Benefits of sleep on reduction of injury and illness in Division I female soccer players

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ABSTRACT

Injuries in soccer athletes continues to rise and there is a cause for concern. Collegiate athletes have physically demanding workloads and struggle to sleep an adequate amount each night. A potential association is how sleep could play a role in an athletes' injury. 24 NCAA DI women's soccer athletes were utilized during the Fall 2019 season. Athletes self-reported their daily hours slept and the athletic trainer tracked and classified athletes' injury and illness status: no-injury, medical attention injury, or time loss injury. K-mean clustering was utilized to classify the athletes into 3 groups: injury/illness-free group (n=12), mild-to-moderate injury/illness group (n=7), and heavy injury/illness group (n=5). Sleep was statistically significantly lower in the heavy-injury group than other groups and small effect sizes were detected (d_{31} = .282, *p* < .001; d_{32} = .278, *p* < .001). Based on the data, it appears hours slept plays a factor in female soccer athletes' risk of injury.

Keywords: Sport medicine, Injury, Sleep, Workload, Sports performance, Collegiate sports.

INTRODUCTION

Participation in female collegiate sports is on the rise and injuries in these athletics events continue to increase as the demand placed on female athletes intensifies. While participation and injuries in female collegiate sports has grown substantially, the research of these sports and their subsequent injuries has failed to keep pace. According to the National Collegiate Athletic Association (NCAA), the overall injury rate in NCAA women's soccer is 7.3 per 1,000 athlete exposures (Powell, 2017). Of these injuries, 34% resulted in an average of 3-6 missed days of sport related activity. While injuries are not exclusive to the female population or soccer in general, female soccer players are an underserved and under resourced population that deserves a deeper look into the injury epidemic that has been described by the NCAA. Soccer is a contact sport in which the chances of injury and illness are common; however, studies must understand what a sports injury is and how to distinguish between them (Finch, 1997; Junge & Dvorak, 2000).

In deciding what is included as a sports injury or illness, the phenomenon should be directly related to the sport, yet there is some debate as to what ailments should be included (Junge et al., 2004). Fuller et. al (2006) labelled an injury as any physical complaint that results from a training session or competition regardless of the need for medical attention or time away from sport activity (Fuller et al., 2006). They also determined that it is best to distinguish between injuries is to classify them as a medical attention injury (MAI) or time loss injury (TLI). Hagglund, Walden, Bahr & Ekstrand (2005) state that a time loss injury definition is practical for all playing levels of soccer (Hagglund, 2005). While illnesses may not be the direct result of sport, they are believed to be indirectly related to athletic participation in many instances (Nimmo et al., 2007). According to an article by Nimmo and Ekblom, there is cause to believe that fatigue can create immune responses and that intense bouts of exercise have been related to suppressed immune system for up to 72 hours post exercise (Nimmo & Ekblom, 2007). This increase in immunosuppressant response post-intense exercise combined with the rigors of being a student-athlete shows reason to include illness as an exercise or sport related occurrence.

In combination with intense exercise, strict training regiments and course schedules, athletes' must find a balance between their activities, sleep and recovery. Interestingly, athletes who sleep less than eight hours a night are at 1.7 times greater risk of sustaining an injury than those who sleep at least eight hours a night (Milewski et al., 2014). Furthermore, Hausswirth & Mujika (2013) reported that a reduction in sleep quality and quantity could result in an autonomic nervous system imbalance which can simulate the symptoms of overtraining syndrome (Hausswirth & Mujika, 2013). Conversely, sufficient sleep can help to increase perceptual and motor learning as these processes continue into and throughout a sufficient night's sleep. Athletes must be able to conceptualize the data and information provided by coaches and opposing teams to be successful on the field. A lack of sleep and subsequent recovery may inhibit an athletes' ability to take in information and make quick adjustments needed to perform at their peak. While there are many factors that may play a role in sports injuries such as lack of conditioning, lack of focus, strength and power, muscular imbalances and more, the focus of this study will be on the relationship between sleep quantity and injury and illness.

The data for collegiate athletes' sleep is limited in regard to what extent sleep affects the risk of sustaining injuries. In a large sample of Division I collegiate athletes, the average sleep duration was 6.98 hours per night with almost 40% sleeping less than 7 hours. When comparing non-athlete college students, the average hours of sleep per night was 7.02 hours (Lund et al., 2010). Chronic lack of sleep has been linked to a greater risk of musculoskeletal injury in adolescent athletes, however there is not enough data to determine a relationship between acute sleep deprivation and injury at this time (Gao et al., 2019). Lack of sleep may

impair psychomotor function in adults, as well as lessen reaction times and cognitive function (Milewski et al., 2014). Lower cognitive performance has been demonstrated to be associated with an increase in injury risk based on changes in athletes' biomechanical patterns which results in increases in movement deficiency and dysfunction (Avedesian et al., 2022). Furthermore, injured athletes performed worse on baseline measures of cognition compared to those athletes who were not injured (Avedesian et al., 2022). Similarly, when college football players were examined throughout a season, 23 of 29 athletes with lower extremity injury had slower reaction time during the IMPACT test battery (Wilkerson, 2012). Reduction in functional cognitive processing and slower reaction time may lead to injury in contact sports such as soccer.

Deviations in normal sleep may impair an individual's endurance and physical capacity as sleep deprivation has been shown to decrease VO_2max in cyclists (Bond et al., 1986), time to exhaustion in volleyball players (Azboy & Kaygisiz, 2009), and decrease in anaerobic Wingate test scores in soccer players, judokas, and judo competitors (Abedelmalek et al., 2013; HajSalem et al., 2013; Souissi et al., 2013). Mah and colleagues showed that basketball players who increased their sleep to at least ten hours per night increased not only physical performance, but also reported higher scores on emotional well-being (Mah et al., 2011). According to the American College of Sports Medicine, decreases in emotional well-being and increases in stress have been linked to increases in injury and illness in athletic activity (Herring et al., 2017).

Therefore, the purpose of this study is to investigate a potential relationship between quantity of sleep of division I female soccer players and rates of injury and illness during the full competition season.

MATERIAL AND METHODS

Participants
All participants were current members (n=24) of a NCAA division 1 soccer team. All participants were between the ages of 18-22 years old. Data collection occurred during the duration of the 2019 fall collegiate soccer season totalling 69 days of participation including 20 match days. Approval from the University of Mississippi's Institutional Review Board was obtained.

Sleep
Athletes were required to complete a daily questionnaire implemented by the staff to gauge a variety of health and well-being parameters that may affect their performance and recovery each day. This survey was completed in the Coach Me Plus (CMP) (Coach Me Plus, Buffalo, NY, USA) system. CMP is a subscription service that is utilized to store each athlete's biometric data, performance metric data, and self-reported data such as sleep. Athletes were required to have the survey completed and submitted a minimum of 1-hour prior to the start of each practice, and 4-hours prior to each game. Each athlete self-reported the number of hours they slept the previous night as a part of the daily questionnaire they completed in the reporting system. This questionnaire was filled out every day and the athletes were continually encouraged to provide an accurate number of hours slept. To encourage compliance and accuracy, the research team asked athletes to record the last time that they saw on the clock prior to falling asleep and the first time they saw on the clock upon waking. The research team exported the data from CMP into an excel spreadsheet for the entire data collection period.

Injury and illness tracking
The Athletic Trainer evaluated and tracked all injuries and illnesses throughout the course of the entire soccer season, including preseason, competition season and championship season. The Athletic Trainer utilized an electronic medical record to document each athletes' injuries, illnesses, daily medical treatment or

rehabilitation, and physician encounters. An injury or illness was specified as a medical encounter with the Athletic Trainer in which the athlete received treatment for a given condition and was monitored, modified, or removed from any team training activity. Injury was distinguished between the types of injury or illness that the athlete had sustained to include 3 groups: Healthy/injury and illness-free, Medical Attention Injury (MAI), or Time-loss injury (TLI). Athletes were assigned a number each day based on their injury or illness grouping. Any athlete who was not receiving medical attention for an injury or illness on a given day was assigned a zero, meaning the athlete was healthy and injury or illness-free. If an athlete sustained an injury or illness that required medical attention but was not withheld from training or competition was assigned the numeral one for a medical attention injury or illness (MAI). If an athlete was injured and withheld from training or competition, they were assigned the number two for a time-loss injury or illness (TLI). Injuries and illnesses were convertible from a MAI to a TLI or inversely (Fuller et al., 2006). If an athlete initially had a time-loss injury or illness but was cleared to play while still receiving medical attention, they will move from a two to a one on the data collection sheet.

Statistical analysis
Data were analysed using IBM SPSS Software (SPSS; V.25.0.0.0; SPSS, Inc, Chicago, IL, USA). A cluster analysis was utilized to enable individuals' tendency to get injured/ill, in turn to test the differences across the clusters. To determine the optimal number of groups (k), the elbow method was utilized (Bholowalia et al., 2014). The within-cluster sum of square (*WSS*) was minimized when three clusters were extracted. ANOVA tests were followed to test the statistical differences in sleep across the injury groups. Q-Q plots of residuals confirmed that each group was fairly normally distributed. Tukey's post-hoc tests were conducted to identify the statistically significant difference of sleep across injury groups.

RESULTS

During the 13-week season, participants totalled 69 days of participation, including 20 matches. Each participant's number of days with no injury, MAI, or TLI are as shown in Table 1.

Table 1. Participants' days of injury/illness.

Number of days (days out of 69 participation days)				
Participant ID	No Injury/illness	MAI	TLI	Injury/illness Group
1	67	2	0	1
2	36	27	6	2
3	67	2	0	1
4	61	8	0	1
5	68	1	0	1
6	68	0	1	1
7	22	23	24	2
8	43	16	10	2
9	69	0	0	1
10	53	15	1	2
11	63	6	0	1
12	69	0	0	1
13	21	45	3	3
14	20	42	7	3
15	62	6	1	1
17	14	54	1	3
18	65	4	0	1

19	13	51	5	3
20	52	17	0	2
21	54	14	1	2
22	69	0	0	1
23	53	16	0	2
24	69	0	0	1
25	30	37	2	3

*Note: * 1: Injury/illness-free group, 2: Mild to moderate injury/illness occurrence group, 3: Heavy injury/illness occurrence group.*

Table 2. Descriptive statistics.

	Sleep (hours)		
Injury Group	M	SD	N
1. Injury/illness-free	7.931	1.333	822
2. Mild-injury/illness	7.918	1.305	478
3. Heavy-injury/illness	7.559	1.275	345

Note: The average number (M) and standard deviation (SD) of hours slept by each classified injury group as well as the total sample size (N).

Based on the number of days in each injury category results, a k-means clustering analysis was performed to categorize participants. After analysing the k-means clustering results, the participants were categorized into three groups: Injury/illness-free group (12 participants), mild to moderate injury/illness occurrence group (7 participants), and heavy injury/illness occurrence group (5 participants). Participants within the mild-moderate injury/illness occurrence group were listed as having an MAI or TLI for 22-69% of the training days, while those participants within the heavy injury/illness occurrence group were listed as having an MAI or TLI for 70% or more of the training days. Welch's ANOVA suggested that sleep was statistically significantly different across the injury groups. Small effect sizes were detected (sleep: η^2 = .013). Sleep was statistically significantly lower in the heavy-injury group than other groups and small effect sizes were detected (d_{31} = .282, p < .001; d_{32} = .278, p < .001).

Additionally, a Pearson correlation to look at injury and illness in a time-sequencing format and while the data did not prove to be statistically significant (p = .057), there appears to be a negative association between sleep loss and injury and illness rates in this population.
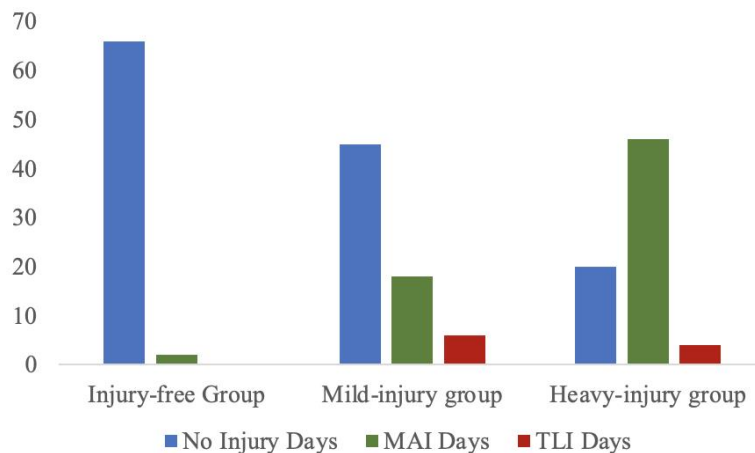
Note. This figure depicts average number of days each group spent injured and type of injury.

Figure 1. Final cluster centres.

Note. This figure depicts the average hours of sleep each injury classified group slept on average throughout the season.

Figure 2. Sleep plot.

DISCUSSION

The aim of this study was to investigate the relationship and potential impact of sleep on injury and illness rate in female college soccer players. The study found significant differences across groups in the average number of hours slept per night, while sleep was the lowest in the heavy injured group. Studies utilizing soccer athletes investigating sleep over a long-term duration, like this study, found comparable results. When examining soccer players for a period of over 4 months, Nédélec et al. found sleep efficiency was lower than baseline values before an injury occurred (Nédélec et al., 2019). When investigating soccer athletes for 6 months, there is also potential evidence indicating a negative correlation between sleep efficiency, injury severity and number of injuries which agrees with the findings of this paper (Silva et al., 2020). Professional soccer players who suffered 3 or more musculoskeletal injuries in a season were more than 2.3 times more likely to report sleep disturbances than those who didn't sustain severe musculoskeletal injuries (Gouttebarge et al., 2016).

There are mixed results about the associations between sleep and injury. The cause for mixed results could be due to the acute nature of the studies compared to the others. When examining just the night before, potentially only one day of extreme sleep loss is not enough to elicit a negative affect compared to overtime the accumulation of sleep debt may be more detrimental to an athlete's risk of injury, recovery, and performance. Similar results were seen with cross-country runners where poor sleep quality was associated with higher injury risk ($p = .04$). Burke et al. found contradictory results to those of this current study finding no association between sleep duration and injury (Burke et al., 2020). This discrepancy could be due to the physical nature of football and heightened injury rate. The result of this study agrees with the study by Milewski et al. (2014) where reported athletes who slept less than 8 hours per night were 1.7 times more likely to have had an injury compared to their counterparts who slept more than 8 hours per night (Milewski et al., 2014).

While the recommended duration of sleep is 7-9 hours per night, it is suggested athletes may need more than that to perform at an optimal level (Mah et al., 2011; Schwartz & Simon, 2015). Previous literature has suggested that college athletes have reduced sleep quantity relative to other non-athlete young healthy adults 18-25 years old (Ohayon et al., 2017). This decrease in total quantity of sleep could be due to several confounding factors related to sport and academic requirements. In one complimentary study, male and

female collegiate tennis players who increased their sleep quantity to 9 hours per night on average saw significant improvements in tennis serving accuracy (Schwartz & Simon, 2015). Similarly in collegiate male basketball players, with the goal of at least 10 hours of sleep a night, saw improvement in shooting accuracy percentage in free throw and 3-point shots by 9 and 9.2% (Mah et al., 2011).

Sleep is essential for athletes to be able to recovery and perform at a high level (Venter, 2012). While research is lacking, there is evidence to suggest there is a potential reduced injury risk and improved with performance when adequate hours of sleep is achieved. Skein et al. (2013) investigated sleep deprivation and normal night sleep following a rugby match and compared the results of between the 16-hour post-match measures (Skein et al., 2013). The sleep deprivation group had moderate to large effects on cognition, creatine kinase, c-reactive protein, core temperature and mean and peak CMJ performance while there was no difference in GPS parameters, player contacts and RPE data compared to the normal night's sleep condition. 16 hours following a game, rugby players who were sleep deprived had significantly higher increases in C-reactive protein and creatine kinase (Skein et al., 2013). The increase in C-reactive protein is a response to increased inflammation, while the increase in creatine kinase indicates greater damage of skeletal muscles. CMJ performance from post-match to 16 hours post-match was also decreased by -4.4 ± 6.5% indicating recovery was also affected by sleep deprivation compared to the control group which increased by 5.7 ± 20.5% (Skein et al., 2013). This gives additional insight into the importance of sleep after training to allow the body to optimally recover and potentially reduce risk of injury.

This study is not without limitations with sleep being self-reported and athletes could have inaccurately reported their time asleep. Another limitation of this study was the small sample size due to only utilizing one team. Furthermore, the athletes were only asked about the quantity of sleep that they gained each night, the research team failed to assess the quality of sleep. There are similar relationships that may have been observed between sleep quality and injury and illness rates as compared to sleep quantity and injury and illness rates. Further studies may assess sleep quality via a short survey when assessing sleep quantity. Additionally, all subjects were college athletes, and while sleep quantity and quality were emphasized and social events that limited sleep in both quantity and quality were discouraged, the research team was unable to control for outside social events. Student athletes are also subject to extreme stress, anxiety, and depression. The research team was unable to look at these compounding factors as they related to loss of sleep or the role that anxiety, depression or other psychosocial conditions may play on increased rates of injury and illness. As stated in the literature review extreme bouts of exercise may contribute to increased rates of injury when combined with lack of sleep and recovery, however this research failed to look at overtraining as a sole cause for injury and illness rates in this population.

CONCLUSIONS

Statistically significant relationships were found between groups for averages in hours of accumulated sleep. Sleep appears to have a large effect on the occurrence of injury and illness in female collegiate soccer players. As seen in Figure 2, as average hours of sleep accumulated gets farther from 8 hours of sleep per night, the risk of injury and illness increases. While this study shows that there may be a beneficial relationship between increased sleep and reduction of injury and illness, further studies are needed to draw conclusions between chronic sleep deprivation in athletics and the ability of the body to remain injury and illness free. Future research may also look further at the cause of sleep loss in athletics as well as the exact relationship between sleep, recover, injury and illness. Athletes are subjected to rigorous training at various hours of the day, as well as erratic behaviour and sleep schedules. These factors combined with the need to perform academically and socially may all factor into decreases in sleep and increases in injury and illness rates

among collegiate athletes. There may also be a causal relationship between poor quality of sleep and increases in injury and illness. A research agenda could establish a sleep quality questionnaire to assess the quality vs quantity of sleep and delve further into the relationship between poor quality sleep and increases in injury and illness in this population. Sleep quality could also be linked to internal factors in this population such as their menstrual cycle, more specifically the phase of their menstrual cycle, which has been linked to decreases in self-reported quality of sleep (Baker et al., 2004).

AUTHOR CONTRIBUTIONS

Dr. Corbit Franks – Principal investigator, collected all of the data. Julia Phillips – Aided in manuscript development and data analysis process. Kaitlyn Armstrong – Aided in manuscript development and data analysis process. Thomas Andre – Co-PI, aided in data collection and development. Jangwoo Jo – Aided in statistical analysis and results. Melinda Valliant – Co-PI, oversaw project and aided in data collection.

SUPPORTING AGENCIES

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

REFERENCES

Abedelmalek, S., Chtourou, H., Aloui, A., Aouichaoui, C., Souissi, N., & Tabka, Z. (2013). Effect of time of day and partial sleep deprivation on plasma concentrations of IL-6 during a short-term maximal performance. European Journal of Applied Physiology, 113(1), 241-248. https://doi.org/10.1007/s00421-012-2432-7

Avedesian, J. M., Forbes, W., Covassin, T., & Dufek, J. S. (2022). Influence of Cognitive Performance on Musculoskeletal Injury Risk: A Systematic Review. The American Journal of Sports Medicine, 50(2), 554-562. https://doi.org/10.1177/0363546521998081

Azboy, O., & Kaygisiz, Z. (2009). Effects of sleep deprivation on cardiorespiratory functions of the runners and volleyball players during rest and exercise. Acta Physiologica Hungarica, 96(1), 29-36. https://doi.org/10.1556/APhysiol.96.2009.1.3

Bholowalia, P., & Kumar, A. (2014). EBK-Means: A Clustering Technique based on Elbow Method and K-Means in WSN. International Journal of Computer Applications, 105(9).

Bond, V., Balkissoon, B., Franks, B. D., Brwnlow, R., Caprarola, M., Bartley, D., & Banks, M. (1986). Effects of sleep deprivation on performance during submaximal and maximal exercise. The Journal of Sports Medicine and Physical Fitness, 26(2), 169-174.

Burke, T. M., Lisman, P. J., Maguire, K., Skeiky, L., Choynowski, J. J., Capaldi, V. F., Wilder, J. N., Brager, A. J., & Dobrosielski, D. A. (2020). Examination of Sleep and Injury Among College Football Athletes. Journal of Strength and Conditioning Research, 34(3), 609-616. https://doi.org/10.1519/JSC.0000000000003464

Finch, C. F. (1997). An Overview of Some Definitional Issues for Sports Injury Surveillance. Sports Medicine, 24(3), 157-163. https://doi.org/10.2165/00007256-199724030-00002

Fuller, C. W., Ekstrand, J., Junge, A., Andersen, T. E., Bahr, R., Dvorak, J., Hagglund, M., McCrory, P., & Meeuwisse, W. H. (2006). Consensus statement on injury definitions and data collection procedures

in studies of football (soccer) injuries. Scandinavian Journal of Medicine and Science in Sports, 16(2), 83-92. https://doi.org/10.1111/j.1600-0838.2006.00528.x

Gao, B., Dwivedi, S., Milewski, M. D., & Cruz, A. I. (2019). Lack of Sleep and Sports Injuries in Adolescents: A Systematic Review and Meta-analysis. Journal of Pediatric Orthopaedics, 39(5), e324-e333. https://doi.org/10.1097/BPO.0000000000001306

Gouttebarge, V., Aoki, H., Ekstrand, J., Verhagen, E. A. L. M., & Kerkhoffs, G. M. M. J. (2016). Are severe musculoskeletal injuries associated with symptoms of common mental disorders among male European professional footballers? Knee Surgery, Sports Traumatology, Arthroscopy : Official Journal of the ESSKA, 24(12), 3934-3942. https://doi.org/10.1007/s00167-015-3729-y

Hagglund, M. (2005). Methods for epidemiological study of injuries to professional football players: developing the UEFA model. British Journal of Sports Medicine, 39(6), 340-346. https://doi.org/10.1136/bjsm.2005.018267

HajSalem, M., Chtourou, H., Aloui, A., Hammouda, O., & Souissi, N. (2013). Effects of partial sleep deprivation at the end of the night on anaerobic performances in judokas. Biological Rhythm Research, 44(5), 815-821. https://doi.org/10.1080/09291016.2012.756282

Hausswirth, C., & Mujika, I. (2013). Recovery for performance in sport. Human Kinetics.

Herring, M. P., Hallgren, M., & Campbell, M. J. (2017). Acute exercise effects on worry, state anxiety, and feelings of energy and fatigue among young women with probable Generalized Anxiety Disorder: A pilot study. Psychology of Sport and Exercise, 33, 31-36. https://doi.org/10.1016/j.psychsport.2017.07.009

Junge, A., & Dvorak, J. (2000). Influence of Definition and Data Collection on the Incidence of Injuries in Football. The American Journal of Sports Medicine, 28(5_suppl), 40-46. https://doi.org/10.1177/28.suppl_5.s-40

Junge, A., Dvorak, J., Graf-Baumann, T., & Peterson, L. (2004). Football Injuries during FIFA Tournaments and the Olympic Games, 1998-2001. The American Journal of Sports Medicine, 32(1_suppl), 80-89. https://doi.org/10.1177/0363546503261245

Lund, H. G., Reider, B. D., Whiting, A. B., & Prichard, J. R. (2010). Sleep Patterns and Predictors of Disturbed Sleep in a Large Population of College Students. Journal of Adolescent Health, 46(2), 124-132. https://doi.org/10.1016/j.jadohealth.2009.06.016

Mah, C. D., Mah, K. E., Kezirian, E. J., & Dement, W. C. (2011). The Effects of Sleep Extension on the Athletic Performance of Collegiate Basketball Players. Sleep, 34(7), 943-950. https://doi.org/10.5665/SLEEP.1132

Milewski, M. D., Skaggs, D. L., Bishop, G. A., Pace, J. L., Ibrahim, D. A., Wren, T. A. L., & Barzdukas, A. (2014). Chronic Lack of Sleep is Associated With Increased Sports Injuries in Adolescent Athletes. Journal of Pediatric Orthopaedics, 34(2), 129-133. https://doi.org/10.1097/BPO.0000000000000151

Nédélec, M., Leduc, C., Dawson, B., Guilhem, G., & Dupont, G. (2019). Case Study: Sleep and Injury in Elite Soccer-A Mixed Method Approach. Journal of Strength and Conditioning Research, 33(11), 3085-3091. https://doi.org/10.1519/JSC.0000000000002251

Nimmo, M. A., & Ekblom, B. (2007). Fatigue and illness in athletes. Journal of Sports Sciences, 25(sup1), S93-S102. https://doi.org/10.1080/02640410701607379

Ohayon, M., Wickwire, E. M., Hirshkowitz, M., Albert, S. M., Avidan, A., Daly, F. J., Dauvilliers, Y., Ferri, R., Fung, C., Gozal, D., Hazen, N., Krystal, A., Lichstein, K., Mallampalli, M., Plazzi, G., Rawding, R., Scheer, F. A., Somers, V., & Vitiello, M. V. (2017). National Sleep Foundation's sleep quality recommendations: first report. Sleep Health, 3(1), 6-19. https://doi.org/10.1016/j.sleh.2016.11.006

Powell, R. (2017, June 1). Overuse injuries and periodization educational resources. Retrieved from [Accessed 2024, April 22]: http://www.ncaa.org/sport-science-institute/overuse-injuries-and-periodization-educational-resources

Schwartz, J., & Simon, R. D. (2015). Sleep extension improves serving accuracy: A study with college varsity tennis players. Physiology & Behavior, 151, 541-544. https://doi.org/10.1016/j.physbeh.2015.08.035

Silva, V. M., Magalhaes, J. E. de M., & Duarte, L. L. (2020). Quality of sleep and anxiety are related to circadian preference in university students. PLOS ONE, 15(9), e0238514. https://doi.org/10.1371/journal.pone.0238514

Skein, M., Duffield, R., Minett, G. M., Snape, A., & Murphy, A. (2013). The Effect of Overnight Sleep Deprivation After Competitive Rugby League Matches on Postmatch Physiological and Perceptual Recovery. International Journal of Sports Physiology and Performance, 8(5), 556-564. https://doi.org/10.1123/ijspp.8.5.556

Souissi, N., Chtourou, H., Aloui, A., Hammouda, O., Dogui, M., Chaouachi, A., & Chamari, K. (2013). Effects of Time-of-Day and Partial Sleep Deprivation on Short-Term Maximal Performances of Judo Competitors. Journal of Strength and Conditioning Research, 27(9), 2473-2480. https://doi.org/10.1519/JSC.0b013e31827f4792

Venter, R. (2012). Role of sleep in performance and recovery of athletes: A review article. South African Journal for Research in Sport Physical Education and Recreation , 34(1), 167-184.

Wilkerson, G. B. (2012). Neurocognitive Reaction Time Predicts Lower Extremity Sprains and Strains. International Journal of Athletic Therapy and Training, 17(6), 4-9. https://doi.org/10.1123/ijatt.17.6.4