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original research

Injury and Illness Epidemiology at a Summer Sport-Camp Program, 2008 Through 2011

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Context: University-sponsored summer sport camps often employ athletic trainers; however, there is a dearth of epidemiologic studies describing the injury and illness experience of sport-camp participants to guide clinicians.

Objective: To describe the injury and illness experience of youth participants at a university-sponsored summer sport-camp program during a 4-year period.

Design: Descriptive epidemiology study.

Setting: A National Collegiate Athletic Association Division I university that sponsored 76 to 81 camps for 28 sports each summer.

Patients or Other Participants: A total of 44 499 camp participants enrolled during the 4 years. Male and female participants ranged in age from 10 to 17 years and in athletic skill from novice to elite.

Main Outcome Measure(s): Data from handwritten injury and illness log books, maintained by sports health care personnel, were accessed retrospectively, entered into an electronic spreadsheet, and coded. Data were applied to the National Athletic Injury/Illness Reporting System. Participant–personnel contacts, defined as any instance when a participant sought health care services from personnel, were calculated per 100 participants. Injury and illness rates were calculated per 10 000 exposures, measured in participant-days. The distribution of injury and illness conditions and affected body regions were calculated.

Results: There were 11 735 contacts, for an overall rate of 26 per 100 participants, and 4949 injuries and illnesses, for a rate of 1 per 10 000 participant-days. Participants at single-sex camps were less likely to sustain injuries and illnesses than participants at coeducational camps (rate ratio [RR] = 0.49; 95% confidence interval = 0.45, 0. 35; $P < .001$, and RR = 0.47; 95% confidence interval = 0.43, 0.51; $P < .001$, respectively). The lower extremity was injured most frequently (27.9%). Most injury and illness conditions were dermatologic (37.1%).

Conclusions: The contact and injury and illness differences observed among sports and between sexes demonstrated potential differences in the sports health care needs of camp participants. These data can be used to make evidence-based clinical decisions, such as determining injury-prevention strategies and sports health care staffing needs.

Key Words: injury and illness surveillance, sports health care, youth sports

Key Points

- Injury and illness surveillance at university-sponsored summer sport-camp programs is needed.
- Sports health care coverage is essential at university-sponsored summer sport-camp programs.
- The findings from this study may be used to help establish best-practice standards as a means to guide sports health care services and personnel operating in this distinctive environment.

Youth athletes commonly attend summer sport-camp programs. Correspondingly, colleges and universities often sponsor sport-camp programs for a variety of boys' and girls' sports. Sport-camp participants can include children and adolescents with athletic abilities that range from novice to elite. Sport-camp programs may have events that emphasize particular skill sets or positions for sports, such as a "starts and turns" camp for swimming or a "goalie" camp for lacrosse. The health care needs of participants may vary by sport or by sex, as evident from high school–based sport epidemiology studies,[1,2] which demonstrated differences in injury and injury risk among sports and between sexes. The age of participants can also influence the risk for injuries and the injuries incurred.[3] In addition to sport-related injuries, the health care staff for sport camps must assess, manage, and treat illnesses. Such injuries and illnesses may occur independently of sport participation.

Athletic trainers (ATs), allied health care students, and other medical personnel frequently provide sports health care services to participants at sport camps, as athletic participation presents a risk for injury and illness. Despite this coverage, there is a dearth of information to describe the injury and illness experience of youth-camp participants at university-sponsored sport-camp programs to allow for evidence-based clinical decisions. Though several sport-camp studies have been conducted, the findings may not be generalizable, as these authors have focused on a single sport or single medical condition and elite participants.[4–8] The studies yielded useful information, but they were very focused and represent only a small sample of sport camps.

Therefore, the purpose of our study was to describe the injury and illness experience of sport-camp participants at a

Table 1. Number of Camp Days and Participants, Exposures, Contacts, and Injuries and Illnesses (2008–2011)[a]

Sport	Camp Days	Enrollment, Participants	Exposure, Participant-Days	Contacts, No.	Contact Rate/100 Participants	95% Confidence Interval	Injuries and Illnesses, No.	Injury and Illness Rate/ 10 000 Exposures	95% Confidence Interval
Baseball, boys	40	958	38 320	56	5.8	4.5, 7.5	36	9.4	6.7, 12.9
Basketball, boys	57	2810	160 170	556	19.8	18.3, 21.3	253	16.4	14.4, 18.3
Basketball, girls	60	1842	110 520	373	20.2	18.5, 22.1	179	16.9	14.5, 19.3
Cheerleading, girls	20	950	19 000	48	5.9	4.5, 7.5	40	21.1	15.3, 28.4
Cross-country, CE	38	440	16 720	58	13.2	10.3, 16.6	27	16.7	11.4, 23.9
Dance, girls	12	168	2016	18	10.7	6.7, 16.1	9	49.6	25.2, 88.4
Diving, CE	37	352	13 024	87	24.7	20.4, 29.4	32	29.2	20.9, 39.6
Fencing, CE	48	778	37 344	251	32.3	29.1, 35.6	98	26.2	21.4, 31.8
Field hockey, girls	68	2710	184 280	549	20.3	18.8, 21.8	294	16.3	14.5, 18.2
Figure skating, girls	27	113	3051	57	50.4	41.3, 59.6	21	78.4	49.0, 111.1
Football, boys	54	9070	489 720	1238	13.6	13.0, 14.4	532	11.2	10.3, 12.2
Golf, CE	99	486	48 114	4	0.8	0.2, 2.0	3	0.6	0.2, 1.7
Gymnastics, boys[b]	4	27	108	3	11.1	2.9, 27.3	1	92.6	4.7, 448.1
Gymnastics, girls	34	685	23 290	143	20.9	18.0, 24.0	74	30.9	24.4, 38.7
Ice hockey, boys	99	1840	182 160	735	39.9	37.7, 42.2	441	24.6	22.3, 26.9
Ice hockey, girls	41	220	9020	118	53.6	47.0, 60.2	78	106.4	86.8, 129.3
Lacrosse, boys	37	725	26 825	128	17.7	15.0, 20.6	100	36.1	29.5, 43.9
Lacrosse, girls	34	683	23 222	115	16.8	14.2, 19.78	58	25.4	19.5, 32.5
Rugby, CE	44	542	23 848	731	134.9	126.0, 144.2	408	168.6	152.8, 185.5
Soccer, boys	60	1598	95 880	347	21.7	19.7, 23.8	198	21.2	18.4, 24.3
Soccer, girls	82	3233	265 106	627	19.4	18.1, 20.8	290	11.2	9.9, 12.5
Softball, girls	32	881	28 192	139	15.8	13.5, 18.3	45	19.5	14.8, 25.2
Swimming, CE	54	1169	63 126	241	20.6	18.4, 23.0	148	24.7	21.2, 28.8
Tennis, CE	34	429	14 586	114	26.6	22.6, 30.9	77	52.8	42.0, 65.6
Track and field, CE	48	504	24 192	107	21.2	17.8, 25.0	34	13.6	9.6, 18.9
Volleyball, boys	57	2641	150 537	392	14.8	13.3, 16.2	134	8.7	7.2, 10.2
Volleyball, girls	66	5326	351 516	1884	35.4	34.10, 36.7	554	15.7	14.4, 17.0
Wrestling, boys	97	3319	321 943	2616	78.8	77.4, 80.2	785	24.5	22.8, 26.3
Total	1383	44 499	61 542 117	11 735	26.4	26.0, 26.8	4949	0.8	0.8, 0.8

Abbreviation: CE, coeducational.

[a] For CE camps, participants were separated by sex during athletic session.

[b] Boys' gymnastics camp began in 2011.

university with a program that had a broad representation of sports, participant ages, and athletic abilities. Because minimal information is currently available on the topic, this description can help to guide clinical practice for ATs treating injured or ill sport-camp participants as a means to improve the quality of care delivered. Such a trend has been demonstrated at the high school[1,2] and collegiate levels,[9,10] indicating that injury surveillance can promote improved injury-prevention methods, adequate sports health care staffing, and overall preparedness. An appreciation can be gained for the unique health care needs of each sport and both sexes represented in this unique work setting.

METHODS

Study Population and Setting

The study was conducted at a summer sport-camp program at a large National Collegiate Athletic Association Division I university. Male and female participants' ages ranged from 10 to 17 years. Participant skill levels ranged from novice through elite. The program offered 76 to 81 camps each summer for 28 sports during a 10-week period for the 4 years of the study (2008–2011). The program hosted camps for 9 male sports and 11 female sports. Eight sports were offered as coeducational camps that allowed both male and female participants to enroll. During athletic sessions, participants were separated by sex, such that males and females did not participate or compete with each other. The sex designation indicated the camps' enrollment composition, not the sports' nature of play. Camp participant enrollment and camp length in days varied by sport (Table 1). The sport-camp program's director of sports health care (G.L.V.) hired approximately 20 ATs and 40 athletic training students each summer to manage injuries and illnesses within a limited standard of care under the direction of a licensed physician (W.J.S.). The number of personnel assigned to each camp was determined by the perceived injury risk of a camp's sport activities and the number of enrolled participants. This study was approved by the university's institutional review board.

Data Collection

The director of sports health care assigned a paper-based log book to each camp for documentation of all injuries and illnesses. According to their job descriptions, the camp personnel documented the date, the camp participant's name, physical examination findings, and the injury or illness type. Any instance in which a participant sought sports health care services mandated documentation.

We retrospectively accessed the log books from 2008–2011 for data collection. The variables consisted of year, camp participant's sex, sport, affected body part, and injury

or illness type. Because the side of the body affected (right, left, bilateral, or midline) was not recorded for 45.6% (n = 5352) of contacts, we decided post hoc to not include it as a variable for statistical analysis. Each case was reviewed for the presence of the variables. Cases for which personnel documented a minimum of 2 variables were included. Data that met the inclusion criteria (see the next paragraphs) were entered into an electronic spreadsheet. The data were coded and applied to the National Athletic Injury/Illness Reporting System for data analyses.[10,11]

Definitions

A *participant–personnel contact* was defined as a single documented event in which a camp participant sought sports health care services. Contacts included but were not limited to initial and follow-up injury and illness assessments, wound care, prophylactic taping, and requests for ice bags to treat muscle soreness. Such a classification allowed for a comprehensive description of the injury and illness experience and the personnel workload. *Contacts*, which included specified documentation of an injury or illness type, were defined as injuries or illnesses without consideration of time lost from activity or severity. Contacts that listed primary or secondary assessment findings only, without explicit documentation of the personnel clinical impression, were not included as injuries or illnesses but were captured as contacts. All documented injuries and illnesses were considered to be new in nature.

Main Measures

Body Part. Affected body parts for contacts were categorized into regions as follows: head (scalp, skull, face, mouth, eye, ear, nose), neck (cervical spine), upper extremity (clavicle, axilla, shoulder, upper arm, elbow, forearm, wrist, hand, finger, thumb), trunk (chest, abdomen, pelvis, thoracic spine, lumbar spine, sacrum, coccyx), lower extremity (hip, groin, thigh, knee, shank, ankle, foot, toe, great toe), or other (organ systems, psychological). Given that personnel did not record a body part for 26.6% of dermatologic injuries and illnesses, "skin" was added as a separate body region post hoc.

Injury and Illness. Injuries and illnesses were categorized according to the body system affected: dermatologic, musculoskeletal, neurologic, systemic, or other.

Participant Exposure. Exposure was defined in participant-days. The final camp enrollment was used to determine the number of participants present daily, which assumed that all registered participants were present for all camp days. The total exposure for a camp represented the product of participants enrolled and the number of camp days.

Sport. Sports were categorized as individual or team in nature and as played indoors or outdoors. Furthermore, sports were categorized as noncontact, limited contact, or contact, according to the American Academy of Pediatrics Council on Sports Medicine and Fitness.[12]

Statistical Analysis

We used the software programs SPSS (version 20.0; IBM Corp, Armonk, NY) and OpenEpi (version 2.3.1; Emory University, Atlanta, GA) for statistical analyses. Frequency counts were obtained for all variables of interest. Enrollment counts were used to calculate contact rates per 100 camp participants (total number of contacts/total number of participants × 100). Participant exposure was used to calculate injury and illness rates per 10 000 participant-days (total number of injuries and illnesses/total number of participant-days × 10 000).

Injury and illness rate ratios (RRs), with 95% confidence intervals (CIs) and *P* values were calculated. An example of an RR calculation is as follows: (No. Male Contacts/No. Male Exposures)/(No. Female Contacts/No. Female Exposures). Statistical significance, set a priori, was indicated by $P < .05$. We calculated 1-sample χ^2 tests to compare the distribution of the sport-camp population by sport to the distribution of interactions and injuries and illnesses by sport.

RESULTS

From 2008–2011, 44 499 participants attended the sport-camp program. There were a total of 321 sport camps and 1383 camp days. Camp length ranged from 1 to 7 days, averaging 4 days per camp. The overall exposure equaled 61 542 117 camp participant-days. Thirty-two ATs and 92 athletic training students provided sport-camp coverage and documented participant–personnel contacts, including injuries and illnesses, in the log books.

Participant–Personnel Contacts

There were 11 735 documented participant–personnel contacts. Contacts occurred at overall rates of 8 per camp day, 26 per 100 camp participants, and 2 per 10 000 participant-days. Including participants at coeducational camps, males accounted for 58.8% (n = 6898) of contacts, and females accounted for 40.4% (n = 4742). We were unable to determine participant sex for 0.8% (n = 95) of all contacts.

Per 10 000 exposures, male camps had 5 contacts, female camps had 5 contacts, and coeducational camps had 8 contacts. Though the rates for male and female camps were the same, the differences between male and coeducational camps (RR = 0.62; 95% CI = 0.59, 0.66; $P < .001$) and between female and coeducational camps (RR = 0.60; 95% CI = 0.57, 0.64; $P < .001$) indicated statistical significance. Participants at male camps and at female camps were less likely to seek sports health care services than participants at coeducational camps.

Incidence rates per 100 participants varied by sport (Table 1). Golf had the lowest contact rate, and rugby had the highest contact rate. For the sex-comparable sports of basketball and lacrosse, no statistically significant differences between contact rates were observed. However, statistically significant differences occurred for ice hockey (RR = 0.31; 95% CI = 0.25, 0.37; $P < .001$), soccer (RR = 1.53; 95% CI = 1.34, 1.75; $P < .001$), and volleyball (RR = 0.49; 95% CI = 0.44, 0.54; $P < .001$). Male ice hockey, female soccer, and male volleyball camp participants were less likely to seek sports health care services than their opposite-sex counterparts. We excluded gymnastics from this analysis, given that boys' gymnastics camp occurred only during the study's final year.

Injuries and Illnesses

There were 4949 documented injuries and illnesses, which comprised 42.2% of the 11 735 contacts. Tasks such as prophylactic taping and assessments in which personnel determined an injury or illness was not present (such as for complaints of anterior thigh pain due to muscle soreness, not a muscle strain) comprised the remaining 57.8% of contacts. These contacts also included instances in which personnel recorded information, such as the affected body part, signs and symptoms, or assessment findings, but did not explicitly record the clinical impression, such as an ankle sprain. Injuries and illnesses occurred at overall rates of 4 per camp day, 11 per 100 participants, and 0.8 per 10 000 participant-days. Including coeducational camps, males accounted for 58.8% (n = 2908) of all injuries and illnesses and females accounted for 40.0% (n = 1981). Participant sex was not recorded for 1.2% (n = 60) of injuries and illnesses.

Injuries or illnesses per 10 000 exposures were 2 for the male camps, 2 for the female camps, and 4 for the coeducational camps. Although participants at male camps and female camps experienced the same injury and illness rates, differences were noted between male and coeducational camps (RR = 0.49; 95% CI = 0.45, 0. 35; $P < .001$) and female and coeducational camps (RR = 0.47; 95% CI = 0.43, 0.51; $P < .001$). Participants at male camps and at female camps were less likely to sustain injuries or illnesses than participants at coeducational camps. The rates at which injuries and illnesses occurred per 10 000 exposures varied by sport (Table 2). Golf had the lowest injury or illness rate and rugby had the highest. For the sex-comparable sport of basketball, no difference in injury or illness rates was observed. However, differences occurred in ice hockey (RR = 0.23; 95% CI = 0.19, 0.29; $P < .001$), lacrosse (RR = 1.42; 95% CI = 1.03, 1.97; $P = .031$), soccer (RR = 1.89; 95% CI = 1.58, 2.26; $P < .001$), and volleyball (RR = 0.56; 95% CI = 0.46, 0.67; $P < .001$). Male ice hockey, female lacrosse, female soccer, and male volleyball camp participants were less likely to sustain injuries and illnesses than their opposite-sex counterparts. Gymnastics was excluded from this analysis because the boys' gymnastics camp only occurred during the study's final year.

Contact and Injury and Illness Distribution by Sport

To compare the distribution of sport-camp enrollees by sport with the distributions of contacts and injury and illness by sport, we calculated 1-sample χ^2 tests (Table 2). Wrestling accounted for more than 3 times as many contacts and 2 times as many injuries and illnesses as enrollees. Conversely, football accounted for approximately half as many contacts and injuries and illnesses as enrollees. The observed distribution differences among all sports were significant for contacts ($P < .001$) and for injuries and illnesses ($P < .001$).

Sport Categorizations

Using participant-days as the denominator, RRs were calculated to compare injury and illness rates within sport categories (Table 3). Injuries and illnesses were more likely to occur for limited-contact than contact sports (RR = 2.07; 95% CI = 1.93, 2.23; $P < .001$) and for noncontact sports (RR = 2.20; 95% CI = 1.96, 2.48; $P < .001$) than contact sports. However, the difference between limited-contact and noncontact sports was not significant. Injuries and illnesses were more likely to occur for individual sports than for team sports (RR = 2.39; 95% CI = 2.25, 2.55; $P < .001$) and for indoor sports than for outdoor sports (RR = 2.13; 95% CI = 2.01, 2.25; $P < .001$).

Table 2. Sport-Camp Participants, Contacts, and Injury and Illness Distributions by Sport (2008–2011), %[a]

Sport	Participants	Contacts	Injuries and Illnesses
Baseball, boys	2.2	0.5	0.7
Basketball, boys	6.3	4.7	5.3
Basketball, girls	4.1	3.2	3.8
Cheerleading, girls	2.1	0.4	0.8
Cross-country, CE	1.0	0.5	0.6
Dance, girls	0.4	0.2	0.2
Diving, CE	0.8	0.7	0.8
Fencing, CE	1.7	2.1	2.0
Field hockey, girls	6.1	4.7	6.1
Figure skating, girls	0.3	0.5	0.5
Football, boys	20.1	10.5	11.1
Golf, CE	1.1	0.0	0.1
Gymnastics, boys[b]	0.1	0.0	0.0
Gymnastics, girls	1.5	1.2	1.5
Ice hockey, boys	4.1	6.3	9.1
Ice hockey, girls	0.5	1.0	1.9
Lacrosse, boys	1.6	1.1	2.0
Lacrosse, girls	1.5	1.0	1.2
Rugby, CE	1.2	6.2	8.1
Soccer, boys	3.6	3.0	4.1
Soccer, girls	7.3	5.3	6.0
Softball, girls	2.0	1.2	1.1
Swimming, CE	2.6	2.1	3.2
Tennis, CE	1.0	1.0	1.6
Track and field, CE	1.1	0.9	0.7
Volleyball, boys	5.9	3.3	2.6
Volleyball, girls	12.0	16.0	11.1
Wrestling, boys	7.5	22.3	16.0
Total	100.0	100.0	100.0

Abbreviation: CE, coeducational.

[a] For CE camps, participants were separated by sex during athletic session.

[b] Boys' gymnastics camp began in 2011.

Conditions

The distribution of injuries and illnesses by condition is illustrated in Figure 1. Dermatologic conditions comprised most (n = 1837) of all documented injuries and illnesses. Blisters accounted for 50.5% (n = 928) of all dermatologic conditions. Sprains accounted for 45.4% (n = 707) of all musculoskeletal conditions, and all neurologic conditions except 1 were concussions (n = 167). Contusions accounted for 51.0% (n = 501) of all *other* conditions. *Other* conditions also included epistaxis, dental injuries, conjunctivitis, otitis media, gastroenteritis, heat illness, and asthma.

Body Regions

The distribution of injuries and illnesses by body region is shown in Figure 2. Relative to body region, the lower extremity was most commonly affected (n = 1381). The ankle was affected in 33.9% (n = 468) of lower extremity

Table 3. Injury and Illness Distribution by Sport Category per 10 000 Participants (2008–2011)

Sport Category	n	Injury or Illness Rate per 10 000 Participants	Rate Ratio	95% Confidence Interval	*P* Value
Limited contact	888	3.1	2.07	1.93, 2.23	<.001[a]
Contact	3763	1.5			
Noncontact	298	3.3	1.06	0.93, 1.21	.35
Limited contact	888	3.1			
Noncontact	298	3.3	2.20	1.96, 2.48	<.001[a]
Contact	3763	1.5			
Individual	1288	2.9	2.39	2.25, 2.55	<.001[a]
Team	3661	1.2			
Indoor	2847	2.4	2.13	2.01, 2.25	<.001[a]
Outdoor	2102	1.1			

[a] Denotes statistical significance ($P < .05$).

injuries and illnesses. The fingers were most often involved in upper extremity injuries and illnesses: 19.8% (n = 118). Skin was affected in 35.2% (n = 1743) of injuries and illnesses. For 11.5% of contacts (n = 1354), the involved body part was not documented, although, ultimately, we were able to determine the body part for 95.6% (n = 11 219) of contacts.

DISCUSSION

For the sport-camp program in our study, male participants predominated over female participants in contact sports (63.4% versus 33.7%). This finding does not include rugby and diving, which were coeducational camps and enrollment by sex was not available. Sports can also be categorized as collision in nature, where participants purposefully make physical contact with one another.[13,14] Subsequently, significant collisions are unavoidable[13,14] and may increase the risk for injury. The collision sports represented in the sport-camp program were football, boys' ice hockey, girls' ice hockey, and boys' lacrosse, rugby, and wrestling. Only 4.9% of female participants were involved in collision-sport camps, compared with 70.0% of male participants; rugby was again excluded because it was coeducational.

We found that participants at male camps had the same overall contact rate and injury and illness rate as participants at female camps, which does not correspond with the higher enrollment of males in contact and collision sports as compared with females. A possible explanation is that the participants at female camps may have reported more injuries and illnesses and sought more follow-up care than their male counterparts. Also, the participants at female camps may have reported to personnel for injury and illness assessments but been found not to have injuries or illnesses, accounting for more contacts than males. This finding demonstrates the need to have a body of literature to consult, as compared with simply relying on the number of participants enrolled in a given camp or a sport's perceived injury risk, when determining sports health care staffing and supply needs.

Participants at coeducational camps had higher rates of contacts and injuries and illnesses than participants at male camps and female camps. These results are of interest, as half of the coeducational camps were for noncontact sports. In part, this may be due to the inclusion of rugby, a collision sport with the highest contact and injury and illness rates. After excluding rugby, the contact rate for coeducational camps was 6 per 10 000 participant-days, demonstrating a significant difference when compared with male sports (RR = 1.11; 95% CI = 0.15, 1.97; $P < .01$) and female sports (RR = 1.14; 95% CI = 1.06, 1.23; $P < .001$).

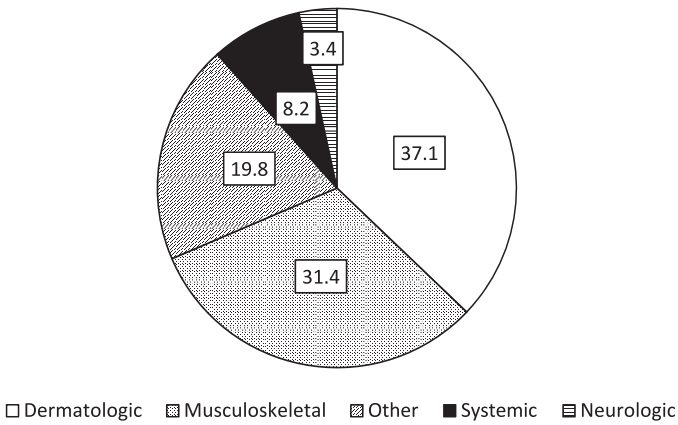

Figure 1. Distribution of injuries and illnesses by condition (%).

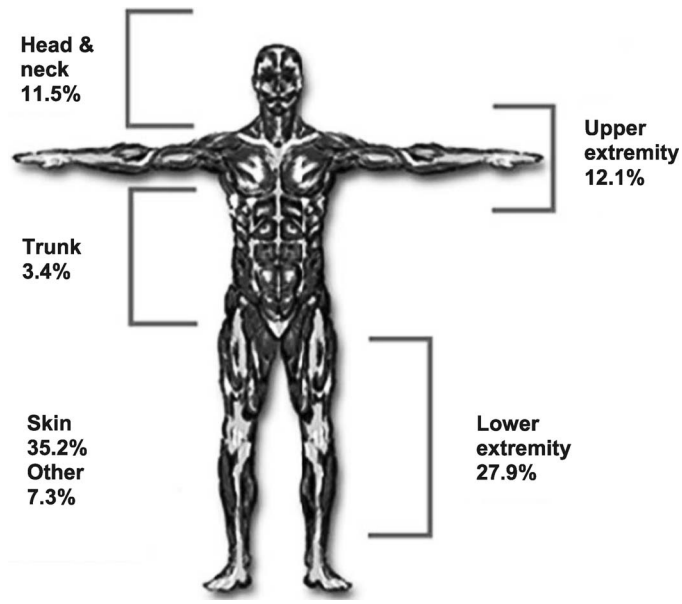

Figure 2. Distribution of injuries and illnesses by body region. The affected body part could not be determined for 2.5% of injuries and illnesses. Affected body part was not documented for 26.6% of skin injuries and illnesses. *Other* includes systemic conditions and psychological conditions.

For injuries and illnesses, the same patterns occurred with the exclusion of rugby. The injury and illness rate for coeducational camps was 3 per 10 000 participant-days, indicating a difference when compared with male sports (RR = 1.31; 95% CI = 1.19, 1.46; $P < .01$) and female sports (RR = 1.35; 95% CI, 1.23, 1.52; $P < .001$). Coeducational camps may have experienced less underreporting of injuries and illnesses than male camps and female camps. Including data such as chief complaint and mechanism of injury in future research may help to identify factors contributing to the increased contact and injury and illness rates for coeducational camps, as compared with their single-sex peers.

Rechel et al[2] examined injuries sustained during high school practices and competitions for male and female sports, including the sex-comparable sports of basketball and soccer. Sport practices are more similar to the sport-camp sessions than to competitions; when we compared those practice results with ours, we noted differences. For sport camps, the injury and illness rate for girls' basketball was 10 times that of boys' basketball, whereas Rechel et al[2] found similar rates between sexes (1.46 per 1000 athlete-exposures for boys and 1.37 per 1000 athlete-exposures for girls). Although in both studies boys' soccer had a higher rate than girls' soccer,[2] in our study, the boys' rate was nearly twice the girls' rate. Rechel et al[2] found a rate difference of 1.58 injuries per 1000 athlete-exposures for boys and 1.10 per 1000 athlete-exposures for girls. These differences may reflect the different settings of high school athletics and summer sport camps.

Rechel et al[2] demonstrated that for 2 sports in 2 different athletic environments, injuries occurred at different rates and to different body parts, supporting the need for further sport-camp research so that guidelines for evidence-based practice can be determined from information that accurately represents the population. Currently, guidelines are not available to address best practices and standards of care for a university-sponsored youth sport-camp program, although a policy statement entitled "Creating Healthy Camp Experiences"[15] was published by the American Academy of Pediatrics in 2011. The guidelines are intended for recreational camps.

A university-sponsored, 28-day wrestling camp for boys aged 15 to 18 years has been described in prior epidemiology studies.[4–7] Authors of these studies examined herpes gladiatorum outbreaks[4–6] and related emergency department referrals.[7] Interestingly, though prevalent at the wrestling camp and starting as early as the fourth day of camp,[4] participants in our sport-camp program did not experience a documented outbreak of herpes gladiatorum for any sport. Further research is needed to examine factors affecting the presence or absence of herpes gladiatorum outbreaks at different wrestling camps, and how, if at all, the factors are related to camp policies and preventive practices.

Although many high school sport-injury epidemiology studies have been conducted,[1,2,16–18] as previously indicated, the results are likely not representative of the sport-camp injury experience. Athlete-exposures are commonly calculated by using athlete-practices or athlete-competitions,[19] with a single practice or competition often held per day. In the sport-camp setting, there may be 3 instructional athletic sessions per day in addition to recreational activities and free time. By describing exposure in participant-days, all contacts and injuries and illnesses were included, not only those that resulted directly from athletic participation. During competitive athletic practices and competitions, exposure can vary greatly among team members. Often in the sport-camp setting, all participants are engaged and physically active throughout all camp sessions, which presents an increased risk for injury. The injury risk and sports health care needs of 10-year-old camp participants differ from those of the teenagers represented in high school studies.[3] By referencing high school sport-injury rates, potentially erroneous evidence-based decisions may be made for the sport-camp population.

To date, only 1 large-scale summer-camp research initiative has been conducted: the Healthy Camp Study.[20,21] The study included recreational overnight and day camps nationwide, and the injuries and illnesses experienced by campers were described. However, the nature of the camps differed from that of the sport camps, which may render the study's findings and conclusions ungeneralizable to the summer sport-camp setting. It is unlikely that recreational campers have similar injury and illness experiences as sport-camp participants. Goldlust et al[20] found an overall injury rate of 49 per 100 000 camper-days for 71 overnight camps in the first year of the Healthy Camp Study. Our overall participant–personnel contact rate and injury and illness rate were 19.1 and 8.04 per 100 000 participant-days, respectively. Additionally, 60.1% of all camper injuries in the Healthy Camp Study required off-site medical referrals and treatment.[20] When we[22] described the physician referral profile from our same sport-camp program, we found that only 9.7% of all sport-camp injuries and illnesses required medical referral. Although further research is needed to determine the reasons for the observed differences between our study and the Healthy Camp Study, the results indicate that recreational campers and sport-camp participants have different injury and illness experiences.

Musculoskeletal injuries commonly occur secondarily to athletic participation,[23] yet the skin was most frequently affected in our study. A reason for this may have been the sport-camp program's policy to document all participant–personnel contacts, even for minor injuries and illnesses. If such documentation does not occur in other athletic settings, the data would then not be included in statistical analysis. In epidemiologic research, an injury is often defined in part by time lost from athletic participation. Because we included all injuries and illnesses, without consideration of time loss, minor skin injuries and illnesses were captured. Injuries and illnesses to the skin in this setting were often minor in nature, but they required proper wound care to avoid potentially negative sequelae, such as infections.

Infrequently, illnesses such as gastroenteritis and mononucleosis occurred. These may not have occurred as a direct result of athletic participation; however, they still required sports health care services from ATs, athletic training students, and physicians as they occurred while the participants were at camp. Therefore, sports health care and medical personnel should be prepared to recognize and treat illnesses in addition to injuries.[21]

As indicated in the "Healthy Camp Study Impact Report,"[24] a document published by the American Camp Association, surveillance at summer camps can help to

identify preventable injury or illness events. The study's authors provided educational material to camp staff members, campers, and campers' parents relative to topics such as hand washing, proper footwear, and adequate nutrition and rest.[24] Anecdotally, camps reported ensuing decreases in injury rates and illness rates.[24] Given its success, this model of surveillance and subsequent policy development can be implemented in the sport-camp setting. Our study represents only 1 institution's sport-camp program, yet nationwide surveillance over several years has the potential to identify injury and illness trends and prevention strategies, as demonstrated by the Healthy Camp Study. Injury and illness prevention can improve the experience of camp participants and reduce health care costs.

Our study had several limitations. Owing to its retrospective nature, the quality of data collected was affected. Although ATs have adequate experience documenting injuries and illnesses in clinical settings,[25] and documentation is a required professional and educational competency, the sports health care staff was not trained to be recorders for this study. Additionally, the method of documentation was not standardized. Key variables, such as participant age, mechanism of injury, time of injury or illness, and time loss were often not recorded. As mentioned previously, many of the included cases had missing data for the study's variables of interest. Given the variables that were not recorded, we could not compare injuries and illnesses that were related to athletics versus those that were not. To calculate exposure by participant-days using camp enrollment numbers, we assumed that all registered participants were present at camp (for both athletic sessions and free time) for the same amount of time. Yet this does not account for participants who may not have been involved in camp activities or who may have left camp and returned home early. However, an injured or ill participant would not have been able to withdraw from camp without reporting to the sports health care staff. Without clear documentation for all injuries and illnesses to indicate new versus preexisting conditions and initial assessments versus follow-up assessments and treatment, the calculated injury and illness rates may be higher than the true values. Preexisting conditions, follow-up assessments, and treatments may have been counted as new injury or illness events. It is possible that an injury or illness might have been reported twice if the camp participant sought care from different personnel at different times or at different venues. Whether a camp participant was seeking sports health care services for a new injury or illness or following up for a previously assessed or treated injury or illness was not clearly documented, which may also have falsely inflated rates. Lastly, as in any surveillance system, reasons for underreporting must be considered. Injuries or illnesses may have been unreported by camp participants or unrecorded by personnel.

CONCLUSIONS

This study is the first to describe summer sport-camp injuries and illness with a large population and a broad representation of sports and participants. Our findings demonstrate the need for injury and illness surveillance at university-sponsored summer sport-camp programs, as this setting presents unique risk factors compared with organized competitive youth sports, such as at the high school level. Over time, such surveillance can characterize injury and illness trends and allow for the implementation of methods to reduce the risk of and prevent injuries and illnesses. These data also demonstrate the need for sports health care coverage at university-sponsored youth summer sport-camp programs. Descriptions of participant-personnel contact rates and injury and illness rates showed that the participants' sports health care needs and personnel workloads varied greatly by sport and by sex. These results can help to identify the appropriate number of personnel to staff each camp. The high percentage of injury and illness conditions that were dermatologic in nature or that occurred to the lower extremity can provide useful information when the health care supply needs for a sport camp are being determined. Future researchers should implement a standardized injury and illness surveillance system and record data prospectively, with the ultimate goal of enabling evidence-based clinical decisions for ATs at university-sponsored summer sport-camp programs.

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