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ABSTRACT

Through this study we report the 2014-15 injuries of high school athletes in 18 west central Florida schools utilizing the Reporting Information Online (RIO) data system. Certified athletic trainers (ATCs) were hired and trained by researchers from the University of South Florida to collect and report injury findings from high school athletes. Descriptive statistics, injury rates, and rate ratios were calculated. Overall, 726 injuries were reported by the ATCs. Football was the leading sport for number of injuries and injuries per athlete-exposures for practices and competitions. Boys had significantly greater injury rates compared to girls overall and in competitions and practices. Our results show the important role football continues to play in high school sports injuries and help lay the groundwork for the development of targeted interventions for athletes.

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BACKGROUND

According to a national study of the Colorado School of Public Health Pediatric Injury Prevention, Education, and Research Program, approximately 7.7 million high school students in the United States (U.S.) participated in sports, with 1,361,986 injuries occurring during the 2012-13 school year (Comstock, Collins, & Currie, 2013) and 1,196,479 injuries during 2014-15 (Comstock, Currie, & Pierpoint, 2015). In the past 20 years, we have seen increasing numbers of high school students participate in certain forms of athletics, from approximately 5.8 million in 1994-95 to over 7.8 million in 2014-15 (National Federation of State High School Associations, 2015). With this increase in participation comes an increased risk for more injuries.

A study analyzing data from the U.S. Consumer Product Safety Commission's National Electronic Injury Surveillance System (NEISS) found that more than 1.35 million children and adolescents ages 19 and under were seen in emergency departments (EDs) in 2012 for injuries related to 14 commonly played sports (Safe Kids Worldwide, 2013). A retrospective study using data from NEISS reported 485,515 sports-related injury cases for children aged 5–18 for 2001–2013 (Bayt & Bell, 2015). The national estimate for sports-related injuries presenting to U.S. emergency departments for 2001–2013 among children aged 5–18 years was 15,960,113 (Bayt & Bell, 2015). These results showed that there was an increase of 10,010 nationally estimated selected sports injuries per year. It also was found that internal injuries more than doubled between 2001 and 2004 and between 2009 and 2013. The sports with the greatest number of sports-related injuries were football, basketball, soccer, and baseball. Other researchers reported that 131,459 high school students were treated in the EDs due to football injuries. More than one-fourth of the injured students (25.8%) were diagnosed with sprains and strains, and 20.8% were head-related injuries (Smart, et al., 2016). The Centers for Disease Control and Prevention (CDC) reported that for the time of period of 2001-2009, there were an estimated 173,285 persons aged 19 years and younger who were treated in U.S. EDs annually for nonfatal traumatic brain injuries related to sports and recreation activities (CDC, 2011).

To plan effective sports injury prevention programs in high school, a good surveillance tool is needed, especially one that captures incidence, prevalence, risk factor, and exposure information (Caine & Nassar, 2005; Fernandez, Yard, & Comstock, 2007; Liller, et al., 2009; Liller, et al., 2015) . To address this need in the state of Florida, a sports injury surveillance tool for high school athletes was developed in 2007-08 as part of the initiatives of the Sports Medicine and Athletic

Related Trauma (SMART) Institute of the University of South Florida (USF) College of Medicine.

Previously, SMART researchers utilized the sports software program Simtrak™ developed by Premier Software, Inc. to conduct high school athlete injury surveillance. Variables added by the researchers to the existing Simtrak™ software to strengthen the system included exposure, which is defined as the number of athletes at each practice and/or competition, demographic information of the injured athlete, level of play, time and season of injury, information if the injury was directly related to action that was ruled illegal/foul, mechanism of injury, activity during the injury, environmental conditions, field locations and positions, concussion information, use of protective equipment, and injury outcomes (Liller, et al., 2009).

In 2011, the SMART program could not continue with this tool due to costs and they decided to use Reporting Information Online or RIO for collection of data beginning in the 2012-13 academic year (Liller, et al., 2015). RIO is a national Internet-based sports-related injury surveillance system that includes eligible U.S. high schools with National Athletic Trainers' Association (NATA)-affiliated certified athletic trainers (ATCs) willing to serve as reporters. Schools are categorized by geographic location (northeast, midwest, south, and west) and school size (enrollment ≤1000 or >1000). From the 8 sampling strata, 100 study schools are randomly selected for data collection. RIO is the tool utilized by the National High School Sports-Related Injury Surveillance System (Darrow, Collins, Yard, & Comstock, 2009). We joined the RIO network as a group of Florida schools in the west central region of the State.

Research findings reported below give the 2014-15 sports injuries from the 18 public health schools in West Central Florida that participated in the Sports Medicine and Athletic Related Trauma (SMART) program of the University of South Florida and utilized the Reporting Information Online (RIO) data collection tool. Without these data, schools cannot target interventions and implement and manage sports injury programs based on needs.

METHODS

Participants

Our paper focuses on all sports-related injuries collected and reported by the ATCs in 18 west central Florida high schools and includes a prospective study design. This is the largest number of schools to date participating in the data collection of sports injuries since SMART started the injury surveillance project in 2007. Schools were chosen based on their willingness to participate, distance to accessible health services, risk of injuries based on sports offered, and status of having an athletic trainer (Liller, et al, 2009). Overall, the schools had an average of 500 athletes, total school enrollments greater than 1000 students, and were representative of the counties' schools in terms of the average percentage of students on free or reduced-price lunch programs (approximately 55%) (http://febp.newamerica.net/k12/FL/1201530).

Data Collection

Certified athletic trainers (ATCs) hired by SMART collected the data for this study. One ATC was hired by SMART per study school.

Instruments

Data collection for the most recent academic year began in August, 2014 after all agreements were signed and the ATCs became skilled through several training sessions on the use of RIO. Injuries were defined as follows:

- Occurred as a result of participation in an organized high school competition or practice;
- Required medical attention by a team physician, certified athletic trainer, personal physician, or emergency department/urgent care facility;
- Resulted in restriction of the high school athlete's participation for one or more days beyond the day of injury; and
- Any fracture, concussion, or dental injury regardless of whether or not it resulted in restriction of the student-athlete's participation.

Procedure

Similar to previous years, the athletes' exposure and sports injury data were collected by the ATCs in weekly reports and the data were submitted by RIO's national office to the researchers on a monthly basis. No identifiers were available to the researchers. These data were imported into SAS (version 9.4) program for analysis. Data were collected on injury rate by exposure, demographic characteristics of athletes, diagnosis of injuries by type of exposure, body site by type of exposure, most common injury diagnoses by type of exposure, time loss of injuries by type of exposure, surgery requirement, history of injuries by type of exposure and time during season along with specific variables per sport (Liller, et al, 2015). The University of South Florida Institutional Review Board approved this study.

Data Analysis

Descriptive statistics were performed in addition to calculation of injury rates and rate ratios. Injury rates were calculated as the ratio of unweighted case counts per 1,000 athlete- exposures, and comparisons among males and females and sports played by both sexes were done using rate ratios (RR) with 95% confidence intervals (CI).

An athlete exposure was defined as 1 athlete participating in 1 practice or competition where he or she is exposed to the possibility of athletic injury. Results of the complete analyses are shared with SMART and individual reports are prepared for each participating school (Liller, et al., 2009; Liller et al., 2015).

RESULTS

Overall Injury Exposure Rates

The leading rate of injury per 1000 athlete-exposures for practices was for football at 2.91, followed by men's cheerleading at 2.23, and women's wrestling at 2.16. For competitions, the injury rate per 1000 athlete-exposures was greatest for football at 13.1 followed by men's lacrosse at 6.80 and men's wrestling at 6.55. A complete listing of all sport-related injuries and rates for practices and competitions is found in Table 1.

Injury Epidemiology

Our reporting style of the injury epidemiology has remained similar over the years (Liller, et al., 2009; Liller et al., 2015). Overall, 726 injuries were reported by the ATCs from the 18 schools. The majority of athletes injured were boys (77.5%). Football was the leading sport with the highest number of reported injuries (395, 54.6%). This was followed by boys' wrestling (39, 5.4%), and boys' soccer (35, 4.8%).

Most injured athletes were in their sophomore year (27.7%) followed by their senior (26.4%), junior (24.9%), and freshman (21.0 %) year. The age in years of those male athletes injured ranged from a minimum of 13 to a maximum of 19 and they had a body mass index (BMI) minimum of 17.0 and a maximum BMI of 55.2. For girls, minimum and maximum ages ranged from 13 to 19 years, respectively, and minimum and maximum BMI's were from 16.5 to 30.9, respectively.

The principal body parts injured across practices and competitions were the head/face (25.9%), knee (16.8%), and ankle (14.9%). Most athletes returned to activity in 10-21 days (24.9%), followed by 3-6 days (18.9%). The vast majority of injuries did not require surgery (92.6%) and were new injuries (90.8%). Most injuries happened during the regular season (74%) and, in terms of practice injuries, during the first 1-2 hours (60.2%). Injuries overall were mostly evaluated by the ATC (95.5%) followed by a general physician (35.4%). Leading assessment methods were evaluation (97.2%) followed by x-ray (33.9%).

The leading types of injury for all sports during practice and competitions were ligament sprains (27.7%) followed by concussions (23.2%) and muscle strains (11.6 %). Table 2 shows detailed injury diagnosis (body part and injury) per type of exposure.

Over the course of the 2014-15 academic year, the ATCs reported they directly supervised 12,868 practices, 2,543 competitions, and 7,621 athletes from the schools. They also supervised 43,518 athletes from other schools who were competing against the SMART schools.

Comparisons were done to determine if there were significant sex differences in sports injuries overall and if there were significant differences in the injury rates for sports played by both boys and girls. Overall for all sports, boys had a significantly greater injury rate compared to girls and this was also true for injuries in competitions and practices (RR=2.79, CI=2.32-3.34; RR=2.98, CI=2.28-3.88; RR=2.88, CI=2.22-3.74, respectively). However, there were no significant sex differences in injury rates overall or in practices and competitions for those sports played by both boys and girls. Table 3 contains additional information pertaining to all rate ratios.

Limitations

We cannot ensure the validity of those data reported by the coaches for sports in which the ATCs did not directly supervise the athletes such as in some away games and in particular sports such as swimming and tennis. In addition, some data were omitted due to one ATC taking a two-month pregnancy leave (although this occurred over the winter break so fewer injuries would have occurred) and one ATC leaving the program two weeks before the end of the season. However, analysis of schools with complete versus incomplete data showed that exposure rates were very similar. Finally, because all of our schools are located in west central Florida, we cannot broadly generalize these data findings.

DISCUSSION

The results of the 2014-2015 SMART injury registry show the important role for sports injury surveillance in high schools. Football continues to be a leading sport for injuries along with wrestling and a newer played sport, lacrosse. Boys continue to have higher injury rates overall and in practices and games. Results of this analysis have been shared with the schools so that targeted interventions may continue to be developed to decrease injuries.

Table 1

High School Athletes' Sports-related Injury Rates per 1000 Athletic Exposures for Practices and Competitions*

(Academic Year 2014-15)

Sport	Number of Competitions	Number of Practices	Injuries in Competition	Injuries in Practice	Injury Rate for Competition (per 1000)	Injury Rate for Practice (per 1000)
Baseball	9261	16206	16	8	1.73	0.49
Basketball (Boys)	8487	17432	16	17	1.89	0.98
Basketball (Girls)	6936	12049	13	5	1.87	0.42
Cheerleading (Boys)	95	449	-	1	-	2.23
Cheerleading (Girls)	2300	25387	2	18	0.87	.71
Cross Country (Boys)	1239	9301	-	8	-	0.86
Cross Country (Girls)	1326	10502	1	4	0.75	0.38
Football	12872	77619	169	226	13.1	2.91
Lacrosse (Boys)	1029	2466	7	3	6.80	1.22
Lacrosse (Girls)	1088	1858	2	1	1.84	0.54
Other Sports	3531	14662	15	5	4.25	0.34
Soccer (Boys)	8245	15056	28	7	3.40	0.47
Soccer (Girls)	7788	13584	21	6	2.70	0.44
Softball	6794	11561	12	8	1.77	0.69
Swimming (Boys)	1825	7996	1	-	0.55	-
Swimming (Girls)	2415	11037	1	1	0.41	0.09
Tennis (Boys)	1934	4109	-	1	-	0.24
Tennis (Girls)	1905	5260	-	-	-	-
Track (Boys)	4076	19868	2	11	0.49	0.55
Track (Girls)	3578	16738	6	11	1.68	0.66
Volleyball (Girls)	7347	14568	11	15	1.50	1.03
Wrestling (Boys)	2441	15343	16	23	6.55	1.50
Wrestling (Girls)	34	463	-	1	-	2.16

Note.

* Injuries related to cheerleading performance were included in analysis but not shown in table.

Missing data are not included in analysis.

Table 2
Ten Most Common Injury Diagnoses* by Type of Exposure (Academic Year 2014-15)

Diagnosis	Practice (n = 380)		Competition (n = 339)		Overall (n = 724)**	
	N	%	N	%	N	%
Head/face concussion	85	22.4%	81	23.9%	167	23.1%
Ankle strain/sprain	45	11.8%	50	14.7%	95	13.1%
Knee strain/sprain	33	8.7%	39	11.5%	72	9.9%
Knee other	26	6.8%	24	7.1%	50	6.9%
Hip/thigh/upper leg strain/sprain	19	5.0%	22	6.5%	41	5.7%
Shoulder strain/sprain	7	1.8%	17	5.0%	24	3.3%
Shoulder other	14	7.0%	9	2.7%	23	3.2%
Lower leg other	13	3.4%	11	3.2%	24	3.3%
Hand/wrist fracture	13	3.4%	6	1.8%	19	2.6%
Neck/cervical spine strain/sprain	6	1.6%	4	1.2%	10	1.4%

Note.
*Knee, shoulder, and lower leg other excluded sprain and strain. Sprain/strain included ligament sprain, muscle strain, and tendon strain. Knee other injuries included fracture, contusion, dislocation, tendonitis, hyperextension, subluxation, and torn cartilage. Shoulder other included contusion, dislocation, tendonitis, subluxation, torn cartilage, bursitis, nerve injury, and separation. Lower leg included fracture, contusion, tendonitis, and shin splints.
** Injuries related to cheerleading performance were included in analysis but not shown in table.
Missing data are not included in analysis.

Table 3
Comparisons of Male and Female Injury Rates (Academic Year 2014-15) *

Sport	Male Injury Rate			Female Injury Rate			RR (95% CI)		
	Total	Game	Practice	Total	Game	Practice	Total	Game	Practice
Overall (all sports)	2.36	4.95	1.64	0.85	1.66	0.57	**2.79 (2.32, 3.34)**	**2.98 (2.28, 3.88)**	**2.88 (2.22, 3.74)**
Baseball/ Softball	0.94	1.73	0.49	1.09	1.77	0.69	0.86 (0.48, 1.57)	0.98 (0.46, 2.07)	0.71 (0.27, 1.90)
Soccer	1.50	3.40	0.46	1.26	2.70	0.44	1.19 (0.72, 1.96)	1.26 (0.72, 2.22)	1.05 (0.35, 3.13)
Basketball	1.27	1.89	0.98	0.95	1.87	0.41	1.34 (0.76, 2.38)	1.01 (0.48, 2.09)	2.35 (0.87, 6.37)
Lacrosse	2.86	6.80	1.22	1.02	1.84	0.54	2.81 (0.77, 10.20)	3.70 (0.77, 17.77)	2.26 (0.24, 21.71)
Track	0.54	0.49	0.55	0.84	1.68	0.66	0.65 (0.32, 1.34)	0.29 (0.06, 1.45)	0.84 (0.37, 1.94)
Cross Country	0.76	0.00	0.86	0.42	0.75	0.38	1.80 (0.59, 5.49)	0.00 (0.01, 8.75)	2.26 (0.68, 7.50)

Note.
* Rate ratios (RR) compared the sex with a higher injury rate to the sex with a lower injury rate; Significant RR*s* are bolded.

For 2014-15, we continued our use of the RIO surveillance tool, and the ATCs over the years have adapted well to this new surveillance system. The tool also can be used as an electronic medical record making it even more effective. The number of athletes served by the ATCs continues to be very high, pointing to the real cost savings related to hiring these professionals. For this year-end study, football and wrestling continue to produce high injury rates. High rates also were found for boys' cheerleading and boys' lacrosse. Throughout several surveillance years, ligament sprains, concussions and muscle strains dominate the injury diagnoses and the head and face, knees, and ankles are the leading injury body sites. Injuries are mostly occurring during regular seasons and do not require surgery. The ATCs are the leading health professionals who are performing the injury evaluations (Liller et al., 2009; Liller et al, 2015).

In terms of concussions, the ATCs reported all concussions, regardless if they led to restriction of participation. This was also the case with fractures and dental injuries. This then influences the findings of these injuries, especially with concussions due to enhanced media attention and rule changes over the last several years (Liller et al., 2015).

Implications for Public Health Practice

Current efforts in adolescent sports injury prevention are primarily focused on education, functional training, and sport-specific skills and have led to some successful results (Abernethy & Bleakley, 2007; Kerr, et al., 2015; Myer, et al., 2011). To gain more effective injury prevention, a holistic approach needs to be taken, focusing on education, engineering/technology, and environmental changes, and policy and legislative advancements to decrease sports-related morbidity and mortality among young athletes. These approaches need to be continually evaluated for efficacy with strong research designs and refined for greater validity and reliability to inform practice.

Since 2007 the SMART program has taken the lead in hiring ATCs in several west central Florida schools for the purpose of not only treating the athletes but also conducting injury surveillance. As stated above, the results of the injury analysis are shared with each school and this has led to educational interventions focused on specific injuries. Examples of these programs include ACL injury prevention and injury prevention programs for coaches. It is recommended that surveillance programs led by ATCs and resulting educational programs be implemented and evaluated in high schools and middle schools so the needs of athletes may be addressed. A suggestion for how this can be accomplished is by schools partnering with Colleges and Schools of Public Health or with university athletic training programs to enlist the support of researchers and students in these efforts. Often, students need internships and other field experiences and working with the high school athletic programs could be a mutually beneficial situation for all (Liller, et al., 2015).

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