
ORIGINAL RESEARCH

ULTIMATE FRISBEE INJURIES IN A COLLEGIATE SETTING

Michael Akinbola, PT, DPT, SCS¹
David Logerstedt, PT, PhD, MPT, SCS²
Airelle Hunter-Giordano, PT, DPT, SCS¹
Lynn Snyder-Mackler, PT, ScD, SCS, FAPTA¹

ABSTRACT

Purpose/Background: Ultimate Frisbee (Ultimate) is a limited-contact team sport growing in popularity, particularly as a collegiate club sport. In 2011, over 947,000 people played Ultimate. Sex, age, skill level, and physical demands of the sport place each player at risk for injury, yet there is limited information on the number of injuries with regard to clinical research. The purpose of this study is to identify injury reporting trends in Ultimate Frisbee against other collegiate club sports and examine correlation with sex, body region, and medical recommendations and to discuss associated risk of injury.

Methods: Athletes who sustained an injury related to participation in their respective club sport attended a physical therapy sports clinic, underwent screening, and were provided direction for injury management. Data was collected on various elements of each case with descriptive statistical analysis performed to catalog injury characteristics. Chi-square analyses were performed to compare proportions between sports, sex, and body region.

Results: Ultimate accounted for 143 (31.0%) of the 461 reported injury cases collected from all club sports. Female injuries represented 101 (70.6%) of the 143 Ultimate cases, whereas men totaled 42 (29.4%) ($p < 0.001$). Women had significantly more foot/ankle (26) than men (4) ($p < .001$) and more lumbar/flank (9) injuries than men (2) ($p = .022$).

Conclusions: Ultimate accounted for one of the highest number of reported injuries among all club sports. Women reported injuries more than twice as frequently as men. The majority of reported Ultimate injuries involved the lower extremity. Injury trends observed are similar to those previously reported in several NCAA Intercollegiate sports.

Level of Evidence: IV

Keywords: College club sports, epidemiology, Ultimate Frisbee

¹ Department of Physical Therapy, University of Delaware, Newark, DE

² Department of Physical Therapy, University of the Sciences, Philadelphia, PA

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CORRESPONDING AUTHOR

David Logerstedt
Address: Department of Physical Therapy,
Samson College of Health Sciences
University of the Sciences in Philadelphia,
108 Woodland
600 S. 43rd St., Philadelphia, PA 19104
E-mail: d.logerstedt@uscience.edu

INTRODUCTION

Ultimate Frisbee (Ultimate) is a fast paced, limited-contact, mixed team sport played with a flying disc, which combines features of other sports such as American football, soccer, and basketball, into a simple yet demanding game. Two teams of seven athletes compete on a 70 by 40 yard playing field (with 25 yard deep end zones) with the aim of scoring goals, which is achieved when a player catches the disc in the end zone. The disc is advanced only by being thrown through the air as players are not allowed to run with it (United States Ultimate 11th edition Rules).¹

As an alternative or lifestyle sport,² Ultimate is one of the fastest growing sports in the United States (US). USA Ultimate is the association that serves as the national governing body of the sport of Ultimate in the US. By the end of 2009, the association had grown to over 30,000 members. In 2011, USA Ultimate reported 947,000 people played Ultimate frequently (≥ 25 times/year) in the US alone.³ Ultimate has grown in popularity as a collegiate club sport; with teams playing in various tournaments throughout the country.

Players run, cut, guard, jump, throw, catch, and dive in a fully outstretched position in order to catch the disc and advance to score a goal. Frequent cutting, physical contact, and jumping amidst other players have all been described as possible risk factors for injury in Ultimate.^{1, 4} Incidental contact is common during gameplay. Ultimate athletes are subject to considerable biomechanical stresses. Incidental contact and various impact forces expose each player to considerable risk for injury. Constant running, with athletes moving unrestricted throughout the entire playing field (similar to soccer or lacrosse), also places them at risk for overuse injuries. Injuries sustained during Ultimate are similar to those in occurring during NCAA field sports, such as soccer. Data from the NCAA Injury Surveillance System (ISS), (which monitors injuries that occur across 15 NCAA sanctioned sports between 1988-1989 to 2003-2004) demonstrated that more than half the injuries sustained were to the lower extremities.⁵ This is a trend also observed in Ultimate.^{1, 4} Contact during gameplay in Ultimate (between athletes or with the ground) results in a significant number of the reported injuries, similar to soccer or basketball,

where contact occurred in 60% to 80% of injuries.⁴

Despite its growing popularity, increasing number of participants, and injury risk, there is a paucity of published literature characterizing the rates and types of injuries specific to this sport. Defined as a limited contact sport, it has received very little attention with regard to prospective injury epidemiology or injury prevention and management research.⁴ Very few teams have professional medical coverage for games or tournaments (unlike counterparts such as soccer or basketball), and most games are self-refereed. USA Ultimate has different requirements depending on age for gameplay and tournament staffing. With respect to the college-age subjects represented in this study, USA Ultimate requires a non-participating First Responder only when the number of participants is between 250 and 500 people. An onsite certified athletic trainer (ATC) is only required if the event size is greater than 501 participants, and less than 999.

Two retrospective studies explored injuries that occurred during participation in Ultimate.^{1, 4} Reynolds & Halsmer¹ evaluated the injuries associated with Ultimate using a retrospective, self-reported survey of 135 adult athletes at a Midwestern Ultimate tournament. Of the respondents, 88% had missed Ultimate activity due to injury, and 71% sought medical care for Ultimate related injuries. Yen and colleagues⁴ conducted a cross-sectional study at the 2007 Ultimate Players Association College Championships in Columbus, Ohio. They quantified and characterized the injuries incurred by Ultimate players using an interview of athletes who called an injury timeout. They identified potential activities associated with risk for injury, including laying out (while catching the disc), covering cutters (athlete cutting to gain position to receive a pass), cutting, jumping, running, and catching. They proposed that the "limited contact" sport classification for Ultimate was inappropriate. Additionally, contact between players and with the ground (e.g. during a layout) resulted in over 50% of the injuries reported. Reynolds & Halsmer¹ reported that the majority of Ultimate athletes in their sample experienced some injury with many going on to pursue medical care. Subsequently, the authors of the current study sought to educate health care professionals on the particular profile of injuries sustained

among collegiate Ultimate athletes. This is the first study to follow one specific Ultimate club consisting of two teams (men's team and women's team) in a collegiate setting, comparing their injury rate to other club sports and performing arts activities. Where previous studies represented data collected at a single game or tournament, this longitudinal study follows the collegiate Ultimate teams (men and women) at a University with over 20,000 undergraduate and graduate students. The purpose of this study is to identify injury reporting trends in Ultimate Frisbee against other collegiate club sports and examine correlation with sex, regional distribution, and medical recommendations and to discuss associated risk of injury.

METHODS

This is a retrospective analysis of data collected during a twelve-year period from 2000 to 2012. Injured collegiate club athletes (including Rugby, Ultimate, Soccer, and Basketball) and performing arts members (e.g. figure skating, marching band, theatre) attended a weekly *Club Sports & Performing Arts Injury Clinic* (Sports Clinic) where they could be screened and offered direction for management of their injuries. All participants were eligible for inclusion. A licensed physical therapist verified injury and diagnosis for data to be recorded and included in the study. Athletes who sustained injuries not related to participation in their club sports were excluded.

Procedure

Each Sports Clinic was conducted by one to three licensed physical therapists: One Orthopaedic or Sports Clinical Specialist and two physical therapy residents. During Sports Clinic, the physical therapist would complete a screen, record the athlete's subjective history, and perform tests and measures in order to determine whether the individual required urgent medical attention, referral to student health services, referral to an orthopedic surgeon, or recommendation for skilled physical therapy. Whereas a formal physical evaluation might be performed in order to determine specific problems, impairments, and limitations for each athlete to direct treatment, these screens were intended to triage and provide direction for each athlete. If an individual's injury was such that they did not require additional professional medical attention, then he/she was educated

on methods to reduce his/her impairments and facilitate safe return to play/activity. This process was completed weekly at the Sports Clinic over a 12 year period. Data regarding complaints, the results of clinical examination, which body region was injured, the clinical impression of diagnosis, and recommendations for management of injury were recorded. *Injury* was defined as any condition for which an athlete sought medical attention at the Sports Clinic. Each injury/condition was recorded only once. Athletes who returned for follow-up for the same condition were not counted as a separate case. While multiple personnel were involved during the 12-year period during which data was collected, standardized procedures and criteria for data collection were maintained throughout the study.

Upon completion of each athlete's subjective interview and physical screen, the evaluating physical therapist made recommendations to each participant based on the clinical impression of the individual's diagnosis and immediate needs. A second therapist and board certified specialist in sports and/or orthopedic physical therapy verified diagnosis to minimize bias and support appropriate medical recommendations.

STATISTICAL METHODS

Descriptive statistical analysis was performed to catalogue injury types and rates for injuries reported by participants in various sports/activities seen at Sports Clinic. Injuries per body part among reported Ultimate injuries were totaled and reported as percentages of the total number of injuries. Assessment of further medical utilization for Ultimate injuries was also performed based on recommendations for injury management. Chi-square analyses were performed to compare proportions between sex and regional distribution of injuries. Calculations were performed using a Microsoft Excel™ spreadsheet. Statistical significance was set at $p < 0.05$.

RESULTS

Participants

Participants in thirty-two club sports and performing arts activities were followed over a 12-year span from 2000 to 2012. The men's and women's Ultimate teams at the University were comprised of at least 28 play-

ers, divided into A and B teams of at least 14 each. This allows for a full squad of 7 players with reserves. At the time of last data collection, the women's team had 37 players and the men's team had 60 players. The teams play year round, but the main competitive season is 13 weeks long, occurring in the spring. Teams practice four times per week, and typically play in two-day weekend tournaments at a rate of 3-5 tournaments per semester, with additional tournament play if teams qualify for regionals or nationals.

Injury Rate

A total of 461 injuries were reported and screened among those presenting at the Sports Clinic over a twelve-year period. Ultimate (men's and women's) accounted for 143 (31%) cases, exceeded only by Rugby (men's and women's) with 156 cases (33.8%) ($p < 0.45$). Ninety-four (94) different Ultimate athletes reported to Sports Clinic, representing 143 distinct cases (Table 1). Sixty-four Ultimate athletes reported to Sports Clinic for only one case, 18 reported for two

Table 1. Number of injuries for each club sport/activity

Club Sport/Activity	Number of Injuries	Percentage of total
Ultimate (M)	42	9.1%
Ultimate (W)	101	21.9%
Rugby (M)	120	26.0%
Rugby (W)	36	7.8%
Soccer (M)	18	3.9%
Soccer (W)	27	5.9%
Lacrosse (M)	4	0.9%
Lacrosse (W)	2	0.4%
Baseball (M)	5	1.1%
Softball (W)	5	1.1%
Wrestling (U)	5	1.1%
Volleyball (M)	11	2.4%
Volleyball (W)	9	2.0%
Basketball (M)	0	0.0%
Basketball (W)	5	1.1%
Tennis (M)	0	0.0%
Tennis (W)	1	0.2%
Track/Field/XC (M)	10	2.2%
Track/Field/XC (W)	0	0.0%
Crew/Rowing (M)	20	4.3%
Crew/Rowing (W)	1	0.2%
Equestrian (W)	4	0.9%
Synchronized Skating (W)	1	0.2%
Figure Skating (W)	6	1.3%
Roller Hockey (M)	2	0.4%
Ice Hockey (M)	1	0.2%
Ice Hockey (W)	4	0.9%
Field Hockey (W)	2	0.4%
Climbing (U)	1	0.2%
Acting—Professional Theatre Training Program (U)	5	1.1%
Marching Band (U)	4	0.9%
ROTC (U)	1	0.2%
Unknown Sport/Activity	8	1.7%
Total	461	100%

M= Men's; W= Women's; U = Unisex; XC = Cross Country

separate cases (36 total), seven reported for three cases (21 total), three reported four different injury cases (12 total), and two reported five separate injuries (10 total). The remaining sports/activities that contributed to injury totals are reported in Table 1. Seventy-nine of the 143 injuries from Ultimate were reported by athletes who sustained more than one (separate, not repeat) injury during the twelve-year study period. Women outnumbered their male counterparts in injury reporting for more than two separate injuries during the study period, with up to five separate injuries reported by two female Ultimate athletes (Table 2).

Relationship Between Ultimate Injuries, Sex, and Body Region

Injuries to females represented 101 (70.6%) of the reported cases from Ultimate, whereas injuries to men totaled 42 (29.4%) ($p < 0.001$). Of the 143 injuries associated with Ultimate, the body part most commonly affected was the knee, accounting for 50 (35%) injuries, followed by foot/ankle at 33 injuries (23.1%), 11 (7.7%) each of lumbar/flank, hamstrings

& shins/Achilles related injuries, 10 (7%) hip/groin injuries, 7 (4.9%) calf/leg injuries, 4 (2.8%) quad/thigh injuries, and 3 (2.1%) each of shoulder & wrist/hand injuries (Table 3).

Among injuries reported in Ultimate, women reported significantly more than men overall (Table 3) ($p < .001$). For each defined body region, women reported more injuries than men with the exception of hip/groin for which men and women both reported five injuries ($p = 1.00$), and shoulder and wrist/hand with two men and one woman reported injuries ($p = 1.00$) for each. While women reported nearly twice as many knee injuries as men (32 vs. 18, respectively), this difference was not statistically significant ($p = .065$). Despite the higher injuries among women overall within Ultimate, only foot/ankle and lumbar/flank injuries demonstrated a significant difference. Twenty-six foot/ankle injuries were reported among the women, whereas men reported only four ($p < .001$). Women reported nine lumbar/flank related cases, as opposed to two cases among the men ($p = 0.022$) (Table 3).

Table 2. Number of injuries for each club sport/activity

Number of Reported Ultimate Injuries	Ultimate Athletes	Cases
1	64	64
2	18 (77% female)	36
3	7 (100% female)	21
4	3 (67% female)	12
5	2 (100% female)	10

Table 3. Ultimate Frisbee Injury per Body Region

BODY REGION	Ultimate		
	Men	Women	p-value
Knee	18	32	.065
Foot/Ankle	4	26	<.001*
Shin(s)/Achilles	3	11	.057
Low back pain/Lumbar Spine/Flank	2	9	.022*
Hamstrings	4	7	1.00
Hip/Groin	5	5	1.00
Calf/Leg	1	6	.13
Quad/Thigh	1	3	.63
Shoulder	2	1	1.00
Wrist/Hand	2	1	1.00
TOTAL	42	101	<.001

* $p < .05$ between men and women

Further Medical Recommendations

Of the total 143 cases of Ultimate athletes, 50 were educated on independent management strategies, or required no follow-up. Forty-eight athletes were encouraged to initiate skilled Physical Therapy (PT) pending a trial of independent management (ranging from one to three weeks) or a follow-up with a physician, whereas 40 were instructed to immediately initiate skilled PT, and nine were referred to an orthopaedic physician for consultation, imaging, or injections. Four female athletes who were referred to an orthopedic physician also went on to initiate PT (Table 4).

Specifically, with respect to further medical recommendations in response to injuries reported by men vs. those reported by women, 35 (34.65%) women sustained minor injuries (those incurring recommendations for education on independent management strategies) versus 15 (35.7%) male Ultimate cases. Thirty-five (34.65%) women reported mildly severe injuries (those where athlete was encouraged to initiate skilled PT pending a trial of independent management or follow-up with a physician), versus 13 (31%) men. Truly severe injuries (those given recommendations to pursue an orthopaedic consult or immediately initiate skilled PT) accounted for 28 (27.7%) of female Ultimate cases, versus 12 (28.6%) men. Seven (6.9%) women and two (4.7%) men were referred to an orthopaedic physician for consults, imaging, or injections with four (3.9%) women also immediately initiating PT. There was no statistically significant difference between the proportion of men or women receiving each recommendation (Table 4).

DISCUSSION

This study represents the largest collection of injuries associated with Ultimate participation in a single setting to date, and the results give an overview of injuries sustained in the sport. Among participants in the 32 club sports and performing arts activities who participated in the Sports Clinic during the twelve-year study period, Ultimate-related sports injuries accounted for the second highest number of reported cases surpassed only by Rugby.

Jumping and diving are frequently performed maneuvers that increase each athlete's risk for injury.⁶⁻⁸ Yen et al⁴ reported that diving was one of the most common activities at time of injury timeout (29% and 22% in men's and women's divisions, respectively) and accounted for all of the men's closed head injuries and two of the three women's closed head injuries. Additionally, continuous running in open field competition can contribute to athletes' risk for over-use injuries, particularly if associated with declining performance related to fatigue.⁹

In this sample, many less skilled athletes may have tried out for Ultimate, or were unaware of the stresses athletic participation places on the body, therefore increasing their risk for injury. Peterson et al¹⁰ examined the association between age, skill level, and injury of 264 soccer players, and found a twofold increase in the incidence of injury among young players with a lower skill level compared to more skilled athletes. Chomiak et al¹¹ reported similar findings in soccer players, with a twofold increase in severe injury incidence among lower skilled athletes compared to those of higher skill level.

Table 4. Further Medical Recommendations

Type of Recommendation	Men (% of 42)	Women (% of 101)	Total (% of 143)
Orthopaedic visit*	2 (4.7%)	7† (6.9%)	9† (6.3%)
Immediate Skilled PT	12 (28.6%)	28† (27.7%)	40† (28%)
PT Pending ‡	13 (31%)	35 (34.65%)	48 (33.6%)
No further professional services	15 (35.7%)	35 (34.65%)	50 (35%)

* Orthopaedic physician visit:= consult, imaging, or injections
† Four female athletes were instructed to pursue an Orthopaedic physician visit AND initiate physical therapy
‡ PT Pending: PT pending trial of independent management (1-3 weeks) or pending physician follow-up

Injuries identified in this study were similar with those reported by Reynolds & Halsmer¹ where knee & ankle injuries accounted for the majority of injuries reported at a Midwestern Ultimate tournament. Similarly, Yen et al⁴ found that the majority of injury time-outs were due to lower extremity injuries. Ultimate injury patterns in the current study closely resembled those reported for 15 NCAA Intercollegiate sports over a sixteen year period.¹² Over half of all injuries were lower extremity, with knee and ankle injuries accounting for the greatest number of the lower extremity injuries.¹²

Data from men's and women's Collegiate Soccer NCAA Injury Surveillance System revealed that lower extremity injuries accounted for almost three quarters of all game and practice injuries.^{5,13} In men's soccer, ankle ligament sprains were the most common injury sustained during practices and games, and knee internal derangements were the most common "severe" injury during those exposures.^{5,14} Similar findings were seen in women's soccer athletes during games, with the addition of upper leg musculotendon strains seen in practices.¹⁴

In the collegiate setting used for the current investigation, women reported Ultimate-related injuries more than twice as frequently as their male counterparts during the twelve-year study period despite the fact that the number of women playing Ultimate was likely smaller. Each year the squad size in this collegiate setting was at minimum of two teams of 14 players each, with the current women's team having 37 players, and the men's team having 60. Injury incidence has been shown to correlate strongly with the number of individuals registered to participate.¹⁵ Although incidence rate was not calculated, it was likely higher in women than men.

Interestingly, one of the most notable differences between male and female injury reporting is the number of athletes returning for separate injuries. Among Ultimate injuries reported, the majority of athletes reporting two or more injuries were women. Two women reported five separate injuries during the study period (Table 2). The higher number of injuries in women compared to men may indicate underlying neuromuscular biomechanical deficits, in particular related to lower extremity injuries. Women have demonstrated the reduced ability to adequately absorb

ground reaction forces, reduced knee flexion during landing and cutting, and limb-to-limb asymmetries during task-specific activities.¹⁶⁻¹⁹ Seventy-nine of the 143 reported Ultimate cases were associated with athletes who sustained multiple injuries during the 12-year study period. The majority of athletes who reported to Sports Clinic more than once were women. Women appear to be more likely to sustain multiple injuries during their careers than men. This may be related to the interaction between movement strategies, alignment, body composition, and physiology. Women generally have less lean body mass than men^{20, 21} with less developed musculature²²⁻²⁴ and greater laxity present in connective tissue,^{25, 26} further contributing to injury risk.

While women globally reported significantly more injuries than men, the foot/ankle and lumbar/flank were the only body regions for which a statistically significant difference was identified. Controversy exists on the role of sex in sports related foot and ankle injuries.^{27, 28} Beynnon et al²⁹ reported that ankle injuries per 1000 person-days of exposure were 1.6 for men and 2.2 for women. Though not significantly different, women who played soccer had a higher incidence of ankle injury than women who played field hockey or lacrosse.²⁹

Significantly more women reported lumbar/flank injuries than men in the current study. Agel et al⁵ and Dick et al¹⁴ reported similar numbers of low back injuries sustained in collegiate men's (135 injuries) and women's (162 injuries) soccer. Similar numbers of injuries were also seen in collegiate lacrosse.¹³ While it is unclear why women in the current study reported more lumbar/flank injuries than men compared to other published reports, women have musculoskeletal risk factors that may increase their risk for injury. Springer et al³⁰ reported significantly decreased transversus abdominis muscular thickness in women as compared to men with a positive correlation between muscle thickness and body mass index. Norton et al³¹ reported that lumbar curvature angle was significantly larger for women than for men, with a significant relationship between sex and different types of low-back pain.

While the quantity of injuries reported by women was significantly higher than men, no statistically significant differences were reported in the num-

ber of recommendations for Orthopedic physician follow-ups or recommendation for skilled PT. The severity of the injuries as measured by the medical recommendations rendered at the Sports Clinic was no different in proportion. The injuries sustained in Ultimate during the study period were largely mild in severity.

Actual follow-through for initiation of skilled PT was not recorded. Some attrition, therefore, may have occurred between athletes encouraged to initiate rehabilitation and their actual pursuit of skilled care. While each recorded case was a distinct injury, the same body part may have been involved, presenting a circumstance where such attrition may contribute to multiple cases. Athletes that do not pursue rehabilitation in spite of clinician recommendations are at considerable risk for sustaining another injury or worsening their condition. Incomplete or improper rehabilitation for specific injuries has been shown to contribute to risk of reinjury.^{32,33}

Limitations and Future Directions

This study presents a retrospective analysis of injuries from a sample of convenience of club sport athletes and performing arts members in a collegiate setting. There are limitations to this study that are related to its design. As athletes were not followed from pre-injury to post-injury, common characteristics of each injured athlete could not be assessed to determine how strong the correlation was between a given characteristic and actual injury onset.

Another limitation of this study is the inability to report on injury prevalence specific to each sport due to incomplete recording of each club's roster sizes over the twelve years. As such, the higher percentage of injuries reported in Ultimate might in fact be simply related to higher participation rates. Additionally, more detailed injury rates and risk levels could not be assessed as the specific number of athlete exposures was not monitored. Additionally, clinical significance of the injury rate for this study may be limited by the fact that some athletes returned for injuries to multiple body parts.

The Sports Clinic where athletes were screened represents a secondary "off-site" healthcare facility. Ideally, screening/evaluation, treatment and recommendations would be provided on-site. On-site

medical coverage would allow for more specific observation of injury trends, rules enforcement, and playing surfaces (natural grass, artificial turf, field conditions, etc). It is worth noting that a potential bias may exist where the current study captures data on individuals with increased likelihood to seek medical care/advice. Future research should include injury surveillance on-site at tournaments or within each Ultimate Club in order to capture all relevant data.

The severity of each injury was not independently measured for this study. Specific information on each athlete's ability or time to return to play/time loss was not systematically recorded. This information might provide one means of measuring the impact of each injury to the athlete and the team. Similarly, a systematic and consistent follow-up was not performed. Recommendations for further medical utilization were provided as appropriate to each athlete, but specific actions taken by each athlete were not recorded. This information would serve to describe the impact of the sustained injury on the athlete; as well as the community/health administration impact. With such data, a true cost-analysis for medical utilization could be measured.

Regarding training habits, the expectations and culture surrounding training within sports like club soccer and lacrosse have mostly been adopted from their official intercollegiate counterparts. Ultimate is not (nor has ever been) a NCAA sponsored program, and therefore does not have the history or background of athletes being formally instructed about proper training. For example, in the setting in which this study was conducted, there are no strength & conditioning coaches or athletic trainers assigned specifically to Ultimate clubs, in contrast to intercollegiate sports which have one or more of both. Subsequently, there is a considerable amount of variability in the training approaches used among different Ultimate Clubs. Future research should include injury surveillance within a club, where a specific club's training practices are observed against injury trends.

This study highlights one means by which rehabilitation specialists can affect change in the health outcomes of their community. Using the injury clinic

implemented in this study design as a starting point, one can make modifications to address aforementioned design limitations, along with continued adjustments, critical review, and retrospective analysis to continue to describe and analyze injury in sports like Ultimate.

CONCLUSION

Ultimate has traditionally been characterized as a limited contact sport with subsequently marginal attention in literature, and an assumed minimal need for on-site professional medical coverage.⁴ The epidemiological analysis of club sports athletes in this collegiate setting suggests that Ultimate athletes are at risk of sustaining injuries, supporting the need for further studies and perhaps even on-site sports medicine management. Given the number of athletic injuries that garnered recommendations for further medical utilization, additional investigation may be warranted regarding the cost benefit of on-site medical management of Ultimate injuries, including acute injuries before they become chronic conditions. Furthermore, the information provided in studies like this are useful in planning and preparation for medical coverage at Ultimate games & tournaments as well as establishing injury prevention programs tailored to the sport's specific injury profile.^{1,4,34}

REFERENCES

1. Reynolds KH, Halsmer SE. Injuries from ultimate frisbee. *WMJ : Official publication of the State Medical Society of Wisconsin*. 2006;105(6):46-49.
2. Wheaton B. *Understanding lifestyle sports : Consumption, identity, and difference*. London ; New York: Routledge; 2004.
3. Impact of Your Membership. 2010; <http://www.usultimate.org/membership/impact.aspx>. Accessed July 15, 2012.
4. Yen LE, Gregory A, Kuhn JE, Markle R. The ultimate frisbee injury study: the 2007 Ultimate Players Association College Championships. *Clin J of Sport Med*. 2010;20(4):300-305.
5. Agel J, Evans TA, Dick R, Putukian M, Marshall SW. Descriptive epidemiology of collegiate men's soccer injuries: National Collegiate Athletic Association Injury Surveillance System, 1988-1989 through 2002-2003. *JAT*. 2007;42(2):270-277.
6. Alentorn-Geli E, Myer GD, Silvers HJ, et al. Prevention of non-contact anterior cruciate ligament injuries in soccer players. Part 2: a review of prevention programs aimed to modify risk factors and to reduce injury rates. *Knee Surg Sports Traumatol Arthrosc*. 2009;17(8):859-879.
7. Gehring D, Wissler S, Mornieux G, Gollhofer A. How to sprain your ankle - a biomechanical case report of an inversion trauma. *J of Biomechanics*. 2013;46(1):175-178.
8. Imwalle LE, Myer GD, Ford KR, Hewett TE. Relationship between hip and knee kinematics in athletic women during cutting maneuvers: a possible link to noncontact anterior cruciate ligament injury and prevention. *J of Strength and Conditioning Research*. 2009;23(8):2223-2230.
9. Clansey AC, Hanlon M, Wallace ES, Lake MJ. Effects of fatigue on running mechanics associated with tibial stress fracture risk. *Med Sci Sports Exer*. 2012;44(10):1917-1923.
10. Peterson L, Junge A, Chomiak J, Graf-Baumann T, Dvorak J. Incidence of football injuries and complaints in different age groups and skill-level groups. *Am J Sports Med*. 2000;28(5 Suppl):S51-57.
11. Chomiak J, Junge A, Peterson L, Dvorak J. Severe injuries in football players. Influencing factors. *Am J Sports Med*. 2000;28(5 Suppl):S58-68.
12. Hootman JM, Dick R, Agel J. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. *JAT*. 2007;42(2):311-319.
13. Dick R, Lincoln AE, Agel J, Carter EA, Marshall SW, Hinton RY. Descriptive epidemiology of collegiate women's lacrosse injuries: National Collegiate Athletic Association Injury Surveillance System, 1988-1989 through 2003-2004. *JAT*. 2007;42(2):262-269.
14. Dick R, Putukian M, Agel J, Evans TA, Marshall SW. Descriptive epidemiology of collegiate women's soccer injuries: National Collegiate Athletic Association Injury Surveillance System, 1988-1989 through 2002-2003. *JAT*. 2007;42(2):278-285.
15. Junge A, Engebretsen L, Mountjoy ML, et al. Sports injuries during the Summer Olympic Games 2008. *Am J Sports Med*. 2009;37(11):2165-2172.
16. Boden BP, Dean GS, Feagin JA, Jr, Garrett WE, Jr. Mechanisms of anterior cruciate ligament injury. *Orthopedics*. 2000;23(6):573-578.
17. Hewett TE, Torg JS, Boden BP. Video analysis of trunk and knee motion during non-contact anterior cruciate ligament injury in female athletes: lateral trunk and knee abduction motion are combined components of the injury mechanism. *Br J Sports Med*. 2009;43(6):417-422.

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18. Myer GD, Ford KR, Khoury J, Succop P, Hewett TE. Biomechanics laboratory-based prediction algorithm to identify female athletes with high knee loads that increase risk of ACL injury. *Br J Sports Med.* 2010;45(4):245-252.
 19. Olsen OE, Myklebust G, Engebretsen L, Bahr R. Injury mechanisms for anterior cruciate ligament injuries in team handball: a systematic video analysis. *Am J Sports Med.* 2004;32(4):1002-1012.
 20. Li C, Ford ES, Zhao G, Balluz LS, Giles WH. Estimates of body composition with dual-energy X-ray absorptiometry in adults. *Am J Sports Med.* 2009;90(6):1457-1465.
 21. Weltman A, Weltman JY, Hartman ML, et al. Relationship between age, percentage body fat, fitness, and 24-hour growth hormone release in healthy young adults: effects of gender. *J of Clin Endocrinology Metabolism.* 1994;78(3):543-548.
 22. Brophy RH, Chiaia TA, Maschi R, et al. The core and hip in soccer athletes compared by gender. *Int J Sports Med.* 2009;30(9):663-667.
 23. Lephart SM, Ferris CM, Riemann BL, Myers JB, Fu FH. Gender differences in strength and lower extremity kinematics during landing. *Clin Orthop Rel Res.* 2002(401):162-169.
 24. Souza RB, Powers CM. Differences in hip kinematics, muscle strength, and muscle activation between subjects with and without patellofemoral pain. *J Orthop Sports Phys Ther.* 2009;39(1):12-19.
 25. Medrano D, Jr., Smith D. A comparison of knee joint laxity among male and female collegiate soccer players and non-athletes. *Sports Biomechanics.* 2003;2(2):203-212.
 26. Shultz SJ, Sander TC, Kirk SE, Perrin DH. Sex differences in knee joint laxity change across the female menstrual cycle. *J Sports Med Phys Fit.* 2005;45(4):594-603.
 27. Beynnon BD, Vacek PM, Murphy D, Alosa D, Paller D. First-time inversion ankle ligament trauma: the effects of sex, level of competition, and sport on the incidence of injury. *Am J Sports Med.* 2005;33(10):1485-1491.
 28. Beynnon BD, Murphy DF, Alosa DM. Predictive Factors for Lateral Ankle Sprains: A Literature Review. *JAT.* 2002;37(4):376-380.
 29. Beynnon BD, Renstrom PA, Alosa DM, Baumhauer JF, Vacek PM. Ankle ligament injury risk factors: a prospective study of college athletes. *J Orthop Res.* 2001;19(2):213-220.
 30. Springer BA, Mielcarek BJ, Nesfield TK, Teyhen DS. Relationships among lateral abdominal muscles, gender, body mass index, and hand dominance. *J Orthop Sports Phys Ther.* 2006;36(5):289-297.
 31. Norton BJ, Sahrman SA, Van Dillen FL. Differences in measurements of lumbar curvature related to gender and low back pain. *J Orthop Sports Phys Ther.* 2004;34(9):524-534.
 32. Croisier JL, Ganteaume S, Binet J, Genty M, Ferret JM. Strength imbalances and prevention of hamstring injury in professional soccer players: a prospective study. *Am J Sports Med.* 2008;36(8):1469-1475.
 33. Hagglund M, Walden M, Ekstrand J. Lower reinjury rate with a coach-controlled rehabilitation program in amateur male soccer: a randomized controlled trial. *Am J Sports Med.* 2007;35(9):1433-1442.
 34. Thacker SB. Public health surveillance and the prevention of injuries in sports: what gets measured gets done. *JAT.* 2007;42(2):171-172.