NCAA

Preliminary Report

2015 Soccer Summit

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Dates: February 23-24, 2015
Location: NCAA national office – Grant Ballroom A
Meeting chair: Brian Hainline MD, NCAA Chief Medical Officer

Background & Context:

The purpose of the Soccer Summit was to share scientific data with, and to facilitate conversation and debate by, stakeholders in the United States soccer community. It was hoped that the meeting would lead to the development of a strategic agenda to be pursued for the improvement of health and safety of not just NCAA soccer student-athletes, but soccer athletes of all ages. The meeting, organized, hosted and financially supported by the NCAA Sport Science Institute (SSI), was the first in what is to be many sport-specific summit held by the NCAA SSI. The idea for these sport-specific summits arose from the second meeting of the NCAA Concussion Task Force (July 2014), and reflects the realization that each sport has its own unique set of health and safety issues that require focused attention and novel solutions. These summits are also the product of a growing recognition that given the continuum of athlete development in the United States, the NCAA cannot address all health and safety challenges facing its student-athletes without engaging in a coordinated effort with those organizations responsible to athletes at all levels of development and participation. Consequently, the soccer summit was a collaborative meeting with organizational stakeholders from the NCAA, U.S. Club Soccer, U.S. Soccer, Major League Soccer, the National Federation of State High School Associations, and FIFA.

Over 60 attendees participated in the day and half long meeting (see attendee list in Appendix A). A structured agenda (see Appendix B) provided for both didactic presentation and open discussion in several key areas, including:

- Rest, recovery, and overtraining.
- Periodization.
- Early specialization and its implications.
- Overuse and lower extremity injuries.
- Concussion.
- Injury prevention/
- Soccer as a model of wellness for life.

This report presents the findings of the summit and is organized around five *focus areas* that are critical for a strategic agenda for the improvement of soccer health and safety. There areas were identified and agreed to by the consensus of those in attendance and were the product of the professional presentations and extensive discussion that occurred during the meeting.

It is important to note that this report is not a formal consensus document, nor is it instilled with the authority to compel change within the NCAA or any other organizations represented at the summit. Instead, the report is meant to formally document the creation of a soccer-specific strategic agenda to which the NCAA SSI and its partners are committed to pursue going forward in order to improve the overall health and safety of United States soccer athletes across the continuum of development. It is anticipated that in the months and years to come, the pursuit of this strategic agenda will produce additional recommendations and guidelines.

Focus Area #1: A Description of the NCAA Soccer Athlete.

Injury. In general, female soccer players are injured at a higher rate than their male counterparts. This includes a significantly higher proportion of knee injuries and facial injuries. Concussion occurs more frequently at the high school level than at college. In high school, the rate of concussion appears to be rising while holding steady at the college level, though this may be a function of greater awareness. Understanding similar issues at the youth soccer level is limited due to a low level of research and data collection infrastructure. No national injury surveillance system exists at the youth level, whereas injuries are tracked at both the high school (High School Rio) and the NCAA (NCAA Injury Surveillance Program) level.

Data from the NCAA Injury Surveillance Program suggests that lower extremity injuries are very common in both the men's and women's game. Sprains and strains are the two most common types of injury in women's soccer, with the knee being the most common area of injury. While the knee is the most common injured area, lateral ankle injuries are the most common specific injury in the women's game.

In the men's game, strains and then sprains are the first and second most common cause of injury, with the thigh being the most common area of injury. Lateral ankle injuries are the most common specific kind of injury in the men's game. Medial collateral knee injuries and anterior cruciate ligament injuries represent 3.6 percent and 3.0 percent of the total injuries in the women's game.

Substance Use. Compared to peer sports, soccer is unremarkable in its use rates across every substance examined - use rates are near NCAA averages across all sports, for instance. However, the use of prescription pain medication is higher in female soccer players (23 percent) than in any other sport.

Academics. Male NCAA soccer players arrive at college with the third highest high school GPA among NCAA sports, but finish with only the fifth highest GPA. Female soccer players come in with the fifth highest high school GPA and leave at the same level, but their GPAs are higher compared to their male counterparts. Eleven percent of women regret the impact that athletics has had on their choice of classes; only five percent of men feel the same. In general, female soccer athletes have a higher academic identity, which is a pattern also seen in other NCAA sports. Soccer is a top 5 sport for first year redshirts compared to all other NCAA sports. Moreover, soccer has the third highest transfer rate among men and eight highest transfer rate for women. Thirty percent of male NCAA soccer athletes believe they'll play at the professional or Olympic level; only 8 percent of women believe the same.

Focus Area #2: Periodization, acclimatization, and pre-season preparation.

In general, the science of training is much more developed than the science of recovery, and periodization is as much about recovery as it is training. In literature established using elite-level international soccer athletes, 72-96 hours or more recovery time following competition is shown to achieve pre-match values for physical performance markers and a normalizing of muscle damage due to competition-based exertion. Competition injury rates are five times greater than practice rates, and the final 15 minutes of game time demonstrate higher rates of injury when compared to the rest of the game. In addition, the literature in professional soccer suggests a six fold increase in injury rates when two matches are played per week as opposed to one. An examination of a representative, but small number of D1 NCAA soccer schedules suggests that as many as eight to 10 matchers per season do not allow for 72-96 hours of recovery.

Findings:

- The 72 hour recovery cycle may be a reasonable starting point, but they are not convinced that it applies to athletes at non-elite levels, which may require more or less time.
- Acclimatization and proper pre-season preparation is also important, but there is not a standardized approach in soccer as is there in football. The dates currently in place for pre-season preparation are not well understood arbitrarily.
- There is reason to be concerned about the increase in injury rate toward the end of games. Existing overtime rules should be re-evaluated.

Future Initiatives:

1. Explore the development of a prospective study that determines optimal rest and recovery intervals for decreases in injury. *Working group established.*

2. The Datalys Center will explore existing data in the ISP for insight into relationship between current rest / recovery practices and injury rates (results in Appendix C).

3. In collaboration with the NCAA Committee on Competitive Safety and Medical Aspects of Sports (CSMAS) and playing rules committee, consideration should be given to elimination [or restructuring] of overtime periods in NCAA soccer.

4. Develop a consensus statement on an appropriate acclimatization protocol that allows for pre-season preparation, as well as preparation for those playing at high altitude and other potentially extreme environments. *Working group established.*

5. In collaboration with the NCAA CSMAS and playing rules committee, explore changes to NCAA injury timeout rules that would allow for easier access of medical professionals to the playing field in the event of an injury. *Working group established.*

6. Identify and develop a standardized tool for all NCAA athletes for pre-participation physical assessment that includes:

a. mental health;
b. concussion baseline assessment;
c. movement / biomechanical screening;
d. nutrition, including related education on doping and supplementation; and
e. 14-point AHA screening criteria. *Working group established.*

Focus Area #3: Lower extremity injuries.

A panel of practicing clinicians shared their experiences and anecdotes about lower extremity injury in soccer across many levels of competition. All agreed that ACL injuries continue to be a significant point of concern, primarily in the women's game, whereas quad strains and hip injury is a growing area of concern in the men's game, even more so than hamstring injuries. Hip and groin injuries are increasingly common, with diagnoses of athletic pubalgia ("sport hernia") and femoro-acetabular impingement (FAI) becoming more common. Clinicians are noticing that athletes are entering college soccer with pre-existing hip and groin injuries, which is a new trend. Some hypothesize that this trend is the result of overuse injuries at a younger level, as well as corner or free kicks when athletes try to "bend" the ball, which has become a popular move.

Several clinicians also expressed concern that the schedule at the college level was not allowing enough time for athletes to recover from soft-tissue injuries. The time required to adequately recover would result in too many missed games given the current schedule. The lack of a standardized method to evaluate movement and joint performance that might reliably identify pathology or potential pathology was also of concern. If younger athletes were given better opportunities to develop sound approaches to the game while also having adequate time to rest and recover, these trends might be reversed.

At the youth level of soccer, similar concerns are also present. Lower extremity injuries are the most common kinds of injuries in youth soccer. Single-sport athletes have a higher incidence of knee pain, and taller players tend to have more knee, ankle and foot issues. Another concern: because of early specialization, many young athletes are increasing their training and competition volume at exactly the time when such increase is biologically and physiological contraindicated.

From the standpoint of injury prevention, in recent years, FIFA has made a commitment to leveraging the popularity of the sport to improve the health and well-being of international communities. The FIFA 11+ Warmup Program has been shown to significantly decrease the incidence of lower extremity injuries in those athletes who commit to it. The program was developed for the amateur community and consists of three parts with fifteen activities performed on a structured course (see http://f-marc.com/11plus/11plus/). The program supplants all other warm-up activities, and compliance with the program is inversely correlated to injury

rates. The more compliant an athlete is with the program, the lower the rate of injury. Reduction in injury rate has been documented as high as 50 percent.

Findings:

- The FIFA 11+ Warmup program has demonstrated effectiveness, but is not widely known amongst soccer coaches and athletes in the United States.

Future Initiatives:

1. Develop an inter-association position statement on the essential aspects of early specialization and the risk of overuse injuries. Seek endorsement of the statement by major soccer NGB's and medical groups. *Working group established.*
2. Socialize the effectiveness of the FIFA 11+ Warmup program within the NCAA and the soccer community at large.

Focus Area #4: Concussion and the act of heading.

Research shows that 75-90 percent of athletes who suffer a concussion return to their clinical baselines in seven to ten days. Repeated exposure to concussion during this time frame is a point of concern because the brain may be in a more vulnerable state. Research also demonstrates that the linear and angular forces across the head created by a normal act of "heading" are well below the commonly accepted threshold of concussion, though it is extremely difficult to reliably predict the forces at which a concussion can occur.

There is a growing scientific consensus that heading the ball does not directly cause concussion. However, concussion often occurs indirectly during heading attempts because of the "head to head," "body to head" or "head to ground" contact that may occur during the aerial challenge. Careful distinction would help to identify: 1) aerial challenge; 2) purposeful head to ball; 3) accidental ball to head; and 4) differentiating the head contacts that occur during the act of aerial challenge. No such formal definitions currently exist.

Moreover, early studies that implicated heading in concussion are now widely recognized as flawed in their design. Additionally, there is no scientific evidence that head gear reduces the risk of concussion in soccer. In fact, head gear may result in more aggressive behavior, known as the "risk compensation" effect, which can actually increase the rate of concussion.

Findings:

- Careful distinction must be given to the ways in which the act of heading may actually lead to a concussion.
- While there is little research about head to ball contact, there is minimal information at the high school and youth level. We do not know how often the event happens at the youth

level, nor do we know how it occurs. Additional research is needed across all levels of competition. The result of a FIFA study regarding heading and concussion in youth soccer is pending.

- In the absence of such data, there is not medical or scientific justification to recommend the appropriate age to either disallow heading or to begin permitting heading.
- Currently, there is no evidence that protective head gear reduces or eliminates the risk of concussion in soccer.
- Broad-band education efforts targeting officials, coaches, players and families that provide sport-specific and age-appropriate information about safe play are warranted. Special emphasis is needed about the important rules already in place that are meant to provide a safer competitive environment. Officials must be urged to enforce such rules more effectively.

Future Initiatives:

1. Create and validate a descriptive system of heading activity that differentiates in a way that is useful for future research. *Working group established*.
    - Use definitions created above and then do a focused pilot study of video cameras in the stands to determine how well the definitions apply. Will require a joint effort for application of definitions to be repeated across all levels of play.

2. Organize a subsequent summit among the major national soccer organizations to identify the characteristics and coaching strategies for teaching safe heading at all levels of competition.

3. Identify a plan for the study of risk compensation and the use of protective headgear, with the primary research question being: "Does behavior change when protective headgear are used in the sport of soccer?"

<u>Focus Area #5: Early soccer specialization, the continuum of athlete development, and soccer as a model of life-long wellness</u>.

Coaches have a significant role to play across the development spectrum to ensure that athletes are developed in a physically sustainable way that will carry them through their careers. The decline of physical education in American schools is implicated in this challenge.

Findings:

- Current injury trends suggest that early specialization and overuse during critical years of physical development are having a negative effect.

Future Initiatives:

3. A focused follow-up meeting between U.S. Soccer Federation, the NCAA and other stakeholders should be held later this year to identify messaging and communication strategies targeting the youth soccer community about:

   a. principles of injury prevention;
   b. risks of pre-puberty sport specialization; and,
   c. other principles that support general health and well-being, including mental health. This content should then be presented at major soccer coaching courses and at the NSCAA.

4. Define for parents what an ideal soccer experience should look like for their children.

5. Identify “best practices” for youth soccer clubs and build into a consensus set of recommendations.

APPENDIX A

A G E N D A

National Collegiate Athletic Association

Soccer Summit Meeting

NCAA national office
Grant Ballroom A

February 23-24, 2015

Day one:

8 to 8:05 a.m. 1. Welcome. (Brian Hainline – 5 minutes)

8:05 to 8:25 a.m. 2. Introductions. (All – 20 minutes)

8:25 to 8:35 a.m. 3. Task force overview. (Brian Hainline – 10 minutes)

a. Purpose.

b. Guiding questions.

8:35 to 9:20 a.m. 4. The Epidemiology of Injuries in United States Amateur Soccer. (Tom Dompier, Zack Kerr, and Dustin Currie – 25 minutes, discussion – 20 minutes

9:20 to 9:30 a.m. **BREAK**

9:30 to 10 a.m. 5. The Academic Habits and Substance Use Habits of NCAA Soccer Student-Athletes. (Tom Paskus – 15 minutes, discussion – 15 minutes)

10 to 10:50 a.m. 6. The Science of Periodization in Soccer. (Mark Kovacs - 25 minutes, discussion – 25 minutes)

10:50 to 11:20 a.m. 7. Survey of NCAA student-athletes and coaches. (Emily Kroshus - 15 minutes, discussion - 15 minutes)

11:20 a.m. to noon 8. US Soccer Federation: Sports Medicine & Science Practices. (George Chiampas and Margot Putukian – 40 minutes)

Noon to 1 p.m. **LUNCH**

1 to 2 p.m. 9. Lower Extremity Injury. (Panel – 1 hour)

- Joe Lueken.
- Hollie Walusz.
- Sue Falsone.
- Larry Lemak.
- Chris Koutres.

2 to 2:45 p.m. 10. Concussion, w/ Emphasis on Heading. (Mike McCrea via video link– 25 minutes, discussion – 20 minutes)

2:45 p.m. to 3p.m. **BREAK**

3 to 3:30 p.m. 11. The Coaching Perspective. (Rob Kehoe – 15 minutes, discusson – 15 minutes)

3:30 to 4:30 12. The Soccer Schedule and Periodization. (moderated group discussion – 60 minutes)

4:30 to 5:30 p.m. 13. Early Specialization and the Continuum of Athlete Development. (Mark Kovacs and Bill Knowles – 30 minutes, discussion – 30 minutes)

5:30 to 7:30p.m **RECEPTION & DINNER**: NCAA Hall of Champions

Day two:

8 to 9 a.m.

14. Soccer as a Model of Life-long Wellness – the FIFA Experience. (Jiri Dvorak via video & Holly Silvers—30 minutes, discussion – 30 minutes)

9 to 10:30 a.m.

15. Break-out group sessions. (Group assignments to be announced at meeting.)

    a. Group One: A review of current NCAA legislation and soccer rules for health and safety considerations. (Moderator: TBD)

    b. Group Two: Concussion and heading in Soccer. (Moderator: TBD)

    c. Group Three: Chronic and overuse injuries: Prevention and intervention strategies. (Moderator: TBD)

    d. Group Four: Strategies for a more integrated and healthy soccer development model in the United States. (Moderator: TBD)

10:30 a.m. to noon

16. Break-out group presentations and integration. Consensus building. (Moderated – 90 minutes)

Noon to 12:30 p.m.

17. Next steps. (Brian Hainline – 30 minutes)

18. Adjourn.

APPENDIX B: ATTENDEES

Last Name	First Name	Position / Organization
Abraham	Todd	Soccer Official – NCAA Soccer Rules Committee
Alexander	Ryan	Fitness Coach – U.S. Soccer
Ambrose	Chuck	President – Central Missouri University
Belzer	J.B.	Head Women's Soccer Coach – Regis University
Blais	Douglas	NCAA Division II Representative – Southern New Hampshire University
Boyce	Keri	Assistant Commissioner – Big 12 Conference
Brown	Chris	Head Men's Soccer Coach – Kenyon College
Burleigh	Becky	Head Women's Soccer Coach – University of Florida
Campbell-McGovern	Carolyn	Deputy Executive Director – Ivy League
Camperell	Evan	Head Women's Soccer Coach – Lincoln University
Chiampas	George	Chief Medical Officer – U.S. Soccer
Cigich	Ryan	NCAA National Coordinator of Officiating for Soccer
Cirovski	Sasho	Head Men's Soccer Coach – University of Maryland
Colgate	Bob	Director of Sports and Sports Medicine – National Federation of State High School Associations
Creighton	R. Alexander	Representative – American Orthopaedic Society for Sports Medicine
Currie	Dustin	Datalys Center
Dalton	Sara	Datalys Center

D'Arcy	Mick	Head Women's Soccer Coach – Central Connecticut University
Djoko	Aristarque	Datalys Center
Dompier	Thomas	Datalys Center
Echemendia	Ruben	Neuropsychologist – U.S. Soccer
Estes	Mike	Senior Associate Athletic Director – Florida Gulf Coast University
Falsone	Sue	Head of Athletic Training and Sport Performance, MNT - U.S. Soccer
Flynn	Dan	Chief Executive Officer - U.S. Soccer
Galbraith	Andrew	Senior Associate Athletic Director – Dartmouth University
Gerardo	Monica	Head Women's Soccer Coach – Whittier College
Gilbert	Jamie	Director of Girls Coaching – FC Pride
Gioia	Gerard	Pediatric Neuropsychologist – Children's National Medical Center
Gumbart	Ted	Conference Commissioner – Atlantic Sun Conference
Hainline	Brian	Chief Medical Officer - NCAA
Hunt	Tamerah	Representative - American College of Sports Medicine
Jordan	Barry	Sports Neurologist – Burke Rehabilitation Hospital
Kebach	Kari	Representative - PAC 12 Conference
Kehoe	Rob	Director of College Programs - National Soccer Coaches Association of America
Kerr	Zackery	Datalys Center
Knowles	Bill	Athletic Trainer and Soccer Conditioning Specialist
Koberlein	Earl	Senior Director of Athletics – Stanford University

Koski	Mark	Director of Sports, Events and Development – National Federation of State High School Associations
Kovacs	Mark	Consultant - NCAA
Koutures	Chris	Pediatric and Sports Medicine Specialist
Krawczak	Kerri	Director of Football Operations
Lemak	Larry	Medical Director – Major League Soccer
Lolla	Ken	Head Men's Soccer Coach – University of Louisville
Lueken	Joe	Athletic Trainer – Indiana University
McCrea	Mike	Professor of Neurosurgery and Neurology – Medical College of Wisconsin
McGrath	Steve	Head Men's Soccer Coach – Barry University
Morris	Noreen	Commissioner – Northeast Conference
Oberle	Janet	Chair – Division I Women's Soccer Committee
O'Malley	Hughie	Sports Medicine Administrator - Major League Soccer
Passalacqua	Connor	Division III SAAC Representative
Parsons	John	Director, Sport Science Institute - NCAA
Payne	Kevin	U.S. Club Soccer
Polson	Ralph	Head Men's Soccer Coach – Wofford University
Putukian	Margot	Team Physician – U.S. Soccer
Ranieri	Tracey	NCAA Division III Representative
Reed	Brittany	Division I SAAC Representative and Soccer Student-Athlete

Richardson	Deborah	Sr. Associate Commissioner - Atlantic 10 Conference
Robles	Kayla	Division II SAAC Representative and Soccer Student-Athlete
Silvers	Holly	Physical Therapist – FIFA F-Marc
Snape	Paul	Head Men’s Soccer Coach – Butler University
Sorel	Eliot	Psychiatrist & Professor – The George Washington University
Walusz	Hollie	Athletic Trainer – Boston University
Weaver	Brianne	Head Women's Soccer Coach – Bowdoin College
Weiss	David	National Basketball Association

APPENDIX C: DATALYS REPORT

The association of days of rest between games and injury in Men's and Women's Soccer

Authored by: Datalys Center for Sports Injury Research and Prevention, Inc
Report Date: April 30, 2015
Deliverable #: 2015_011 Soccer Periodization

INTRODUCTION

At the 2015 Soccer Summit held at the headquarters of the National Collegiate Athletic Association (NCAA), a group of college sport administrators, athletes, team physicians/athletic trainers, soccer coaches and researchers/scientists gathered to discuss soccer-related injury and prevention issues. Throughout the Summit, questions arose regarding the association of periodization and injury/illness. Concerns were voiced that not allowing sufficient time for recovery between two games could increase the incidence of injury. It was recommended that a retrospective study, based on current data, plus a prospective study (to be designed) be performed to address whether periodization recommendations can be made based on an analysis of days of rest between soccer games and injury rate. Previous recommendations have called for 72 hours of rest between games (Ispirlidis et al. 2008; Reilly & Ekblom, 2005).

The Datalys Center for Sports Injury Research and Prevention (hereafter known as the Datalys Center) was asked to utilize data from the NCAA Injury Surveillance Program (NCAA-ISP) to examine retrospectively the association of periodization and injury/illness. The following report examines the following research question: **Is there an association in college soccer between days of rest between games and injury/illness rates?**

METHODS

Men's and Women's Soccer data across six academic years (2009/10-2014/15) were utilized. Information regarding the NCAA-ISP is summarized below. Additional information is available at:

Kerr ZY, Dompier TP, Snook EM, et al. National Collegiate Athletic Association Injury Surveillance System: Review of methods for 2004-2005 through 2013-2014 data collection .J Athl Train. 2014;49(4):552-560. doi: 10.4085/1062-6050-49.3.58.

PARTICIPATION IN THE NCAA-ISP

The NCAA-ISP utilized a convenience sample of NCAA varsity teams from sports with the athletic trainers (ATs) working with these teams reporting injury data. The number of programs providing data varied by sport and year. For this study, a total of 44 Men's Soccer and 64 Women's Soccer programs provided 104 and 167 team-seasons of data, respectively (Table 1). Program participation ranged from one year to six years. In Men's Soccer, 12 Division I programs provided 34 team-seasons of data; 8 Division II programs provided 20 team-seasons of data; 24 Division III programs provided 50 team-seasons of data. In Women's Soccer, 24 Division I programs provided 59 team-seasons of data; 12 Division II programs provided 33 team-seasons of data; 28 Division III programs provided 75 team-seasons of data.

Table 1: Men's and Women's Soccer participation numbers, 2009/10-2014/15 academic years

Sport	Overall		Yearly participation											
			2009/10		2010/11		2011/12		2012/13		2013/14		2014/15	
	n	%[a]	n	%[a]	n	%[a]	n	%[a]	n	%[a]	n	%[a]	n	%[a]
Men's Soccer	**104**	**2.2%**	22	2.8%	18	2.3%	22	2.7%	12	1.5%	12	1.5%	18	2.2%
Division I	**34**	**2.8%**	7	3.6%	6	3.0%	6	3.0%	6	2.9%	5	2.5%	4	2.0%
Division II	**20**	**1.7%**	3	1.7%	2	1.1%	6	3.0%	2	1.0%	2	1.0%	5	2.4%
Division III	**50**	**2.1%**	12	3.0%	10	2.5%	10	2.5%	4	1.0%	5	1.2%	9	2.2%
Women's Soccer	**167**	**2.8%**	26	2.7%	31	3.2%	33	3.3%	23	2.3%	24	2.3%	30	2.9%
Division I	**59**	**3.1%**	8	2.6%	12	3.8%	11	3.5%	11	3.4%	9	2.8%	8	2.5%
Division II	**33**	**2.2%**	4	1.8%	4	1.7%	7	2.8%	4	1.6%	5	1.9%	9	3.5%
Division III	**75**	**2.9%**	14	3.3%	15	3.5%	15	3.5%	8	1.9%	10	2.3%	13	3.0%

[a] % is the percentage of NCAA member institutions that sponsor soccer that participate in the NCAA Injury Surveillance Program

DATA COLLECTION

Athletic trainers (ATs) working with soccer programs attended school-sanctioned practices and games and logged the dates of each event as well as number of participating student-athletes. When injuries occurred, they were reported into the electronic health record application used by the team medical staff. In addition to injuries, other sports-related adverse health events (illnesses) were captured, such as illness, heat-related conditions, general medical conditions, and skin infections. Data included varsity level games and practices, which included team conditioning sessions. Individual weight lifting and conditioning sessions were excluded.

The ATs completed a detailed event report on each injury/illness, including mechanism of injury/illness, event type (i.e., game or practice), time in season (i.e., preseason, regular season, postseason). After initially entering injury data, the ATs could return to view and update the data as needed over the course of a season, such as when the student-athlete returned to sports participation.

DEFINITIONS

An injury or illness was defined as resulting from participation in NCAA-sanctioned practices or games, and requiring the attention from an AT or physician. Multiple injuries from one injury event were included. Time loss injuries/illnesses were defined as those injuries/illnesses resulting in less than one day of time loss (i.e., restriction from full participation). A reportable athlete-exposure (AE) was defined as one student-athlete

participating in one NCAA-sanctioned practice or game in which he or she was exposed to the possibility of athletic injury/illness regardless of the time associated with that participation. Only athletes with actual playing time in a game were included in game exposures.

DETERMINING TIME BETWEEN GAMES

Because ATs provide information regarding when games are played, we were able to compute a value for the number of days since the previous game. In cases where this time was calculated to be over 7 days, we consulted soccer schedules on each member institution's athletics website to verify dates and correct any errors. As this study focuses on time between games, the first games of the season were dropped from analysis.

STATISTICAL ANALYSES

Data were analyzed to assess rates of injuries/illnesses sustained in NCAA Men's and Women's Soccer. Data were restricted to exposures and injuries/illnesses occurring during games only.

Injury/illness rates

We calculated injury/illness rates as the number of injuries/illnesses divided by the number of AEs. Injury/illness rates were expressed as the number of injuries/illnesses per 1000AE. Injury/illness rates were also computed for two time frames:

1) For games with 2 days or less of rest (i.e., the time since the last game was 2 days or less)
2) For games with 3 days or more of rest

Although the recommended time between games is 72 hours (Ispirlidis et al. 2008; Reilly & Ekblom, 2005), The NCAA-ISP is unable to accurately account for time differences by hours. As a result, days is used as a proxy.

Injury/illness rates were also calculated for the following types of injuries:

- All injuries and illnesses
- Injuries/illnesses resulting in time loss (at least 24 hours)
- Injuries/illnesses resulting in time loss of at least 30 days (including season-ending injuries)
- Lower extremity injuries
- Lower extremity injuries resulting in time loss (at least 24 hours)
- Lower extremity injuries resulting in time loss of at least 30 days (including season-ending injuries)
- Knee Sprains
- Ankle Sprains
- ACL Tears
- Hamstring Strains
- Illnesses

Lower extremity injuries and the particular injuries included have been found to be common injuries in soccer. As a result, we wanted to focus analyses on these injury types as well to determine if analyses differed from general findings.

Rate ratios

Injury/illness rates were compared using rate ratios (RRs). All RRs whose 95% confidence intervals (CIs) did not include 1.0 were deemed significant. The following is an example of an RR comparing the injury rates between games with 2 days or less of rest and games with 3 days or more or rest:

$$RR = \frac{\left(\frac{\sum \text{injuries during games with 2 days or less of rest}}{\sum \text{athlete-exposures during games with 2 days or less of rest}}\right)}{\left(\frac{\sum \text{injuries during games with 3 days or more of rest}}{\sum \text{athlete-exposures during games with 2 days or less of rest}}\right)}$$

Thus, in all subsequent analyses, RRs over 1.0 suggest that more days of rest have a protective effect on injuries. Data were analyzed using SAS-Enterprise Guide software (version 4.3; SAS Institute Inc., Cary, NC).

RESULTS

OVERALL INJURY FREQUENCIES AND RATES

In the 2029 and 3190 games reported in Men's and Women's Soccer during the 2009/10-2014/15 academic years, a total of 729 and 1122 injuries were respectively reported. These led to game injury rates of 17.7/1000AE and 27.2/1000AE in Men's and Women's Soccer, respectively. Of all the injuries in Men's Soccer games, 52.8% resulted in time loss, and 63.6% were sustained to the lower extremity. Of all the injuries in Women's Soccer games, 51.9% resulted in time loss, and 63.4% were sustained to the lower extremity.

COMPARISONS OF RATES BY DAYS OF REST

Most game injuries occurred in games with 3 or more days of rest (Men: 76.7%; Women: 67.3%). However, this was due to a large majority of games occurring with 3 or more days of rest (Men: 70.2%; Women: 62.6%).

Injury rates in Men's Soccer did not differ between games with 2 days or less of rest and 3 days or more of rest (Table 2). However, in Women's Soccer, the injury rate in games with 2 days or less of rest (33.5/1000AE) was higher than that of games with 3 or more days or rest (23.9/1000AE; RR=1.4; 95%CI: 1.2, 1.6; Table 3). These findings were similar when restricted to all time loss injuries, all lower extremity injuries, and all lower extremity injuries resulting in time loss.

Table 2: Men's Soccer Injury Rates (per 1000AE) and Rate Ratios by Recommendations of Days of Rest, 2009/10-2014/15 Academic Years

Type of injury	Game injury rates (per 1000AE) by number of days of rest		RR (95%CI)
	2 days or less	3 days or more	
All injuries	15.9	18.1	0.9 (0.7 , 1.0)
Time loss injuries	8.0	9.7	0.8 (0.6 , 1.1)
Time loss injuries of 30 days and over	1.1	1.0	1.1 (0.6 , 2.3)
Lower extremity injuries	10.7	11.2	0.9 (0.8 , 1.2)
Time loss lower extremity injuries	5.6	6.3	0.9 (0.7 , 1.2)
30 day+ time loss lower extremity injuries	0.7	0.7	1.0 (0.4 , 2.4)
Knee Sprains	0.6	1.1	0.6 (0.2 , 1.3)
Ankle Sprains	1.9	2.7	0.7 (0.4 , 1.2)
ACL Tears	0.1	0.2	0.5 (0.1 , 4.0)
Hamstring Strains	1.3	1.5	0.9 (0.5 , 1.6)
Illnesses	0.0	0.0	n/a

Table 3: Women's Soccer Injury Rates (per 1000AE) and Rate Ratios by Recommendations of Days of Rest, 2009/10-2014/15 Academic Years

Type of injury	Game injury rates (per 1000AE) by number of days of rest		RR (95%CI)
	2 days or less	3 days or more	
All injuries	33.5	23.9	1.4 (1.2 , 1.6)
Time loss injuries	17.0	12.6	1.4 (1.1 , 1.6)
Time loss injuries of 30 days and over	3.7	2.7	1.4 (0.9 , 2.0)
Lower extremity injuries	20.9	15.1	1.4 (1.2 , 1.6)
Time loss lower extremity injuries	10.7	7.6	1.4 (1.1 , 1.8)
30 day+ time loss	2.9	2.2	1.3 (0.8 ,

lower extremity injuries			2.0)
Knee Sprains	3.0	2.5	1.2 (0.8 , 1.8)
Ankle Sprains	4.8	3.7	1.3 (0.9 , 1.8)
ACL Tears	1.5	1.0	1.5 (0.8 , 2.8)
Hamstring Strains	1.3	0.9	1.4 (0.7 , 2.7)
Illnesses	0.0	0.1	n/a

To further explore differences in injury rates, we broke apart the days of rest further. For Men's Soccer, injury rates peaked with games providing 4 days of rest. For Women's Soccer, injury rates peaked with games with 2 days or less of rest, and again at games with 5 days of rest.

Table 4: Men's Soccer Injury Rates (per 1000AE) and Rate Ratios by Days of Rest, 2009/10-2014/15 Academic Years

	Game injury rates (per 1000AE) by number of days of rest				
Type of injury	**2 days or less**	**3 days**	**4 days**	**5 days**	**6 or more days**
All injuries	15.9	19.0	21.3	13.4	16.3
Time loss injuries	8.0	10.3	13.0	6.4	7.3
Time loss injuries of 30 days and over	1.1	1.1	1.3	0.5	0.8
Lower extremity injuries	10.7	12.0	13.9	8.7	9.0
Time loss lower extremity injuries	5.6	7.0	8.5	3.7	4.7
30 day+ time loss lower extremity injuries	0.7	0.8	0.8	0.2	0.8
Knee Sprains	0.6	1.0	1.5	0.7	0.9
Ankle Sprains	1.9	3.3	3.1	2.0	2.0
ACL Tears	0.1	0.1	0.5	0.0	0.1
Hamstring Strains	1.3	1.2	1.8	2.2	1.1
Illnesses	0.0	0.0	0.0	0.0	0.0

Table 5: Women's Soccer Injury Rates (per 1000AE) and Rate Ratios by Days of Rest, 2009/10-2014/15 Academic Years

	Game injury rates (per 1000AE) by number of days of rest				
Type of injury	**2 days or less**	**3 days**	**4 days**	**5 days**	**6 or more days**
All injuries	33.5	23.4	18.0	35.2	24.6
Time loss injuries	17.0	13.2	9.2	17.1	12.7
Time loss injuries of 30 days and over	3.7	3.4	1.5	3.5	2.8
Lower extremity injuries	20.9	14.0	11.7	23.0	15.8
Time loss lower extremity injuries	10.7	7.2	4.9	12.9	8.1
30 day+ time loss lower extremity injuries	2.9	2.6	1.0	3.5	2.4
Knee Sprains	3.0	2.3	1.3	4.7	2.9
Ankle Sprains	4.8	3.4	2.6	6.7	3.6
ACL Tears	1.5	1.0	0.4	2.0	1.1

Hamstring Strains	1.3	0.9	0.9	1.7	0.6
Illnesses	0.0	0.1	0.1	0.2	0.1

DISCUSSION

The findings suggest that the number of days between games had no effect in Men's Soccer on injury rates. However, in Women's Soccer, there was a 40% increase in injury rates among games with 2 days or less of rest when compared to games with 3 or more days of rest. According to Baird et al. (2012) and Flores et al. (2011), this gender difference may be attributed to the idea that women may be more inclined to muscle disruption and have a delayed strength recovery process when compared to men. Higher degrees of muscle disruption and increased strength deficits increase the potential for injury. Regardless of sex, when a soccer schedule is congested, it takes longer for student-athletes to fully recover psychologically (Kovacs, 2015) which may lead to mental burnout and lack of motivation. Lack of psychological astuteness may lead to a lack of focus which increases the risk of physical injury. Findings suggest further exploration of appropriate periodization for soccer season structure is needed along with assurance that soccer student-athletes are not overburdened. Sex-specific periodization needs to be examined as well.

However, when further exploring injury rates by days of rest, we found that injury rates peaked past the 72 hour recommendation for rest (Ispirlidis et al. 2008; Reilly & Ekblom, 2005). In Men's Soccer, the highest overall injury rates were found among games with four days of rest. In Women's Soccer, the highest overall injury rates were found among games with five days of rest. These findings were consistent when injuries were calculated for specific injuries (e.g., time loss injuries, overall lower extremity injuries, and specifically knee sprains and hamstring strains). The peak in injury rates at the 4 and 5 day mark for men and women, respectively, may be spurious. However, our data originates from 6 years of injury surveillance data. Findings may also suggest Delayed Onset Muscle Soreness (DOMS), which may persist up to 7 days after the strenuous exercise bout (Flores et al., 2011) subsequently, inhibit body function. Last, we hypothesize that when student-athletes are allotted adequate rest periods, they may perform with higher intensity compared to performing after inadequate rest periods. The transition from scrimmaging teammates to games with opposing players takes time to adapt and therefore, may increase the risk of injury. To better understand the issue of periodization, these qualities would need to be taken into consideration.

LIMITATIONS

Our study relied upon a convenience sample of NCAA Men's and Women's Soccer programs. Thus, our data may not be generalizable to non-participating programs. At the same time, findings may also not be generalizable to other levels of play such as high school or professional soccer.

Although 104 Men's and 167 Women's Soccer team-seasons were utilized in this analysis, there were still insufficient power to detect differences. Injuries such as ACL tears and Hamstring Strains had low reported incidence and thus yielded imprecise effect estimates. Illnesses were also rarely reported, and this may be a function of our data collection methodology in that sick student-athletes may not have their illnesses reported within an electronic health record.

At the same time, although injury rates and time points at which a peak in injury rates occurred may be attributable to coaching style (i.e. incorporating a practice on the schedule in which game-pace is mimicked due to an increased number of days off between games), our study did not account for such factors and therefore, cannot be determined. Additionally, our study did not account for other factors that may have placed soccer student-athletes at risk such as types of

practices, intensity or volume load of practices, or travel associated with games that may cause fatigue. Future research is warranted.

PREVENTION RECOMMENDATIONS AND FUTURE RESEARCH

Periodization is an optimal strategy for organization in which athletes' peak performance is developed. Essential components of periodization include the need to manipulate volume loads, progress from general to sport-specific training, and dissipate fatigue (Turner, 2011). Extending the season has also been recommended to help to spread apart games so that there are more opportunities for soccer student-athletes to acquire the recommended 72 hours of rest between games (Ispirlidis et al. 2008; Reilly & Ekblom, 2005). *However, it is also important to consider the activities occurring within practices. A greater number of strenuous practices may increase risk for injuries, particularly those resulting from overuse. Furthermore, mental health concerns, such as student-athlete burnout, must be considered. Thus, any discussion regarding modifications to soccer scheduling (e.g., practice volume, season length, etc.) must consider both the physical and mental health of student-athletes.*

Our study suggests that the number of days of rest between games may be associated with injury risk. However, peaks in injury rates occurred at different time points in Men's and Women's Soccer. In addition, trends in injury rates across days of rates fluctuated. These findings may suggest a sex-specific "sweet spot" in the number of days rest between games that provide the lowest injury rates in soccer student-athletes. However, future research needs to consider the limitations of the current study. Future research should aim to obtain more detail on games and practices, particularly related to physical and mental fatigue risk. Prospective data collection should consider the following factors:

- Practice schedules
- Types of practice sessions
- Travel schedule of games including:
    - Home vs. Away
    - Location of away games
    - Method of transport to and from away games
- Load calculations for volume of running within and across practices and games

Considering such additional individual-event characteristics will help to better assess the association of days rest between games and injury in soccer.

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