

Robert A. Huggins¹, Ryan M. Curtis¹, Courteney L. Benjamin¹, Yasuki Sekiguchi¹, Erin B. Wasserman², David A. Klossner³, William M. Adams⁴, Shawn M. Arent, FACSM⁵, Rajat K. Jain⁶, S. John Miller⁷, Matthew J. Armistead⁷, Stephen M. Borchik⁴, Christopher D'Andrea⁵, Andrew P. Landry⁸, Tyler Sylvester⁶, Alan J. Walker⁵, Douglas J. Casa, FACSM¹

¹Korey Stringer Institute, University of Connecticut, ²Datalys Center for Sports Injury Research and Prevention, ³University of Maryland,

⁴University of North Carolina at Greensboro, ⁵Rutgers University, ⁶Northwestern University, ⁷Penn State University, ⁸University of Connecticut

ABSTRACT

The impact of match congestion, training load (TL), perceived stress, fatigue and soreness on the odds of injury remains unclear. **PURPOSE:** To examine the influence of: 1) days rest between matches on injury rate (IR) and odds of injury and; 2) TL on injury, perceived stress, fatigue and soreness. **METHODS:** A prospective multi-site study tracked daily exposures, TL (distance and duration), injury and perceptual data from six Division I NCAA men's soccer teams in one season. Overall and non-contact (NC) IRs expressed per 1000 athlete exposures (AEs), and odds ratios (OR) were determined by days before and after matches. Associations between injury and changes in both TL and perception were analyzed using a multilevel logistic regression. **RESULTS:** 132 players experienced 116 injuries in 125 matches and 75 injuries in 301 practices. Overall match and practice IRs (per 1000AEs [95%CI]) were 47.9 [39.1, 56.6] and 39.0 [31.1, 46.9], respectively. Match IRs [range = 0.0 to 57.9] were highest 1 to 5 days [range = 1 to 12] from the last match. While insignificant (p > 0.21), match IRs were highest 3 days between matches (IR= 57.9 [39.0, 76.8]). Players were at increased odds of being injured in a match with 1 to 5 days since the last match vs. 6+ days (OR [95%CI] = 1.93 [1.15, 3.23]). Practice IRs were highest in the preseason (IR = 25.3 [12.5, 38.0]). Players were at increased odds of being injured in practice 3 and 4 days before vs. 1 day before (OR= 6.19 [3.03, 12.66] and 3.89 [1.92, 7.88]). Players were at increased odds (p < 0.001) of feeling fatigue (> 5) (OR= 7.04 [3.75, 13.21]) and soreness (> 5) (OR= 4.00 (2.17, 7.37)) in practice with 1 vs. 6 days since the last game. For each additional 3500m covered on a day, odds of NC injury, stress, soreness and fatigue increased (OR = 1.70 [1.38, 2.10], 1.16 [1.05, 1.28], 1.67 [1.54, 1.81], 1.82 [1.67, 1.98]), respectively. For each additional hour of activity on a day, odds of NC injury, stress, soreness and fatigue increased (1.83 [1.43, 2.34], 1.08 [0.97, 1.20], 1.28 [1.17, 1.39], 1.34 [1.22, 1.47]), respectively. **CONCLUSION:** Days between matches and acute TL increases on a given day had a negative impact on odds of injury and perception. The odds of getting injured in a match were greater with 1 to 5 days vs. 6+ days between matches. These data may be used to inform and guide the NCAA in determining optimal scheduling and recovery.

INTRODUCTION

- Fixture congestion has demonstrated increase injury rate in professional soccer.^{1,2}
- The current structure of the compressed NCAA men's soccer season has been suggested as a major cause for increased injury risk and rate during matches.³
- Previous findings determined that injury rates in matches with ≤ 2 days rest versus 3 or more days rest did not differ for men's soccer (Rate Ratio (RR)= 0.9, (95%CI: 0.7, 1.0)).³
- Previous investigations examining injury rate have focused on days between matches with little attention paid to the training load or perceived stress, soreness and fatigue.

PURPOSE

To examine the influence of days rest between matches on injury rate and odds of injury as well as training load on injury, perceived stress, fatigue and soreness.

METHODS

- Prospective multi-site study tracked daily athlete exposures, injuries, training load and perceptual data in practices and matches from preseason to end of season.
- Overall and non-contact (NC) IRs expressed per 1000 athlete exposures (AEs), and odds. Odds ratios (OR) were determined by days between matches.
- Duration and distance was collected using GPS devices (Polar Team Pro, Polar Electro Inc, Bethpage, NY).
- Associations between injury and changes in both TL and perception were analyzed using a multilevel regression with binary distribution and a logit link using SAS-Enterprise Guide software (version 4.3; SAS Institute Inc., Cary,NC). When appropriate, a random intercept for athlete ID was included, and degrees of freedom were calculated with the between-within method.

RESULTS

Table 1. Practice and Match Injuries by Days Relative to Previous Match

Days from last match	Practices (IR/1000AE)			Matches (IR/1000AE)		
	All Injuries	Acute Non-Contact	Non-Contact/Overuse	All Injuries	Acute Non-Contact	Non-Contact/Overuse
Preseason	25.3 (12.5, 38.0)	6.7 (0.1, 13.3)	18.5 (7.6, 29.5)	33.3 (0.7, 66.0)	8.3 (0.0, 24.7)	8.3 (0.0, 24.7)
1	9.7 (1.2, 18.2)	1.9 (0.0, 5.7)	5.8 (0.0, 12.4)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)
2	6.7 (2.9, 10.4)	2.2 (0.0, 4.4)	3.3 (0.7, 6.0)	52.9 (20.1, 85.7)	10.6 (0.0, 25.2)	10.6 (0.0, 25.2)
3	15.9 (9.3, 22.6)	4.3 (0.9, 7.8)	5.1 (1.3, 8.8)	57.9 (39.0, 76.8)	17.7 (7.2, 28.1)	22.5 (10.7, 34.3)
4	17.7 (8.1, 27.3)	10.9 (3.3, 18.4)	13.6 (5.2, 22.0)	53.9 (35.2, 72.5)	11.8 (3.1, 20.5)	18.5 (7.6, 29.5)
5	9.6 (0.2, 18.9)	2.4 (0.0, 7.1)	4.8 (0.0, 11.4)	52.1 (29.8, 74.4)	14.9 (3.0, 26.8)	22.3 (7.7, 36.9)
6	12.7 (9.8, 15.5)	4.1 (2.4, 5.7)	6.9 (4.8, 9.0)	22.9 (0.5, 45.3)	5.7 (0.0, 16.9)	5.7 (0.0, 16.9)
7-14	17.2 (0.3, 34.1)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	29.2 (10.1, 48.3)	9.7 (0.0, 20.8)	9.7 (0.0, 20.8)
Total	39.0 (31.1, 46.9)	7.1 (3.7, 10.4)	10.8 (6.6, 14.9)	47.9 (39.1, 56.6)	12.8 (8.3, 17.3)	16.9 (11.7, 22.1)

Table 2 Odds of Injury as Distance and Duration Increases

Summary measure	Injury Odds Per SD Increase For All Players and Starters Only (Odds Ratio (95% CI))					
	Overall Injury	Acute Non-Contact Injury	Non-Contact Overuse Injury	Acute Non-Contact Injury (Starters)	Acute Non-Contact Injury (Starters)	Non-Contact Overuse Injury (Starters)
Distance run on that day – per 3500 m increase	1.78 (1.59, 2.00)	1.70 (1.38, 2.10)	1.18 (0.97, 1.44)	1.71 (1.49, 1.97)	1.63 (1.26, 2.10)	1.52 (1.28, 1.81)
Distance run in past 3 days – per 5500 m increase	0.88 (0.76, 1.02)	1.04 (0.80, 1.36)	1.36 (1.09, 1.69)	0.73 (0.61, 0.87)	0.82 (0.59, 1.15)	0.78 (0.63, 0.97)
Duration of activity on that day – per 1-hour increase	1.83 (1.59, 2.12)	1.83 (1.43, 2.34)	1.12 (0.90, 1.40)	1.93 (1.60, 2.33)	1.96 (1.41, 2.72)	1.49 (1.20, 1.85)
Duration of activity in past 3 days – per 2-hour increase	0.81 (0.69, 0.94)	1.12 (0.85, 1.47)	1.30 (1.04, 1.62)	0.72 (0.60, 0.88)	1.06 (0.74, 1.50)	0.75 (0.60, 0.94)

Table 3 Odds of Feeling Fatigue, Stress and Soreness as Distance and Duration Increases

Summary measure	Odds Per SD Increase (Odds Ratio (95% CI))		
	Fatigue >5	Stress >5	Soreness >5
Distance run on that day – per 3500m increase	1.82** (1.67, 1.98)	1.16* (1.05, 1.28)	1.67** (1.54, 1.81)
Distance run in past 3 days – per 5500m increase	1.72** (1.57, 1.89)	1.26** (1.13, 1.41)	1.63** (1.49, 1.78)
Duration of activity on that day – per 1-hour increase	1.43** (1.34, 1.55)	1.14* (1.01, 1.29)	1.34** (1.25, 1.44)
Duration of activity in past 3 days – per 2-hour increase	1.39** (1.25, 1.53)	1.10* (1.01, 1.20)	1.34** (1.22, 1.48)

*p<0.05; **= p<0.0001

RESULTS

- Six men's teams representing 5 NCAA conferences were collected over 2 competitive seasons 2016 (n=2) and 2017 (n=4).
- 132 players experienced 116 injuries in 125 matches and 75 injuries in 301 practices.
- **MATCH OVERALL: Injury rate for 1-5 days between matches was 1.93 times higher than 6+ days between matches** (IRR: 1.93 [1.15, 3.23], p=0.01). For starters. For starters (IRR:1.82 (0.98, 3.37), p=0.06
- **MATCH NON-CONTACT OVERUSE:** Injury rate for 1-5 days between games was 2.38 times higher vs. 6+, with support trending towards statistical significance (IRR: 2.38 (0.94, 6.08), p=0.07).
- **PRACTICE OVERALL: Injury rates were highest in the preseason** (IR: 25.3 [12.5, 38.0]) and also on day 4 after the last game (IR=17.7 [CI:8.1, 27.3] respectively).
- **PRACTICE NON-CONTACT OVERUSE:** Preseason (IR: 18.5 [7.6, 29.5]) and 4 days (IR: 13.6 [5.2, 22.0]) removed from a game are elevated above the seasonal average injury rates (IR: 6.9 [4.8, 9.0]), although statistical significance testing was not possible to low injury counts (n=41).
- **Players were at increased odds** (p < 0.001) of feeling fatigue (> 5) (OR= 7.04 [3.75, 13.21]) and soreness (> 5) (OR= 4.00 (2.17, 7.37)) in practice with 1 vs. 6 days since the last game.
- **Odds of NC injury increased 70%** for each additional 3500m covered on a day and 83% for each additional 1hr increase.
- **Odds of feeling stress, sore and fatigue increased 82%, 16%, and 67%, respectively** for each additional 3500m covered in a day.

CONCLUSIONS

- Higher injury rates occurred with 1-5 days between matches vs. 6+ for all injuries and non-contact/overuse injuries.
- Injury rates in the preseason were substantially elevated (often 2-fold increase) above seasonal average, regardless of injury classification.
- Increases in training load resulted in increased odds of overall and acute non-contact injury as well as feelings of stress fatigue and soreness.
- The current congested schedule of men's collegiate soccer appear to be putting players at increased odds for injury.

REFERENCES

1. Dupont G, Nedelec M, McCall A, McCormack D, Berthoin S, Wisløff U. Effect of 2 soccer matches in a week on physical performance and injury rate. *Am J Sports Med* 2010;38(9):1752–8.
2. Dellal A, et al. The effects of a congested fixture period on physical performance, technical activity and injury rate during matches in a professional soccer team. *Br J Sports Med*. 2015 Mar;49(6):390-4.
3. 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):552–60.