©Journal of Sports Science and Medicine (2016) **15,** 601-605
http://www.jssm.org

Research article

Sleep Quality, Mood and Performance: A Study of Elite Brazilian Volleyball Athletes

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Abstract
This investigation analyzed the relationships between sleep quality, mood, and game results in the elite athletes participating in Brazilian volleyball competitions. Participants (n = 277 elite Brazilian volleyball athletes, 214 (77.3%) men and 63 (22.7%) women) completed the Brunel Mood Scale (BRUMS) and reported their subjective sleep perception. Athletes with poor sleep quality reported higher scores for confusion compared to athletes with good sleep quality ($p < 0.01$, $d = 0.43$). In addition, athletes who lost their game at the time of evaluation showed higher tension ($p < 0.01$, $d = 0.49$) and confusion ($p < 0.01$, $d = 0.32$) levels compared to athletes who won their game. A regression analysis demonstrated that for each point increase in the confusion level, there was a 19.7% reduction in sleep quality. Multivariate analysis of variance indicated that athletes who slept well, and won their games, had lower tension levels. Further, our results indicated that the athletes' mood associated with their success in the competitions. Therefore, in a competition, it is important that the athletes show good sleep quality, and use techniques and strategies to ease their mood variations.

Key words: Competition, psychology, team sport.

Introduction

During the last decade, there has been an increase in the number of sport psychology studies that have focused on understanding the relationship between emotional health and the performance of athletes during competition (Brandt et al., 2016; Jacobson and Matthaeus, 2014; Zandi and Rad, 2013).

Previous studies have shown that emotions are predictive of performance (Lane et al., 2012). Lane et al. (2016a) reported that to prevent poor performance, the greater challenge is to reduce the intensity of unpleasant emotions. The athlete's mood, among these emotions, has received increasing attention and has been studied in athletes of various sports, and competitive levels (Harris et al., 2015; Killer et al., 2015).

Mood has been operationalized and measured as a construct composed of six states: tension, depression, anger, confusion, vigor and fatigue. Moods are frequently temporary, and can vary in intensity and duration (Lane and Terry, 2000). Studies suggest that more pleasant moods (high vigor, and low fatigue, tension, depression, anger, and confusion) are associated with better performance in sports competitions (Brandt et al., 2016; Terry and Lane, 2000; Zandi and Rad, 2013). Indeed, evidence has reinforced the belief that negative moods are more prevalent in athletes who lose competitions, while positive moods are ideal for improved performances. Zandi and Rad (2103) found differences in the mood profiles between winning and losing athletes in the components of confusion, vigor, tension, fatigue and anger. According to Lane et al. (2016b), some individuals seek an optimal state through intense arousal and unpleasant emotions, while others seek low arousal and pleasant emotions.

Sleep has a direct relationship with mood (Lastella et al., 2014) and sports performance (Sargent et al., 2014). Recently, studies have strengthened the relationship between sleep quality, mood and sports performance (Harris et al., 2015; Killer et al., 2015; Lahart et al., 2013; Lastella et al., 2015; Thun et al., 2015). Research indicates that better sleep quality, besides homeostatic, neuroendocrine and immune regulation influence, is an important element contributing to better physical and emotional recovery of the athlete (Kölling et al., 2015).

In this context, Lastella et al (2015) observed behaviors of sleep / wake cycles in athletes of several sports, including five individual sports and four team sports. Athletes with fewer than the ideal number of hours sleep per day (less than 8 hours), were found to have had their sports performance negatively affected. According to Chen et al (2014), biological and psychosocial conditions, daily activities, and habits are all factors that can affect sleep duration.

However, there are still a paucity of investigations confirming the relationship between sleep, emotional health and sports performance (Fullagar et al., 2015). Therefore, this study aimed to analyze the relationship between sleep quality, mood and match results in men and women elite athletes participating in Brazilian volleyball competitions.

Methods

Participants

For this study, 277 elite Brazilian volleyball athletes (men = 214 / 77.3%; women = 63 / 22.7), with a mean age of 19 ± 5.86 years (men = 19.64 ± 4.70; women = 16.23 ± 2.62) were approached. All approached athletes met the inclusion criteria. Participants were selected using the criteria of having participated in either state

Received: 22 July 2016 / Accepted: 15 August 2016 / Published (online): 01 December 2016

level competition (A) or another national competition (B). Of the selected athletes, 138 (49.8%) and 139 (50.2%) athletes had participated in competitions A and B, respectively. This study received the approval of the ethics committee of the State University of Santa Catarina (Protocol n. 44/11). The parents or guardians of athletes under 18 years signed a consent form.

Materials and procedure

Two instruments for data collection were used: Brunel Mood Scale (BRUMS) (Terry et al., 2003) and one question that evaluate perceived sleep quality (Brandt et al., 2014). The question on self-reported sleep quality was "How would you evaluate the quality of your sleep in the past few days?" Participants rated their sleep quality on a Likert-type scale as follows: 1 = very bad, 2 = bad, 3 = regular, 4 = good, 5 = excellent. For further analysis, three categories were established. Bad sleep quality (very bad and bad), regular sleep quality (regular) and good sleep quality (good and excellent). The use of a self-completed questionnaire was a reliable method that reflected the athletes' sleep quality specifically during the competition period, and thus the time of data collection was a unique feature of this study. However, the self-rated sleep quality may also be considered a study limitation.

Athlete's moods were assessed using BRUMS (Terry et al., 2003). The BRUMS has been demonstrated to have Cronbach alpha values above 0.70 and is a reliable tool used to measure the mood of Brazilian athletes. The instrument consisted of 24 items and six subscales assessing mood: tension, depression, anger, vigor, fatigue and confusion. Each item was rated on a Likert scale ranging from nothing (0) to extremely (4), where the respondent indicated how they were feeling at that moment. The results were calculated using the mean of the items in each subscale.

Data collection was performed during volleyball competitions. The researchers had access to the competition area for recruitment and assessment of the athletes. Study information was given to all athletes and informed consent was signed by athletes who agreed to participate. After signing the informed consent, each participant was asked to respond in a quiet location in the presence of the investigator.

The questionnaires were answered approximately 30 minutes before the matches took place, individually at the site of competition. The timing and location was designed to cause minimal interference to athlete preparation, and in particular to improve the responses related to competition and sleep.

Performance was determined by the summary or official report provided by the competition organizer; we classified it as a dichotomous variable (i.e. won or lost). We have opted for the dichotomized variable of performance because previous study had used this model (Slimani et al., 2016).

Data analysis

The data were analyzed using descriptive statistics (mean, standard deviation, frequency and percentage) and inferential statistics. Inferential analysis was performed using comparison tests. Non-parametric data were assessed using Kolmogorov-Smirnov tests to compare the equality of continuous variables. A multivariate analysis of variance (MANOVA) was performed to investigate the effect of self-rated sleep quality (bad or good) and performance (won or lost) on mood. As the Box's test was significant ($p < 0.05$), and only tension and vigor did not violate the homogeneity of variance assumption as assessed by the Levene's test, a Mann-Whitney U test was used for the following variables: confusion, depression, anger, and fatigue . For this test, *P*-values < 0.025 were adopted to reduce the chance of type I error. The Cohen's *d* effect size was calculated as well. A value of $d = 0.2$ was indicative of a small effect, $d = 0.5$ a medium effect, and $d = 0.8$ a large effect.

Logistic regression analyses were also performed to assess the association between mood and the dichotomous variable for sleep quality (good and bad). *P*-values <0.05 were considered significant.

Results

The majority of athletes (70%) reported having good sleep quality by self- reported questionnaires. In regards to gender, men and women had similar responses. When assessed by performance, the majority of athletes, including both winners and losers, reported good sleep quality (see Table 1).

Overall, the 277 elite Brazilian volleyball athletes had a mood profile known as Iceberg (high level of vigor associated with low levels of tension, depression, anger, fatigue and confusion). Men and women did not differ significantly. The relationships between elite Brazilian volleyball athlete mood, sleep quality and performance are presented in Table 2.

The mood variables did not meet the Box's M test assumptions ($p < 0.05$), and only vigor and tension complied with the Levene's homogeneity assumption ($p > 0.05$). Therefore, the MANOVA indicated significant differences between performance and self-rated sleep quality groups on mood (Wilks lambda $_{(6, 264)} = 0.943$, $p = 0.16$, Partial Eta$^2 = 0.057$), identified tension ($F_{(3, 269)} = 6.191$, $p < 0.01$, $\eta^2 = 0.065$) as a significant contributor to the interaction between sleep and performance, indicating that among athletes who slept well, those who won their game had lower tension levels compared to those who lost their game (Table 2).

We used the Mann-Whitney test to analyze all

Table 1. Self-Rated Sleep Quality of the elite Brazilian volleyball athletes (n/%).

	General	Gender		Performance	
Sleep Quality	**n(%)**	**Men n(%)**	**Women n(%)**	**Won n(%)**	**Lost n(%)**
Bad	83(30)	61(28.5)	22(34.9)	38(30.4)	45(29.6)
Good	194(70)	153(71.5)	41(65.1)	87(69.6)	107(70.4)

Table 2. Mood in relation to gender, sleep quality and performance of elite Brazilian volleyball athletes. Data are means (±SD).

	Tension	Depression	Anger	Vigor	Fatigue	Confusion
General	3.5 (2.4	.7 (1.7)	1.3 (2.3)	11.7 (2.4)	2.6 (2.6)	1.6 (1.9)
Men	3.6 (2.4	.8 (1.8)	1.4 (2.5)	11.8 (2.4)	2.8 (2.7)	1.7 (2.1)
Women	3.3 (2.4	.4 (1.0)	1.0 (1.4)	11.2 (2.3)	2.2 (2.0)	1.2 (1.5)
Sleep Quality						
Bad	3.9 (2.4	1.0 (2.2)	1.8 (2.9)	10.1 (3.0)	2.9 (3.1)	2.2 (2.4) *
Good	3.4 (2.3)	.6 (1.4)	1.1 (1.9)	11.8 (2.3)	2.5 (2.4)	1.3 (1.7)
Performance						
Won	2.9 (2.1) #	.7 (1.9)	1.4 (2.4)	11.4 (2.4)	2.9 (2.9)	1.2 (1.7) †
Lost	4.1 (2.5)	.7 (1.5)	1.3 (2.2)	11.9 (2.4)	2.4 (2.3)	1.9 (2.1)

* $p < 0.01$ compared with Good. # $p < 0.01$ compared with Lost. †$p < 0.01$ compared with Lost.

variables that did not meet the assumptions of Box's M test, and Levene's test. An analysis of the self-rated sleep quality and mood revealed that athletes with bad sleep quality had higher confusion levels compared to athletes with good sleep quality ($U = 6141.5$, $p < 0.01$, $d = 0.67$), and were consequently at a greater risk of losing (Table 2).

Athletes who lost their game, at the time of evaluation showed higher tension ($U = 6899.5$, $p < 0.01$, $d = 0.49$) and confusion ($U = 7487.0$, $p < 0.01$, $d = 0.32$) compared to winning athletes (Table 2).

Binary logistic regression analysis was conducted to determine the relationships between self-rated sleep quality, and the mood of the elite Brazilian volleyball athletes. The model indicated that there was a significant relationship between self-rated sleep quality and confusion ($p < 0.01$; $B = -0.219$; $Exp(B) = 0.803$; $CI95\% = 0.705–0.914$), with bad sleep quality found to be associated with increased confusion. Using the formula [Exp(B)-1]x100 to calculate the factors predicting sleep quality, we determined that for each point increase in the confusion level, there was a 19.7% reduction in sleep quality.

Discussion

The main finding of this study was that with each point increase in the confusion level, there was a 19.7% reduction in the sleep quality, which can negatively influence the athlete's performance and interfere with attaining the desired game result. Confusion can be characterized by an unusual response/outcome to anxiety and depression, feelings of uncertainty and inability to control emotions (Beck and Clark, 1988). Lane and Terry (2000) suggest that confusion may have debilitating effects on income.

Sleep has a direct relationship with mood (Lastella et al., 2014). In our study, even though self-rated sleep quality, athletes with bad sleep quality perception had higher confusion before the game when compared to athletes with regular and good sleep quality. When changes in mood occur, athlete performance can be affected, negatively influencing cognition, decision making and execution of motor skills (Dinges et al., 1997). In team sports, correct decision-making is crucial (Furley et al., 2013). For example, in a study of basketball athletes, it was found that making the wrong decision was one of the main factors contributing to team defeat (Halson, 2014).

Our results are consistent with the results from other studies assessing athletes using different modalities. Lastella et al (2014) assessed marathon runners and found that athletes with better quality and a longer duration of sleep prior to competition showed less fatigue and tension. Tension levels were negatively associated with the number of times the athletes woke during the night. Thus, bad quality and insufficient sleep is associated with an increase in the fatigue and tension of athletes during competitions.

Scott et al (2006) showed a significant relationship between fatigue and the reaction time between those investigated, with highest levels of fatigue corresponding to reduced reaction time. Reaction time is a common measure used to evaluate the motor performance of athletes in various sports, including volleyball (Fontani et al., 2006). According to the authors, reaction time is a factor that influences the performance of athletes, and can be decisive in the result of competitions.

In our study, most of the elite Brazilian volleyball athletes reported having good sleep quality. This is a positive factor, because in competitive conditions, sleep is an important factor that can influence athletic performance (Sargent et al., 2014; Thun et al., 2015). For example, bad quality or insufficient sleep can result in an imbalance of the autonomic nervous system, causing the athlete to experience symptoms similar to those during overtraining, and resulting in a reduction of immunity (Fullagar et al., 2015) and cognitive function (Halson, 2014). Moreover, as indicated by this study, good sleep quality is positive for the continuity of the sporting season, and has an important role in the physical and emotional recovery of the athlete (Kölling et al., 2015).

However, our results differ from previous studies that evaluated the sleep quality of athletes who participated in other sports. Poussel et al (2014) assessed the subjective sleep quality of athletes from a number of sports and further investigated 137 athletes who reported bad sleep quality. Juliff et al (2015) also investigated athletes participating in several sports, and found that 64% of them indicated bad sleep on nights before a major competition. In addition, George et al (2003) showed that a large proportion of football players had excessive daytime sleepiness. These data highlight the need for adequate guidance to assist athletes and coaches in minimizing the influence of poor sleep quality on the performance of athletes.

Our study did not find any differences in sleep quality between men and women. However, the study of

Leeder et al (2012) reported that men had a decreased duration of sleep. Further investigation into the differences in sleep quality between men and women are necessary, given that there are psychopathological differences between genders (Schaal, 2011).

There were significant differences in the levels of tension and confusion amongst winning and losing athletes, with the athletes who lost their game having higher levels of both variables. The MANOVA test demonstrated that athletes who reportedly slept well, and won their games, had lower stress levels. In the study of Thun et al (2015), athlete performance was negatively associated with bad sleep quality. Reyner and Horne (2013) investigated young tennis players, and also found an association between sleep quality and performance. In particular, they noted that reduced sleep negatively affected the performance of approximately one third of tennis players.

It is important to consider other factors which may influence the well- being of athletes during competitions, such as sleeping in accommodation away from home and having a lack of daily routine. Factors such as sleep, rest and mood can be affected under these conditions.

Conclusion

In conclusion, athletes generally reported good sleep quality during competition periods. However, our results suggest that elite Brazilian volleyball athletes with poor sleep quality have higher levels of confusion compared with athletes reporting good sleep quality. The defeated athletes have higher levels of tension and confusion before the game. Moreover, for every pointwise increase in the level of confusion, there was an associated 19.7% reduction in sleep quality that can compromise the athlete's performance. In addition, athletes who slept well, and won their games, had lower tension levels. Further studies, utilizing more robust and detailed sleep instruments as well as longer follow-up of sleep quality and athletes' mood, will be required to identify other factors that may affect the relationship between sleep quality, mood states, and performance during athletic competitions.

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Key points

- Study evaluated Self-Rated sleep quality, mood and performance of 277 elite Brazilian volleyball athletes.
- Our results indicated that for every pointwise increase in the level of confusion, there was an associated 19.7% reduction in sleep quality
- Athletes who slept well, and won their games, had lower tension levels.

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