

**SUMMARY REPORT**

**HIGH SCHOOL RIO™ (REPORTING INFORMATION ONLINE):  
INTERNET-BASED SURVEILLANCE OF INJURIES SUSTAINED BY  
US HIGH SCHOOL ATHLETES**

**2005-2006**

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## **Note**

The analyses presented here provide only a brief summary of collected data, with the feasibility of a more-detailed presentation limited by the extensive breadth and detail contained in the dataset. The principal investigator, Dr. R. Dawn Comstock, is happy to provide further information or to discuss research partnership opportunities upon request.

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<b>Chapter</b>	<b>Contents</b>	<b>Page</b>
<b>1.</b>	<b>Introduction and Background</b>	<b>5</b>
1.1	Project Overview	5
1.2	Background and Significance	5
1.3	Specific Aims	6
1.4	Project Design	7
	1.4.1 Sample Recruitment	7
	1.4.2 Data Collection	8
	1.4.3 Data Management	8
	1.4.4 Data Analysis	9
<b>2.</b>	<b>Rates of Injury</b>	<b>10</b>
<b>3.</b>	<b>General Injury Epidemiology</b>	<b>12</b>
3.1	General Injury Patterns	12
3.2	Additional General Injury Information	22
<b>4.</b>	<b>Sport-Specific Injury Epidemiology</b>	<b>23</b>
4.1	Boys' Football	23
4.2	Boys' Soccer	26
4.3	Girls' Soccer	29
4.4	Girls' Volleyball	32
4.5	Boys' Basketball	35
4.6	Girls' Basketball	38
4.7	Boys' Wrestling	41
4.8	Boys' Baseball	44
4.9	Girls' Softball	47
<b>5.</b>	<b>Gender Differences within Sports</b>	<b>50</b>
5.1	Soccer	50
5.2	Basketball	50
5.3	Baseball/Softball	51
<b>6.</b>	<b>Reporter Compliance</b>	<b>52</b>
<b>7.</b>	<b>Summary</b>	<b>53</b>

## List of Tables and Figures

<b>Table</b>	<b>Page</b>
2.1 Rate of Injury by Sport	11
3.1 Distribution of Injury Type, Body Site, Outcome, and New or Recurring	13
3.2 Body Site of Injury by Sport	18
3.3 Proportion of Injuries Related to Illegal Activity by Sport	21
4.1 Demographic Characteristics of Injured Football Athletes	23
4.2 Mechanism of Boys' Football Injury by Type of Injury	24
4.3 Demographic Characteristics of Injured Boys' Soccer Athletes	26
4.4 Mechanism of Boys' Boys' Soccer Injury by Type of Injury	27
4.5 Demographic Characteristics of Injured Girls' Soccer Athletes	29
4.6 Mechanism of Girls' Soccer Injury by Type of Injury	30
4.7 Demographic Characteristics of Injured Girls' Volleyball Athletes	32
4.8 Mechanism of Girls' Volleyball Injury by Type of Injury	33
4.9 Demographic Characteristics of Injured Boys' Basketball Athletes	35
4.10 Mechanism of Boys' Basketball Injury by Type of Injury	36
4.11 Demographic Characteristics of Injured Girls' Basketball Athletes	38
4.12 Mechanism of Girls' Basketball Injury by Type of Injury	39
4.13 Demographic Characteristics of Injured Boys' Wrestling Athletes	41
4.14 Mechanism of Boys' Wrestling Injury by Type of Injury	42
4.15 Demographic Characteristics of Injured Boys' Baseball Athletes	44
4.16 Mechanism of Boys' Baseball Injury by Type of Injury	45
4.17 Demographic Characteristics of Injured Girls' Softball Athletes	47
4.18 Mechanism of Girls' Softball Injury by Type of Injury	48

### **Figure**

3.1 Time Loss by Sport	15
3.2 Type of Injury by Sport	16
3.3 Time Loss by Injury Type, All Sports	17
3.4 New and Recurring Injuries by Sport	19
3.5 Mechanism of Injury by Sport	20
4.1 Type of Boys' Football Injury by Body Site	25
4.2 Type of Boys' Soccer Injury by Body Site	28
4.3 Type of Girls' Soccer Injury by Body Site	31
4.4 Type of Girls' Volleyball Injury by Body Site	34
4.5 Type of Boys' Basketball Injury by Body Site	37
4.6 Type of Girls' Basketball Injury by Body Site	40
4.7 Type of Boys' Wrestling Injury by Body Site	43
4.8 Type of Boys' Baseball Injury by Body Site	46
4.9 Type of Girls' Softball Injury by Body Site	49

# **1. Introduction and Background**

## **1.1 Project Overview**

To combat the epidemic of obesity among youth in the United States (US), adolescents must be encouraged to get up off the couch and participate in physically active sports, recreation, and leisure activities. Participation in high school sports, one of the most popular physical activities among adolescents, has grown rapidly from an estimated 4.0 million participants in 1971-72 to an estimated 7.0 million in 2004-2005. While the health benefits of a physically active lifestyle including participating in sports are undeniable, high school athletes are at risk of sports-related injury because a certain endemic level of injury can be expected among participants of any physical activity. The challenge to injury epidemiologists is to reduce injury rates among high school athletes to the lowest possible level without discouraging adolescents from engaging in this important form of physical activity. This goal can best be accomplished by investigating the etiology of preventable injuries; by developing, implementing, and evaluating protective interventions using such science-based evidence; and by responsibly reporting epidemiologic findings while promoting a physically active lifestyle among adolescents.

## **1.2 Background and Significance**

High school sports play an important role in the adoption and maintenance of a physically active lifestyle among millions of US adolescents. Too often injury prevention in this population is overlooked as sports-related injuries are thought to be unavoidable. In reality, sports-related injuries are largely preventable through the application of preventive interventions based on evidence-based science. The morbidity, mortality, and disability caused by high school sports-related injuries can be reduced through the development of effective prevention strategies and

through programmatic decisions based on injury prevention. However, such efforts rely upon accurate national estimates of injury incidence, injury rate calculations, and risk and protective factor data. Previously, no injury surveillance system capable of providing researchers with the needed quality of injury and exposure data for high school sports-related injuries existed.

The Centers for Disease Control provided Dr. R. Dawn Comstock with the funding support needed to implement the time- and cost-efficient RIO<sup>TM</sup> (Reporting Information Online) surveillance system to monitor injuries among US high school athletes participating in boys' football, boys' and girls' soccer, girls' volleyball, boys' and girls' basketball, boys' wrestling, boys' baseball, and girls' softball during the 2005-2006 academic year.

### **1.3 Specific Aims**

The objective of this study was to implement an internet-based injury surveillance system, High School RIO<sup>TM</sup>, among a nationally representative sample of US high schools. The specific aims of this study were:

- A) To determine the incidence (number) of injuries among US high school boys' football, boys' and girls' soccer, girls' volleyball, boys' and girls' basketball, boys' wrestling, boys' baseball, and girls' softball athletes.
- B) To calculate the rate of injuries per 1,000 athlete-competitions, per 1,000 athlete-practices, and per 1,000 athlete-exposures for US high school athletes in these 9 sports.
- C) To provide detailed information about the injuries sustained by US high school athletes including the type, site, severity, initial and subsequent treatment/care, outcome, etc.
- D) To provide detailed information about the injury events including athlete demographics, position played, phase of play/activity, etc.
- E) To identify potential risk or protective factors.

## 1.4 Project Design

RIO<sup>TM</sup>, an internet-based sports injury surveillance system developed by Dr. Comstock at the Center from the Injury Research and Policy at Columbus Children's Hospital, was utilized to perform surveillance of injuries sustained by US high school athletes throughout the 2005-2006 academic year. For the purpose of this study, a reportable injury was defined as:

- A) An injury that occurs as a result of participation in an organized high school competition or practice and
- B) Requires medical attention by a team physician, certified athletic trainer, personal physician, or emergency department/urgent care facility and
- C) Results in restriction of the high school athlete's participation for one or more days beyond the day of injury.

An athlete exposure was defined as one athlete participating in one practice or competition where he or she is exposed to the possibility of athletic injury. Exposure was expressed in two parts:

- A) Number of athlete-practices = the sum of the number of athletes at each practice during the past week. For example, if 20 athletes practiced on Monday through Thursday and 18 practiced on Friday, the number of athlete-practices would equal 98.
- B) Number of athlete-competitions = the sum of the number of athletes at each practice during the past week. For example, if 9 athletes played in a Freshman game, 12 in a JV game, and 14 in a Varsity game, the number of athlete-competitions would equal 35.

### 1.4.1 Sample Recruitment

All US high schools with a certified athletic trainer (ATC) affiliated with the National Athletic Trainer's Association with a valid email address were invited to participate in this study via email. Those that indicated an interest in participating were placed into one of 8 sampling

stratum according to their high school's US Census geographic location (west, midwest, northeast, and south) and enrollment size (<1,000 or  $\geq$  1,000 students). Schools were randomly selected from each stratum to obtain the nationally representative study sample of 100 high schools. To maintain the representativeness of the study sample, if a school dropped out of the study, another school from the same stratum was randomly selected for replacement.

#### 1.4.2 Data Collection

Each ATC that enrolled their school in High School RIO<sup>TM</sup> received an email every Monday throughout the study period reminding them to enter their school's data into the surveillance system. Each participating ATC was asked to complete 42 weekly exposure reports: one for each week from August 22, 2005 through June 11, 2006. Exposure reports collected exposure information (number of athlete-competitions and athlete-practices) and the number of reportable injuries sustained by student athletes of each sport that was currently in session at their school. For each injury reported, the ATC was asked to complete an injury report. The injury report collected detailed information about the injury (e.g. site, type, severity, etc.) and the injury event (e.g. player demographics, position played, phase of play, etc.). This internet-based surveillance tool provided reporters with the ability to view all the data they had reported throughout the study as well as the option to update all injury reports with information that was not available at the time the initial report was submitted (e.g. the need for surgery, the ultimate outcome, etc.).

#### 1.4.3 Data Management

In an effort to decrease loss-to follow up, a log of reporters' utilization of the internet-based injury surveillance system was maintained throughout the study period. Reporters who repeatedly failed to log on to complete the weekly exposure and injury reports received a phone



call or email from the Center for Injury Research and Policy reminding them to do so and assessing their willingness to continue participating in the study.

#### 1.4.4. Data Analysis

Data were analyzed using SPSS software, version 14.0. With the exception of injury rate information, data were weighted for all analyses to produce national estimates. For each sport in each stratum, these weights accounted for the total number of US schools offering the sport and the average number of participating study schools reporting each week. For example, following is the algorithm used to calculate football weights for each stratum:

$$\text{Weight} = \frac{\# \text{ US schools in stratum offering football}}{\text{Average \# of participating schools in stratum reporting football each week}}$$

Injury rates were compared using relative risks (RR) with 95% confidence intervals (CI). The relative risks assess the magnitude and direction of associations.  $RR > 1$  indicate an association exists between a risk factor and an outcome. Such associations are considered statistically significant if the 95% CI does not include 1. Following is an example of the RR calculation comparing the rate of boys' soccer competition injuries to the rate of girls' soccer competition injuries:

$$RR = \frac{\# \text{ boys' soccer competition injuries} / \text{total boys' soccer athlete - competitions}}{\# \text{ girls' soccer competition injuries} / \text{total girls' soccer athlete - competitions}}$$

Injury proportions were compared using injury proportion ratios (IPR) and corresponding CIs calculated using the Complex Samples module of SPSS in order to account for the weights and the complex sampling design. Following is an example of the IPR calculation comparing the proportion of male soccer concussions to the proportion of female soccer concussions:

$$IPR = \frac{\# \text{ boys' soccer concussions} / \text{total boys' soccer injuries}}{\# \text{ girls' soccer concussions} / \text{total girls' soccer injuries}}$$

## 2. Rates of Injury

Throughout the 2005-2006 academic year, there were 4,350 injuries (2,240 competition injuries and 2,110 practice injuries) and 1,730,764 athlete-exposures (484,265 athlete-competitions and 1,246,499 athlete-practices) reported. The overall injury rate was 2.5 injuries per 1,000 athlete-exposures, with the rate higher in competition (4.6 injuries per 1,000 athlete-competitions) than practice (1.7 injuries per 1,000 athlete-practices).

Half of all reported injuries (52.8%) were assessed by the ATC, with 44.4% assessed by a physician. An evaluation (64.7%) was the most commonly employed method of assessment, with 23.9% of injuries diagnosed via x-ray, 7.0% via MRI, and 2.4% via a CT scan. Surgery, blood work/lab test, and other methods were each employed in less than 1% of injury diagnoses. Table 2.1 presents injury rate information.

**Table 2.1 Rate of Injury by Sport\***

	# Injuries	# Exposures	Injury rate (per 1,000 athlete- exposures)
<b>Overall total</b>	4,350	1,730,764	2.5
<b>Competition</b>	2,240	484,265	4.6
<b>Practice</b>	2,110	1,246,499	1.7
Boys' football total	1,880	431,242	4.4
Competition	992	82,059	12.1
Practice	888	349,183	2.5
Boys' soccer total	372	153,400	2.4
Competition	208	49,294	4.2
Practice	164	104,106	1.6
Girls' soccer total	334	141,581	2.4
Competition	226	43,415	5.2
Practice	108	98,166	1.1
Girls' volleyball total	196	119,235	1.6
Competition	84	43,691	1.9
Practice	112	75,544	1.5
Boys' basketball total	412	218,342	1.9
Competition	184	61,663	3.0
Practice	228	156,679	1.5
Girls' basketball total	374	186,161	2.0
Competition	192	53,325	3.6
Practice	182	132,836	1.4
Boys' wrestling total	415	166,279	2.5
Competition	158	40,220	3.9
Practice	257	126,059	2.0
Boys' baseball total	214	179,435	1.2
Competition	113	63,871	1.8
Practice	101	115,564	0.9
Girls' softball total	153	135,089	1.1
Competition	83	46,727	1.8
Practice	70	88,362	0.8

\*Injuries reported as occurring during "other" exposures were not included in this analysis

Table 2.1 highlights:

- Football had the highest injury rate, followed by wrestling and soccer, while baseball and softball had the lowest injury rates.
- The rate of injury in football was significantly higher than the rate of injury in all other sports combined (RR= 2.29, 95% CI: 2.16-2.43).
- For all sports, the rates of competition injury were higher than rates of practice injury (RR=2.72, 95% CI: 2.57-2.89).

### **3. General Injury Epidemiology**

#### **3.1 General Injury Patterns**

The 4,350 reported injuries represent an estimated 1,480,556 injuries that occurred nationally among all US high school athletes participating in the nine sports of interest. Table 3.1 presents the overall distribution of injuries by injury type, body site, outcome, and whether the injury was new or recurrent. Tables 3.1-3.2 and Figures 3.1, 3.2, 3.4, and 3.5 present injury type, body site, time loss, new/recurring, mechanism, and presence of illegal activity overall and for each sport. Figure 3.3 presents time loss by injury type for all sports combined. Numbers in these tables represent national estimates of the total number of athletes injured in the US during the 2005-2006 academic year while participating in the nine sports of interest.

**Table 3.1 Distribution of Injury Type, Body Site, Outcome, and New or Recurring**

	<b>n*</b>	<b>%</b>
<b>Total # Injuries</b>	<b>1,480,556</b>	<b>100%</b>
<b>Injury Type</b>		
Sprain/Strain	765,466	51.7%
Contusion	178,075	12.0%
Fracture	143,221	9.7%
Concussion	133,162	9.0%
Other/unknown	260,632	17.6%
<b>Body Site</b>		
Head/Face	180,614	12.2%
Neck	32,571	2.2%
Shoulder	115,683	7.8%
Arm	59,794	4.0%
Hand/Wrist	115,198	7.8%
Trunk	132,902	9.0%
Leg	185,816	12.6%
Knee	210,521	14.2%
Ankle/Foot	389,259	26.3%
Other/unknown	58,199	3.9%
<b>Outcome (time loss<sup>†</sup>)</b>		
<1 Week	736,411	49.7%
1-3 Weeks	428,569	28.9%
>3 Weeks	234,161	15.8%
Other/unknown	81,416	5.5%
<b>New or Recurring</b>		
New injury	1,283,485	86.7%
Recurrence (this academic year)	80,404	5.4%
Recurrence (previous academic year)	103,862	7.0%
Other/unknown	12,806	0.9%

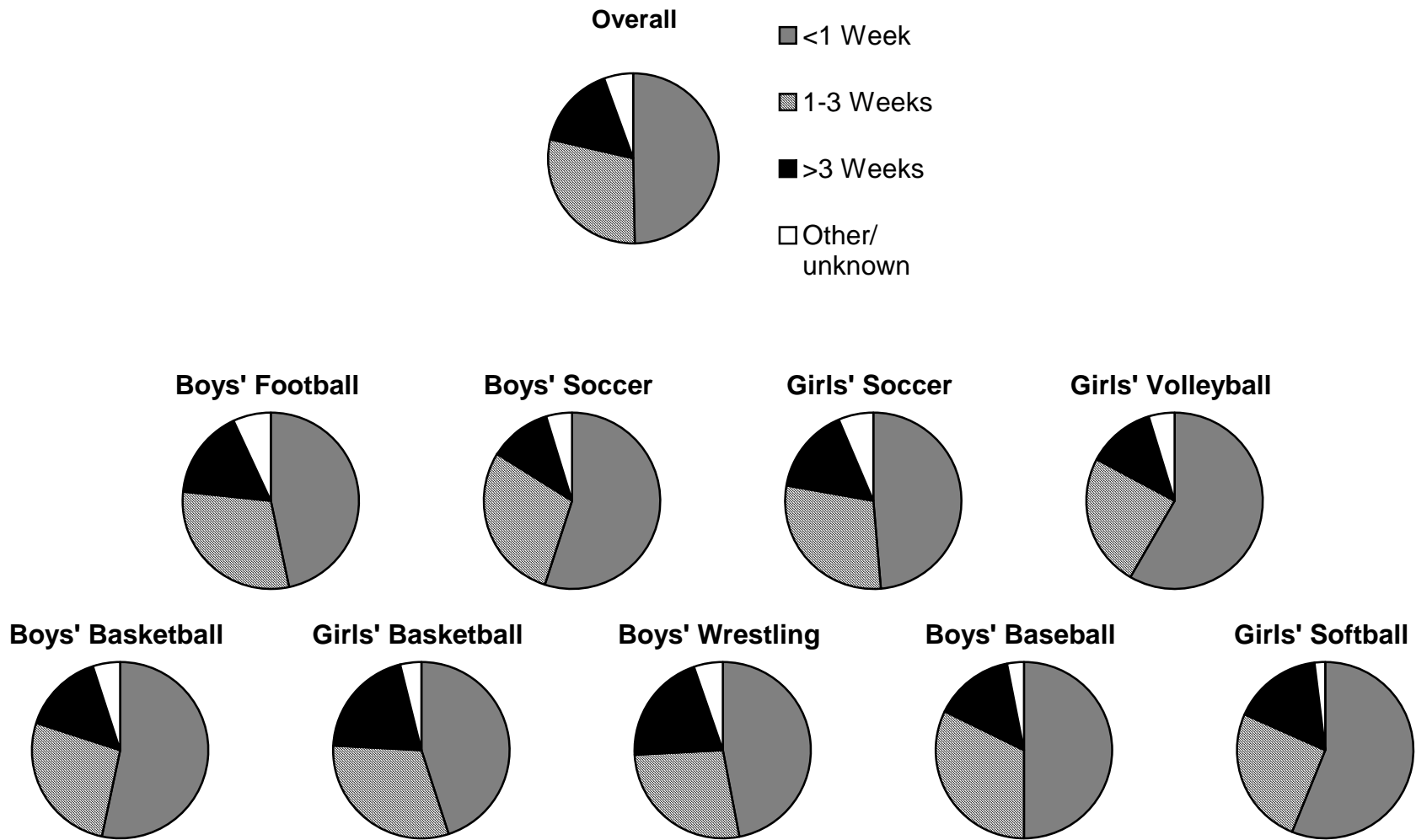
\* “n” represents weighted national estimates

† Time-loss represents the amount of time athlete was kept out of practice and/or competition as a result of the injury.

Table 3.1 highlights:

- Half of all reported injuries were a sprain/strain (51.7%), and half caused the injured athlete to miss less than 1 week of play (49.7%).
- The ankle/foot was the most common body site injured (26.3%), followed by the knee (14.2%) and head/face (12.2%).
- The majority of injuries were new (86.7%).
- No fatalities or catastrophic injuries were recorded during the study period.

**Figure 3.1 Time loss\* by Sport**



\* Time-loss represents the amount of time athlete was kept out of practice and/or competition as a result of the injury.

Figure 3.1 highlights:

- Time loss due to injury was similar among all sports: 49.7% of injuries kept the athlete out of practice and/or competition less than 1 week, 28.9% kept the athlete out from 1-3 weeks, and 15.8% kept the athlete out for more than 3 weeks.
- Volleyball (58.3%) and softball (56.1%) had the greatest proportion of injuries keeping athletes out for less than 1 week.
- The highest proportions of injuries keeping athletes out of play for more than 3 weeks were seen in wrestling (20.5%) and girls' basketball (20.1%).

**Figure 3.2 Type of Injury by Sport**

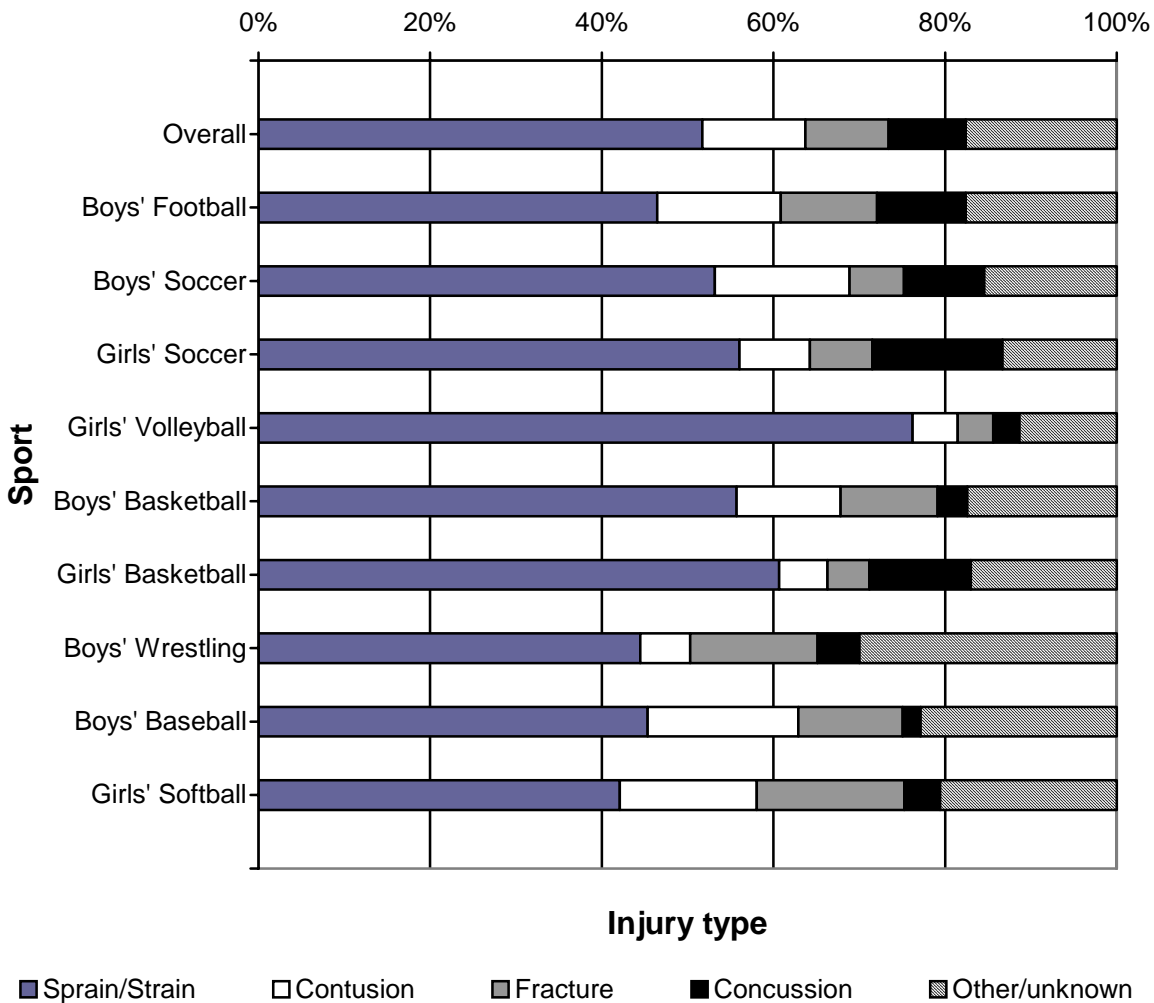
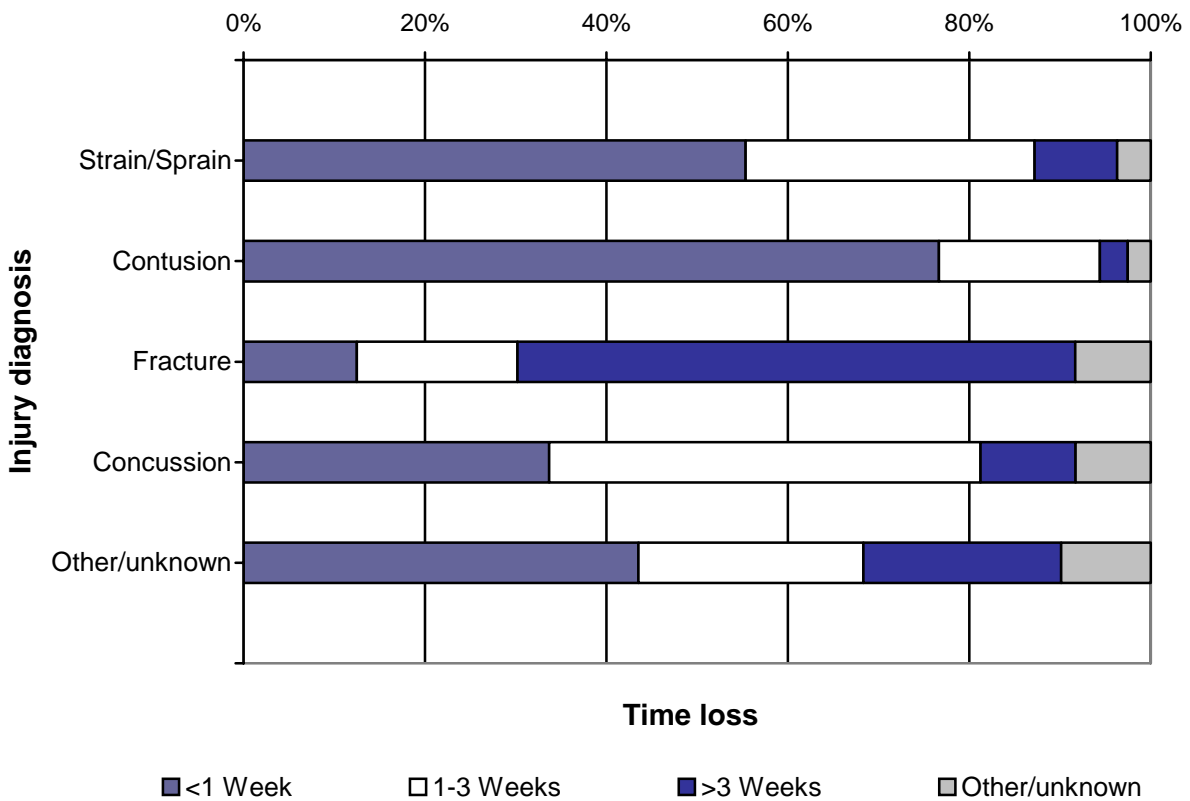




Figure 3.2 highlights:

- Over 50% of injuries in all sports were sprains/strains.
- Softball had the highest proportion of fractures (17.2%), followed by wrestling (14.8%).
- Girls' soccer had the highest proportion of concussion (15.2%), followed by girls' basketball (11.8%).

**Figure 3.3 Time Loss\* by Injury Type, All Sports**



\* Time-loss represents the amount of time athlete was kept out of practice and/or competition as a result of the injury.

Figure 3.3 highlights:

- The majority of athletes sustaining a strain/sprain or a contusion were able to return to practice and/or competition in less than 1 week (55.4% and 76.6%, respectively).
- The majority of athletes sustaining a fracture took over 3 weeks to return (61.5%).
- One-third of athletes sustaining a concussion returned to play within 1 week (33.7%), with 47.5 returning in 1-3 weeks.

**Table 3.2 Body Site of Injury by Sport**

	<b>Overall</b>	<b>Boys' Football</b>	<b>Boys' Soccer</b>	<b>Girls' Soccer</b>	<b>Girls' Volleyball</b>	<b>Boys' Basketball</b>	<b>Girls' Basketball</b>	<b>Boys' Wrestling</b>	<b>Boys' Baseball</b>	<b>Girls' Softball</b>
<b>Head/Face</b>	12.2%	11.3%	12.0%	16.3%	3.5%	10.8%	14.0%	11.4%	13.7%	18.1%
<b>Neck</b>	2.2%	4.1%	0.0%	0.2%	0.3%	0.7%	0.3%	8.0%	0.3%	0.6%
<b>Shoulder</b>	7.8%	11.8%	1.6%	0.6%	5.2%	3.5%	1.2%	17.3%	19.7%	10.9%
<b>Arm</b>	4.0%	4.9%	0.7%	0.7%	3.6%	2.1%	1.5%	12.3%	10.1%	6.3%
<b>Hand/Wrist</b>	7.8%	10.1%	3.3%	3.1%	7.7%	8.5%	6.5%	7.3%	10.7%	17.3%
<b>Trunk</b>	9.0%	9.4%	11.9%	4.0%	13.2%	8.4%	4.3%	13.3%	9.6%	5.7%
<b>Leg</b>	12.6%	10.6%	21.0%	17.2%	3.5%	9.4%	12.9%	6.0%	14.5%	10.1%
<b>Knee</b>	14.2%	15.2%	14.8%	16.6%	13.0%	9.8%	15.9%	13.8%	6.7%	11.2%
<b>Ankle/Foot</b>	26.3%	18.1%	31.4%	35.1%	45.2%	45.3%	40.5%	8.5%	10.9%	17.4%
<b>Other/unknown</b>	3.9%	4.5%	3.3%	6.0%	4.7%	1.6%	3.0%	2.1%	3.8%	2.4%
<b>Total</b>	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 3.2 highlights:

- The ankle/foot was the most commonly injured body site among boys' football (18.1%), boys' soccer (31.4%), girls' soccer (35.1%), girls' volleyball (45.2%), boys' basketball (45.3%) and girls' basketball (40.5%).
- The head/face accounted for larger proportions of injuries in girls' softball (18.1%), girls' soccer (16.3%) and girls' basketball (14.0%) than other sports.
- The neck accounted for a greater proportion of injuries in wrestling (8.0%) compared with all other sports (IPR= 4.62, 95% CI:2.92-7.29).

**Figure 3.3 New and Recurring Injuries by Sport**

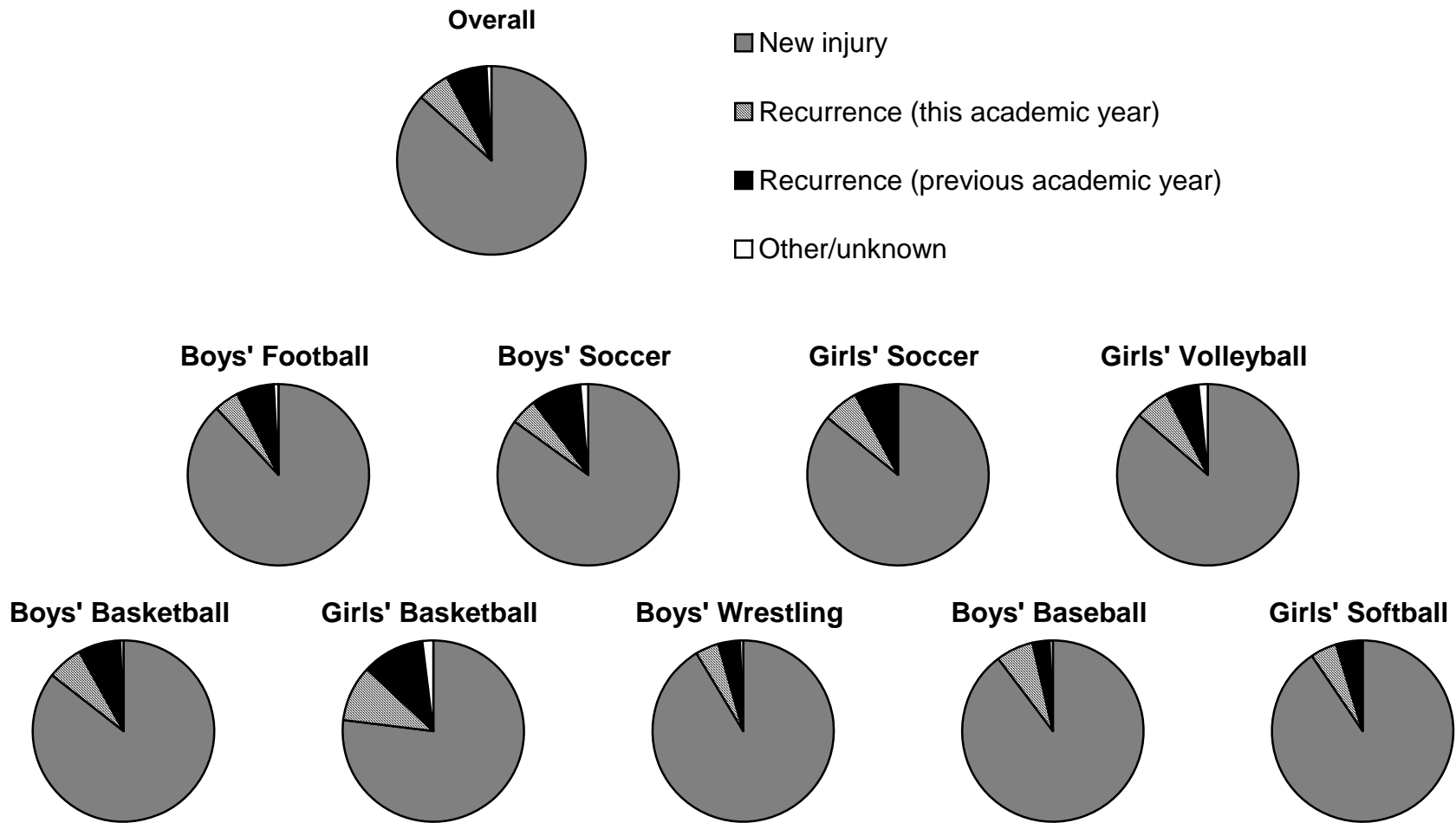


Figure 3.3 highlights:

- The patterns of new and recurring injuries were similar between sports, with the majority of injuries being new (86.7%).
- Girls' basketball had the highest proportion of recurring injuries (21.1%).

**Figure 3.4 Mechanism of Injury by Sport**

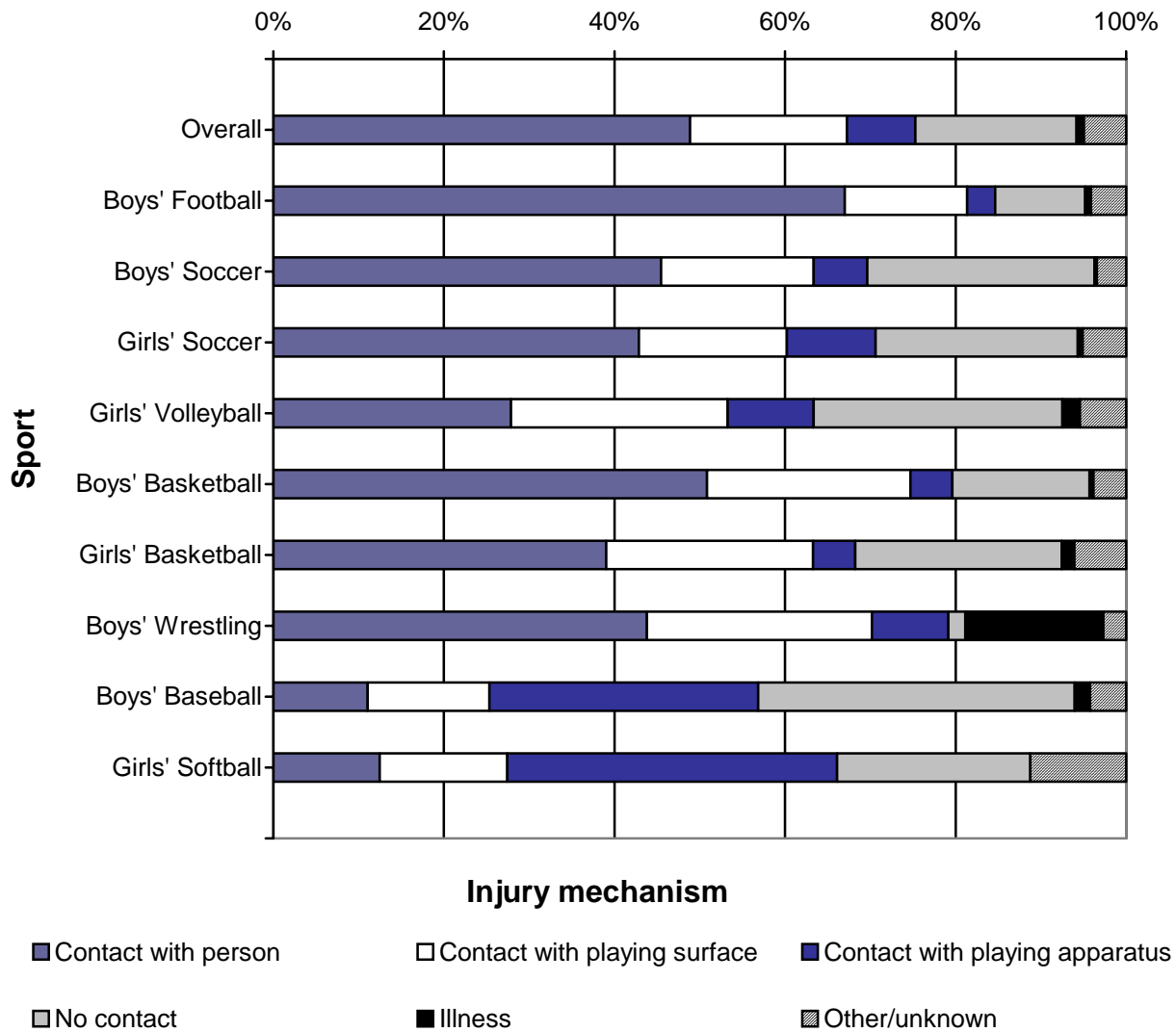


Figure 3.4 highlights:

- Overall, contact with another person accounted for half (48.9%) of all injuries, followed by no contact (18.9%) and contact with the playing surface (18.4%).
- Contact with another person caused the greatest proportion of injuries in boys' football (67.0%) and the smallest proportion of injuries in boys' baseball (11.1%) and girls' softball (12.5%).
- Contact with playing apparatus caused the greatest proportion of injuries in boys' baseball (31.5%) and girls' softball (38.7%).

**Table 3.3 Proportion of Injuries Related to Illegal Activity by Sport**

	% of injuries related to illegal activity
Overall	6.2%
Boys' Football	1.2%
Boys' Soccer	10.6%
Girls' Soccer	12.1%
Girls' Volleyball	0%
Boys' Basketball	11.1%
Girls Basketball	13.7%
Boys' Wrestling	6.4%
Boys' Baseball	3.8%
Girls' Softball	1.3%

Table 3.3 highlights:

- Basketball (12.5%, both genders combined) and soccer (11.3%, both genders combined) had greater proportions of injuries attributable to illegal activity (IPR=2.37, 95% CI: 1.50-3.77 and IPR=2.96, 95% CI: 1.89-4.64) compared with all other sports combined (1.8%).

### **3.2 Additional General Injury Information**

The majority of all injuries occurred during the regular season (76.8%), with 20.5% occurring during preseason and 2.7% occurring during postseason. Overall, 51.4% of injuries occurred during a competition, 46.3% occurred during a practice, and 2.3% occurred during other training. However, this pattern varied between sports, with competition representing larger proportions of injuries in girls' soccer (63.8%) and boys' soccer (53.9%) and practice representing a larger proportion of injuries in wrestling (62.5%).

The majority of practice injuries occurred between 30-60 minutes (27.3%) and between 60-90 minutes (31.4%) into practice. For competition injuries, over half occurred during the middle of the competition (53.1%), with 29.2% occurring at the end of competition and 14.5% at the beginning. A similar proportion of competition injuries occurred while at home (50.1%) as while away (48.0%), with 2.0% occurring at a neutral site.

Surgery was required following 5.2% of the injury events. This proportion was highest among baseball (9.9%) and wrestling (7.1%) and was lowest among boys' soccer (3.2%) and volleyball (4.5%). A previous, unrelated injury was experienced earlier in the season by 14.0% of injured athletes. This proportion was highest among football (18.2%) and wrestling (17.7%) and lowest among volleyball (3.3%) and softball (8.8%).

Overall, 9.0% of athletes sustained a concussion. During these events, 41.2% of athletes experienced a headache, 15.6% experienced dizziness/unsteadiness, 8.8% experienced confusions or disorientation, and 6.5% experienced amnesia. A loss of consciousness was sustained by 4.0%. While 15.2% of concussed athletes reported symptoms to be resolved within an hour, 37.9% took up to a day to resolve, 35.7% took between 1 and 3 days, and 26.5% took 4 or more days.

## 4. Sport-Specific Injury Epidemiology

### 4.1 Boys' Football

The 1,880 reported football injuries represent an estimated 523,368 injuries that occurred nationally during the 2005-2006 academic year. Table 4.1 presents demographic characteristics of injured football athletes.

**Table 4.1 Demographic Characteristics of Injured Boys' Football Athletes**

	<b>Mean</b>	<b>St. Dev.</b>	<b>Minimum</b>	<b>Maximum</b>
<b>Age (years)</b>	15.9	1.3	13	19
<b>Height (inches)</b>	69.9	3.1	53	79
<b>Weight (pounds)</b>	178.4	33.2	94	327

	<b>n*†</b>	<b>%</b>
<b>Freshmen</b>	105,232	20.3%
<b>Sophomores</b>	128,836	24.9%
<b>Juniors</b>	121,478	23.5%
<b>Seniors</b>	162,293	31.3%
<b>Total</b>	517,839	100%

\* "n" represents weighted estimates representing all US boys' football athletes

† Cases with missing/unknown class were excluded from this table

Table 4.1 highlights:

- The mean body mass index (BMI) for injured football athletes (25.7).
- There were a higher proportion of seniors among injured athletes than freshmen, sophomores, and juniors.

Running backs (15.8%), linebackers (14.4%), and wide receivers (11.7%) were most commonly injured. The majority of injuries occurred while the player was between the 20-yard lines (71.6%), with 15.3% occurring in the red zone, 11.5% occurring off field, and 1.6%

occurring in the end zone. The playing surface upon which injuries were sustained was typically grass (85.4%), followed by artificial fill (12.9%). Table 4.2 presents the mechanism of football injury by the injury type.

**Table 4.2 Mechanism of Boys' Football Injury by Type of Injury**

	<b>Sprain/Strain, n=238,825</b>	<b>Contusion, n=75,022</b>	<b>Fracture, n=57,649</b>	<b>Concussion, n=53,296</b>	<b>Other, n=84,848</b>
Being tackled	28.1%	39.1%	28.3%	36.0%	17.8%
Tackling	17.6%	22.9%	22.9%	33.6%	26.4%
Blocking	16.8%	8.5%	17.5%	14.5%	14.2%
Being blocked	9.1%	12.9%	6.1%	14.0%	10.5%
Stepped on/ fell on/ kicked	8.1%	11.0%	10.9%	0.2%	4.9%
Other	20.4%	5.6%	14.2%	1.7%	26.2%
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

Table 4.2 highlights:

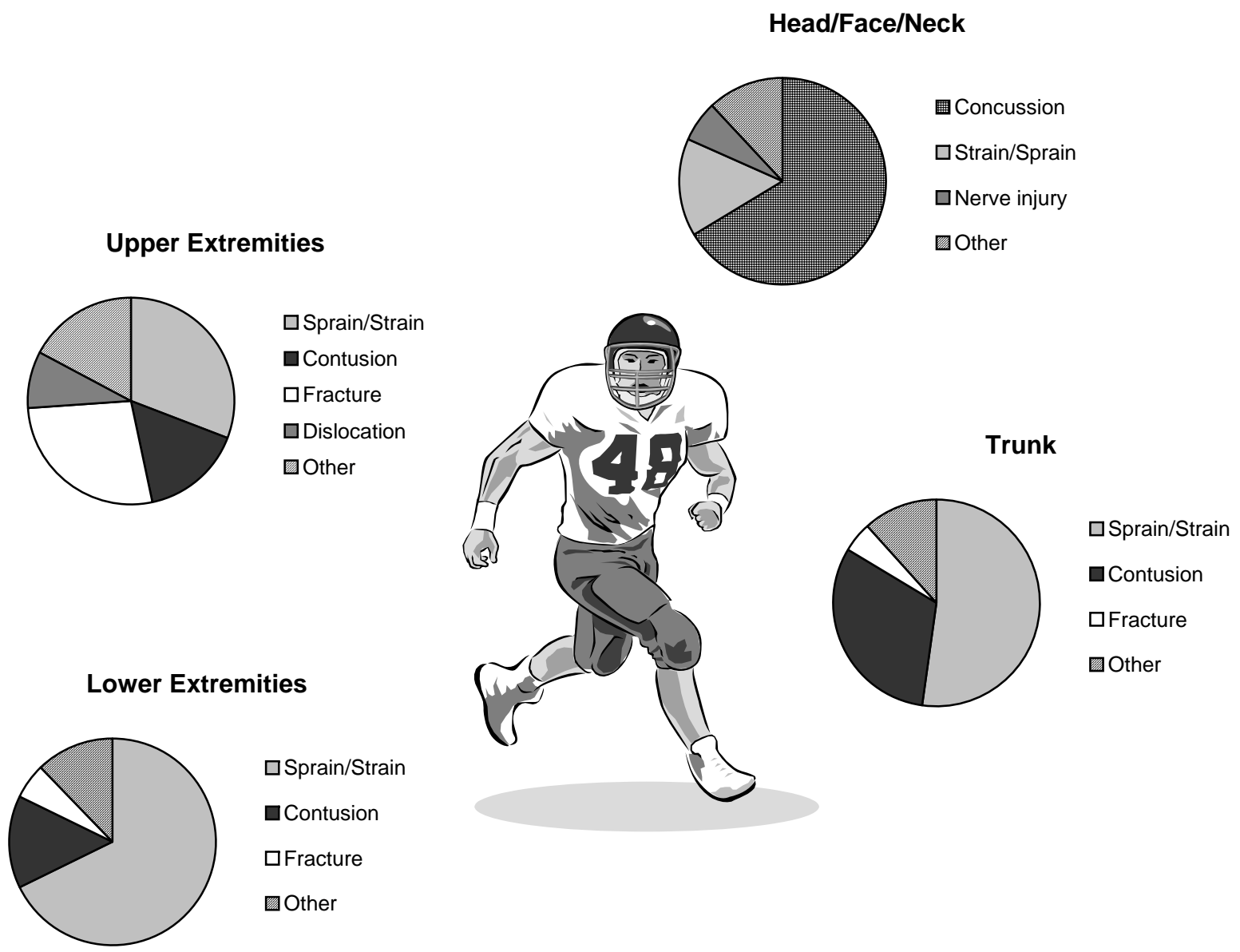
- Overall, being tackled (28.9%) and tackling (22.1%) caused the greatest proportion of injuries.

Figure 4.1 presents the type of injury by body site. Figure 4.1 highlights:

- Concussions made up the majority (66.5%) of head/face/neck injuries, followed by strain/sprain (15.1%), and nerve injury (6.3%).
- Strains/sprains were more common among lower extremity injuries (67.7%) than trunk injuries (52.2%) and upper extremity injuries (30.9%).
- Fractures made up a greater proportion of upper extremity injuries (27.2%), with fewer fractures occurring to the lower extremities (5.7%) and trunk (4.8%).
- Less than 0.2% of injuries were due to dehydration or heatstroke/heat exhaustion.



**Figure 4.1 Type of Boys' Football Injury by Body Site**



## 4.2 Boys' Soccer

The 378 reported boys' soccer injuries represent an estimated 223,386 injuries that occurred nationally during the 2005-2006 academic year. Table 4.3 presents demographic characteristics of injured boys' soccer athletes.

**Table 4.3 Demographic Characteristics of Injured Boys' Soccer Athletes**

	<b>Mean</b>	<b>St. Dev.</b>	<b>Minimum</b>	<b>Maximum</b>
<b>Age (years)</b>	16.1	1.2	13	19
<b>Height (inches)</b>	69.1	3.5	57	96
<b>Weight (pounds)</b>	153.1	22.2	102	238

	<b>n*†</b>	<b>%</b>
<b>Freshmen</b>	28,158	12.9%
<b>Sophomores</b>	49,879	22.8%
<b>Juniors</b>	67,857	31.0%
<b>Seniors</b>	72,996	33.3%
<b>Total</b>	218,890	100%

\* "n" represents weighted estimates representing all US boys' soccer athletes

† Cases with missing/unknown class were excluded from this table

Table 4.3 highlights:

- The mean BMI for injured boys' soccer athletes was 22.5.
- There was a lower proportion of freshmen among injured athletes.

Boys' soccer forwards (33.5%) and midfielders (33.5%) sustained the largest proportion of reported injuries, with defenders accounting for 23.5% and goalkeepers for 9.5%. The most common field location of injury was the offensive side of the field from the top of the goal box extended to the center line (39.8%). Defensively, this area of the field accounted for 18.6% of all injuries. Table 4.4 presents mechanism of boys' soccer injury by the injury type.

**Table 4.4 Mechanism of Boys' Soccer Injury by Type of Injury**

	<b>Sprain/Strain, n=117,411</b>	<b>Contusion, n=34,332</b>	<b>Fracture, n=13,436</b>	<b>Concussion, n=20,826</b>	<b>Other, n=31,633</b>
General play	18.5%	17.8%	12.9%	10.6%	31.9%
Ball handling/ dribbling	14.9%	23.8%	18.0%	0.0%	7.3%
Shooting/ passing	19.6%	6.2%	19.4%	0.0%	5.4%
Chasing loose ball	16.1%	8.6%	10.1%	1.4%	7.8%
Slide tackle	7.8%	5.3%	11.6%	4.6%	10.7%
Goaltending	5.1%	12.2%	0.0%	20.5%	8.7%
Heading ball	1.9%	6.4%	12.5%	40.5%	4.3%
Defending	8.1%	5.1%	13.5%	3.7%	3.0%
Other	7.9%	14.6%	2.1%	18.7%	20.9%
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

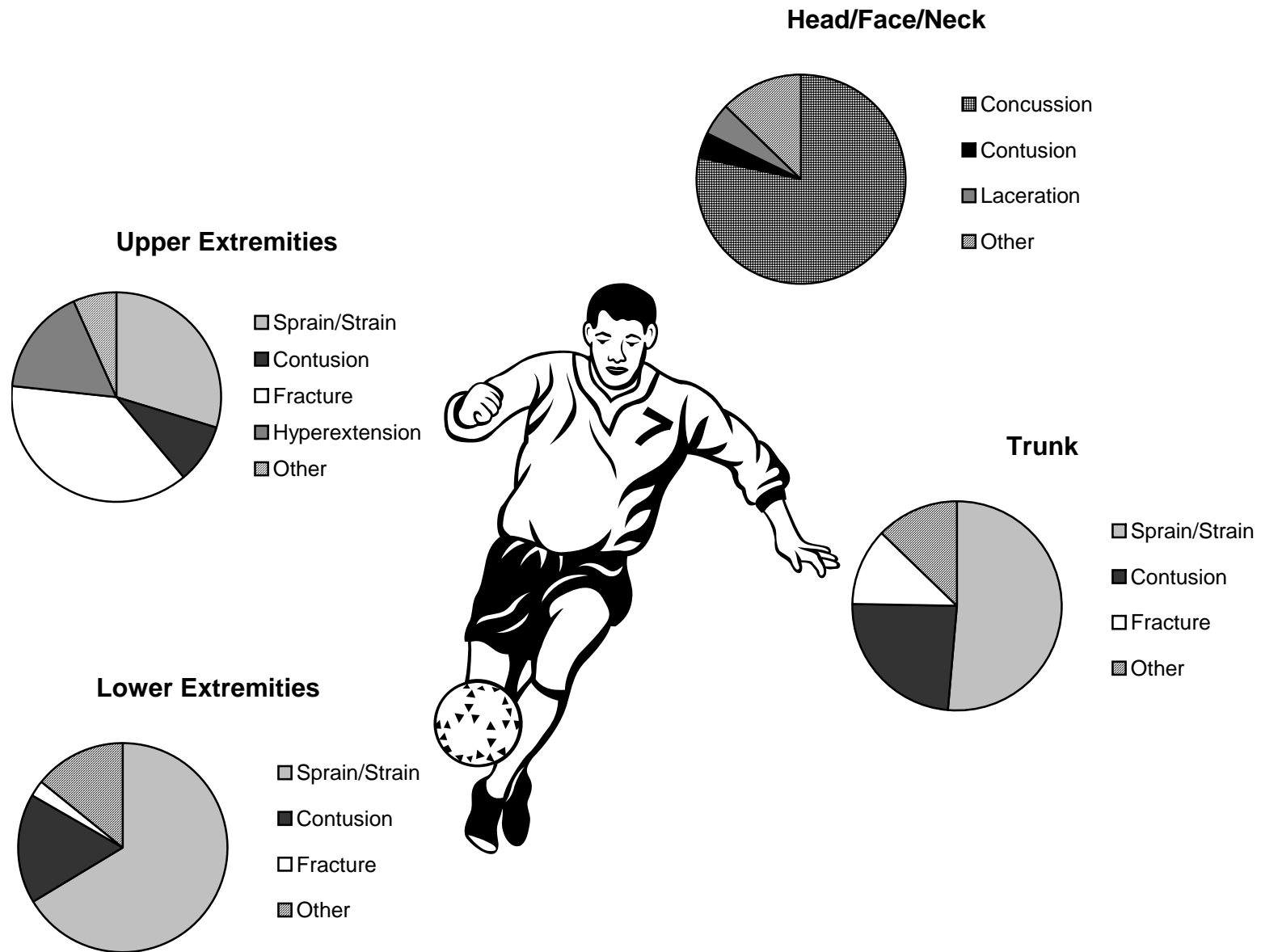
Table 4.4 highlights:

- Overall, general play (19.2%) caused the greatest proportion of injuries, followed by ball handling/dribbling (14.0%) and shooting/passing (13.5%).
- The majority of concussions were caused by heading the ball (40.5%) and goaltending (20.5%).

Figure 4.2 presents type of injury by body site. Figure 4.2 highlights:

- The majority of head/face/neck injuries were concussions (78.3%), with fewer lacerations (5.0%) and contusions (3.9%).
- Fractures made up a larger proportion of upper extremity injuries (37.8%) than trunk (11.9%) or lower extremity injuries (2.4%).

**Figure 4.2 Type of Boys' Soccer Injury by Body Site**



### 4.3 Girls' Soccer

The 346 reported girls' soccer injuries represent an estimated 193,672 injuries that occurred nationally during the 2005-2006 academic year. Table 4.5 presents demographic characteristics of injured girls' soccer athletes.

**Table 4.5 Demographic Characteristics of Injured Girls' Soccer Athletes**

	<b>Mean</b>	<b>St. Dev.</b>	<b>Minimum</b>	<b>Maximum</b>
<b>Age (years)</b>	16	1.2	13	18
<b>Height (inches)</b>	64.7	3.1	50	86
<b>Weight (pounds)</b>	129.1	16.9	90	210

	<b>n<sup>*†</sup></b>	<b>%</b>
<b>Freshmen</b>	33,818	17.7%
<b>Sophomores</b>	41,990	22.0%
<b>Juniors</b>	70,219	36.9%
<b>Seniors</b>	44,522	23.4%
<b>Total</b>	190,549	100%

\* "n" represents weighted estimates representing all US girls' soccer athletes

† Cases with missing/unknown class were excluded from this table

Table 4.5 highlights:

- The mean BMI for girls' soccer athletes was 21.7.
- Juniors made up a higher proportion of injured athletes than any other class.

A similar number of girls' soccer injuries occurred among forwards (30.5%), midfielders (31.1%), and defenders (29.1%). Goalkeepers accounted for 8.7% of injuries. Similarly to boys' soccer, in girls' soccer injuries occurred most often between the top of the goal box and the center line while on offense (31.4%), followed by this same area while on defense (17.1%) and

while defending in the goal box (12.5%). Table 4.6 presents mechanism of injury by the injury type.

**Table 4.6 Mechanism of Girls' Soccer Injury by Type of Injury**

	<b>Sprain/Strain, n=108,556</b>	<b>Contusion, n=15,856</b>	<b>Fracture, n=14,068</b>	<b>Concussion, n=29,425</b>	<b>Other, n=25,766</b>
Defending	12.3%	28.7%	21.5%	15.3%	14.9%
General play	16.6%	7.0%	10.9%	7.9%	17.9%
Ball handling/ dribbling	16.2%	16.6%	26.6%	6.1%	6.1%
Chasing loose ball	16.5%	9.6%	4.4%	11.9%	7.0%
Shooting/ passing	15.2%	7.4%	6.4%	0.7%	8.9%
Slide tackle	7.3%	0%	18.2%	5.1%	6.1%
Goaltending	3.3%	28.2%	8.5%	8.5%	0%
Heading ball	2.0%	2.5%	0%	37.2%	3.0%
Other	10.6%	0%	3.4%	7.2%	36.0%
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

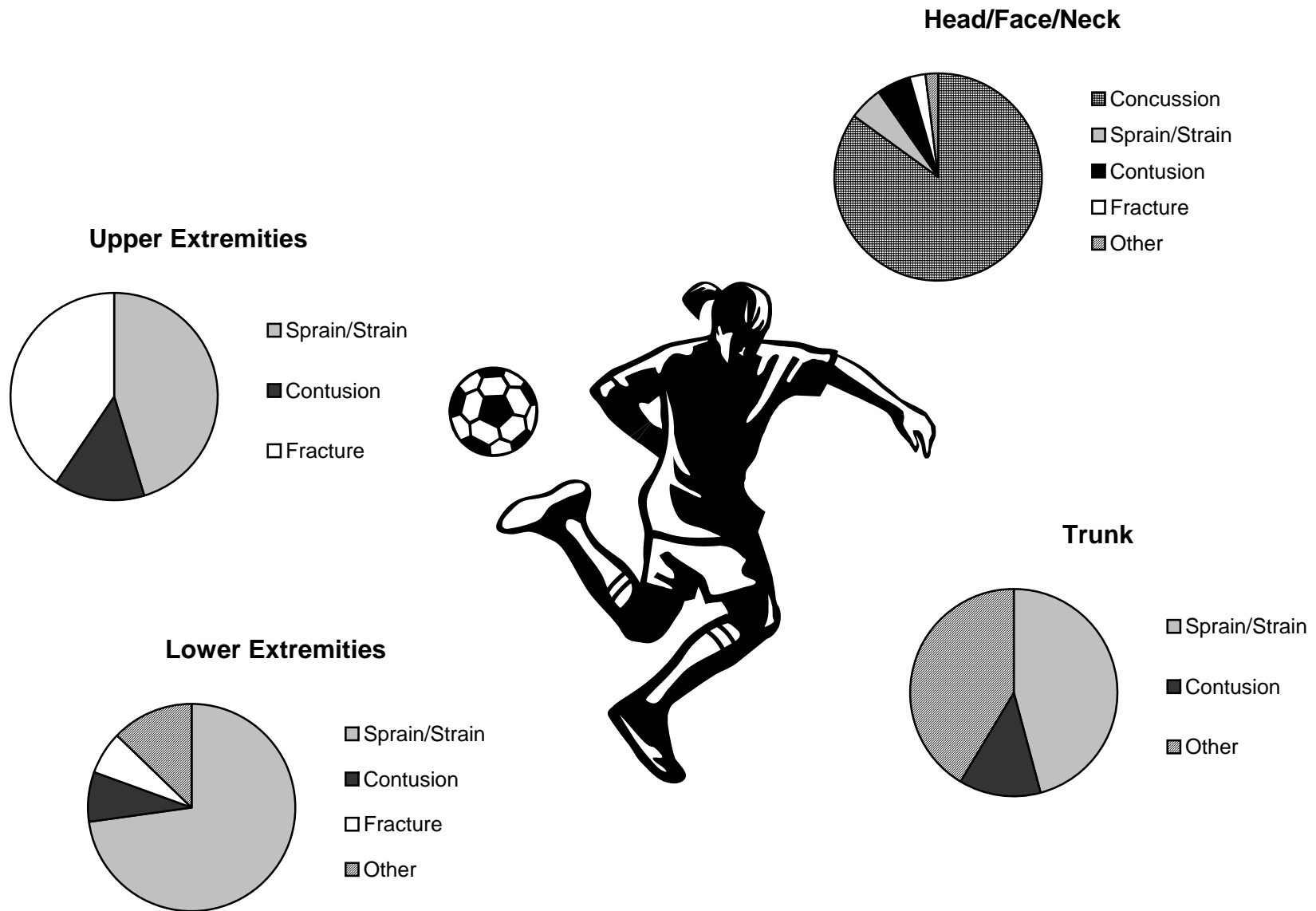
Table 4.6 highlights:

- Defending (15.1%), general play (14.2%), and ball handling/dribbling (14.2%) led to the greatest proportion of injuries.
- The greatest proportion of concussions were caused by heading the ball (37.2%) and defending (15.3%).

Figure 4.3 presents the type of injury by body site. Figure 4.3 highlights:

- Head/face/neck injuries were most commonly concussions (85.1%), with fewer sprains/strains (5.3%), contusions (5.0%), and fractures (2.6%).
- Fractures were more common among upper extremity injuries (40.7%) than lower extremity injuries (6.6%), and were absent among trunk injuries.

**Figure 4.3 Type of Injury by Body Site for Girls' Soccer Injuries**



#### 4.4 Girls' Volleyball

The 203 reported volleyball injuries represent an estimated 83,530 injuries that occurred nationally during the 2005-2006 academic year. Table 4.7 presents demographic characteristics of injured volleyball athletes.

**Table 4.7 Demographic Characteristics of Injured Girls' Volleyball Athletes**

	<b>Mean</b>	<b>St. Dev.</b>	<b>Minimum</b>	<b>Maximum</b>
<b>Age (years)</b>	15.7	1.3	13	18
<b>Height (inches)</b>	66.2	3.5	56	79
<b>Weight (pounds)</b>	140.8	22.4	95	225

	<b>n<sup>*†</sup></b>	<b>%</b>
<b>Freshmen</b>	19,357	23.2%
<b>Sophomores</b>	23,161	27.8%
<b>Juniors</b>	17,604	21.1%
<b>Seniors</b>	23,188	27.8%

\* "n" represents weighted estimates representing all US girls' volleyball athletes

† Cases with missing/unknown class were excluded from this table

Table 4.7 highlights:

- The mean BMI for girls' volleyball athletes was 22.6.
- Injuries were evenly distributed among the classes.

The largest proportion of volleyball injuries occurred among outside hitters (34.5%), followed by the middle blocker (27.1%), the setter (19.6%), the opposite/diagonal player (10.1%), and the libero (4.4%). The middle forward portion of the court was the most common location of injury (33.7%), followed by the right forward (23.4%), the left forward (13.5%), and the left back (12.4%). Table 4.8 presents mechanism of injury by the injury type.



**Table 4.8 Mechanism of Girls' Volleyball Injury by Type of Injury**

	<b>Sprain/Strain, n=63,669</b>	<b>Contusion, n=4,367</b>	<b>Fracture, n=3,468</b>	<b>Concussion, n=2,568</b>	<b>Other, n=9,458</b>
Blocking	36.2%	3.4%	42.1%	0%	7.1%
Passing	13.8%	0%	34.4%	41.7%	8.5%
Digging	8.3%	81.3%	4.8%	17.3%	12.3%
Spiking	12.6%	0%	0%	0%	10.4%
General play	7.6%	0%	8.0%	10.8%	33.3%
Setting	10.3%	15.2%	6.4%	0%	6.0%
Other	11.2%	0%	4.3%	30.2%	22.3%
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

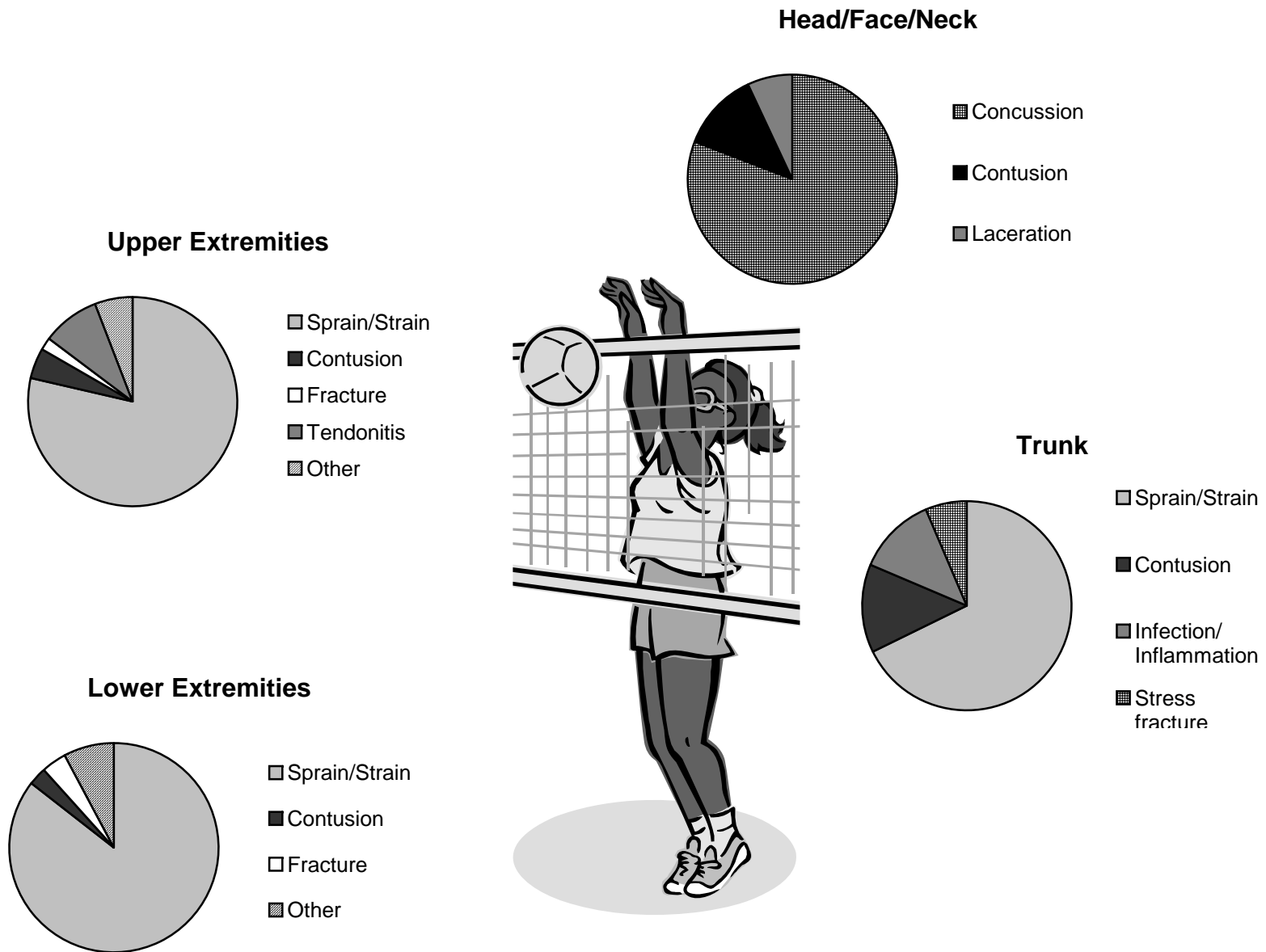
Table 4.8 highlights:

- Blocking (30.5%) accounted for the most injuries, followed by passing (14.3%) and digging (12.8%).
- Almost half of all concussions were caused by passing (41.7%).

Figure 4.4 presents type of injury by body site. Figure 4.4 highlights:

- Concussion made up 80.8% of head/face/neck injuries, with fewer contusions (12.1%) and lacerations (7%).
- The majority of lower extremity (85.6%), upper extremity (78.6%), and trunk (67.8%) injuries were sprains/strains.
- Infections/inflammation accounted for 12.2% of trunk injuries.
- Tendonitis accounted for 8.8% of upper extremity injuries.

**Figure 4.4 Type of Injury by Body Site for Girls' Volleyball Injuries**



## 4.5 Boys' Basketball

The 416 reported boys' basketball injuries represent an estimated 101,105 injuries that occurred nationally during the 2005-2006 academic year. Table 4.9 presents demographic characteristics of injured boys' basketball athletes.

**Table 4.9 Demographic Characteristics of Injured Boys' Basketball Athletes**

	<b>Mean</b>	<b>St. Dev.</b>	<b>Minimum</b>	<b>Maximum</b>
<b>Age (years)</b>	16.1	1.2	13	19
<b>Height (inches)</b>	71.5	3.4	56	81
<b>Weight (pounds)</b>	167.8	26.1	105	305

	<b>n<sup>*†</sup></b>	<b>%</b>
<b>Freshmen</b>	19,029	19.2%
<b>Sophomores</b>	26,477	26.7%
<b>Juniors</b>	28,366	28.7%
<b>Seniors</b>	25,133	25.4%
<b>Total</b>	99,005	100%

\* "n" represents weighted estimates representing all US boys' basketball athletes

† Cases with missing/unknown class were excluded from this table

Table 4.9 highlights:

- The mean BMI for injured boys' basketball athletes was 23.1.
- Injuries were distributed evenly throughout the classes, with freshmen accounting for slightly fewer injuries than upperclassmen.

Among boys' basketball, forwards (43.9%) and guards (43.8%) accounted for the most injuries, followed by centers (11.9%). Half of all injuries occurred inside either the defensive or offensive lane (31.7% and 28.3%, respectively). The next most common location was while the player was on offense or defense between the 3-point arc and the center lane (10.5% and 7.2%,

respectively). Being outside of the 3-point arc while playing offense or defense accounted for 8.3% and 6.4% of all reported injuries, respectively. Table 4.10 presents mechanism of injury by the injury type.

**Table 4.10 Mechanism of Boys' Basketball Injury by Type of Injury**

	<b>Sprain/Strain, n=56,323</b>	<b>Contusion, n=12,265</b>	<b>Fracture, n=11,391</b>	<b>Concussion, n=3,513</b>	<b>Other, n=17,145</b>
General play	12.6%	11.4%	8.7%	0%	30.5%
Rebounding	40.2%	13.2%	34.7%	33.1%	17.4%
Defending	12.3%	28.2%	19.9%	5.8%	9.2%
Shooting	10.9%	3.4%	7.5%	14.1%	5.4%
Dribbling	7.7%	12.6%	1.9%	11.4%	9.3%
Chasing loose ball	6.4%	14.5%	7.7%	28.3%	3.6%
Other	9.8%	16.6%	19.7%	7.4%	24.5%
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

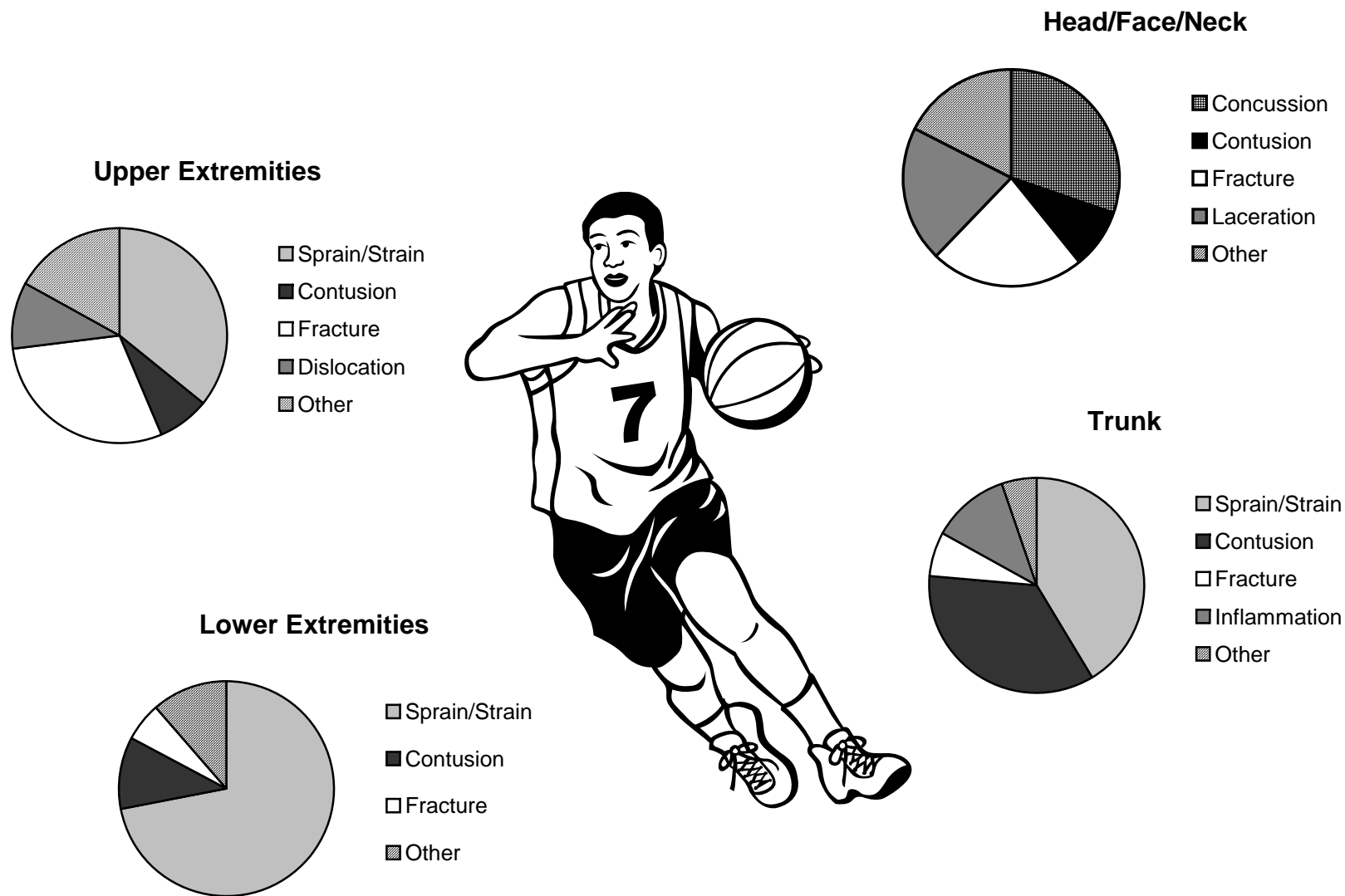
Table 4.10 highlights:

- Rebounding accounted for the greatest proportion of injuries (32.2%), followed by general play (14.6%) and defending (14.4%).
- Chasing loose balls accounted for 28.3% of concussions.

Figure 4.5 presents type of injury by body site. Figure 4.5 highlights:

- Head/face/neck injuries were comprised of concussions (30.2%), fractures (22.8%), lacerations (20.4%), and contusions (9.1%).
- Strains/sprains were more common among lower extremity injuries (71.8%) than trunk (41.4%) and upper extremity (35.9%) injuries.
- Fracture was more common among upper extremity injuries (29.4%) than trunk (6.7%) and lower extremity injuries (5.7%).

**Figure 4.5 Type of Injury by Body Site for Boys' Basketball Injuries**



## 4.6 Girls' Basketball

The 392 reported boys' basketball injuries represent an estimated 110,891 injuries that occurred nationally during the 2005-2006 academic year. Table 4.11 presents demographic characteristics of injured girls' basketball athletes.

**Table 4.11 Demographic Characteristics of Injured Girls' Basketball Athletes**

	<b>Mean</b>	<b>St. Dev.</b>	<b>Minimum</b>	<b>Maximum</b>
<b>Age (years)</b>	15.6	1.2	13	18
<b>Height (inches)</b>	66.5	3.5	52	74
<b>Weight (pounds)</b>	138.1	23	94	236

	<b>n<sup>*†</sup></b>	<b>%</b>
<b>Freshmen</b>	35,837	32.4%
<b>Sophomores</b>	29,445	26.6%
<b>Juniors</b>	27,656	25.0%
<b>Seniors</b>	17,806	16.1%
<b>Total</b>	110,744	100%

\* "n" represents weighted estimates representing all US girls' basketball athletes

† Cases with missing/unknown class were excluded from this table

Table 4.11 highlights:

- The mean BMI for girls' basketball athletes was 22.0.
- There were twice as many freshmen injured as seniors.

In girls' basketball, half of all injuries were sustained by guards (50.5%), with forwards sustaining 30.7% and centers sustaining 17.4%. Similarly to boys' basketball, the most common court location of injury was being on defense or offense inside the lane (23.3% and 22.7%, respectively), followed by being on offense or defense between the 3-point arc and the inside

lane (12.2% and 10.2%, respectively) and being on offense or defense while outside of the 3-point arc (10.3% and 9.2%, respectively).

**Table 4.12 Mechanism of Girls' Basketball Injury by Type of Injury**

	<b>Sprain/Strain, n=67,259</b>	<b>Contusion, n=6,256</b>	<b>Fracture, n=5,400</b>	<b>Concussion, n=13,136</b>	<b>Other, n=18,370</b>
General play	18.5%	28.0%	5.4%	3.3%	38.6%
Rebounding	21.2%	21.3%	24.8%	16.4%	8.7%
Defending	16.9%	9.8%	12.1%	21.9%	9.2%
Conditioning	13.9%	0%	9.1%	0%	16.2%
Dribbling	9.3%	0%	5.8%	18.7%	3.9%
Chasing loose ball	7.4%	19.8%	14.0%	10.4%	6.5%
Other	12.9%	21.0%	28.8%	29.3%	16.9%
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

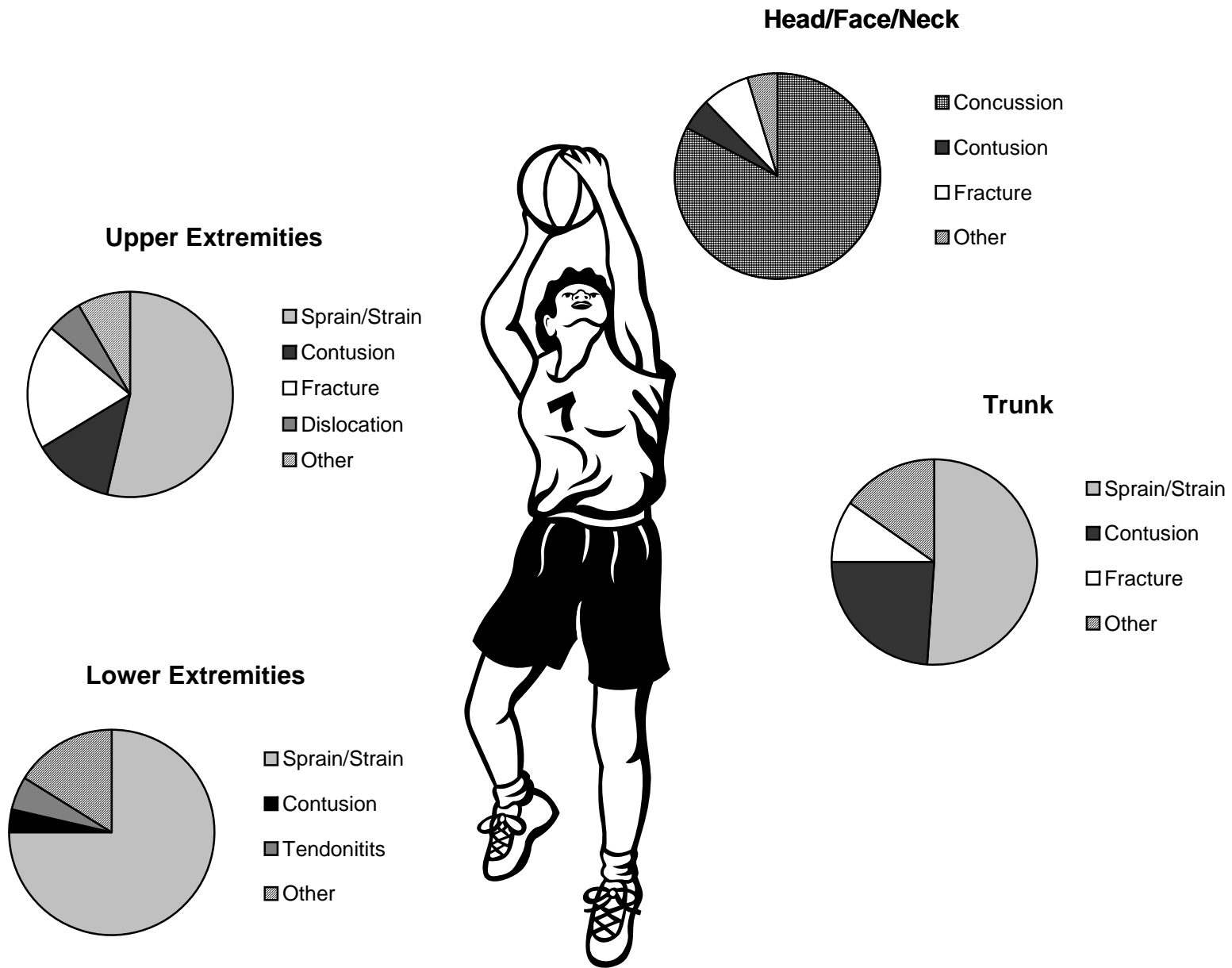
Table 4.12 highlights:

- General play accounted for the greatest proportion of injuries (19.8%), followed by rebounding (18.7%) and defending (15.6%).

Figure 4.6 presents the types of injury by body site. Figure 4.6 highlights:

- The majority of head/face/neck injuries were concussions (82.8%), followed by fractures (7.5%) and contusions (4.9%).
- Sprains/strains made up a greater proportion of lower extremity injuries (74.9%) compared with upper extremity (53.7%) and trunk (51.1%) injuries.
- There was a greater proportion of fractures among upper extremity injuries (19.7%) compared to trunk injuries (9.5%). There were no fractures among lower extremity injuries.

Figure 4.6 Type of Injury by Body Site for Girls' Basketball Injuries





## 4.7 Boys' Wrestling

The 430 reported wrestling injuries represent an estimated 110,889 injuries that occurred nationally during the 2005-2006 academic year. Table 4.13 presents demographic characteristics of injured wrestling athletes.

**Table 4.13 Demographic Characteristics of Injured Boys' Wrestling Athletes**

	<b>Mean</b>	<b>St. Dev.</b>	<b>Minimum</b>	<b>Maximum</b>
<b>Age (years)</b>	15.9	1.2	14	18
<b>Height (inches)</b>	67.8	3.7	51	75
<b>Weight (pounds)</b>	155.5	36.6	98	310

	<b>n<sup>*†</sup></b>	<b>%</b>
<b>Freshmen</b>	26,013	23.5%
<b>Sophomores</b>	28,159	25.4%
<b>Juniors</b>	28,661	25.9%
<b>Seniors</b>	27,815	25.1%
<b>Total</b>	110,648	100%

\* "n" represents weighted estimates representing all US wrestling athletes

† Cases with missing/unknown class were excluded from this table

Table 4.13 highlights:

- The mean BMI for injured boys' wrestling athletes was 23.8.
- Injuries were distributed evenly among classes.

The wrestling injuries reported were fairly uniformly distributed among the various weight classes. The majority of injuries occurred within the circle (86.4%), with 10.1% of injuries occurring off the mat and 3.6% sustained out of bounds. Table 4.14 presents mechanisms of wrestling injury by injury type.

**Table 4.14 Mechanism of Boys' Wrestling Injury by Type of Injury**

	<b>Sprain/Strain, n=49,326</b>	<b>Contusion, n=6,436</b>	<b>Fracture, n=16,459</b>	<b>Concussion, n=5,417</b>	<b>Other, n=33,151</b>
Takedown	29.3%	58.3%	47.3%	52.7%	31.8%
Sparring	17.6%	10.7%	16.6%	27.0%	7.8%
Near fall	6.7%	15.9%	11.6%	0%	9.5%
Escape	11.0%	0%	3.8%	7.9%	9.1%
Fall	10.1%	0%	13.1%	4.2%	0.9%
Other	25.3%	15.0%	7.8%	8.3%	40.9%
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

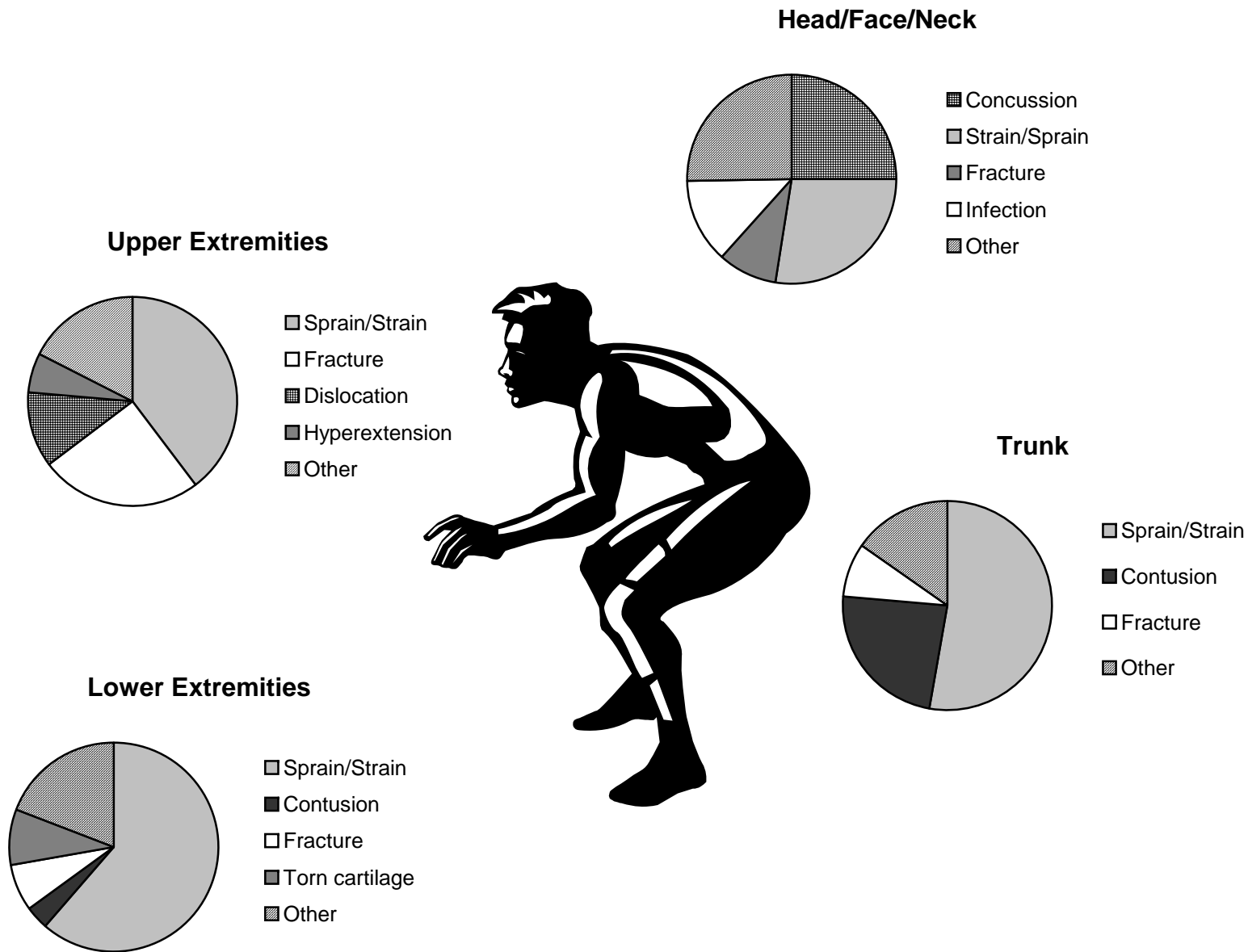
Table 4.14 highlights:

- The takedown (35.8%) accounted for the greatest proportion of injuries, followed by sparring (14.7%).
- More than half of all concussions occurred during takedowns.

Figure 4.7 presents injury type by body site. Figure 4.7 highlights:

- Head/face/neck injuries were composed of concussions (25.1%), sprains/strains (27.3%), fractures (9.3%), and infections (13.1%).
- Strains/sprains made up the largest proportion of upper extremity injuries (39.6%), followed by fractures (25.2%), dislocations (11.6%), and hyperextensions (6.1%).
- Lower extremity injuries were composed mainly of sprains/strains (61.3%), followed by torn cartilage (8.5%), fracture (7.2%), and contusion (3.8%).
- Potential skin infections accounted for approximately 9.7% of reported injuries, with six participating study schools reporting multiple occurrences.

**Figure 4.7 Type of Injury by Body Site for Boys' Wrestling Injuries**



## 4.8 Boys' Baseball

The 221 reported baseball injuries represent an estimated 69,151 injuries that occurred nationally during the 2005-2006 academic year. Table 4.15 presents demographic characteristics of injured baseball athletes.

**Table 4.15 Demographic Characteristics of Injured Boys' Baseball Athletes**

	<b>Mean</b>	<b>St. Dev.</b>	<b>Minimum</b>	<b>Maximum</b>
<b>Age (years)</b>	16.1	1.3	14	19
<b>Height (inches)</b>	69.5	3.4	60	76
<b>Weight (pounds)</b>	164.2	28.8	110	260

	<b>n<sup>*†</sup></b>	<b>%</b>
<b>Freshmen</b>	18,056	26.4%
<b>Sophomores</b>	14,455	21.1%
<b>Juniors</b>	18,355	26.8%
<b>Seniors</b>	17,603	25.7%
<b>Total</b>	68,469	100%

\* "n" represents weighted estimates representing all boys' baseball US athletes

† Cases with missing/unknown class were excluded from this table

Table 4.15 highlights:

- The mean BMI of injured boys' baseball athletes was 23.9.
- Injuries were distributed evenly across the classes.

The pitcher was the most commonly injured position (20.4%), followed by base runners (11.4%), catchers (10.3%), and first base men (9.2%). Home plate was the most common location of injury (18.8%), followed by the pitcher's mound (17.2%), first base (12.9%), outfield (12.7%), and second base (12.2%). Table 4.16 presents the mechanism of injury by the injury type.

**Table 4.16 Mechanism of Boys' Baseball Injury by Type of Injury**

	<b>Sprain/Strain, n=31,342</b>	<b>Contusion, n=12,160</b>	<b>Fracture, n=8,400</b>	<b>Concussion, n=1,450</b>	<b>Other, n=15,703</b>
Fielding	13.5%	27.4%	29.2%	0%	22.1%
Running bases	22.6%	13.3%	7.1%	0%	6.1%
Sliding	11.4%	15.8%	14.9%	0%	6.3%
Throwing	16.2%	0%	4.4%	0%	13.4%
Batting	4.4%	14.2%	12.9%	69.5%	10.1%
Other	31.9%	29.2%	31.4%	30.5%	42.0%
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

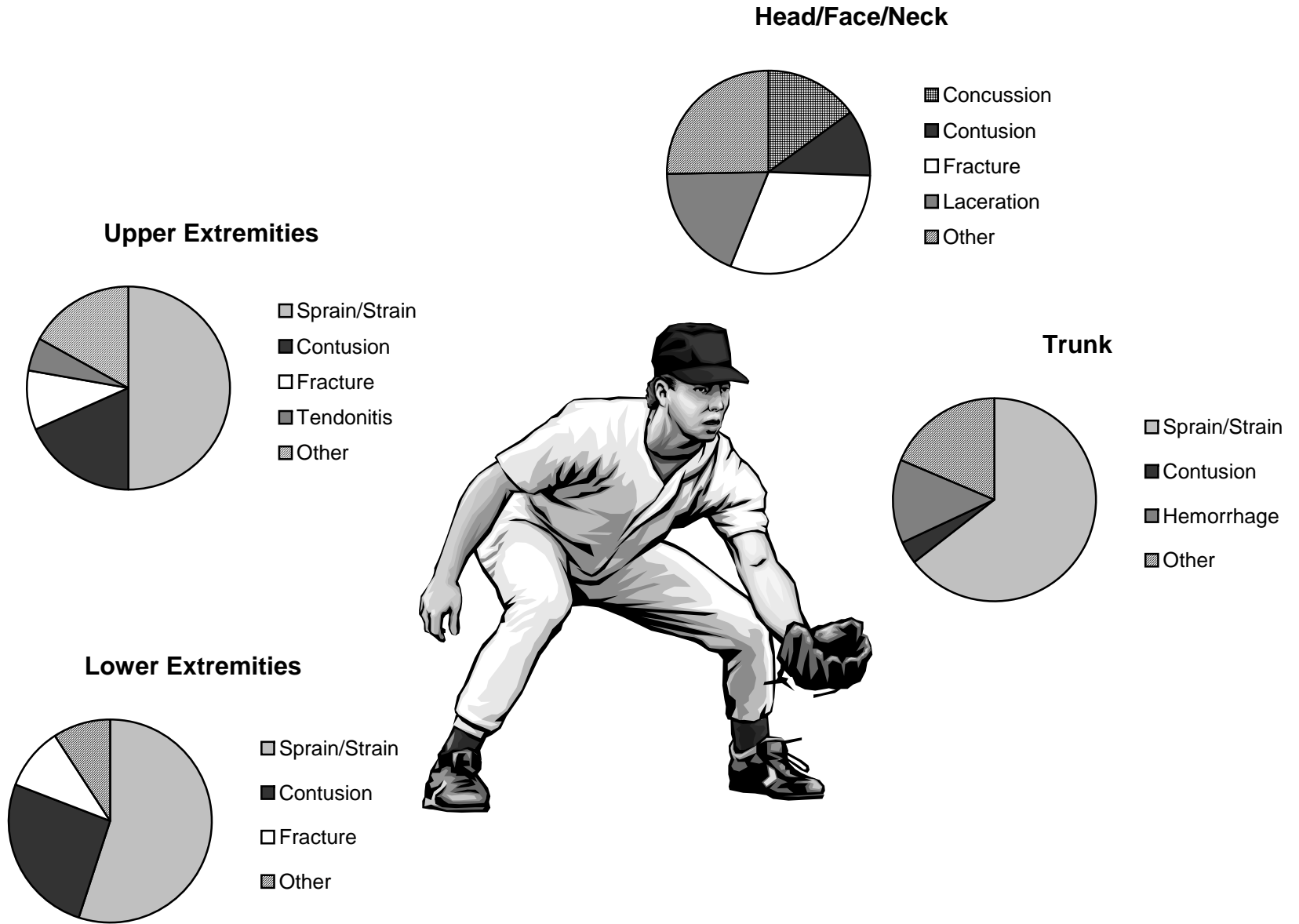
Table 4.16 highlights:

- Fielding accounted for the greatest proportion of injuries (19.3%), followed by running bases (15.2%).
- The majority of concussions occurred while batting (69.5%).

Figure 4.8 presents type of injury by body site. Figure 4.8 highlights:

- Fractures accounted for 12.1% of all injuries.
- Head injuries were composed of fractures (30.7%), lacerations (18.6%), concussions (15.0%), and contusions (10.5%).
- A greater proportion of strains/sprains were seen among trunk injuries (64.5%) than lower (55.0%) or upper (50.0%) extremity injuries.
- There were greater proportions of contusions among lower extremity injuries (25.8%) than upper extremity (18.2%) or trunk (3.6%) injuries.

**Figure 4.8 Type of Injury by Body Site for Boys' Baseball Injuries**



#### 4.9 Girls' Softball

The 157 reported softball injuries represent an estimated 64,563 injuries that occurred nationally during the 2005-2006 academic year. Table 4.17 presents demographic characteristics of injured softball athletes.

**Table 4.17 Demographic Characteristics of Injured Girls' Softball Athletes**

	<b>Mean</b>	<b>St. Dev.</b>	<b>Minimum</b>	<b>Maximum</b>
<b>Age (years)</b>	15.9	1.1	13	19
<b>Height (inches)</b>	65.6	3	53	74
<b>Weight (pounds)</b>	138.2	24.1	97	249

	<b>n<sup>*†</sup></b>	<b>%</b>
<b>Freshmen</b>	13,769	21.3%
<b>Sophomores</b>	24,884	38.5%
<b>Juniors</b>	15,378	23.8%
<b>Seniors</b>	10,533	16.3%
<b>Total</b>	64,564	100%

\* "n" represents weighted estimates representing all US girls' softball athletes

† Cases with missing/unknown class were excluded from this table

Table 4.17 highlights:

- The mean BMI of injured girls' softball athletes was 22.6.
- There was a higher proportion of sophomores among the injured than the other classes.

The most commonly injured softball position was the catcher (17.5%), followed by base runners (14.6%), the pitcher (10.4%), and left field (9.5%). The most common location of injury was home plate (24.5%), followed by second base (21.3%), outfield (13.2%), and third base (10.9%). Table 4.18 presents mechanism by injury type.

**Table 4.18 Mechanism of Girls' Softball Injury by Type of Injury**

	<b>Sprain/Strain, n=27,180</b>	<b>Contusion, n=10,295</b>	<b>Fracture, n=11,094</b>	<b>Concussion, n=2,695</b>	<b>Other, n=13,299</b>
Sliding	22.2%	9.4%	12.8%	0%	20.2%
Fielding	11.0%	31.4%	25.7%	14.8%	6.1%
Running bases	24.0%	10.4%	0%	5.6%	10.7%
Catching	5.4%	10.8%	34.3%	39.2%	7.9%
Throwing	10.7%	2.5%	0%	0%	26.7%
Batting	9.9%	13.4%	12.8%	9.1%	0%
Other	16.7%	22.2%	14.4%	31.2%	28.4%
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

Table 4.18 highlights:

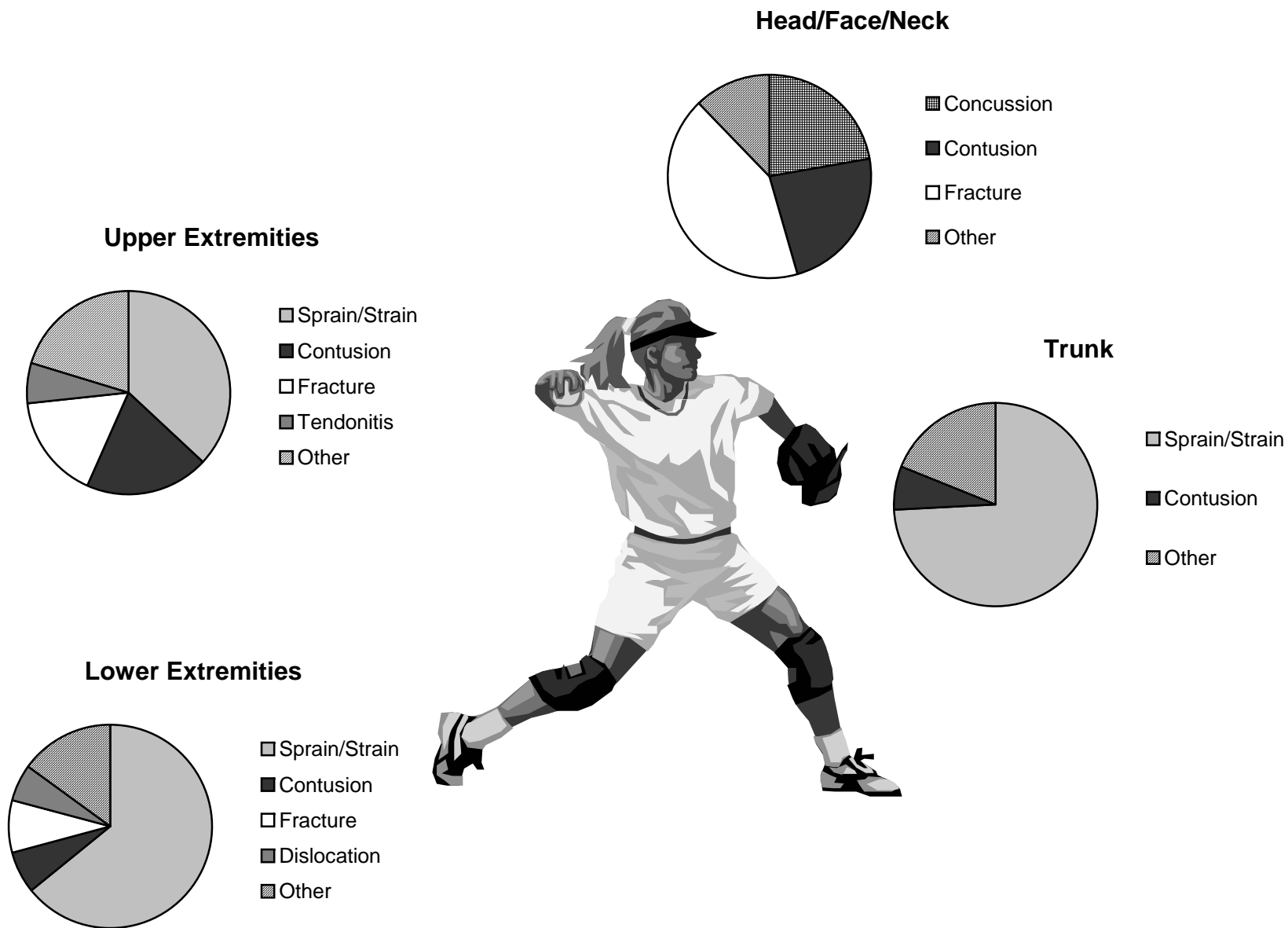
- Sliding (17.2%) accounted for the highest proportion of injuries, followed by fielding (16.0%).
- Concussions were caused most often by catching (39.2%) and fielding (14.8%).

Figure 4.9 presents the type of injury by body site. Figure 4.9 highlights:

- Head/face/neck injuries were composed of fractures (42.3%), contusions (23.4%), and concussions (22.2%).
- Sprains/strains accounted for the majority of trunk (74.2%) and lower extremity injuries (64.3%), with fewer amongst upper extremity injuries (36.9%).
- There was a greater proportion of upper extremity fractures (16.7%) than lower extremity fractures (8.6%).



**Figure 4.9 Type of Injury by Body Site for Girls' Softball Injuries**



## 5. Gender Differences within Sports

### 5.1 Soccer

Although the overall rate of soccer injury did not differ by gender, girls' soccer had a higher competition injury rate than boys' (5.2 injuries per 1,000 athlete-competitions and 4.2 injuries per 1,000 athlete-competitions, respectively) (RR=1.23, 95% CI: 1.02-1.49). Boys' and girls' soccer injuries did not differ with respect to injury mechanism, time loss, and whether the injury was new or recurring. Girls (15.2%) had an insignificantly greater proportion of concussions than boys (9.4%) (IPR=1.61, 95% CI: 1.00-2.61). Boys had a greater proportion of trunk injuries (11.9%) than girls (4.0%) (IPR=2.90, 95% CI: 1.47-5.75). Although girls tended to sustain a greater proportion of lower extremity fractures (6.6%) than boys (2.4%) (IPR=2.70, 95% CI: 0.88-8.29), this difference was insignificant.

### 5.2 Basketball

Although the overall rate of basketball injury did not differ by gender, girls' basketball had a higher rate of competition injury than boys' basketball (3.6 injuries per 1,000 athlete-competitions and 3.0 injuries per 1,000 athlete-competitions, respectively) (RR=1.21, 95% CI: 0.99-1.48). Girls sustained an insignificantly larger proportion of injuries keeping them out of play for >3 weeks compared with boys (20.1% and 15.2%, respectively) (IPR=1.33, 95% CI: 0.92-1.91). Girls sustained a larger proportion of concussion (11.9%) than boys (3.5%) (IPR=3.41, 95% CI: 1.71-6.81) and a larger proportion of recurring injuries (21.2%) than boys (14.2%) (IPR=1.50, 95% CI: 1.03-2.18). Girls also had a larger proportion of knee injuries (16.0%) than boys (9.8%) (IPR=1.62, 95% CI: 1.06-2.50). Boys (3.5%) had a larger proportion of shoulder injuries than girls (1.2%) (IPR=2.88, 95% CI: 1.07-7.78). While 5.1% of boys' lower extremity injuries were fractures, no girls sustained lower extremity fractures.

A larger proportion of boys' injuries (50.8%) resulted from contact with another person compared to girls' injuries (39.0%) (IPR=1.30, 95% CI: 1.08-1.57). Boys also had more injuries from rebounding (32.2%) than girls (18.7%) (IPR=1.72, 95% CI: 1.28-2.31), while girls had more injuries from conditioning (11.5%) compared to boys (4.2%) (IPR=2.74, 95% CI: 1.52-4.96). Although there were differences in mechanisms of concussions and fractures, these were insignificant.

### **5.3 Baseball/Softball**

Injury rates were similar between baseball (1.2 per 1,000 athlete-exposures) and softball (1.1 per 1,000 athlete-exposures) (RR=1.05, 95% CI: 0.86-1.30). Boys' baseball and girls' softball injuries did not differ greatly with respect to mechanism of injury, time loss, whether the injury was new or a recurrence, and whether the injury occurred during a competition or a practice. Girls' softball athletes experienced an insignificantly higher proportion of concussions (4.2%) than boys' baseball athletes (2.1%) (IPR=1.99, 95% CI: 0.61-6.47), while boys' baseball athletes experienced an insignificantly higher proportion of shoulder injuries (19.8%) than girls' softball athletes (10.9%) (IPR=1.81, 95% CI: 0.90-3.66).

Baseball pitchers sustained a larger proportion of injuries than softball pitchers (20.4% and 10.4%, respectively) (IPR=1.95, 95% CI: 1.01-3.75). Although baseball participants tended to sustain a higher proportion of concussion while batting (69.5%) compared to softball participants (9.1%) (IPR=7.6, 95% CI: 0.88-66.2), there were too few cases for this to be significant.

## 6. Reporter Compliance

During the 2005-2006 academic year, 95 out of 100 reporters (95%) logged into High School RIO™ at least once to report injury data. Of these 95 reporters, 84 (88.4%) completed a weekly exposure report for each week of the study and completed an injury report form for every injury reported on the weekly exposure report. There were 5 reporters (5.3%) that either missed 1 or more weeks of reporting or did not complete an injury report form for every reported injury. There were only 2 reporters (2.1%) that were missing multiple weeks of reporting or multiple injury report forms, and only 4 reporters (4.2%) that dropped out of the study prematurely. Of these 6 reporters, the most common reason for failing to complete the study was being moved to a new school.

The non-response rate of questions in the injury report form tended to be low, with most questions having a non-response rate of less than 2%. The non-response rate was lowest for non-sport specific questions, such as questions asking for injury diagnosis, body site, etc. It was highest for sport-specific questions, such as questions asking for specific mechanism, field/court location of injury, etc.

An online “End of Season” survey gave all reporters the opportunity to provide feedback on their experiences with High School RIO™. This survey was completed by 33 reporters (33%). Average reporting times were 13.7 minutes for the weekly exposure report and 7.0 minutes for the injury report form. RIO™ was reported to be either very easy (84.8%) or somewhat easy (15.2%) to use, with reporters being either very satisfied (73.3%) or somewhat satisfied (26.7%) with the study. Suggestions provided by reporters were used to improve the survey that will be used when the study is replicated during the 2006-2007 academic year.

## 7. Summary

High school sports play an important role in the adoption and maintenance of a physically active lifestyle among millions of US adolescents. Too often injury prevention in this population is overlooked as sports-related injuries are thought to be unavoidable. In reality, sports-related injuries are largely preventable through the application of evidence-based preventive interventions. Such preventive interventions can include educational campaigns, introduction of new/improved protective equipment, rule changes, other policy changes, etc. The morbidity, mortality, and disability caused by high school sports-related injuries can be reduced through the development and implementation of effective prevention strategies as well as through improved injury diagnosis and treatment modalities. However, surveillance of exposure based injury rates in a nationally representative sample of high school athletes and subsequent epidemiologic analysis of patterns of injury are needed to drive evidence-based prevention practices.

The study of high school sports-related injuries to date has largely been limited by an inability to calculate injury rates due to a lack of exposure data (i.e., frequency of participation in athletic activities including training, practice, and competition), an inability to compare findings across groups (i.e., sports/activities, genders, schools, and levels of competition), or an inability to generalize findings from small non-representative samples. The value of national injury surveillance studies that collect injury, exposure, and risk factor data from representative samples has been well demonstrated by the National Collegiate Athletic Association's Injury Surveillance System (NCAA ISS). Data collected by the NCAA ISS since 1982 has been used to develop preventive interventions including changes in coaching habits, increased use of protective equipment, and rule changes which have had proven success in reducing injuries among collegiate athletes. For example, NCAA ISS data has been used to develop several interventions

intended to reduce the number of preseason heat-related football injuries including the elimination of consecutive days of multiple practices, daily hour limitations, and a gradual increase in equipment for conditioning and heat acclimation. Additionally, several committees have considered NCAA ISS data when making recommendations including the NCAA Committee on Competitive Safeguards and Medical Aspects of Sports' recommendation for mandatory eye protection in women's lacrosse, the NCAA Men's Ice Hockey Rules Committee's recommendation for stricter penalties for hitting from behind, checking into the boards, and not wearing a mouthpiece, and the NCAA Men's Basketball Rules Committee's recent discussions of widening the free-throw lane to prevent injuries related to player contact. Unfortunately, because an equivalent injury surveillance system to collect injury and exposure data from a nationally representative sample of high school athletes has not previously existed the usefulness of currently available high school sports-related injury data has been limited.

During the 2005-2006 academic year, the success of the study presented here, High School RIO™ (Reporting Information Online): Internet-Based Surveillance of Injuries Sustained by US High School Athletes, demonstrated the ability to implement a national injury surveillance system at the high school level. Dr. Comstock and her research staff are committed to using this pilot study to launch a permanent national high school sports injury surveillance system. To this end, The Ohio State University and the Center for Injury Research and Policy at Columbus Children's Hospital are funding a second year of High School RIO™. Ultimately, however, funds will need to be found to implement a permanent high school injury surveillance system.

While the health benefits of a physically active lifestyle including sports participation are undeniable, participants are at risk of injury because a certain endemic level of injury can be expected during any physical activity, especially those with a competitive component. However,

injury rates among high school athletes should be reduced to the lowest possible level without discouraging adolescents from engaging in this important form of physical activity. This goal can best be accomplished by monitoring injury rates and patterns of injury among high school athletes; investigating the etiology of preventable injuries; and developing, implementing, and evaluating evidence-based preventive interventions. Surveillance systems such as the model used for this study are critical in achieving these goals.