

[Athletic Training]



Injury and Treatment Characteristics of Sport-Specific Injuries Sustained in Interscholastic Athletics: A Report From the Athletic Training Practice-Based Research Network

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Background: The inclusion of clinical practice factors, beyond epidemiologic data, may help guide medical coverage and care decisions.

Hypothesis: Trends in injury and treatment characteristics of sport-specific injuries sustained by secondary school athletes will differ based on sport.

Study Design: Retrospective analysis of electronic patient records.

Level of evidence: Level 4.

Methods: Participants consisted of 3302 boys and 2293 girls who were diagnosed with a sport-related injury or condition during the study years. Injury (sport, body part, diagnosis via ICD-9 codes) and treatment (type, amount, and duration of care) characteristics were grouped by sport and reported using summary statistics.

Results: Most injuries and treatments occurred in football, girls' soccer, basketball, volleyball, and track and field. Sprain or strain of the ankle, knee, and thigh/hip/groin and concussion were the most commonly documented injuries across sports. The injury pattern for boys' wrestling differed from other sports and included sprain or strain of the elbow and neck and general medical skin conditions. The most frequently reported service was athletic training evaluation/reevaluation treatment, followed by hot/cold pack, therapeutic exercise, manual therapy techniques, electrical stimulation, and strapping of lower extremity joints. Most sports required 4 to 5 services per injury. With the exception of boys' soccer and girls' softball, duration of care ranged from 10 to 14 days. Girls' soccer and girls' and boys' track and field reported the longest durations of care.

Conclusion: Injury and treatment characteristics are generally comparable across sports, suggesting that secondary school athletic trainers may diagnose and treat similar injuries regardless of sport.

Clinical Relevance: Subtle sport trends, including skin conditions associated with boys' wrestling and longer duration of care for girls' soccer, are important to note when discussing appropriate medical coverage and care.

Keywords: medical coverage; practice characteristics; adolescent athletes

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Because of an increase in participation²⁴ and the potential for sport-related injuries in interscholastic athletics,⁹ identifying appropriate medical coverage and care for secondary school athletes has become an important topic within the sports medicine community.¹⁰ Recommendations for medical coverage and care have historically been based primarily on injury risk data from epidemiologic investigations. However, while epidemiologic studies have provided an abundance of data regarding the incidence and rates of injury between the sexes,^{17,19,20} in different sports,^{1-4,11-13,15,20,34} and across different levels of play,^{18,29,33} these investigations often exclude many tasks performed by the athletic medicine staff, including injury prevention and rehabilitation, that are essential elements of high-quality medical coverage and care. As a result, sports medicine organizations such as the National Athletic Trainers' Association (NATA),²³ American Orthopaedic Society for Sports Medicine,⁶ and American Medical Society for Sports Medicine¹⁰ have recently highlighted the need to include the wide variety of tasks associated with assessing, treating, and managing sport-related injuries and illnesses when determining appropriate medical coverage for secondary school athletes, including clinician demands for the development of injury and illness strategies and the treatment and rehabilitation of time loss and non-time loss injuries in various sports.^{5,10,22}

The inclusion of other clinical practice factors beyond injury incidences and rates is important in determining appropriate medical coverage and care because many duties provided by the athletic medicine staff include preventative measures and treatment for non-time loss injuries (eg, overuse injuries) and may be unaccounted for, by definition, in epidemiologic studies.^{14,28} However, without adequate clinical data of preventative, treatment, and rehabilitation efforts for all types of sports and injuries, determining appropriate medical coverage and care for secondary school athletes can be difficult. However, these investigations were broad in scope considering typical practice patterns³¹ and an aggregate of all documented injuries³² and did not account for injuries sustained in different sports. Specific attention toward injuries grouped by sports as well as an understanding of the treatment characteristics associated with these injuries is needed to aid in medical coverage recommendations and patient care decisions. Therefore, the purpose of this study was to describe the injury and treatment characteristics of injuries sustained by patients participating in various interscholastic sports as recorded through a national practice-based research network.

MATERIALS AND METHODS

Design and Setting

This study was a retrospective analysis of de-identified patient records within a Web-based electronic medical record (EMR). The A.T. Still University Institutional Review Board exempted the study because the study was deemed to be a retrospective analysis of de-identified patient records. All records were created by an athletic trainer (AT) who was a member of the

Athletic Training Practice-Based Research Network (AT-PBRN)³² and was providing patient care in a secondary school. The ATs practiced in 62 secondary schools across 14 different states (Arizona, California, Connecticut, Florida, Kansas, Massachusetts, Minnesota, Missouri, New Hampshire, New York, Utah, Virginia, Vermont, Wisconsin). Most schools were public (85%) and coeducational (95%) institutions, set in an urban area (71%), and employed 1 certified AT (77%). On average, ATs collected data over 16.1 ± 12.5 months (range, 1-48 months). To ensure data quality, all ATs completed a formal, 2-hour EMR training session prior to joining the AT-PBRN, and the administrative team of the AT-PBRN routinely reviewed the clinical data entered into the EMR relational database.³²

Participants

Patients who were diagnosed with a sport-related injury between October 1, 2009 and October 31, 2013 and participated in an interscholastic sport were included in this report (Table 1). A sport-related injury was defined as that diagnosed by a health care provider (eg, AT, physician) and required at least 1 AT service, such as an initial evaluation. A Certification of Honest Broker System/Processes provided by the EMR developer (Essentialtalk) ensured that patient data obtained by the AT-PBRN research team were void of all federally defined personal identifiers (ie, protected health information).²⁵

Instrumentation

Clinical data were recorded in a Web-based EMR previously described by Valovich McLeod et al.³² AT services were recorded as International Classification of Diseases, Ninth Revision (ICD-9) and Current Procedural Terminology (CPT)²⁷ codes within the EMR.

Statistical Analysis

All variables of interest were grouped based on sport and reported using summary statistics. Patient demographics included age, sex, height, and weight of the patient, while injury characteristics were represented by sport, body part, and diagnosis (ICD-9 code). The most frequent injuries were reported for each sport. Treatment characteristics included the type (CPT code), amount (number of services for the duration of care), and duration (number of days between the initial evaluation to the last documented episode of care) of care for each injury.

RESULTS

Injury Characteristics

A total of 5595 sport-related injuries (boys, 3302; age, 16.3 ± 1.5 years and girls, 2293; age, 16.0 ± 1.4 years) were documented during the study period. The 10 sports reporting the most injuries during the study years accounted for 84% of all documented injuries (Table 1). In general, concussions and a sprain or strain of the ankle, knee, and thigh/hip/groin were the most documented injuries, in varying rank order, across most sports (Table 2).

Table 1. Injuries and athletic training services documented within the AT-PBRN grouped by sport

Sport	Injuries, n (%)		Athletic Training Services, n (%)	
	Boys	Girls	Boys	Girls
Badminton	5 (0.2)	36 (1.6)	4 (0.0)	102 (1.2)
Baseball	132 (4.0)	0 (0.0)	528 (4.3)	0 (0.0)
Basketball	302 (9.1)	416 (18.1)	1079 (8.8)	1345 (15.4)
Cheerleading	3 (0.1)	121 (5.3)	6 (0.0)	269 (3.1)
Cross-country	62 (1.9)	122 (5.3)	208 (1.7)	421 (4.8)
Field hockey	1 (0.0)	23 (1.0)	1 (0.0)	73 (0.8)
Football	1934 (58.6)	33 (1.4)	7340 (60.2)	139 (1.6)
Golf	1 (0.0)	5 (0.2)	0 (0.0)	17 (0.2)
Gymnastics	0 (0.0)	4 (0.2)	0 (0.0)	20 (0.2)
Hockey	28 (0.8)	4 (0.2)	104 (0.9)	44 (0.5)
Lacrosse	26 (0.8)	67 (2.9)	108 (0.9)	373 (4.3)
Other	49 (1.5)	72 (3.1)	103 (0.9)	165 (1.9)
Soccer	238 (7.2)	484 (21.1)	705 (5.8)	2188 (25.1)
Softball	2 (0.1)	188 (8.2)	5 (0.0)	595 (6.8)
Swimming	9 (0.3)	23 (1.0)	12 (0.1)	68 (0.8)
Tennis	5 (0.2)	61 (2.7)	14 (0.1)	198 (2.3)
Track	221 (6.7)	303 (13.2)	1075 (8.8)	1435 (16.5)
Volleyball	20 (0.6)	328 (14.3)	85 (0.7)	1264 (14.5)
Wrestling	264 (8.0)	3 (0.1)	816 (6.7)	2 (0.0)
Total	3302 (100.0)	2293 (100.0)	12,193 (100.0)	8718 (100.0)

AT-PBRN, Athletic Training Practice-Based Research Network.

Treatment Characteristics

A total of 20,911 services were recorded during the study period. Across all sports, the most frequently reported service was AT evaluation or reevaluation, followed by hot or cold pack, therapeutic exercise or activities, manual therapy techniques or massage, electrical stimulation, and strapping of lower extremity joints (ankle, foot, hip knees, toes) (Table 3). The only exceptions were reported for football, in which more strapping of the upper extremity was reported than manual therapy or massage; boys' basketball, in which more whirlpool treatments were reported than electrical stimulation treatments; and boys' wrestling, in which more strapping of the upper extremity was reported than electrical stimulation (Table 4).

Girls' soccer, boys' track and field, and girls' track and field reported the highest number of services per injury (Table 5). Boys' track and field reported the longest average duration of care (18.1 ± 72.9 days), while girls' softball reported the shortest average duration of care (6.2 ± 10.8 days).

DISCUSSION

Our findings are similar to previous epidemiologic^{7,8,16,19,21,26,29,30,33,34} and clinical practice characteristics investigations³² and suggest that secondary school ATs tend to diagnose similar injuries and use similar methods to treat these injuries, regardless of sport. While the injury characteristics were generally similar across

Table 2. Common injuries documented for the top 10 sports reporting the most injuries in the AT-PBRN^a

Diagnosis	ICD-9 Code	Boys' Football (n = 1934), n (%)	Girls' Soccer (n = 623), n (%)	Girls' Basketball (n = 416), n (%)	Girls' Volleyball (n = 328), n (%)	Girls' Track and Field (n = 302), n (%)
Concussion	850.9, 850.0, 850.5	409 (21.1)	80 (12.8)	72 (17.3)	30 (9.1)	9 (3.0)
General medical: skin	684, 110.9, 54.9, 704.8	6 (0.3)	1 (0.1)	0 (0.0)	1 (0.3)	0 (0.0)
Pain (general): knee	719.46	31 (1.6)	22 (3.5)	22 (5.3)	10 (3.0)	25 (8.3)
Sprain/strain: ankle	845, 845.01, 845.03, 845.09	225 (11.6)	87 (14.0)	78 (18.8)	75 (22.9)	41 (13.6)
Sprain/strain: elbow	841.1, 841.9	23 (1.2)	4 (0.6)	1 (0.2)	4 (1.2)	2 (0.7)
Sprain/strain: hand/finger	842.1	53 (2.7)	6 (1.0)	19 (4.6)	21 (6.4)	0 (0.0)
Sprain/strain: low back	846.00, 846.10, 847.90	39 (2.0)	13 (2.1)	3 (0.7)	14 (4.2)	7 (2.3)
Sprain/strain: knee	844, 844.1, 844.2, 844.9	148 (7.7)	45 (7.2)	29 (7.0)	12 (3.7)	24 (7.9)
Sprain/strain: neck	847	34 (1.8)	6 (1.0)	4 (0.6)	5 (3.0)	5 (1.7)
Sprain/strain: shoulder	831.00, 840	87 (4.5)	4 (0.6)	5 (1.2)	5 (1.5)	1 (0.3)
Sprain/strain: thigh/hip/groin	843.9, 843.90	94 (4.3)	65 (10.4)	33 (7.9)	12 (3.7)	47 (15.6)
Tendinitis: Anterior/posterior tibialis	726.72	8 (0.4)	13 (2.1)	5 (1.2)	10 (3.0)	39 (12.9)

(continued)

Table 2. (continued)

Diagnosis	ICD-9 Code	Boys' Basketball (n = 271), n (%)	Boys' Wrestling (n = 264), n (%)	Boys' Soccer (n = 238), n (%)	Boys' Track and Field (n = 221), n (%)	Girls' Softball (n = 188), n (%)
Concussion	850.9, 850.0, 850.5	33 (10.9)	27 (10.2)	30 (12.6)	4 (1.8)	40 (21.3)
General medical: skin	684, 110.9, 54.9, 704.8	0 (0.0)	12 (4.5)	0 (0.0)	0 (0.0)	0 (0.0)
Pain (general): knee	719.46	5 (1.6)	7 (2.7)	9 (3.8)	9 (4.1)	1 (0.5)
Sprain/strain: ankle	845, 845.01, 845.03, 845.09	107 (35.4)	19 (7.2)	40 (16.8)	22 (10.0)	27 (14.4)
Sprain/strain: elbow	841.1, 841.9	0 (0.0)	17 (6.4)	0 (0.0)	1 (0.5)	9 (4.8)
Sprain/strain: hand/finger	842.1	14 (4.6)	4 (1.5)	3 (1.3)	0 (0.0)	5 (2.7)
Sprain/strain: knee	844, 844.1, 844.2, 844.9	24 (7.9)	15 (5.7)	15 (6.3)	15 (6.8)	9 (4.8)
Sprain/strain: low back	846.00, 846.10, 847.90	15 (5.0)	10 (3.8)	8 (3.4)	6 (2.7)	3 (1.6)
Sprain/strain: neck	847	3 (1.0)	11 (4.2)	4 (1.7)	5 (2.3)	2 (1.1)
Sprain/strain: shoulder	831.00, 840	8 (2.6)	11 (4.2)	10 (4.2)	6 (2.7)	1 (0.5)
Sprain/strain: thigh/hip/groin	843.9, 843.90	13 (4.3)	0 (0.0)	29 (12.2)	47 (21.2)	13 (6.9)
Tendinitis: anterior/posterior tibialis	726.72	2 (0.7)	0 (0.0)	4 (1.7)	23 (10.4)	4 (2.1)

AT-PBRN, Athletic Training Practice-Based Research Network; ICD-9, International Classification of Diseases, Ninth Revision.

^aBoldfaced values indicate the top 5 injuries for each sport.

Table 3. Athletic training services recorded during study period

Treatment or Procedures	CPT Codes	n (%)
Athletic trainer evaluation or reevaluation	97005, 97006	9608 (45.9)
Hot or cold packs	97010	4120 (19.7)
Therapeutic activities or exercise	97110, 97530	3206 (15.3)
Strapping: Lower extremity (ankle/foot, hip, knee, toes)	29540, 29520, 29230, 29550	1278 (6.1)
Electrical stimulation	97014	778 (3.7)
Manual therapy techniques or massage	97140, 97124	746 (3.6)
Strapping: Upper extremity (elbow or wrist, hand or finger, shoulder)	29280, 29260, 29240	401 (1.9)
Whirlpool	97022	318 (1.5)
Physical performance test or measurement	97750	141 (0.7)
Ultrasound	97035	118 (0.6)
Neuromuscular re-education	97112	82 (0.4)
Vasopneumatic devices	97016	53 (0.3)
Gait training	97116	36 (0.2)
Contrast bath	97034	14 (0.1)
Infrared	97026	7 (0.0)
Aquatic therapy	97113	3 (0.0)
Iontophoresis	97033	2 (0.0)
Total		20,911 (100.0)

CPT, Current Procedural Terminology.

sports, there were a few trends noted between sports. For example, boys' wrestling included diagnoses related to general medical skin conditions (ie, tinea, folliculitis, herpes simplex) and sprain or strain of the neck, while boys' wrestling and girls' softball were the only sports where sprain or strain of the elbow was documented as a common injury. It appears that the types of injuries suffered during girls' soccer, girls' track and field, and boys' track and field tend to require more time and effort to provide treatment and care than other sports. Girls' soccer and basketball required longer durations of care when compared with boys' soccer and basketball, respectively. In contrast, boys' track and field required longer durations of care when compared with girls' track and field.

The basis of determining appropriate medical coverage and care, as described by the NATA's Appropriate Medical Coverage of Intercollegiate Athletics (AMCIA)²² document, is the relative workload of each sport. To calculate the relative work load for each sport, AMCIA guidelines recommend multiplying the injury

risk (based on multiyear injury surveillance data) with the average number of treatments per injury. As a result, certain sports may require increased coverage because of increased risk of injury. Contact sports like football and soccer often require daily on-field practice and game coverage because of the increased risk of catastrophic injuries. In contrast, noncontact sports such as track and field may not require on-field event coverage but may require the same or greater amount of time to care for chronic, overuse, and recurrent injuries that may linger for a large portion of a season. While our inclusion of the type, amount, and duration of care offers a more comprehensive perspective on the demands on ATs, our data set likely does not provide a complete picture in terms of all of the treatments delivered in the secondary school setting. To continue the discussion related to appropriate medical coverage and care within the context of AMCIA²² and Appropriate Medical Coverage for Secondary School Athletes summary document,⁵ future studies should aim to capture data for services that are

Table 4. Common athletic training services documented for the top 10 sports reporting the most injuries, n (%)

	Boys' Football	Girls' Soccer	Girls' Track and Field	Girls' Basketball	Girls' Volleyball
Athletic trainer evaluation or reevaluation	3547 (48.3)	882 (40.3)	588 (41.0)	667 (49.6)	521 (41.2)
Electrical stimulation	295 (4.0)	100 (4.6)	57 (4.0)	41 (3.0)	47 (3.5)
Hot or cold pack	1493 (20.3)	427 (19.5)	306 (21.3)	231 (17.2)	226 (17.9)
Manual therapy or massage	132 (1.8)	99 (4.5)	68 (4.7)	59 (4.4)	76 (6.0)
Therapeutic exercise or activities	1041 (14.2)	427 (19.5)	238 (16.6)	194 (14.4)	246 (19.5)
Strapping of the lower extremities	369 (5.0)	175 (8.0)	118 (8.2)	86 (6.4)	81 (6.4)
	Boys' Basketball	Boys' Track and Field	Boys' Wrestling	Boys' Soccer	Girls' Softball
Athletic trainer evaluation or reevaluation	489 (45.3)	428 (39.8)	427 (52.3)	338 (47.9)	259 (43.5)
Electrical stimulation	18 (1.7)	38 (3.5)	21 (2.6)	24 (3.4)	28 (4.7)
Hot or cold pack	186 (17.2)	271 (25.2)	173 (21.2)	152 (21.6)	118 (19.8)
Manual therapy or massage	36 (3.3)	60 (5.6)	24 (2.9)	31 (4.4)	32 (5.4)
Therapeutic exercise or activities	174 (16.1)	177 (16.5)	105 (12.9)	72 (10.2)	85 (14.3)
Strapping of the lower extremities	75 (7.0)	42 (3.9)	22 (2.7)	63 (8.9)	40 (6.7)

Table 5. Amount and duration of care per injury for the top 10 sports reporting the most injuries

	Boys' Football	Girls' Soccer	Girls' Track and Field	Girls' Basketball	Girls' Volleyball
Amount of care (number of services)	4.7 ± 6.6	5.4 ± 9.9	5.2 ± 5.1	4.1 ± 4.2	4.6 ± 5.5
Duration of care (days of service)	11.8 ± 31.3	14.4 ± 25.6	10.1 ± 30.0	14.7 ± 36.7	11.5 ± 19.3
	Boys' Basketball	Boys' Track and Field	Boys' Wrestling	Boys' Soccer	Girls' Softball
Amount of care (number of services)	4.3 ± 4.3	5.3 ± 5.9	3.6 ± 4.1	3.6 ± 3.2	4.1 ± 4.1
Duration of care (days of service)	11.1 ± 27.4	18.1 ± 72.9	12.6 ± 18.7	6.6 ± 5.8	6.2 ± 10.8

associated with non-time loss injuries and preventative services in the secondary school setting.

This study is not without its limitations. We analyzed injuries based on ICD-9 coding which, at times, did not allow us to identify a specific diagnosis for an injury. Our analyses may have been more informative if we were able to differentiate between sprain and strain injuries, for example.

CONCLUSION

Secondary school ATs tend to diagnose similar injuries and use similar treatment methods, regardless of sport. ATs covering wrestling should pay special attention to skin conditions and should be well prepared to prevent and treat these conditions.

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