International Research Journal Diagnostics
Volume 1 Issue 1, February 2024
ISSN: pending…

RESTING FOR PERFORMANCE: A COMPREHENSIVE ANALYSIS OF SEASONAL SLEEP PATTERNS IN COLLEGE STUDENT ATHLETES

Emily Anne Williams and Jonathan Michael Harris
[1]University of Tennessee at Martin, Department of Health and Human Performance, Martin, TN, USA
[2]University of Tennessee at Martin, 3006 Elam Center, Martin, TN, USA

Abstract: Sleep, as elucidated by William Charles Dement, heralded as The Father of Sleep, is characterized as a reversible behavioral state marked by perceptual disengagement from and unresponsiveness to the environment (Carskadon & Dement, 2011). This fundamental aspect of human existence unfolds within two distinct stages: rapid eye movement (REM) and non-REM (NREM). REM sleep, distinguished by electroencephalogram (EEG) activation, muscle atonia, and rapid eye movements, represents a crucial component of the intricate landscape of sleep architecture. This study delves into the foundational insights provided by William Charles Dement and peers into the intricacies of REM sleep, a pivotal stage within the sleep cycle. By exploring the physiological markers that define REM sleep, such as EEG activation and muscle atonia, the research aims to unravel the intricate dynamics of this stage and its significance in the broader context of sleep patterns. Understanding the nuances of REM sleep holds implications for elucidating the mysteries of sleep disorders, cognitive functions, and overall well-being. The abstract encapsulates the essence of sleep as delineated by William Charles Dement and directs attention towards the focal point of this study - REM sleep - and its physiological attributes.
Keywords: Sleep, REM Sleep, William Charles Dement, Electroencephalogram (EEG), Sleep Architecture

Introduction

According to William Charles Dement, The Father of Sleep, sleep is a reversible behavioral state of perceptual disengagement from and unresponsiveness to the environment (Carskadon & Dement, 2011). Within sleep, there are two separate stages: rapid eye movement (REM) and non-REM (NREM). REM sleep has been defined by electroencephalogram (EEG) activation, muscle atonia, and bursts of rapid eye movements. It has also been described as “an activated brain in a paralyzed body.” NREM sleep has been defined by four stages along an EEG. It has also been described as “a relatively inactive yet actively regulating brain in a movable body” (Carskadon & Dement, 2011). According to Hirshkowitz et al. (2015), the National Sleep Foundation suggests the appropriate sleep duration for young adults and adults is 7 to 9 hours. Lastella et al. (2015), reported that college athletes obtain an average of 6.8 hours of sleep per night. Furthermore, individual team athletes average 6.5 hours per night, while team athletes average approximately 7 hours of sleep per night. Kroshus et al. (2019) reported that of the 14,134 athletes at NCAA member institutions, 61% of athletes reported daytime fatigue. Also, 70% of male and 82% of female athletes reported a preference for more sleep. Sleep inconsistency tends to be greatest in teens and young adults as they tend to stay up late followed by strict morning routines (Okano et al., 2019). This is extremely insightful as it identifies the effects of sleep deprivation in college athletes. According to the NCAA's Interassociation Task Force on Sleep and Wellness, sleep has not been a primary focus of collegiate athletic training and is often neglected due to competing academic, athletic, and social demands (Kroshus, et al., 2019). Lund et al. (2010) study reported that 60% of the more than 1000 college student participants were categorized as poor-quality sleepers. In addition, students who identified as poor-quality sleepers reported significantly more problems with physical and psychological health than did the good-quality sleepers. In general, students stated that emotional and academic stress negatively impacted their sleep. Despite participation in sports being associated with psychosocial health benefits, (Facer-Childs, 2021 and Kroshus et al., 2019), mental health concerns are prevalent in the college athlete population since athletes must focus on both mental and physical aspects of sport. Combining all the activities in a student athletes' daily life, academics, extracurricular activities, relaxation, and socializing, leaves little time for restorative sleep (Kroshus et al., 2019). Sleep deprivation and sleep disturbance result in decreased academic performance (Prichard, 2019), impaired recovery and increased performance risk (Facer-Childs, 2021). Chen and Chen (2019) found that students who experienced sleep deprivation from their freshman to senior years had lower graduation rates than students who were not sleep deprived. There are many factors that can reduce sleep time and sleep habits, thereby affecting overall well-being. Sleep can be affected by caffeine, alcohol, and other types of non-prescription and prescription drugs. Also, the use of electronic devices within one hour of going to bed decreases melatonin levels and increases alertness, thus disrupting the opportunity for quality sleep. Additionally, athletes living in student housing could have sleep issues related to noise, brightness, and crowdedness (Kroshus et al., 2019). To better understand sleep behavior in athletes and the factors that may affect sleep, the purpose of this study was to compare sleep behavior between female and male college student athletes during the pre, mid, and postseason.

. Materials and Methods

Upon receiving approval by the Institutional Review Board (IRB), (2020-808-E05-4055), the current methods were utilized.

Study population and data collection

This study included members of the women's and men's basketball teams, for a total of 25 athletes during the preseason and midseason, 12 females and 13 males; 11 females and 11 males were compared during the postseason testing session. The athletes completed both instruments during the three testing sessions (pre, mid, and post season) prior to practice for 5-10 minutes. Informed consent was obtained from all participants.

Variables and Instruments

The Athletic Sleep Behavior Questionnaire (ASBQ; Driller et. al., 2015) is scored out of 90 and was designed to measure more athlete-specific sleep problem areas, like frequent travel, sleeping in different environments, and dehydration and muscle soreness when trying to sleep. Athletes answered about how frequently they engaged in specific behaviors (never, rarely, sometimes, frequently, and always). The ASBQ was found to be highly correlated with the SHI (Sleep Hygiene Index), $r = 0.69$, and moderately correlated with the widely used sleep quality measure, the PSQI (Pittsburgh Sleep Quality Inventory), $r = .38$. The three subscales included 1) *environmental factors* (score out of 30)- e.g., different sleep schedules and sleeping in hotels.

Behavioral factors (score out of 35)– e.g., technology usage and light exposure before bed, alcohol consumption, or worrying in bed 3) *Sport-related factors* (score out of 25)– e.g., I train late at night, or I worry about sport-related things in bed. The Athlete Sleep Screening Questionnaire (ASSQ; Samuels et al., 2015) was also developed as an athletespecific sleep-screening tool measuring sleep quality. A sleep difficulty score (SDS) was computed with the higher the number the more severe the sleep problems. This survey could be used in conjunction with individual clinical interventions, depending on where the circadian difficulty area is for a person. For the present study only the computed SDS, ranging from 0-20, was considered for analyses.

Statistical analysis

To test for differences between female and male basketball players, MANOVA's were performed, using the ASBQ overall disruption scores and the subscale scores indicating the types of disruptions reported (environmental, behavioral, and sports related). A second MANOVA was performed on the SDS comparing the pre, mid, and postseason scores. Pillai's trace was used when assumptions were met and Wilk's statistic when violations were present.

It was believed that female athletes would report greater sleep disruptions compared to male athletes, although it was not clear which specific disruptions would affect their sleep more during the three data collection times.

Seasonal differences were analyzed using repeated measures ANOVA's separately for female and male athletes because sex differences were found for the testing sessions. Sphericity was assumed for all analyses.

Results

Table 1 illustrates the following results:

Sex differences in total sleep disruptions (preseason and midseason)

For the main hypothesis that females would report a greater number of sleep disruptions, as measured by the ASBQ total score, using Wilk's statistic, significant differences were found, $V = .606$, $F(3, 20) = 4.34$, $p<.05$, $\eta_p^2 = .394$. Univariate tests indicated significant sex differences during preseason, $F(1, 22) = 13.08$, $p = .002$, $\eta_p^2 = .896$ and midseason, $F(1, 22) = 10.73$, $p = .003$, $\eta_p^2 = .373$, but not during postseason. In both testing sessions, females reported a greater number of sleep disruptions than their male counterparts. When looking at the types of sleep disruptions, there were environmental and behavioral differences, but no significant differences in sport related disruptions were reported. There were no significant sex differences on the sleep difficulty scores (SDS) during pre, mid, and postseason. Although females reported higher scores during each session.

Sex differences in environmental factors (midseason and postseason)

To examine the differences in the specific type of disruptions (environmental, behavioral, sports related) reported by female and male basketball players, using the Pillai's trace, differences were found for environmental factors, $V =.293$, $F(3, 20) = 2.76$, $p = .035$, $\eta_p^2 = .293$. Univariate tests indicated significant differences midseason, $F(1, 22) = 8.08$, $p = .009$, $\eta_p^2 = .269$, as well as postseason, $F(1, 22) = 4.68$, $p = .042$, $\eta_p^2 = .175$.

Sex differences in behavioral factors (preseason and midseason)

Significant differences were also found in the behavioral disruptions, $V = .668$, $F(3, 18) = 12.06$, $p<.001$, $\eta_p^2= .668$. Univariate tests indicated significant differences in the preseason, $F(1, 20) = 28.32$ p $<.001$, $\eta_p^2 = .93$ and midseason, $F(1, 20) = 20.15$ $p<.001$, $\eta_p^2 = .50$. Female basketball players reported more environmental and behavioral disruptions compared to their male counterparts during those times.

Seasonal differences for female athletes

Since there were sex differences in reported sleep disturbances, seasonal differences were analyzed separately for male and female athletes. Significant differences were for found for female SDS scores, F (2, 20) =

9.55, p = .001, η_p^2 = .488, between preseason and midseason, 3.00, p<.05, and midseason compared to postseason, 3.09, p<.05. Total disruptions, as reported by the ASBQ, also decreased significantly over the season, $F(2, 20)$ = 6.28, p = .001, η_p^2 = .385, between preseason and postseason, 5.91, p<.05. Females also differed in the number of behavioral disruptions, $F(2, 20)$ = 3.42, p = .05, η_p^2 = .26, between preseason and midseason, 3.18, p = .05. Sport related disruptions also differed, $F(2, 20)$ = 22.83, p< .001, η_p^2 = .70, between preseason and postseason, 4.91, p<.05 and midseason and postseason, 2.82, p<.05.

Seasonal differences for male athletes

Male athletes reported fewer disturbances on the SDS, $F(2, 20)$ = 7.62, p = .003, η_p^2 = .433, between preseason and midseason, 2.18, p<.05. No differences were found on the ASBQ. There were differences between environmental disruptions, $F(2, 24)$ = 11.27, p<.001, η_p^2 = .484, between preseason and midseason, 7.07, p = .005 and midseason and postseason, 8.31, p = .016. No differences were found for the behavioral or sport related disturbances.

Table 1: *Sex Differences in Sleep Disruption Scores at Pre, Mid, and Postseason*

	Female		Male		
	M	SD	M	SD	sig
Preseason					
Total ABSQ	53.08	5.68	43.08	8.35	**
Environmental	16.00	3.59	13.92	3.35	ns
Behavioral	19.58	2.47	14.38	3.25	**
Sport Related	17.50	2.75	14.76	4.19	*
SDS	7.64	2.58	6.31	2.39	ns
Midseason					
Total ABSQ	50.58	9.99	41.62	7.44	*
Environmental	17.42	4.52	21.00	3.34	*
Behavioral	20.25	4.90	14.31	3.01	**
Sport Related	15.17	2.94	14.84	2.93	ns
SDS	4.64	2.77	4.27	2.26	ns
Postseason					
Total ABSQ	47.82	5.27	36.23	9.58	ns
Environmental	17.18	3.16	12.69	6.22	*
Behavioral	17.91	2.62	14.27	5.83	ns
Sport Related	12.73	2.24	13.54	4.18	ns
SDS	7.73	3.44	4.91	2.26	*

Sig at p<.05*, Sig at p<.01**, ns = not significant

Table 2: *Environmental, Behavioral, and Sports Related Disruptions on the ASBQ*

Environmental Disruptions (6 questions)
Q1. I take afternoon naps lasting two or more hours
Q5. I go to bed at different times each night (more than ±1 hour variation
Q15. I get up at different times each morning (more than ±1 hour variation)
Q16. At home, I sleep in a less than ideal environment (e.g too light, too noisy, uncomfortable bed/pillow, too hot/cold)
Q17. I sleep in foreign environments (e.g hotel rooms)
Q18. Travel gets in the way of building a consistent sleep-wake routine
Behavioral Disruptions (7 questions)
Q2. I use stimulants when I train/compete (e.g caffeine)
Q4. I consume alcohol within 4 hours of going to bed
Q8. I use light-emitting technology in the hour leading up to bedtime (e.g laptop, phone, television, video games)
Q10. I think, plan, and worry about issues not related to my sport when I am in bed
Q11. I use sleeping pills/tablets to help me sleep
Q12. I wake to go to the bathroom more than once per night
Q13. I wake myself and/or my bed partner with my snoring
Related Disruptions (5 questions)
Q3. I exercise (train or compete) late at night (after 7pm)
Q6. I go to bed feeling thirsty
Q7. I go to bed with sore muscles
Q9. I think, plan, and worry about my sporting performance when I am in bed
Q14. I wake myself and/or my bed partner with my muscle twitching

Discussion

The primary purpose of the study was to compare sleep behavior between female and male college student athletes during the pre, mid, and postseason.

According to the ASBQ total scores, anything over 42 is poor sleep behavior. Females reported scores over the 42 for all three testing times, males only scored over 42 during preseason. Female athletes reported greater sleep disturbances than male athletes across the board.

Behavioral

Data indicates that female athletes tend to score higher on behavioral issues during pre, mid, and postseason with significant differences between pre and mid. Questions for this scale are illustrated in Table 2. Female athletes in this study were more susceptible to behavioral issues, as identified by the ABSQ, than male athletes. (i.e., 2) I use stimulants when I train/compete (e.g. caffeine), 4) I consume alcohol within 4 hours of going to bed (males usually said no to this), 8) I use light-emitting technology in the hour leading up to bedtime, 10) I think, plan, worry about issues not related to my sport performance when I am in bed 11) I use sleeping pills/tablets to help me sleep 12)

I wake to go to the bathroom more than once a night 13) I wake myself/and or my bed partner with my snoring.) Male athlete's mean scores were consistent across the pre, mid, and post season (Table 1).

Environmental

Environmental differences were seen between female and male athletes during mid and post season. Questions pertaining to one's environment included naps lasting more than two hours, varying bedtimes each night ± 1 hour, sleep in foreign environments, and the use of technology in the hour prior to bedtime. See Table 2 for the full list of environmental factors. The only difference recorded was during the postseason measures. Considering female athletes tend to be better focused on academics than male athletes (Tudor & Ridpath, 2019). The females in this study may have felt more pressure to catch up in their academics. Thus, they find themselves still adhering to getting up and going to bed at various times daily.

Sports Related

The only differences in ABSQ sub-score were found during preseason. Females scored higher than male athletes, 17.5 and 14.76, respectively. Again, female athletes may have found themselves focusing on keeping up their academics prior to the season thus engaging in less rest time. Inadequate recovery time can delay the healing process of muscle recovery (Tero, Teppo, Minna, et al., 2007). It may explain why female athletes in this study scored higher in questions pertaining to muscle soreness and scattered training times which can affect recovery time if an athlete does not allow time in between training sessions and practice. In addition, as seen in sprinters entering the preseason, athletes can be vulnerable to muscular injuries when they return to previous training volume (Haugen, Danielsen, McGhie, et al., 2018). An abrupt increase in workload can increase the likely hood of muscular injury (Windt&Gabbett, 2017). In summary, female athletes tended to be balanced across the testing sessions for their sleep disruptions, they did go down on their sports related disturbances during the post season, but their SDS was still high in the post season.

Conclusion

The current information does shed some light on potential topics for educating the student athlete. According to the current data, sleep behaviors should play a significant role in that education. Sleep behaviors are modifiable, which may aid sleep health intervention strategies for athletes (Facer-Childs et al., 2021). O'Donnell and Driller, (2017), identified that sleep hygiene education may be used to improve sleep in elite athletes. Additionally, a single one-hour session of sleep hygiene education resulted in a significant improvement in total sleep time and wake variance. This is promising and strong support for the development of sleep hygiene programs for college athletes. Simple behavioral changes, like not using a computer or phone between the hours of 11 pm - 4 am, which is a known finding in the neuroscience literature as it tells your brain to stay awake or wake up and light stops melatonin production, and it just takes one night to disrupt your circadian cycle (Chang, Aeschbach et al., 2015). Sleeping pills and melatonin should be prohibited for athletes and education on its potential detrimental effects should be emphasized during all three stages of the athletic season. In closing, investigators agree with the NCAA Task Force recommendations reported by Kroshus (2019), that coaches and trainers need to be aware of the following:

1) evidence-based sleep education that includes best sleep practices,
2) Information about the role of sleep in optimizing athletic and academic performance and over well-being, and
3) strategies for addressing sleep barriers.

References

Carskadon, M. A., & Dement, W. C. (2011). Monitoring and staging human sleep. In M. H. Kryger, T. Roth, & W. C. Dement (Eds.), *Principles and Practice of Sleep Medicine, 5th ed*., (pp 16-26). St. Louis: Elsevier Saunders

Chang, A. M., Aeschbach, D., Duffy, J. F., & Czeisler, C. A. (2015). Evening use of light-emitting eReaders negatively affects sleep, circadian timing, and next-morning alertness. *Proc Natl Acad Sci U S A, 112*(4), 1232–1237. https://doi.org/10.1073/pnas.1418490112

Chen, W. L., & Chen. J. H. (2019). Consequences of inadequate sleep during the college years: Sleep deprivation, grade point average, and college graduation. *Prev Med, 124,* 23-28. doi:10.1016/j.ypmed.2019.04.017

Driller, M., Mah., C., & Halson, S. (2018). Development of the athlete sleep behavior questionnaire: A tool for identifying maladaptive sleep practices in elite athletes. *Sleep Sci 11*(17), 37-44. doi:10.5935/19840063.20180009

Facer-Childs, E., Hoffman, D., Tran, J., Drummond, S., & Rajaratnam, S. (2021). Sleep and mental health in athletes during COVID-19 lockdown. *Sleep, 44*(5), https://doi.org/10.1093/sleep/zsaa261

Haugen, T., Danielsen, J., McGhie, D. et al. (2018). Kinematic asymmetry in the stride cycle is not associated with performance and injuries in athletic sprinters. *Scand J Med Sci Sports, 28,* 1001-1008. doi:10.1111/sms.12953

Hirshkowitz, M., Whiton, K., Albert, S. M., Alessi, C., Bruni, O., DonCarlos, L., Hazen, N., Herman, J., Katz, E. S., Kheirandish-Gozal, L., Neubauer D.N, O'Donnell, A.E, Ohayon, M., Peever, J., Rawding, R., Sachdeva, R. C, Setters, B., Vitiello, M. V., Ware, J. C., Adams, Hillard. P. J. (2015). National Sleep Foundation's sleep time duration recommendations: Methodology and results summary. *Sleep Health, 1*(1), 40-43. doi:10.1016/j.sleh.2014.12.010

Järvinen, T., Järvinen, T., Kääriäinen, M., Äärimaa, V., Vaittinen, S., Kalim, H. & Järvinen, M. (2007). Muscle injuries: Optimising recovery, *Best Pract & Res Clin Rheumatol, 21*(2) 317-331. https://doi.org/10.1016/j.berh.2006.12.004

Kroshus, E., Wagner, J., & Wyrick, D., et al. (2019). Wake up call for collegiate athlete sleep: narrative review and consensus recommendations from the NCAA interassociation task force on sleep and wellness, *Brit J of Sports Med, 53,* 731-736. doi:10.1136/bjsports-2019-100590. Epub

Lastella. M., Roach, G. D., Halson, S. L., & Sargent, C. (2014). Sleep/wake behaviours of elite athletes from individual and team sports. *Eur J Sport Sci, 15*(2), 94-100. doi:10.1080/17461391.2014.932016

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. *J of Adol Health 46*(2), 124-32. doi:10.1016/j.jadohealth.2009.06.016

O' Donnell., S., & Driller, M. W. (2017). Sleep-hygiene education improves sleep indices in elite female athletes. *Int J of Ex Science*, *10*(4), 522–530. PMID:28674597

Okano, K., Kaczmarzyk, J. R., Dave, N., Gabrieli, J., & Grossman, J. (2019). Sleep quality, duration, and consistency are associated with better academic performance in college students. *NPJ Sci Learn, 4*(16). https://doi.org/10.1038/s41539-019-0055-z

Prichard, J. R. (2020). Sleep predicts collegiate academic performance: Implications for equity in student retention and success, *Sleep Med Clin, 15*(1), 59-69. doi:10.1016/j.jsmc.2019.10.003

Samuels, C., James, L., & Meeuwisse, W. (2016). The Athlete Sleep Screening Questionnaire: A new tool for assessing and managing sleep in elite athletes. *Br J Sports Med., 50*(5). doi:10.1136/bjsports-2014-094332

Tudor, M. & Ridpath, B. (2019). Does gender significantly predict academic, athletic career motivation among NCAA Division I college athletes. *J of High Educ Athl & Innovat, 1*(5), 122-147. doi:10.15763/ISSN.23765267

Windt, J., & Gabbett, T. J. (2017). How do training and competition workloads relate to injury? The workloadinjury aetiology model. *Br J Sports Med,* 51, 428-435. doi:10.1136/bjsports-2016-096040