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The Impact of Sleep Quality on Mood in Beach Volleyball Athletes: A Cross-Sectional Study
El estado de ánimo difiere entre los jugadores de vóley playa con buen sueño y mal sueño: un estudio transversal

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Abstract. This study aimed to investigate the association between sleep quality and mood states or matched results in beach volleyball athletes. We designed a cross-sectional study. We employed the Brazilian Mood Scale (BMS) through Google Forms to assess the mood state of the athletes, which was sent to them at 8 pm the day before the first match. We considered only responses received until 10 pm (GMT-3). In addition to the BMS, we included two extra questions: "last night's sleep hours" and "how do you feel now?". The athletes were required to choose one of the following five items: very bad, bad, regular, good, or excellent. We collected statistical data of the matches, including points scored, points conceded, set won, set defeats, matches won, and match defeats. To verify the correlation and differences between variables, we employed Bayesian analysis. The Bayesian ANOVA model, which included sleep quality on fatigue, was 12.465 times more likely than the null model. Post-hoc analyses revealed that bad sleepers were 5.545 times more likely to experience more fatigue than good sleepers. Our findings suggest that worse sleep quality is associated with a higher likelihood of experiencing increased fatigue. We also found anecdotal evidence, using Bayesian analysis, for a potential interference of sleep quality in confusion, vigor, and tension. However, when testing the interference of sleep quality in depression or anger using frequentist analysis, we did not detect any significant differences. Finally, our data did not support any hypotheses of interference of sleep quality in match statistics.
Key words: Bayesian analysis, fatigue, depression, confusion, sport, performance.

Resumen. Con el objetivo de investigar la asociación entre la calidad del sueño y los estados de ánimo o resultados emparejados en atletas de vóley playa, diseñamos un estudio transversal. Empleamos la Escala de Humor Brasileña (BMS) a través de Google Forms para evaluar el estado de ánimo de los atletas, que se les envió a las 8 pm del día anterior al primer partido. Solo consideramos las respuestas recibidas hasta las 10 pm (GMT-3). Además de la BMS, incluimos dos preguntas adicionales: "horas de sueño de la última noche" y "¿cómo se siente ahora?". Se solicitó a los atletas que eligieran uno de los siguientes cinco elementos: muy malo, malo, regular, bueno o excelente. Recopilamos datos estadísticos de los partidos, incluyendo puntos hechos, puntos en contra, victorias y derrotas en sets, partidos ganados y perdidos. Para verificar la correlación y las diferencias entre las variables, empleamos análisis bayesiano. El modelo de ANOVA bayesiano, que incluyó la calidad del sueño en la fatiga, fue 12.465 veces más probable que el modelo nulo. Los análisis post hoc revelaron que los malos durmientes eran 5.545 veces más propensos a experimentar más fatiga que los buenos durmientes. Nuestros hallazgos sugieren que una peor calidad del sueño se asocia con una mayor probabilidad de experimentar mayor fatiga. También encontramos evidencia anecdótica, mediante análisis bayesiano, de una posible interferencia de la calidad del sueño en la confusión, el vigor y la tensión. Sin embargo, al probar la interferencia de la calidad del sueño en la depresión o el enojo mediante análisis frecuentista, no detectamos diferencias significativas. Finalmente, nuestros datos no respaldaron ninguna hipótesis de interferencia de la calidad del sueño en las estadísticas del partido.
Palabras clave: Análisis bayesiano, fatiga, depresión, confusión, rendimiento atlético.

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Introduction

Beach volleyball is a high-intensity intermittent team sport that requires athletes to perform jumps, agility movements, and experience low recovery times during matches (Magalhães et al., 2011; Medeiros et al., 2014). To maintain stability in technical and tactical actions, players must engage in synergistic cooperation to successfully attack and defend (Caldeira et al., 2020). This pressure means that if an athlete is not adequately prepared, it may negatively affect the team's performance in terms of tactical and technical actions.

Understanding the demands of sports is one of the greatest challenges in sports science (Gabbett et al., 2019). Self-report scales such as the rating of perceived exertion (RPE) are highly useful for monitoring internal load (Medeiros et al., 2020). Sleep and mood are two aspects that form a part of this complex puzzle (Andrade et al., 2016; Juliff et al., 2014; Roberts et al., 2019), and in recent years, their assessment has gained significant attention among physiologists and coaches (Andrade et al., 2016; Samuels, 2008; Vitale et al., 2019). More than 80% of all peer-reviewed publications on "sleep" and "athlete" have been published in the last 10 years (Walsh et al., 2020). However, determining the cause-and-effect direction of sleep and mood behavior presents challenges due to the circular causality between the two factors. Mood can impact sleep quality, and sleep can influence mood (Walsh et al., 2020). Therefore, it is necessary to understand the correct cause and effect variables to avoid biased decisions (Friedrich Nietzsche, 2020).

In a study of Australian athletes, it was found that 64.0% reported experiencing poor sleep before important competitions or games (Juliff et al., 2014). Interestingly, 46.6% of these athletes did not believe that poor sleep affected their performance (Juliff et al., 2014). Despite the importance of monitoring sleep, it appears that many athletes are unaware of its potential impact on performance. The study also revealed that age was positively associated with the likelihood of poor sleep in individual sport athletes, while team sport athletes exhibited a negative association (Juliff et al., 2014). These findings suggest that the relationships with sleep quality may vary depending on the sport. It is possible that sleep quality is non-ergodic among levels of analysis (Molenaar, 2004; Bakdash & Marusich, 2017). As such, it is important to inquire about sleep quality in specific sports.

Biggins et al. (2021) investigated the sleep, health, and well-being of elite athletes from different sports before, during, and after international competition. They found that clinically relevant sleep problem significantly decreased during competition and improved post-competition. Additionally, they found that clinically relevant sleep problem was positively associated with overall health and well-being. These findings suggest that monitoring sleep quality and promoting healthy sleep habits may be important for maintaining the health and performance of athletes. Furthermore, other study found that athletes who reported better sleep quality also reported better mood states, and both factors were positively associated with athletic performance (Brandt et al., 2017), highlighting the importance of sleep quality for both physical and mental performance in elite athletes. Unfortunately, we are not aware of any studies specifically investigating the impact of sleep quality on mood state during the pre-competition period in beach volleyball.

Mood is recognized as a significant modulator of athletic performance. For instance, Andrade et al. (2016) investigated the correlation between sleep, mood, and match outcomes in 277 elite Brazilian volleyball athletes. The study revealed that athletes who lost the game had higher scores of tension and confusion compared to the winners (Andrade et al., 2016). The researchers further observed that for each increase in confusion score, the sleep quality of the athletes reduced by 19.70%. However, the exact magnitude of the association between mood, sleep quality, and performance in beach volleyball remains largely unexplored. Hence, it is crucial to investigate this association to obtain a comprehensive understanding of the relationship between these factors in beach volleyball.

Our aim was to analyze the relationship between sleep quality status, mood scores, and match results in beach volleyball athletes. We hypothesized that athletes with poor sleep quality would have lower mood scores and would lose more matches compared to athletes with good sleep quality.

Materials and methods

Ethical approval

Federal University of Ceará - PROPESQ-UFC ethical committee approved this research with the following number: 44757021.6.0000.5054. We conducted a cross-sectional design during an official beach volleyball championship. We met the recommendations of The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement (von Elm et al., 2007) to improve the study reports.

Sample and eligibility criteria

We invited athletes from the Brazilian Beach Volleyball Confederation OPEN 2020/2021 (CBVP OPEN) to participate in our study. We contacted them online and provided a detailed explanation of the ethical procedures and data collection purpose. The athletes confirmed their participation by agreeing to the informed consent form.

To be eligible for the study, athletes had to compete in the CBVP OPEN, complete the Brazilian Mood Scale (BMS) (the Portuguese version of the Brunel Mood Scale) (Rohlfs et al., 2008) between 8 pm and 10 pm, and agree with the informed consent form. A total of 18 athletes responded to the BMS and met the eligibility criteria. Due to the COVID-19 pandemic, we did not have any in-person contact with the athletes during the study. We present sample characterization by gender, beach volleyball practice time, functional specialization, weight, height, and age (Table 1).

Table 1.
Characteristics of the beach volleyball athletes

Gender	Frequency	Percentage	Missing	Total
Male	9.00	50.00	0.00	9.00
Female	9.00	50.00	0.00	9.00
Practice time	Frequency	Percentage	Missing	Total
1-5 years	4.00	22.22	0.00	4.00
5-10 years	5.00	27.78	0.00	5.00
10-15 years	5.00	27.78	0.00	5.00
15-20 years	3.00	16.67	0.00	3.00
More than 20 years	1.00	5.56	0.00	1.00
Functional specialization	Frequency	Percentage	Missing	Total
Blocker	10.00	55.56	0.00	10.00
Defender	6.00	33.33	0.00	6.00
Universal	2.00	11.11	0.00	2.00
Age and Anthropometrics	Median	Interquartile range	Missing	Total
Body mass (kg)	80.00	16.00	5.00	13.00
Height (cm)	187.00	12.00	3.00	15.00
Age (years)	24.50	8.25	2.00	16.00

Experimental design

To assess the mood state of athletes, we designed the Brazilian Mood Scale (BMS) (Rohlfs et al., 2008) using Google Forms and sent it to the athletes at 8 pm the day before the first match. We only considered form answers sent until 10 pm (GMT-3) for analysis. The BMS is a self-report questionnaire that assesses mood and comprises of 24 items divided into six mood subscales: tension, depression, anger, fatigue, and confusion. Each item on the subscales ranges from 0 (not at all) to 4 (extremely).

Based in other studies, we included two questions to evaluate sleep quality: "last night's sleep hours" and "how do you rate the quality of your sleep in the last few days?" (Andrade et al., 2019; Andrade et al., 2021; Andrade et

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al., 2016)

The athletes answered these questions with one of the following five items: very bad, bad, regular, good, or excellent. For data analysis (Andrade et al., 2016), we categorized the answers as bad (very bad plus bad), regular, and good (good plus excellent).

Since the CBVP OPEN is a championship with an eliminatory design, we monitored match data until the athletes were out of the competition. The maximum number of matches played by one team was seven, and the minimum was one. We checked the match data on the Volleyball Brazilian Confederation website and collected statistical data such as points scored, points conceded, set won, set defeats, matches won, and match defeats.

The missing anthropometric variables for some players occurred because we could not access them in loco due to the COVID-19 pandemic. To collect anthropometrics and age information, we accessed and searched federation websites. In some cases, we were unable to access the athletes' data online, which prevented us from including these variables in the inferential analysis. However, given their limited relevance to our research question, the missing anthropometric variables did not compromise the integrity of our statistical analysis.

Statistical procedures

The Shapiro-Wilk, Skewness, Kurtosis and Q-Q plots were used to test the Normality distribution (Ghasemi & Zahediasl, 2012). Levene Test tested homoscedasticity. We used descriptive statistics to show median and interquartile ranges.

We used Bayesian ANOVA (for three groups) with fixed prior probability in 0.5 for normal distributed variables (van den Bergh et al., 2020; van Doorn et al., 2021). We conducted post hoc testing for Bayesian ANOVA through pairwise comparisons using Bayesian t-tests, which were corrected for multiplicity by adjusting the prior odds (Dienes, 2011; Westfall, 1997). This approach is commonly used to determine significant differences among the groups in Bayesian analyses. We performed the Kruskal-Wallis test (three groups) for non-normal distributed variables. We conducted the Dwass-Steel-Critchlow-Fligner pairwise comparisons (DSCF) test when Kruskal-Wallis detected differences. The Bayes factor classification followed the modified Jeffreys scheme (Andraszewicz et al., 2014; Jeffreys, 1961). Threshold values for alternative hypotheses were 1 no evidence, >1-3 anecdotal, >3-10 moderate, >10-30 strong, >30-100 very strong, >100 extreme. Values less than 1 favors null hypothesis.

We have conducted resampling analyses for 10000.00 samples through algorithms like Markov Chain Monte Carlo (MCMC) in Bayesian ANOVA (Goss-Sampson, 2020). Alpha value adopted for frequentist analyses was 0.05. We performed the analyses in Jamovi 2.3 and JASP 0.16.3.0.

Results

In Table 2, we presented the mood status, sleep hours, and match statistics with their respective median, interquartile range, maximum, and minimum values. The prevalence of sleep quality among the beach volleyball athletes was found to be 44.4% for good sleep, 38.9% for bad sleep, and 16.7% for regular sleep.

Table 2
Descriptive Statistics of Mood Dimensions, Sleep Duration, and Match Performance in Beach Volleyball Athletes

	Confusion	Depression	Fatigue	Anger	Tension	Vigor	Sleep hours	Points scored	Points conceded	Set won	Set defeats	Won	Lost
N	18	18	18	18	18	18	18	18	18	18	18	18	18
Missing	0	0	0	0	0	0	0	0	0	0	0	0	0
Median	3.00	0.00	3.00	0.00	5.00	10.50	7.00	138.50	121.00	5.00	2.50	2.00	1.00
IQR	4.00	2.00	4.50	1.75	4.00	5.00	3.00	84.25	87.25	3.75	2.00	1.75	1.00
Minimum	0	0	0	0	0	0	0	25	42	0	2	0	1
Maximum	9	16	10	8	12	16	10	325	340	10	10	5	3

The Bayesian ANOVA model that included sleep quality and matches statistics exhibited anecdotal evidence. Data of Bayesian ANOVA model that included sleep quality and fatigue was 12.465 more likely than the null model. Post-hoc analyses revealed that more fatigue in bad sleepers is 5.545 (moderate evidence) times more likely than in good sleepers (Table 3). Fatigue in bad sleepers (mean (M): 6.571, 95% credible interval (CI): 3.654, 9.489) is higher than in good sleepers (M: 2.000, 95% CI: 0.389, 3.611).

We found that the data of the model including sleep quality and confusion was 5.006 times more likely than the null model. Additionally, when we included sleep quality and vigor, the data of this model was 5.773 times more likely than the null model. Post-hoc analyses revealed that bad sleepers were 2.143 times more likely to experience higher confusion levels (M: 5.429, 95% CI: 3.302, 7.555) compared to good sleepers (M: 2.000, 95% CI: -0.096, 4.096) and 2.353 times more likely compared to regular sleepers (M: 1.000, 95% CI: -1.484, 3.484) (Table 2). Furthermore, the post-hoc analyses showed that good sleepers were 2.143 times more likely to have higher vigor levels (M: 11.750, 95% CI: 9.619, 13.881) than bad sleepers (M: 7.000, 95% CI: 3.418, 10.582) and 1.438 times more likely compared to regular sleepers. However, according to the modified Jeffrey scheme (<3.0) (Andraszewicz et al., 2014; Jeffreys, 1961), this evidence is only anecdotal.

We used a Bayesian ANOVA model with a fixed factor of sleep quality to analyze tension, which provided anecdotal evidence (BF10: 1.879). Due to their non-normal distribution, we employed the Kruskal-Wallis test to analyze anger and depression. The model including sleep quality and anger did not detect any differences (p: 0.1464). However, the model including sleep quality and depression did detect differences (p: 0.0371), but these differences did not persist in the DSCF test.

We treated fatigue like normal distribution despite the Shapiro-Wilk Test result. We did this because the skewness (M: 0.739±0.536), kurtosis (-0.512±1.038), and Q-Q plot of residuals did not corroborate with the Shapiro-Wilk Test result.

Table 3.
Post-hoc comparisons of fatigue, confusion, and vigor scores in relation to sleep quality

		Prior Odds	Posterior Odds	$BF_{10,U}$	error %
Fatigue					
Regular	Bad	0.587	1.525	2.596	3.187e -4
	Good	0.587	0.327	0.556	5.603e -4
Bad	Good	0.587	5.545	9.440	1.900e -5
Confusion					
	Bad	0.587	2.353	4.005	0.001
Regular	Good	0.587	0.340	0.580	0.001
Bad	Good	0.587	2.143	3.648	0.006
Vigor					
	Bad	0.587	1.438	2.448	3.001e -4
Regular	Good	0.587	0.390	0.664	0.006
Bad	Good	0.587	2.438	4.151	2.198e -5

Note. Posterior odds have been corrected for multiple testing by fixing to 0.5 the prior probability that the null hypothesis held across all comparisons (Westfall et al., 1997). Individual comparisons are based on the default t-test with a Cauchy prior. The "U" in the Bayes factor denotes that it is uncorrected (Goss-Sampson, 2020).

We observed an iceberg profile in our sample, as depicted in Figure 1, with higher scores for vigor than for depression, tension, confusion, anger, and fatigue.

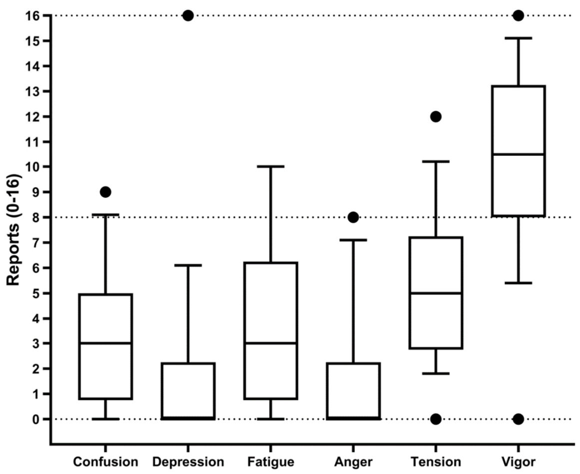

Figure 1. Median, 10-90 percentile, and atypical values in our sample reports

Discussion

In this study, we collected self-reported mood and sleep quality data from beach volleyball athletes on the night preceding their first match in a high-level competition. Our results provide moderate evidence to support the association between worse sleep quality and increased fatigue in athletes. We also found anecdotal evidence that bad sleep quality is associated with higher confusion and lower vigor levels when compared to regular or good sleep quality. These findings suggest that sleep quality is an important factor in achieving a less fatigue state in beach volleyball players.

Our study results conflicted with those of Andrade et al. (2016), who found that indoor volleyball athletes with bad sleep quality had higher confusion levels compared to those with good sleep quality. In contrast, our study found only anecdotal evidence for differences in confusion levels between good and bad sleepers. It is worth noting that Andrade et al. (2016) had a larger sample size of 277 athletes and therefore had greater statistical power to detect differences (Norton & Strube, 2001). The discrepancies in results may be attributed to differences between the two sports, as beach volleyball involves different environmental factors and game dynamics compared to indoor volleyball.

Like our study, Lastella et al. (2014) found a weak negative correlation between sleep quality and fatigue in marathon runners. They also concluded that athletes who experience disrupted sleep on the night prior to the competition have a worse mood status. However, it should be noted that the type of sport (individual or team) is related to sleep quality (Andrade et al., 2021). Individual sport athletes were found to be 3.45 times more likely to have poor sleep quality than team sport athletes. It is important to interpret these results with caution and consider that comparing sleep quality between individual and team sports may not always be appropriate due to the unique demands and characteristics of each sport.

Brandt et al. (2017) found that every increase in tension increase the chance of winning in 10% and decrease vigor and anger led to a 6% and 11% decrease in winning chance, respectively. In other hand, Andrade et al. (2016) found higher tension and confusion level in athletes who lost their games. The conflicting results from the studies by Andrade et al. (2016) and Brandt et al. (2017) may be attributed to differences in the specific populations studied. It is also possible that other factors, such as differences in training or coaching may have influenced the outcomes. Moreover, Andrade et al. (2019) showed that increased tension and decreased vigor negatively affect sleep quality in athletes, which may in turn affect their performance. Although clinically relevant sleep problems were positively associated with the Sports Profile of Mood States (sPOMS) score (Biggins et al., 2021), the relationship between sleep quality and match statistics in beach volleyball remains unclear. Our study only found anecdotal evidence, which is insufficient to support any definitive conclusions regarding the association between sleep quality and match results. Therefore, our data cannot provide sufficient evidence to support either the alternative or null hypotheses.

Our sample showed a profile known as the iceberg (Brandt et al., 2016; Morgan, 1980). A previous study showed this same profile in indoor volleyball athletes

(Andrade et al., 2016). This means that athletes have a high level of vigor associated with low levels of tension, depression, anger, fatigue and confusion. This pattern was found in athletes with better perceived sleep quality (Brandt et al., 2017). The iceberg profile is commonly observed in comparisons of POMS scores between athletes and non-athletes through T-scores (McNair et al., 1971). However, our study did not intend to conduct a direct comparison with non-athletes. Instead, we sought to describe the presence of the iceberg profile in our athlete sample, building on the findings of previous research. By doing so, our study contributes to the understanding of mood states among athletes and adds to the literature on the iceberg profile.

This study improved the knowledge and confidence that self-report fatigue is affected by sleep quality. Therefore, our results fortify the need for monitoring and modulating sleep variables in high-level athletes. Individuals involved in athlete training and support may benefit from seeking out additional training or resources related to sleep science. By enhancing their understanding of the impact of sleep on athletic performance and well-being, they can better develop effective interventions aimed at improving sleep quality and reducing mood disorders in athletes..

Limitations of our inquiry were: collecting the mood and sleep quality information only in the first match; the use of a self-report methodology, which might have compromised data precision. Future researchers should design a long-term study utilizing more sophisticated resources, like actigraphy, to assess sleep variables.

Conclusion

Our findings suggest that worse sleep quality is associated with a higher likelihood of experiencing increased fatigue. We also found anecdotal evidence, using Bayesian analysis, for a potential interference of sleep quality in confusion, vigor, and tension. When testing the interference of sleep quality in depression or anger using frequentist analysis, we did not detect any significant differences. Finally, our data did not support any hypotheses of interference of sleep quality in match statistics.

Conflicting interests

The authors have no conflicting interests.

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