

Sleep, energy, and stress in collegiate female volleyball athletes

EMANI FOSTER¹, CLAIRE SCHUMANN², JENNIFER A. BUNN³

Abstract

Introduction. Sleep duration and quality among collegiate athletes is of great importance for their recovery and has been linked to performance, but little is known about reasons for missed sleep or the relationship between sleep and stress in this population. **Aim of Study.** The aim of this study was to 1) assess the relationship between sleep quality, sleep duration, energy, and stress in female collegiate volleyball players through the four months of the competitive season, and 2) report the frequency of provided reasons for poor sleep quality and duration. **Material and Methods.** De-identified data from an athlete monitoring platform for sleep duration, sleep quality, stress, energy, and reasons for missed sleep were analyzed for this study. Data were gathered from a total of 67 female collegiate volleyball athletes during the competitive seasons from 2016 through 2021. **Results.** Sleep quality and sleep duration showed a moderate correlation ($r = 0.404$ to 0.552) across all four months of the volleyball season, $p < 0.001$. Sleep quality had a low correlation with energy for each month ($r = 0.348$ to 0.387), except September where there was a moderate correlation ($r = 0.400$, $p < 0.001$). Sleep quality and stress showed to no correlation ($r = 0.184$ to 0.266 , $p < 0.001$). Sleep duration and energy showed low to no correlation ($r = 0.160$ to 0.246 , $p < 0.001$). Sleep duration and stress were not correlated for any of the months evaluated ($r = 0.091$ to 0.195 , $p < 0.001$). The results of the study also showed that “other”, overtiredness, and worry/stress were the top reported sleep ailments for these athletes. **Conclusions.** These data can be applicable to coaches, athletes, and athletic trainers looking to gain insight on the sleep habits and effectiveness in collegiate female volleyball athletes during the competition season.

KEYWORDS: athlete monitoring, team sports, wellness.

Received: 26 May 2023

Accepted: 11 July 2023

Corresponding author: jab229@shsu.edu

¹ University of North Carolina at Charlotte, Department of Psychology, Charlotte, North Carolina, United States

² Sam Houston State University, College of Osteopathic Medicine, Conroe, Texas, United States

³ Sam Houston State University, Department of Kinesiology, Huntsville, Texas, United States

Introduction

Sleep is a necessary process that rejuvenates the body and mind from life activities. Sufficient amounts of sleep vary from person to person based on their energy output, age, and sex. On average, an adult should attain about 7-7.5 hours of sleep per night to maintain optimal physical and mental function [27]. Consistently attaining less than 7-7.5 hours can lead to a state of sleep deprivation, which is correlated to many health issues like decreased physical and psychological well-being and pain, decreased cognitive function, hypertension, diabetes mellitus, and coronary artery disease [9, 18, 26]. Sleep can be assessed objectively through somnography or subjectively through self-report assessments of sleep quality and duration. Research suggests that subjective measures gave more useful data than objective measures [2].

Previous studies have demonstrated that compared to non-athletes of the same gender and age, athletes report lower quality and duration of sleep [16]. Athletes endure training to induce physical stress to produce an effect that will increase athletic performance [11]. If training

and recovery methods, including sleep, are improperly balanced, a negative stress response may occur [11]. Heidari et al. determined a relationship between sleep and optimal competition condition, describing the importance of sleep in the athlete recovery routine [14]. In addition, lack of sleep has been correlated to decreased reaction time, increased injury risk, and increased perceived effort [17, 20]. Duration of sleep is not the only determinate of sleep benefits; sleep quality also impacts the effects of sleep on physiology and performance [2, 6]. In female collegiate lacrosse athletes, sleep quality proved to be a predictor of external load variables including total distance and high-intensity distance [6]. Female athletes experience stressors through school and sport that impact sleep but may face differences due to differing physiological processes like menstruation. Female athletes with an average age of 23 have been shown to have higher post-game cortisol levels during training and control conditions which may affect sleep quality and quantity [22]. Longitudinal research in female cross-country athletes found that resting heart rate increased over time and was positively associated with increased slow wave sleep but not the timing and regularity of sleep [24]. These differing characteristics are important to investigate, as female athletes are frequently underrepresented in athlete research literature [5].

College athletes participating in the National Collegiate Athletics Association (NCAA) must balance their time through their academic, athletic, and social commitments [13]. This struggle to manage time can create stress and lead to disrupted sleep [4]. Division I volleyball players reported lower levels of sleep duration and higher levels of soreness and perceived stress on days with reported pain and injury incidences [13]. Additionally, poor sleep quality before away games was reported more than home games in both female and male volleyball players [10]. Through objective measures of sleep (e.g., measurements taken through somnography), volleyball athletes reported a lower amount of sleep the day after the match, compared with pre-match sleep amounts and sleep two nights post-match [25]. Therefore, location of training or competition, time of training, or intensity of training can impact the sleep quality of the athlete.

Lack of sleep demonstrates a two-prong effect on lower performance; amount of sleep alone can predict athletic performance [2] and the physiological effect of stress caused by a lack of sleep can result in a subpar athletic performance [11, 23]. Because athletes have unique schedules and training loads that lead to stressors impacting performance, it is important to gain knowledge

about the physiological and psychological relationship of stressors with measurements of recovery [21].

Aim of Study

Evidence indicates that stress and sleep are intertwined for athletes and there may be some degree of fluctuation in these wellness markers throughout the season [11]. These aspects have not yet been explored in collegiate female athletes. The aim of the current study was to 1) assess the relationship between sleep quality, sleep duration, energy, and stress in female collegiate volleyball players through the four months of the competitive season, and 2) report the frequency of provided reasons for poor sleep quality and duration. The study includes data from the competitive season of collegiate volleyball athletes. We hypothesized that sleep quality and duration will demonstrate a strong positive relationship, and stress and energy would have moderate positive relationships between the two sleep measures. We also hypothesized that stress and worry would be the most cited reason for poor sleep quality or reduced sleep duration.

Materials and Methods

Experimental design

A retrospective, observational study design was used to test the hypotheses. De-identified data were received from an athlete monitoring platform (Metrifit, Louth, Ireland). Participants submitted data during collegiate volleyball seasons (August through November) from 2016 through 2021. This study was approved as exempt status by the Sam Houston State University institutional review board, and this study was conducted in alignment with the Declaration of Helsinki. Due to the retrospective nature of the study, informed consent was not necessary.

Participants

Data was gathered from a total of 67 female collegiate volleyball athletes from the United States through an athlete monitoring platform. Athletes were varsity players from teams competing in the NCAA, but no divisional characteristics (e.g., I, II, or III) were gathered. There were a varied number of data entries per participant, ranging from three to 429 entries. Athletes were excluded from the study if they did not complete at least three data entries per month.

Measures

The study utilized the Metrifit athlete monitoring application to gather wellness data from collegiate

volleyball athletes. Mtrifit is a mobile athlete self-report measure (M-ASRM) delivered to athletes through a phone application [8]. The application provided a daily self-report wellness assessment [7]. Wellness characteristics like stress, fatigue, mood, sleep, recovery, health status, energy [12] were collected within Mtrifit, but for the purpose of this study, only sleep quality, sleep duration, energy, and stress were analyzed. Participants received a text message notification reminder to complete these daily subjective assessments to encourage participation. Perceived sleep quality and perceived stress used a scale of 1 to 5, with higher values indicating a more positive affect. Sleep duration was a self-report measure estimated to the nearest half hour by participants. Daily reports of sleep duration and wellness sub-scores were used for analyses. Athletes also had the option to provide reasons for poor sleep. The list of reasons included: consumed alcohol/caffeine late at night, pain/irritation, overtired, worried/stressed, noise/disturbance during the night, late night, consumed food/beverage late at night, and other. These data were tallied by month of the competitive season.

Statistical analysis

Data analyses were conducted with RStudio (Boston, MA). Descriptive statistics for sleep quality, sleep

duration, and stress were tabulated for the whole season and by month of the season – August, September, October, and November. A Shapiro-Wilk test determined the data were normally distributed. For the primary aim of the study, repeated measures correlations (procedure rmcrr) were conducted for the whole data set and individual months to evaluate the relationship between the sleep quality, sleep duration, energy, and stress [1]. Correlation coefficients (r) were interpreted as no correlation (< 0.2), low correlation ($0.2-0.39$), moderate correlation ($0.4-0.59$), moderately high ($0.6-0.79$), and high (> 0.8) [28]. Effect sizes (q) for the difference between monthly correlations were calculated and interpreted as no effect (< 0.1), small ($0.1-0.3$), intermediate ($0.3-0.5$), and large (> 0.5) [3]. For the secondary aim of the study, total frequency of each sleep-related ailment were tallied for each month. Percent contributions of each ailment were calculated and organized into a heat map.

Results

A total of 9509 observations were included in the analyses, across 67 participants. Figure 1 shows the means and standard deviations for sleep quality, energy, stress, and sleep duration scores for each month of the volleyball season. The athletes report a slight reduction

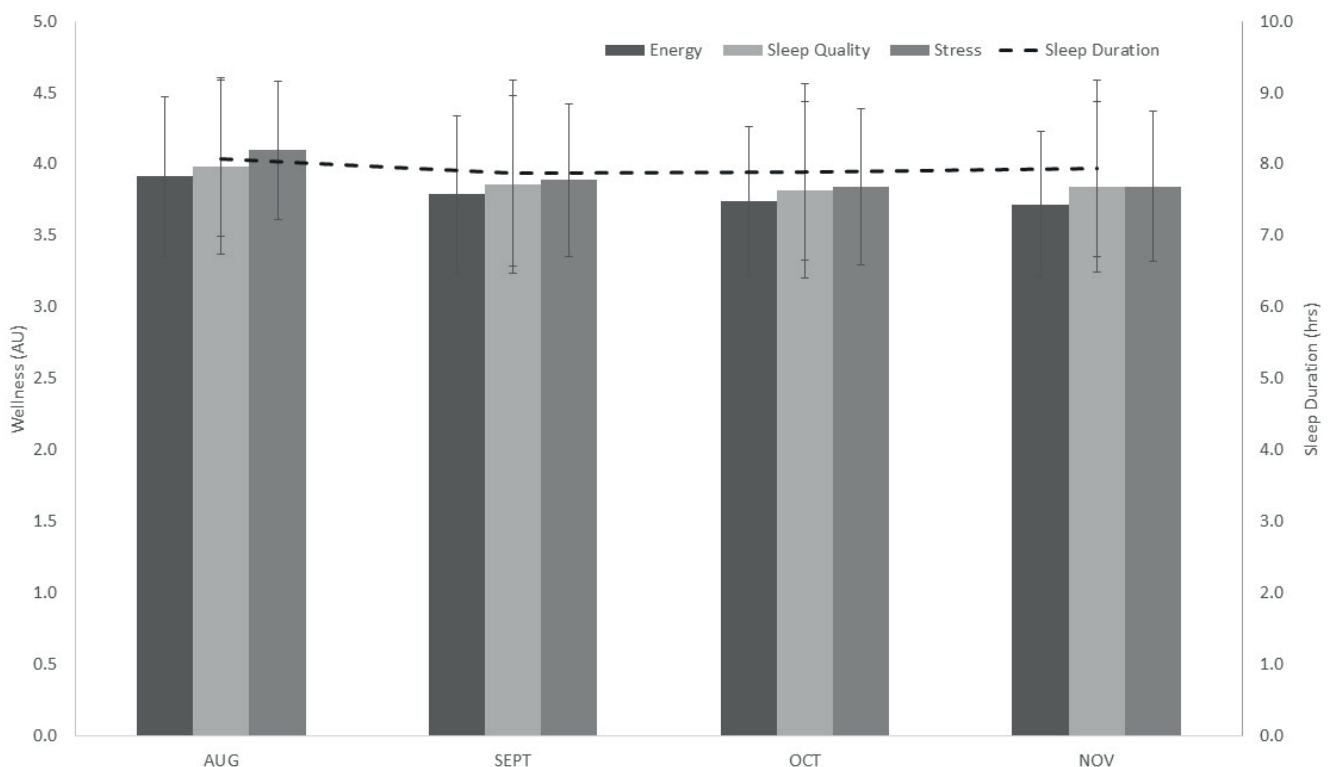


Figure 1. Means and standard deviations of wellness sub-scores and sleep duration across the volleyball season by month

in all the wellness components as the season progressed, with all scores peaking in August and reaching their lowest points in November. Sleep duration remained steady for the entirety of the season.

Table 1 shows the results of the repeated measures correlation analyses. Sleep quality and sleep duration showed a moderate correlation, with r-values ranging from 0.404 to 0.552 across all four months of the volleyball season, $p < 0.001$ for all. Sleep quality had a low correlation with energy for each month, except September where there was a moderate correlation ($p < 0.001$ for all). Sleep quality and stress showed no correlation for August and September ($p < 0.001$) and a low correlation for October, November, and the whole data set ($p < 0.001$ for all). Sleep duration and energy were lowly correlated in September, October, November, and for all of the data, but had no correlation in August ($p < 0.001$ for all). Sleep duration and stress were not correlated for any of the months evaluated.

Table 1. Repeated measures correlation coefficients (r) for wellness sub-scores for each month of the collegiate volleyball season. Bolded values indicate a moderate correlation

		Sleep duration	Energy	Stress
All data	Sleep quality	0.491	0.387	0.255
	Sleep duration		0.218	0.179
AUG	Sleep quality	0.404	0.373	0.184
	Sleep duration		0.16	0.091
SEPT	Sleep quality	0.552	0.400	0.193
	Sleep duration		0.246	0.173
OCT	Sleep quality	0.504	0.348	0.238
	Sleep duration		0.219	0.187
NOV	Sleep quality	0.501	0.356	0.266
	Sleep duration		0.224	0.195

Table 2 shows the effect sizes evaluating differences between monthly correlations. There was a small effect in sleep quality and sleep duration for August ($q = 0.122$ to 0.193) compared to the other three months of the season with no effect ($q = 0.004$ to 0.071). This was due to athletes scoring sleep quality and duration slightly higher in August compared to the other three months, and then sleep quality scores dropped by 0.2-0.3 points and sleep duration remained fairly stable. Effect sizes for sleep quality with energy and stress were all negligible. All effect sizes for sleep duration and energy

Table 2. Effect sizes to evaluate differences in monthly correlation coefficients

	SEPT	OCT	NOV
Sleep quality and sleep duration			
AUG	0.193	0.126	0.122
SEPT		0.067	0.071
OCT			0.004
Sleep quality and energy			
AUG	0.032	0.029	0.02
SEPT		0.06	0.051
OCT			0.009
Sleep quality and stress			
AUG	0.009	0.057	0.086
SEPT		0.047	0.077
OCT			0.030
Sleep duration and energy			
AUG	0.090	0.061	0.066
SEPT		0.029	0.023
OCT			0.005
Sleep duration and stress			
AUG	0.084	0.098	0.106
SEPT		0.014	0.023
OCT			0.008

were also negligible. There was also a small effect in sleep duration and stress r-values between August and November ($q = 0.106$), but all other q effect sizes are interpreted as no effect.

Table 3 shows a heat map of the distribution of sleep-related ailments reported by the athletes per month of the competitive season. The color shading starts at dark red (high frequency of reporting) and fades to green (low frequency reporting). The light colored/white shades represent moderate reporting. The category of “other” was the highest reported sleep ailment for each month of the season, representing approximately 40% of all sleep ailments. Overtired was the second highest sleep ailment cited, with highest amounts in the middle of the season in September and October. Noise/disturbance as the primary reason reported for negative sleep quality comprised 15.3% of the total responses. Worried/stress

as the reason for a decreased sleep quality contributed to 14.4% of total reported reasons. However, this reason was reported more frequently as the season progressed from August to October. Athletes reported being worried/stressed at an increasing rate throughout each month of the season. Late night consumption of food, beverage, alcohol, and caffeine were least frequently reported as a reason for poor sleep.

Table 3. Percent frequency distribution of identified reasons negatively affecting sleep quality

	AUG	SEPT	OCT	NOV	Total
Alcohol/caffeine late	0.4%	0.7%	0.2%	0.3%	0.4%
Pain/irritation	5.6%	4.0%	4.2%	3.6%	4.2%
Overtired	14.4%	19.3%	19.4%	15.4%	17.6%
Worried/stressed	7.4%	12.3%	14.6%	20.0%	14.4%
Noise/disturbance	23.2%	16.2%	11.4%	15.2%	15.3%
Late night	4.6%	2.6%	9.9%	12.9%	8.1%
Food/beverage late	0.4%	0.2%	0.8%	1.0%	0.6%
Other	44.0%	44.7%	39.5%	31.7%	39.4%

Note: Red indicates a high frequency, white is moderate, and green is low, with deeper shades of each color representing higher values

Discussion

The current study assessed the relationship between collegiate volleyball athletes' stress, sleep quality, energy, and sleep quantity during the competitive season. Reasons for poor sleep quality and duration were also reported. We hypothesized that sleep quality and quantity would have a strong positive relationship and stress and energy would have moderate positive relationships with the two sleep measures. There was a moderate correlation between sleep quality and quantity, but there was low correlation with sleep quality and energy and stress, and no correlation between sleep duration and stress or energy. The volleyball athletes' subjective scoring for sleep quality and duration were stable over the course of a volleyball competition season. The top three reasons reported for diminished sleep quality were other, over-tiredness, and worry/stress. As the season progressed, worry/stress increased as the primary reason for lower sleep quality, while other was reported less frequently.

The results showed a moderate correlation between sleep quality and sleep duration during the whole season (August-November, $r = 0.491$). This moderate correlation may be attributed to athletes preferring

different durations of sleep and if the athlete's sleep habits aligned with their chronotype. These findings may be used to better regulate athletes' rest, recovery, and in-season training. Knufinke and colleagues emphasized that the body adjusts necessary sleep time according to the need for recovery from physical exertion [16]. Compared to their respective age groups, 88% of elite athletes had lower sleep, alluding to the need for more athlete-sleep data to better understand the relationship between athlete sleep duration and quality. The present study shows that sleep duration and quality were stable with each month of the season and correlated with one another. Encouraging athletes to increase their time spent in bed may subsequently improve sleep duration, quality, and efficiency. This should be further explored through both objective and subjective methods.

Energy and stress had low correlations with sleep quality ($r = 0.387$ and $r = 0.255$, respectively). Low correlations between these variables concur with previous research that investigated well-being factors of sleep, stress, and delayed onset of muscle soreness during a semi-pro soccer season in male athletes [21]. However, a study by Brandt and colleagues on elite male and female athletes competing in team and individual sports found notable correlations between perceived sleep quality and mood state [2]. The researchers defined mood state as encompassing vigor, tension, depression, anger, fatigue, and mental confusion. Specifically, they found that higher levels of sleep quality were directly correlated with high vigor and lower depression, anger, fatigue, and mental confusion, associating better sleep quality with a more positive mood state. These differences in study findings may be attributed to differences in sport type, level of competition, and gender of athletes. Specifically, Mascaro and colleagues reported that women athletes reported higher levels of negative mood and stress, and this should be considered when comparing studies with different genders represented [19].

Interestingly, there were no substantive changes in the wellness sub-scores and sleep duration as the season progressed. The athletes consistently obtained less than the optimal eight hours of sleep throughout the season. This is concerning because athletes deal with life stressors like school, family life, and relationships alongside athlete specific stressors like high caloric and mental expenditure. Weekly sleep analysis in male rugby players detailed differences in sleep duration of athletes between competition, low load, and high load weeks [4]. Essentially, when addressed in a more granular fashion – within a week – there were sleep differences as opposed to analyzing sleep via analog methods over

a month or season. This can be applied to the current study because the data was compiled over monthly amounts, providing no notable differences based on the time in season. A weekly analysis may have provided more insight towards the specific difference in sleep duration during different weeks of load. Many studies detail specific daily or weekly differences in sleep duration for athletes based on scenarios like presence or absence of a competition and the extent of training. For example, Vitale and colleagues conducted a study where they assessed differences in total sleep time pre-match and days post-match, finding that sleep was lower the first night post-match [25]. This alludes to the current study assessing athlete sleep duration in a more general expanse over months of a season instead of daily or weekly data analysis. The secondary analysis nature of the present study did not include knowledge of when competitions were relative to their sleep and wellness, just that the athletes were within the competition phase of the training year. Future studies should consider both in their assessments when able.

Monthly data was gathered from athletes on perceived sleep ailments across the four months of the competitive season. The “other” category was reported most often during the competitive season (Table 3), followed by overtired which peaked in the months of September and October. Worried/stressed and noise disturbance followed with peaks in separate months. Worry/stressed steadily increased as the season progressed, peaking in November. This finding is important due to implications of other factors like increased academic demands and impending post season competition near the end of the semester. Noise disturbance peaked in August, which was likely associated with beginning of the semester celebrations in college housing. Additionally, both ailments could have possibly become an issue due to the different environments of home and away games, such as athletes sleeping in a hotel. Previous research involving male volleyball players investigated sleep quality prior to an away game, home game, and training days and found that sleeping in a hotel before an away game demonstrated greater occurrences of nocturnal awakenings, reduced sleep latency (time it takes to fall asleep), poorer overall sleep quality, and less total sleep [10]. The former study may explain why “other” and noise/disturbance were commonly reported in this study. Many athletes must sleep in hotel rooms and unfamiliar environments with multiple teammates during competition season and they may have perceived this environment as noisy or classified the experience as “other” while reporting what decreased their sleep

quality. A study focusing on worry/stress in elite Australian male and female athletes, described the top sleep ailments the night before a competition as thoughts about competition at 83.5% and nervousness at 43.8% [15]. This result is reflected in the present study as worry/stress were reported more as the season progressed. This could be attributed to more pregame nervousness prior to more important competitions as the season advanced, as well as academic stress due to intra-term exams and finals.

A limitation in the current study is the use of de-identified data. This data lacked information related to athletes’ training calendars and level of play, referring to the NCAA division. This information provides context to the commitment and rigor expected of athletes. Another limitation is variation in number of data entries. While this was controlled for in the correlation analysis, an athlete with more data entries would have a larger influence over the descriptive data provided in this study compared to an athlete with few entries. The athletes completing more entries may have also experienced survey fatigue. Another limitation of the data is sleep-related ailments category “other”. This category cannot be decoded and holds vital information for the most reported category of sleep-related ailments. Decoding this could have provided useful information about why athletes report a reduced sleep quality. Insight from the “other” category would also aid in the understanding of why female, college athletes are experiencing a reduced sleep quality. Lastly, this study did not assess for training volume or timing of games relative to sleep and stress. This information may provide contextual insight for fluctuations in sleep duration and wellness sub-scores.

Conclusions

This study provided a general concept of perceived sleep quality, stress, energy, and self-reported sleep duration of many female volleyball athletes throughout the competitive season. To our knowledge, this is the first study to evaluate the relationships between these variables in this population. This study found that sleep quality and duration are moderately correlated during the competition season of collegiate volleyball players, although there was little to no correlation for sleep quality, sleep duration, stress, and energy. Wellness sub-scores also presented no change over the course of the four-month season. The results of the study also showed that “other”, overtiredness, and worry/stress were the top reported sleep ailments for these athletes. These data can be applicable to coaches, athletes, and athletic trainers looking to gain insight on the sleep habits and

effectiveness in collegiate female volleyball athletes during the competition season. Athletes should aim for consistency in their sleep habits as often as possible, which will likely positively impact their sleep quality. Coaches should speak regularly about good sleep habits with their athletes and let them know that sleep duration and quality are linked, but these sleep parameters are not necessarily related to their stress or energy levels. Future directions for study could isolate the competitive level of athletes to determine if competition level such as Division I, II, or III athletes get different amounts of sleep. The study could even explore different athletes of various sports to see if the results are consistent across sports.

Conflict of Interest

The authors declare no conflict of interest.

References

- Bland JM, Altman DG. Statistics notes: Calculating Correlation coefficients with repeated observations: Part 1—correlation within subjects. *BMJ*. 1995;310(6977):446.
- Brandt R, Bevilacqua GG, Andrade A. Perceived sleep quality, mood states, and their relationship with performance among brazilian elite athletes during a competitive period. *J Strength Cond Res*. 2017; 31(4):1033-1039. Available from: https://journals.lww.com/nsca-jscr/Fulltext/2017/04000/Perceived_Sleep_Quality_Mood_States_and_Their.20.aspx
- Cohen J. Statistical power analysis for the behavioural science (2nd Edition). *Statistical Power Analysis for the Behavioral Sciences*: Hillsdale, NJ; 1988.
- Conlan G, McLean B, Kemp J, Duffield R. Effect of training/competition load and scheduling on sleep characteristics in professional rugby league athletes. *J Strength Cond Res*. 2022;36(12):3390. Available from: https://journals.lww.com/nsca-jscr/Fulltext/2022/12000/Effect_of_Training_Competition_Load_and_Scheduling.16.aspx
- Costello JT, Bieuzen F, Bleakley CM. Where are all the female participants in Sports and Exercise Medicine research? *Eur J Sport Sci*. 2014;14(8):847-851. <https://doi.org/10.1080/17461391.2014.911354>
- Crouch AK, Jiroutek MR, Snarr RL, Bunn JA. Relationship between pre-training wellness scores and internal and external training loads in a Division I women's lacrosse team. *J Sports Sci*. 2020;39(9):1070-1076. Available from: <https://www.tandfonline.com/action/journalInformation?journalCode=rjsp20>
- Cullen BD, McCarren AL, Malone S. Ecological validity of self-reported wellness measures to assess pre-training and pre-competition preparedness within elite Gaelic football. *Sport Sci Health*. 2021;17(1):163-172. <https://doi.org/10.1007/s11332-020-00667-x>
- Duignan CM, Slevin PJ, Caulfield BM, Blake C. Exploring the use of mobile athlete self-report measures in elite gaelic games: a qualitative approach. *J Strength Cond Res*. 2021;35(12):3491-3499. Available from: https://journals.lww.com/nsca-jscr/Fulltext/2021/12000/Exploring_the_Use_of_Mobile_Athlete_Self_report.31.aspx
- Durmer JS, Dinges DF. Neurocognitive consequences of sleep deprivation. *Semin Neurol*. 2005;25(1):117-129. Available from: <http://www.thieme-connect.com/products/ejournals/html/10.1055/s-2005-867080>
- Erlacher D, Schredl M, Lakus G. Subjective sleep quality prior to home and away games for female volleyball players. *International Journal of Dream Research*. 2009;2(2):70-72. Available from: <https://journals.ub.uni-heidelberg.de/index.php/IJoDR/article/view/412>
- Hamlin MJ, Deuchrass RW, Olsen PD, Choukri MA, Marshall HC, Lizamore CA, et al. The effect of sleep quality and quantity on athlete's health and perceived training quality. *Front Sports Act Living*. 2021;10(3):245.
- Hamlin MJ, Wilkes D, Elliot CA, Lizamore CA, Kathiravel Y. Monitoring training loads and perceived stress in young elite university athletes. *Front Physiol*. 2019;10:34. <https://doi.org/10.3389/fphys.2019.00034>.
- Haraldsdottir K, Sanfilippo J, McKay L, Watson AM. Decreased sleep and subjective well-being as independent predictors of injury in female collegiate volleyball players. *Orthop J Sports Med*. 2021;9(9):23259671211029284. <https://doi.org/10.1177/23259671211029285>
- Heidari J, Beckmann J, Bertollo M, Brink M, Kallus KW, Robazza C, et al. Multidimensional monitoring of recovery status and implications for performance. *Int J Sports Physiol Perform*. 2019;14(1):2-8. Available from: <https://journals.humankinetics.com/view/journals/ijsp/14/1/article-p2.xml>
- Juliff LE, Halson SL, Peiffer JJ. Understanding sleep disturbance in athletes prior to important competitions. *J Sci Med Sport*. 2015;18(1):13-18.
- Knufinke M, Nieuwenhuys A, Geurts SAE, Møst EIS, Maase K, Moen MH, et al. Train hard, sleep well? Perceived training load, sleep quantity and sleep stage distribution in elite level athletes. *J Sci Med Sport*. 2018;21(4):427-432.
- Kroshus E, Wagner J, Wyrick D, Athey A, Bell L, Benjamin HJ, et al. Wake up call for collegiate athlete sleep: narrative review and consensus recommendations from the NCAA interassociation task force on sleep

- and wellness. *Br J Sports Med.* 2019;53(12):731-736. Available from: <https://bjsm.bmj.com/content/53/12/731>
18. Lateef OM, Akintubosun MO. Sleep and reproductive health. *J Circadian Rhythms.* 2020;18(1):1-11. Available from: <https://pubmed.ncbi.nlm.nih.gov/32256630/>
 19. Mascaro L, Drummond SPA, Leota J, Boardman JM, Hoffman D, Rajaratnam SMW, et al. Cognitive fitness modulates gender differences in sleep and mental health among competitive athletes under chronic stress. *Front Physiol.* 2023;8;14.
 20. Nicholls AR, Backhouse SH, Polman RCJ, McKenna J. Stressors and affective states among professional rugby union players. *Scand J Med Sci Sports.* 2009;19(1):121-128. Available from: <https://onlinelibrary.wiley.com/doi/full/10.1111/j.1600-0838.2007.00757.x>
 21. Nobari H, Gholizadeh R, Martins AD, Badicu G, Oliveira R. In-season quantification and relationship of external and internal intensity, sleep quality, and psychological or physical stressors of semi-professional soccer players. *Biology (Basel).* 2022;11(3). Available from: <https://pubmed.ncbi.nlm.nih.gov/35336840/>
 22. O'Donnell S, Bird S, Jacobson G, Driller M. Sleep and stress hormone responses to training and competition in elite female athletes. *Eur J Sport Sci.* 2018 May 28;18(5):611-618. <https://doi.org/10.1080/17461391.2018.1439535>
 23. Saw AE, Main LC, Gastin PB. Monitoring the athlete training response: Subjective self-reported measures trump commonly used objective measures: A systematic review. *Br J Sports Med.* 2016;50(5):281-291. Available from: <https://bjsm.bmj.com/content/50/5/281>
 24. Sekiguchi Y, Adams WM, Benjamin CL, Curtis RM, Giersch GEW, Casa DJ. Relationships between resting heart rate, heart rate variability and sleep characteristics among female collegiate cross-country athletes. *J Sleep Res.* 2019;28(6):e12836.
 25. Vitale JA, Banfi G, Galbiati A, Ferini-Strambi L, La Torre A. Effect of a night game on actigraphy-based sleep quality and perceived recovery in top-level volleyball athletes. *Int J Sports Physiol Perform.* 2019;14(2):265-269.
 26. Whale K, Gooberman-Hill R. The importance of sleep for people with chronic pain: Current insights and evidence. *JBMR Plus.* 2022;6(7):e10658. Available from: <https://onlinelibrary.wiley.com/doi/full/10.1002/jbm4.10658>
 27. Worley SL. The extraordinary importance of sleep: The detrimental effects of inadequate sleep on health and public safety drive an explosion of sleep research. *Pharmacy and Therapeutics.* 2018;43(12):758. Available from: [/pmc/articles/PMC6281147/](https://pubmed.ncbi.nlm.nih.gov/306281147/)
 28. Zhu W. $p < 0.05, < 0.01, < 0.001, < 0.0001, < 0.00001, < 0.000001, \text{ or } < 0.0000001 \dots$ *J Sport Health Sci.* 2016; 1;5(1):77-79.