한국학교보건교육학회지 제 10권 2호 (2009. 12) pp. 29~42
The Journal of Korean Society for School Health Education, Vol. 10 Iss. 2 (December, 2009)

# Results of the SMART Injury Surveillance Registry for High School Athletes in West-central Florida, USA : A Pilot Study

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**국문초록**

**연구목적:** 본 연구는 고교운동선수들의 스포츠상해(부상)현황 파악을 통한 사고 및 손상예방을 목적으로 개발된 손상감시프로그램을 설명하고, 1년간 수집된 자료를 보고하기 위하여 수행되었다.

**연구방법:** 본 연구는 미국 플로리다주 내의 10개 고등학교에 재학 중인 학생 운동선수들의 스포츠상해(부상)에 대한 세부내용(사고경위, 상해부위, 사고 당시 환경적 요소 등)을 수집하여 이루어졌다. 학생 운동선수들에게 발생한 스포츠상해 조사 및 보고는 2007년에서 2008년에 걸친 학기동안 각 학교에 배치된 운동트레이너(Certified Athletic Trainer)에 의해 이루어졌다.

**연구결과:** 조사기간 동안 10개 조사대상 고등학교에서 614건의 스포츠상해가 발생하였고, 연습 중 사고노출 비율(1,000회의 연습 중 1명의 선수가 상해를 입는 경우를 기준으로 함)에 있어서는 풋볼(Football)이 2.73을 기록해 가장 높은 상해율을 보였으며 여자축구(2.03)와 남자농구(1.67)가 그 뒤를 이었다. 실전경기 중 사고노출 비율(1,000회의 실전경기당 1명의 선수가 상해를 입는 경우를 기준으로 함)의 경우, 풋볼(Football)이 14.4, 여자농구가 9.96, 레슬링이 7.1을 기록하였다. 운동상해로 인한 증상은 염좌/삠(관절손상)이 가장 많았고, 가장 많이 다치는 신체부위는 발목, 무릎, 머리인 것으로 나타났다.

***Key words***: Sport, Injury, High school, Surveillance, Registry

## Ⅰ. Introduction

With the rates of overweight and obese young adults continuing to rise, participation in high school sports is viewed as beneficial and important in the establishment of norms so that as adults, high school athletes will continue to exercise and stay fit. More and more young adults are participating in high school sports. According to the 2007-08

접 수 일 : 2009년 8월 26일, 수 정 일 : 2009년 11월 14일, 채 택 일 : 2009년 12월 9일
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High School Athletes Participation Survey conducted by the National Federation of State High School Associations (National Federation of State High School Associations 2009), over seven million students (7,429,381) participated in high school sports compared to approximately four million (3,960,932) in 1971-1972 in the US. Florida ranked tenth in participation rate, totaling 227,157students.

However, with participation comes the risk for injury. The Centers for Disease Control and Prevention (CDC) report that approximately 4.3 million sports and recreation-related injuries are treated each year in the US (Centers for Disease Control and Prevention 2002). According to the Lucile Packard Children's Hospital (2009), national data show that 30 million children and teens participate in some form of organized sports, leading to over 3.5 million injuries each year. Burt and Overpeck (2001) estimated that approximately 2.6 million persons between the ages of 5 and 24 visited the emergency rooms for a sports-related injury from 1997 to 1998. Emery (2005) reported that sports were the leading causes of adolescent injury requiring medical attention and emergency department admissions, leading to 7.03 to 8.55 injuries/100 adolescents each year.

A recent survey was conducted by the Center for Injury Research and Policy at Columbus Children's Hospital in Columbus, Ohio to ascertain injuries in high school athletes (Centers for Disease Control and Prevention 2006). Certified athletic trainers in 100 nationally representative high schools collected data on injury incidence and athletic exposures for nine sports, including baseball, football, wrestling for boys; softball and volleyball for girls; and basketball and soccer for both boys and girls. The results showed that an estimated 1, 442,533 injuries occurred among US high school athletes participating in practices or competitions. The data were collected utilizing the High School RIO (Reporting Information Online) injury surveillance tool. This tool is an internet-based injury surveillance system that collects injury and exposure data for high school athletes.

A recent study was conducted evaluating the costs of injuries of high school athletes in North Carolina (Knowles et al. 2007). The study used an injury cost model to estimate the economic cost of injury. The annual estimates were $9.9 million in medical costs, $44.7 million in human capital costs (medical costs plus loss of future earnings), and $144.6 million in comprehensive costs (human capital costs plus lost quality of life). Football accounted for 41.4% of the observed injuries, 57% of medical costs, 58.1% of human capital costs, and 53.8% of comprehensive costs.

In many sports injury prevalence studies, football has been found to account for the highest injury rate (Centers for Disease Control and Prevention 2006).The 2006 CDC study cited previously showed that football recorded the highest injury rate (4.36 injuries per 1,000 high school athletes) followed by wrestling (2.50) and soccer (2.43 for boys and 2.36 for girls). The overall injury rate was 2.44 per 1,000 high school

athletes. Researchers have estimated that, in an average year, "41 - 61% of football players, 40 - 46% of wrestlers and gymnasts, and 31 - 37 % of basketball players sustain an injury while participating in organized high school sports" (Yang et al., 2005. p. 511). While types of injury vary by sport, lower extremity injuries appear occur most often. In a national study conducted by Fernandez and colleagues that targeted the epidemiology of lower extremity injuries among high school athletes, sprains/strains, contusions, and fractures were the most commonly occurred among nine high school sports studied (boys' baseball, football, and wrestling; girls' softball and volleyball; and boys' and girls' basketball and soccer). The most common body parts of injury were the ankle, knee, and thigh (Fernandez, Yard, and Comstock, 2007).

In terms of sports injuries prevention strategies, a recent review conducted by Youthsafe of the sports injury prevention literature from 1999-2006 showed that there continues to be a paucity of information to guide effective intervention efforts for young people, aged 15-24 years (Youthsafe, 2008). Strategies that showed the strongest evidence for implementation included: 1)Full face/head protection plus mouthguards to reduce risk of eye, dental, and other facial injuries in ice hockey; 2)Ankle disc training to reduce risk of ankle injuries in players across different sports; 3)Ankle bracing (semi-rigid) to reduce the risk of ankle injuries among players with a previous ankle injury; and 4)Plyometric conditioning with balance training to reduce risk of knee injuries across different sports.

There is a real need in the sports injury prevention field to conduct studies to determine the effectiveness of sports injury prevention interventions (MacKay & Liller, 2006). According to MacKay and Liller (2006), systematic reviews of sports and recreational injury prevention interventions have led to disappointing findings due to lack of theoretical frameworks and evaluations. And there continues to be lack of good exposure data. The authors suggest that randomized trials are needed along with rigorous evaluations of existing practices (MacKay & Liller, 2006).

In order to address the critical need for sports injury prevention, a comprehensive sports safety institute was developed through the University of South Florida College of Medicine that utilizes a multidisciplinary approach with a team of professionals through education, research, and injury care and prevention, elevating the standard of care for the youth, recreational, high school, collegiate and professional athlete. The Sports Medicine & Athletic Related Trauma (SMART) Institute was funded by the Florida Legislature to improve sports safety and reduce needless deaths on the playing and practice fields. One of the critical components of SMART is the development, implementation, and evaluation of a sports injury surveillance registry for high school athletes. To date there are no comprehensive national, state or local injury surveillance registries that capture incidence, risk factor,

and exposure information for high school athletes in Florida. While national data exist, none are specific to Florida and include all sports played in the schools.

### Purpose of the Study:

The purpose of this study is to describe the SMART sports injury surveillance registry and to report the first year of findings for high school athletes enrolled in 10 schools in west-central Florida.

## Ⅱ. Methods

The research team of the study was comprised of experts in public health, injury prevention, and sports medicine In addition, SMART administrators hired and trained 10 certified athletic trainers (ATCs) to be placed in 10 individual high schools in west central Florida to serve the athletes' medical needs and to collect the injury data. These high schools had an average of 2,229 students and had an average of 400 to 500 student athletes. Of the twenty-six public high schools serving this region, the 10 schools were purposely selected in collaboration with the county athletic director based upon perceived need of services. The factors utilized to determine the need included, but were not limited to, average socioeconomic status of immediate surrounding community, distance to accessible health care services, current status (or lack thereof) of athletic training services, and historical risk of injury based upon sport offerings.

The foundation of the Registry was developed utilizing professional sports injury software, Simtrak™ developed by Premier Software, Inc. Since 1995 Simtrak™ has provided injury tracking and information management systems to support sports medicine efforts. The software is PC-based, which meant it could be operated on servers controlled by SMART, thereby maintaining better data security, loss prevention, and access control than web-based systems. Also, this software system had the unique ability to tie together remote locations (10 high schools) through its proprietary data synchronizer feature and included Injury Surveillance System features already built to accommodate research needs. Customers of Simtrak™ include professional leagues and intercollegiate conferences.

Variables added to the existing Simtrak™ software for this project included those related to exposure which is defined as the number of athletes at each practice and/or competition each week, demographic information on the injured athlete, level of play, time and season of injury, mechanism of injury, activity during he injury, environmental conditions, field locations and positions, concussion information, and injury outcomes. Each sport in the 10 schools was included, making this collection tool advantageous over others. In addition medical treatment data are also collected and sent with the surveillance making this a much more comprehensive tool than what is already available. The data entries were cast in the software as pull-down menus, logical checkbox selections,

or data entry fields to reduce the potential for error and speed up data entry, saving valuable athletic trainer man-hours. Data were collected on the following sports: football, baseball, volleyball, swimming, track, cross-country, flag football, soccer, basketball, wrestling, softball, tennis, and golf. We reviewed several national data sources for variables, especially the National Collegiate Athletic Association Injury Surveillance System (Dick, Agel, and Marshell, 2007). We also conducted several meetings of local and state sports injury experts who helped verify and expand our choice of sports injury indicators.

Data were collected over the course of the 2007-2008 academic year (from August, 2007 to early June, 2008). The ATCs practiced several months with the injury software before formal data collection began and participated in ongoing data meetings and email communication with the researchers throughout the course of the year. Data were collected from all sports, including those not directly supervised by the ATCs, which included golf, tennis, and swimming in most schools. In a few schools, cheerleading, cross country, soccer, and flag football, track, and wrestling data were also provided by the coaches.

Injuries were defined as follows: 1)An injury that occurs as a result of participation in an organized high school competition or practice; 2)Requires medical attention by a licensed medical professional; and 3) Results in restriction and/or modification of the high school athlete's participation for one or more days beyond the day of injury. The athletes' exposure and sports injury data were collected on a weekly basis by the ATCs on laptops and submitted to the researchers for analysis through email transmission. An athlete exposure is defined as 1 athlete participating in 1 practice or competition. In addition, detailed information on each athlete's injury and treatment is also sent to the researcher in charge of the ATCs treatment activities. Data are sent blinded to the lead researchers who analyzed the injury data and kept as electronic version in the researchers' personal computers using passwords. The collection of data for injury analysis was approved by the University of South Florida Institutional Review Board. Data were analyzed using Simtrak™ software and SAS, version 8.

## Ⅲ. Results

### 1. ATC Participation in the Schools

Over the course of the 2007-2008 academic year, the 10 ATCs directly supervised 4,180 athletes and were present at 5,040 practices and 1,112 games.

### 2. Sports-Related Injury Exposure Rates

The leading rate of sports-related injury per 1000 athlete exposures for practices was for football at 2.73, followed by women's soccer at 2.03 and men's basketball at 1.67.

The leading rate of sports-related injury per 1000 athlete exposures for competitions was for football at 14.4, followed by women's soccer at 9.96 and wrestling at 7.10. A complete list of all sports-related injuries rates for practices and competitions is found in Table 1.

### 3. Injury Frequencies:

Overall, 732 sports-related and non-sports related injuries were reported by the ATCs. This manuscript focuses on sports-related injuries as they made up the bulk of the injuries. Six-hundred fourteen (614) of these injuries were sports-related (83.88%). The majority of injuries took place during the regular season (76.12%) and was nearly evenly split between competitions (45.27) and practices (single-sessions) (48.92%). The majority of injuries occurred on grass (64.45%) and either in hot weather (34.46%) or indoors (20.95%). Surface conditions were mostly dry (88.18%) and the majority of all injuries was initial injuries (87.58%). For sports-related injuries, most injuries occurred

<Table 1> High School Athletes' Sports Injury Rates per 1000 Athletic Exposures for Practices and Competitions (2007-2008 Academic Year)

| Sport | Number of Practices | Number of Competitions | Number Injured In Practice | Number Injured in Competitions | Injury Rate for Practices (per 1000) | Injury Rate for competition (per 1000) |
|---|---|---|---|---|---|---|
| Baseball | 9072 | 4707 | 4 | 9 | .44 | 1.91 |
| Basketball Men | 10194 | 5241 | 17 | 18 | 1.67 | 3.43 |
| Basketball Women | 6411 | 3657 | 7 | 18 | 1.09 | 4.92 |
| Cheerleading Women | 10588 | 1603 | 13 | 2 | 1.23 | 1.25 |
| Cross Country Men | 4876 | 640 | 1 | 1 | .21 | 1.56 |
| Cross Country Women | 4390 | 517 | 4 | 3 | .91 | 5.80 |
| Football | 61939 | 8113 | 169 | 117 | 2.73 | 14.4 |
| Football Flag | 7935 | 2511 | 9 | 14 | 1.13 | 5.58 |
| Golf Men | 2132 | 712 | . | . | . | . |
| Golf Women | 1569 | 442 | . | . | . | . |
| Soccer Men | 7645 | 3961 | 8 | 18 | 1.05 | 4.54 |
| Soccer Women | 6402 | 2812 | 13 | 28 | 2.03 | 9.96 |
| Softball | 6548 | 3398 | 6 | 8 | .92 | 2.35 |
| Swimming Men | 3817 | 780 | 2 | . | .52 | . |
| Swimming Women | 4567 | 899 | . | . | . | . |
| Tennis Doubles Men | 0 | 90 | . | . | . | . |
| Tennis Doubles Women | 52 | 92 | . | . | . | . |
| Tennis Singles Men | 845 | 507 | . | . | . | . |
| Tennis Singles Women | 996 | 493 | . | . | . | . |
| Track Men | 9672 | 2105 | 10 | 8 | 1.03 | 3.80 |
| Track Women | 8828 | 1754 | 11 | 1 | 1.25 | .57 |
| Volleyball Women | 7452 | 2880 | 4 | 3 | .54 | 1.04 |
| Wrestling | 13493 | 2818 | 19 | 20 | 1.41 | 7.10 |

<Table 2> Leading Activities of Sports-Related Injury by Sport

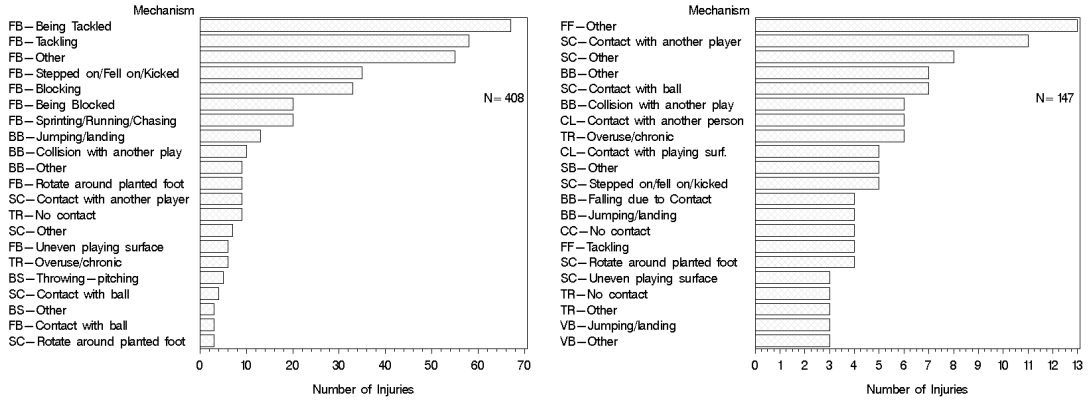
| Sport, Total N | Leading Injury Activity (N, %) | Second Leading Injury Activity (N, %) |
|---|---|---|
| Basketball-Women, 25 | Ball handling/Dribbling (5, 20%), Rebounding (5, 20%) | Chasing loose ball (4, 16%); Other (4, 16%) |
| Cheerleading, 15 | Stunt Work (7, 46.67%) | Landing (3, 20%) |
| Cross Country-Men, 2 | Running (2, 100%) | |
| Cross Country-Women, 8 | Running (7, 87.5%) | Other (1, 12.5%) |
| Football, 307 | General Play (87, 28.34%) | Running Play (Offense), (41, 13.36%) |
| Flag Football, 23 | Other (6, 26.09%) | General Play (3, 13.04%); Pulling Flag (3, 13.04%) |
| Soccer-Men, 25 | Ball handling/dribbling (9, 36%) | Defending (4, 16%) |
| Soccer-Women, 40 | Chasing loose ball (10, 25%); General Play (10, 25%) | Ball handling/Dribbling (7, 17.5%) |
| Softball, 15 | Sliding (4, 26.67%) | Conditioning (2, 13.33%); Running Bases (2, 13.33%); Throwing (not pitching) (2, 13.33%) |
| Baseball, 14 | Pitching (5, 35.71%) | Fielding (2, 14.29%) and Running Bases (2, 14.29%) |
| Basketball-Men, 37 | Rebounding (13, 35.14%) | General Play (7, 18.92%) |
| Swimming-Men, 2 | Flip turn (1, 50%); Other (1, 50%) | |
| Track-Men, 18 | Running (14, 77.78%) | Conditioning (1, 5.56%); Landing (1, 5.56%), Other (1, 5.56%); Weight Room (1, 5.56%) |
| Track-Women, 12 | Running (7, 58.33%) | Hurdling (3, 25%) |
| Volleyball-Women, 6 | Conditioning (2, 33.33%) | Blocking (1, 16.67%); Chasing Ball 1, 16.67%); Setting (1, 16.67%); Spiking (1, 16.67%) |
| Wrestling, 40 | Other (12, 30%) | Takedown (8, 20%) |

in the middle of competition (23.86%), followed by the third half hour of practice (16.21%) and then the end of competition (13.48%). The leading location for all injuries was in football-between the 20 yard lines.

## 4. Other Characteristics of those Injured:

The injured athletes were mostly juniors (27.44%) followed by seniors (25.39%), sophomores (25.04%), and freshman (22.13%). The leading level of play for injury was varsity (75.91%) followed by JV (22.59%). The leading player positions of those suffering a sports-related injury included: football linebacker (54, 11.37%), followed by flanker/ wide receiver (33, 6.95%) and defensive tackle (30, 6.32%). Positions related to football comprised over 60% (64.61%) of the injured player's positions. The leading physiologic sports-related injury when one injury was reported was sprain (N-163, 26.81%) followed by strain (112, 18.42%) and contusions (77, 12.66%). When two injuries were reported, the leading injury was strains (25, 22.94%) and

sprains (23, 21.10%) and subluxations (9, 8.26%). The leading body part injured (when one anatomic site was reported) were ankles (21.23%), knees (15.72%) and the head (9.53%).

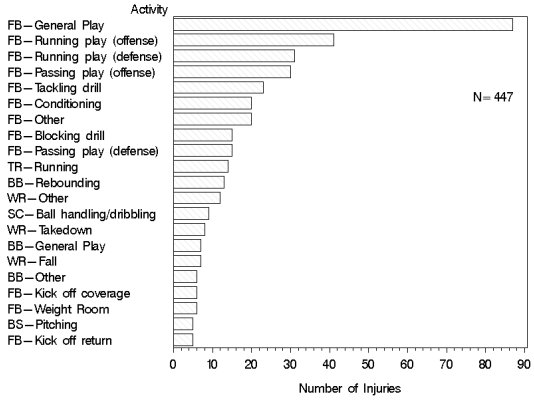



(1) Leading Mechanisms of SRI* for Men† (2)Leading Mechanisms of SRI for Women†

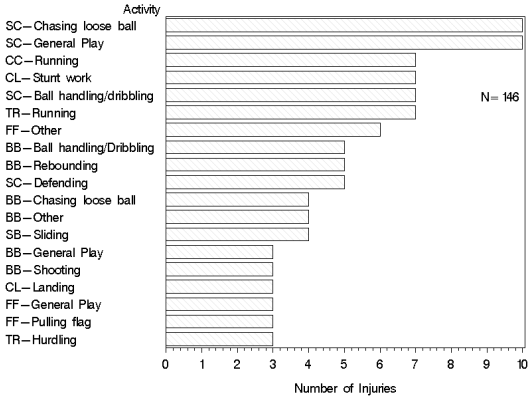
<Figure 1> Sports-related leading injury mechanisms and activities

<Table 3> Leading Mechanisms of Sports-Related Injury by Sport

| Sport, Total N | Leading Mechanism of Injury (N, %) | Second Leading Mechanism of Injury (N, %) |
|---|---|---|
| Basketball-Women, 25 | Other (7, 28%) | Collision with another player (6, 24%) |
| Cheerleading, 15 | Contact with another person (6, 40%) | Contact with playing surface (5, 33.33%) |
| Cross Country-Men, 2 | Overuse/chronic injury (2, 100%) | |
| Cross Country-Women, 8 | No contact (4, 50%) | Overuse/chronic injury (2, 25%) |
| Football, 306 | Being Tackled (67, 21.90%) | Tackling (58, 18.95%) |
| Flag Football, 21 | Other (13, 61.90%) | Tackling (4, 19.05%) |
| Soccer-Men, 25 | Contact with another player (9, 36%) | Other (7, 28%) |
| Soccer-Women, 39 | Contact with another player (10, 25.64%) | Other (8, 20.51%) |
| Softball, 14 | Other (5, 35.71%) | Contact with bases (2, 14.29%); Contact with bat (2, 14.29%); Contact with thrown ball (2, 14.29%) |
| Baseball, 14 | Pitching (5, 35.71%) | Other (3, 21.43%) |
| Basketball-Men, 37 | Jumping/Landing (13, 35.14%) | Collision with another player (9, 24.32%); Other (9, 24.32%) |
| Swimming-Men, 2 | Contact with playing apparatus (1, 50%); Overuse, chronic (1, 50%) | |
| Track-Men, 18 | No contact (9, 50%) | Overuse/chronic (6, 33.33%) |
| Track-Women, 12 | Overuse/chronic (6, 50%) | No contact (3, 25%) and Other (3, 25%) |
| Volleyball-Women, 7 | Jumping/landing (3, 42.86%); Other (3, 42.86%) | Diving for ball (1, 14.29%) |




<Figure 2> Leading SRI Activities for Men††




<Figure 3> Leading SRI Activities for Women†

*SRI: Sports Related Injury
*FB=Football, SC=Soccer, FF=Flag football, BB=Basketball, TR=Track, CL=Cheerleading, SB =softball, CC=Cross Country, VB=Volleyball, WR=Wrestling, and BS=Baseball
†Sport's Mechanisms/Activities with less than 3 injuries not shown.
††Sport's Activities with less than 5 injuries not shown

<Table 4> Leading Types of Sports-Related Injury Per Sport

| Sport, Total N | Leading Injury (N, %) | Second Leading Injury (N, %) |
|---|---|---|
| Baseball, 17 | Strain (10, 58.8%) | Sprain (2, 11.8%); Tendonitis (2, 11.8%) |
| Basketball, Men, 39 | Sprain (22, 56.4%) | Contusion (5, 12.8%) |
| Basketball, Women, 30 | Sprain (8, 26.7%) | Strain (5, 16.7%) |
| Cheerleading, Women, 17 | Sprain (4, 23.5%) | Strain (3, 17.6%) |
| Cross Country, Men, 2 | Shin Splints (1, 50%) | Tendonitis (1, 50%) |
| Cross Country, Women, 10 | Tendonitis (2, 20%); Strain (2, 20%); Inflammation (2, 20%) | Bursitis (1, 10%); Sprain (1, 10%); Tightness (1, 10%); Illness (1, 10%) |
| Football, 372 | Sprain (100, 26.9%) | Strain (69, 18.5%) |
| Flag Football, 27 | Sprain (7, 25.9%) | Concussion (5, 18.5%) |
| Soccer, Men, 27 | Sprain (10, 37%) | Strain (9, 33.3%) |
| Soccer, Women, 43 | Sprain (17, 39.5%) | Contusion (7, 16.3%) |
| Softball, 19 | Sprain (4, 21.1%) | Strain (3, 15.8%); Fracture (3, 15.8%) |
| Swimming, Men, 2 | Tightness (1, 50%) | Strain (1, 50%) |
| Tennis, Singles Women, 1 | Dislocation (1, 100%) | |
| Track, Men, 19 | Strain (12, 63.2%) | Shin Splints (2, 10.5%); Patellar Tendonitis (2, 10.5%) |
| Track, Women, 13 | Strain (4, 30.8%) | Soreness (2, 15.4%) |
| Volleyball, Women, 7 | Sprain (3, 42.9%) | Neuritis (1, 14.3%); Meniscus, Medial (1, 14.3%); Dizziness (1, 14.3%); Bone Bruise (1, 14.3%) |
| Wrestling, 46 | Strain (9, 19.6%) | Sprain (8, 17.4%) |

See Figures 1 for sports-related leading injury mechanisms and activities for those sports with sufficient data (10 or more cases) and information pertaining to the overall leading injuries for sports.

For reported concussion symptoms for sports-related injuries, when one symptom was reported it was amnesia (22, 38.6%) followed by dizziness/unsteadiness (13, 22.81%). The leading concussion symptoms reported when there were two, three, four, five, or six symptoms reported were as follows, respectively: concentration difficulty (16, 29.63%), dizziness/unsteadiness (12, 25.53%),

<Table 5> Leading Body Part/s Injured By Sport for Sports-Related Injuries

| Sport, (Total N) | Leading Body Part (N, %) | Second Leading Body Part (N, %) |
|---|---|---|
| Baseball, 16 | Right Knee (3, 18.83%); Left Shoulder (3, 18.8%) | Left Hamstring (2, 12.5%) |
| Basketball, Men, 37 | Left Ankle (11, 29.7%) | Right Ankle (9, 24.3%) |
| Basketball, Women, 25 | Left Knee (5, 18.5%) | Right Knee (4, 14.8%) |
| Cheerleading, Women, 16 | Left Knee (3, 18.8%) | Hip Flexor (2, 12.5%); Left Shoulder (2, 12.5%) |
| Cross Country, Men, 2 | Left Ankle (1, 50%) | Left Shin (1, 50%) |
| Cross Country, Women, 7 | Mid Back (1, 14.3%); Right Foot (1, 14.3%); Left Patellar Tendon (1, 14.3%); Right Peroneal (1, 14.3%); Right Shin (1, 14.3%); Right Gluteal (1, 14.3%); Left Quadriceps (1, 14.3%) | |
| Football, 313 | Head (36, 11.1%) | Left Knee (27, 8.36%); Left Ankle (27, 8.36%) |
| Flag Football, 24 | Head (6, 25%) | Right Knee (3, 12.5%); Bilateral Ankle (3, 12.5%) |
| Soccer, Men, 26 | Left Ankle (7, 26.9%) | Right Ankle (4, 15.4%) |
| Soccer, Women, 39 | Right Ankle (10, 25.6%) | Left Ankle (8, 20.5%) |
| Softball, 16 | Right Ankle (4, 25%) | Left Eye (2, 12.5%); Left Knee (2, 12.5%); Head (2, 12.5%) |
| Swimming, Men, 2 | Left I-T Band (1, 50%); Right Ankle (1, 50%) | |
| Tennis, Singles Women, 1 | Right Shoulder (1, 100%) | |
| Track, Men, 18 | Left Hamstring (3, 15.8%); Low Back (3, 15.8%) | Right Hamstring (2, 10.5%); Left Foot (2, 10.5%); Right Knee (2, 10.5%) |
| Track, Women, 10 | Right Knee (3, 25%) | Left Knee (2, 16.7%) |
| Volleyball, Women, 7 | Right Ankle (2, 28.6%) | Right Wrist (1, 14.3%); Neck (1, 14.3%); Right Knee (1, 14.3%); Head (1, 14.3%); Left Ankle (1, 14.3%) |
| Wrestling, 40 | Right Shoulder (5, 12.5%); Left Knee (5, 12.5%) | Left Elbow (3, 7.5%); Left Ankle (3, 7.5%) |

headache (12, 32.43%), headache (12, 44.44%), and nausea (8, 44.44%). Reported concussion times were split between 1 hour to 11 hours (12, 21.43%) and 1-3 days (12, 21.43%).

### 5. Details of Injuries Reported:

The following sports had the greatest number of sports-related injuries:

Football: 313 injuries (51.82%)

Wresting: 42 injuries (6.95%)

Women's Soccer: 41 injuries (6.79%)

The leading mechanism for sports injuries overall focused on football. The Tables below show the leading mechanisms and activities related to overall injuries and sports-related injuries by sport. (Note-there are no mechanisms for wrestling but there are injury activities for wresting-see next table.) Also shown are Tables containing information on the types of sports injury per sport and the body parts injured.

## Ⅳ. Discussion

The SMART Sports Injury Surveillance Registry provided data on the leading high school sports in west-central Florida for the 2007-2008 academic year. This includes data on flag football injuries which to date have not been reported. The registry was created through a collaboration of public health, injury prevention, computer engineer, and sports medicine experts who each brought their respective strengths to its design and implementation. In addition, the ATCs were hired by SMART and were critical to the development of the variables and performed all data collection. By having the ATCs as research and practice partners, we were able to work as a cohesive group with one goal-creating the most innovative high school athlete sports injury registry possible. We were able to meet with the ATCs on a routine basis, allowing corrections to be made when needed. The ATCs have created a manual as a result of the lessons learned this year.

Several revisions are being made to the software for collection of data next year. Some changes include separating out spring football as a separate sport, treating "season" as in-season or out of season only, more clearly differentiating those injuries where athletes lost practice or competition time versus those where the athlete returned to play but was altered in some way-in other words non-time loss injuries, and recording illegal/foul play and lack/misuse of protective equipment. We also will refine our collection of variables that focus on the athlete's need for surgery, transport to the emergency department, need for EMS transport, and if they were referred to a physician. Finally, we will be recording in depth treatment information to accompany our surveillance data.

When comparing this data with the national RIO data, several similarities exist, including the injury rates for various injuries. We plan to send our data to the RIO research team to test for further comparisons and collaborate with them to

prepare a manuscript of our findings.

In addition to refining the software to increase ease of use, we plan to develop and utilize several more case studies with the ATCs to continue to assess their data collection abilities and related inter-rater reliabilities before the next academic year begins. We are fortunate that all ATCs will remain employed in their respective school settings.

We plan to continue to collect data in the schools for the purpose of developing targeted sports injury prevention strategies to decrease morbidity for high school athletes. We also plan to address the several limitations of previous studies by developing studies based on theory and implementing rigorous evaluation designs. For example, SMART offers several sports injury prevention programs across the State. Those schools and athletes receiving our programs, such as training on heat illness, can be compared through the registry to those schools not receiving our programs in terms of sports injury morbidity.

Finally, we acknowledge that while detailed data have been collected at the collegiate level, more attention needs to be given now to high school athletics. In addition to the uses of the SMART Injury Registry stated throughout this paper, it is also our hope that the registry will someday be used to track athletes from high school to their respective colleges. This would eliminate the need for colleges to start databases on athletes from scratch but allow them to have an accurate history of the athlete's previous injuries in high school. With accurate data and resultant targeted prevention programs, we predict that the morbidity related to high school sports injuries will decline and the health of athletes will improve.

In Korea, injuries are the leading cause of death among children and adolescents. According to the Korea Centers for Disease Control and Prevention (KCDC), the child death rate due to injury was 14.8 deaths per 100,000 children in 2003, which was higher than those of such developed countries as Japan (5.8), Germany (5.0), and England (3.8). (Korea Centers for Disease Control and Prevention, 2009). Although experts have suggested the need for systematic injury surveillance as a fundamental step to identify the risk factors and provide basic information for effective intervention development, only a few organizations have provided limited information based on their systems (Ministry for Health, welfare, and family affairs of Korea 2006). Recently, KCDC launched a national injury surveillance system providing injury data mainly based on National Hospital Discharge Survey data (http://injury.cdc.go.kr/index.jsp). In order to generate more accurate data, the system needs to incorporate other data sources such as cause of death statistics classified according to the Korean Classification of Disease (KCD).

Considering that many injuries occur in school settings where children and adolescents spend most of their time, systematic efforts to establish a national level injury surveillance system for schools needs to be done. In

particular, sports injuries that can occur in physical education classes and/or school sports club activities should be analyzed and effective interventions should be developed based on accurate data. We hope this article contributes to a better understanding of sports injury surveillance in high school settings.

Because this was our pilot study of the SMART sports injury registry, corrections and revisions were continuously made throughout the year to improve the data collection procedures. We attempted to correct all data when problems arose but this was dependent on the expertise of the ATCs who were new to this study and to injury surveillance tools. In addition, we cannot confirm the accuracy of the data supplied by the coaches for those sports the ATCs did not physically attend. As we continue to refine the registry and work with the ATCs, we believe that data collection procedures will improve.

There are also limitations surrounding generalization of the data. First, we have only one year of pilot data to report. Secondly, the data are derived from only 10 schools in west-central Florida.

## Ⅴ. Conclusions

The results of the first year data from the Florida SMART Sports Injury Registry are in concert with the sports injury prevention literature in that the sports producing the greatest amount of injury were football, women's soccer, wrestling, and men's basketball. For example, the 2005-2006 RIO data showed that the practice and competition rate for boy's football was 2.54 and 12.09, respectively. This is similar to our rate of 2.73 and 14.4. Overall, the risk for injury was much greater in competitions than in practices-nearly seven times as great for football. This enhanced risk in competition is shown throughout all the sports and is also shown in the RIO data. Sprains and strains were the leading physiologic injuries and the leading body sites injured were the ankles, knees, and head.

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