are not made regarding the disposition of injured players, the athletes could be put at further risk. The logistics of providing trained health care providers at all youth football venues are impractical, but requiring at least 1 coach or league official who is present at an event to be first-aid certified may be feasible.

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