

Relationship between sleep quality and recovery levels in young swimmers

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Abstract:

The undeniable benefits of enhanced sleep quality resulting from physical exercise have been well-established. However, analyzing the intricate relationship between recovery levels and sleep quality necessitates a thorough investigation. This exploration is essential to develop a comprehensive of how sleep influences recovery, particularly concerning training loads, in the context of young athletes. Physical recovery is a pivotal and rejuvenating aspect for athletes, highlighting the importance of examining its interplay with sleep. This study aimed to evaluate the impact of sleep quality on recovery during the tapering period among young swimmers. Based on a cross-sectional, descriptive, and quantitative approach, this research involved 15 swimming athletes affiliated with both the Pernambuco Aquatic Federation and the Brazilian Confederation of Aquatic Sports. The Pittsburgh Sleep Quality Index (PSQI) questionnaire and the Epworth Sleepiness Scale (ESS) sleepiness questionnaire were used to assess sleep behavior, and the Total Quality Recovery Scale was applied to verify levels of recovery (TQR). Data were collected 21 days before the target competition, body composition measurements were obtained and questionnaires were applied. Spearman's correlation showed a difference between total sleep time and sleep efficiency ($r = -0.64$) and a positive correlation between recovery from the second week to the third week ($r = 0.0223$). Females showed good sleep quality and recovery at week 1, while males did not show significant changes. The conclusion of the study was that the quality of sleep and its variables showed good quality in relation to recovery, described as reasonably recovered in week 2 closes to the competition.

Key Words: Young Swimmers, Tapering, Sleep Quality, Recovery

Introduction

In contemporary society, with the advent of technological advances and the facilities arising from this convenience, which also includes nutritional conveniences, favoring increasingly less active behaviors among young people, it reflects changes to the body, the promotion of health and quality of life (Luciano *et al.*, 2016). Excessive screen time contributes to a series of physical and mental illnesses, which can also influence sleep quality (Viner *et al.*, 2019).

During the process of human growth and development, adolescence is the phase that presents significant biopsychosocial changes that identify needs for behaviors characteristic of the end of maturation, and this behavior may reflect changes in sleep phases, which in turn will have repercussions in adulthood, with routines and habit preferences (Crowley *et al.*, 2018).

Furthermore, it is during adolescence that intense physiological and hormonal changes and the secretion of growth hormone (GH) are associated with frequent complaints, which can influence the quality of sleep. However, recent studies show that in this phase, not only biological and behavioral changes are responsible for the increase in sleep complaints, but also that strategies aimed at improving sleep quality are essential to mitigate health problems during adolescence, and physical exercise seems to establish an efficient and effective connection as a procedure (Lloyd *et al.*, 2014; Crowley *et al.*, 2018).

Studies that analyze the association between the effects of physical exercises and their loads associated with improved sleep quality seem controversial and require further investigation, to substantiate understandings about the influence of sleep on recovery, through training loads, in young athletes (Nogueira *et al.*, 2015). Allied to this, the monitoring of training through internal and external loads seems to be an effective tool, which translates the perceived intensity, being a strategy that identifies in athletes the adaptation or not of the periodization planned by the coach, allowing the optimization and adequacy of the loads to the training process, before evaluating the results of a competition. (Nogueira *et al.*, 2015).

About the period of tapering in swimming, Le Meur, Hausswirth and Mujika (2012) clarify that, the reduction of the volume and increase or maintenance of the intensity during the training being an element that

composes the phases of periodization, configuring the period pre-competitive (Le Meur, Hausswirth, Mujika, 2012). This phase is usually carried out between two and three weeks before a competition (De Sousa Fortes *et al.*, 2017).

Recovery, in turn, is a fundamental aspect for athletes, being considered part of training, and should be included in training planning (periodization), as well as in its various phases (macro, meso and microcycles) (Fabiani, 2009). In the study by Santiago *et al.* (2015) carried out with adolescents, observed the relevance of sleep for good recovery between training sessions and that the time, duration, and intensity of the practice positively or negatively impact the quality of sleep (Santiago *et al.*, 2015).

In this context, a gap needs investigation, considering adolescent athletes and the relationship between systematized training during the tapering period and sleep to establish the recovery of energy expenditure promoted by the intensity and duration of training, in addition to the athlete's subjective perception of effort, which can lead to understanding the dimensions of sleep, associated with better sleep quality (Nogueira *et al.*, 2012). Additionally, an athlete's sleep may be influenced by sources external to the sport, such as gender, feelings of anxiety, as well as specificities of the modality according to the competition calendar (competitive trips and studies - Walsh *et al.*, 2021).

Occurrences of sleep changes are noticed in athletes before competition, which can compromise the athlete's performance, making it difficult in some cases to differentiate changes from disorders in this population, and it is not uncommon for athletes to spend one or more nights with insufficient quantity and quality of sleep for recovery. satisfactory (Walsh *et al.*, 2021).

Furthermore, despite studies seeking answers to elucidate this specific relationship: sleep and performance, there is still no effective relationship found between the pre-competitive period and inadequate sleep in young elite athletes. The influence of several aspects must be taken into account as they are also associated with social factors (such as prolonged use of smartphones and exposure to bright screens for long periods), which can lead to losses in training and competition performance. In addition to this, morning training, night competitions, short and long distance travel must be included, in addition to the volume and training loads, which must be considered (De Assis Santana *et al.*, 2022; Walsh *et al.*, 2021).

For these reasons and knowing that the beneficial effects of physical exercise are frequently reported in studies, but training protocols and intensity of loads need to be evaluated and understood, as non-pharmacological strategies in adolescent athletes, considering these variations in intensity and duration , but that aim for this same effect. The present study aimed to verify the influence of sleep quality on recovery during the polishing period in young swimmers.

Material & methods

This is a cross-sectional, descriptive, and quantitative study. The study included 15 swimming athletes, affiliated to the Pernambuco Aquatic Federation - FAPE and the Brazilian Confederation of Aquatic Sports - CBDA, with an average age of 13.40 ± 0.51 years, eight men and ten women, as an exclusion criterion in the study, non-participation in all stages of the research and/or withdrawal from training due to an injury were considered. All athletes were invited to participate in the research, being informed to parents and/or guardians and team coach about the associated risks, in addition to the research procedures. The sample was selected in a non-probabilistic way, based on convenience and adherence. The Free and Informed Consent Term (TCLE) was delivered, read and signed by the parents and/or guardians and the Free and Clarified Assent Term (TALE) was read and signed by the athletes, agreeing with the terms, guaranteeing anonymity and confidentiality of the data, according to the adopted procedures that met the norms of Resolution 466/12 of the National Health Council for research with human beings, having the approval by the Research Ethics Committee of the Federal University of Pernambuco, for research with human beings, under opinion nº. 3.366.677/2019, CAAE 96625018.1.0000.5208.

Height was obtained using a Sanny stadiometer (São Paulo, Brazil) with a precision of 0.1 cm, recorded in centimeters, considering the first decimal place, with the subject barefoot, with legs and feet parallel, arms extended to the side. side of the body. Body mass was assessed using a digital scale (Filizola, São Paulo, Brazil) with a precision of 100 grams (Lohman, 1986). From these data, it was possible to calculate the Body Mass Index (BMI) through the equation: $[\text{body mass (kg)} / \text{height}^2 \text{ (m)}]$.

In the evaluation of sleep behavior, the Pittsburgh Sleep Quality Index (PSQI) questionnaire was used, which verified the quality of sleep in the last month, providing an index of severity and nature of the disorder. The questionnaire has 19 questions, grouped into seven components with weight distribution ranging from zero to three. Consisting of seven components, which can be scored from zero to three, obtaining a total score ranging from zero to 21 points. The PSQI presents classifications related to sleep complaints divided into: subjective sleep quality, total sleep time, sleep latency, habitual sleep efficiency and sleep disturbance. Scores from zero to four indicate good sleep quality, from five to 10 poor quality and values above 10 indicate poor sleep quality, the reliability coefficient (Cronbach's α) of the eight scale items was 0.83, indicating a high degree of internal consistency, validated in the Portuguese version (Bertolazi *et al.*, 2011).

The Epworth Sleepiness Scale (ESS) sleepiness questionnaire has characteristics to be evaluated, differentiating people with and without sleepiness from those with excessive sleepiness. Consisting of eight questions that describe everyday situations that can induce drowsiness (Bertolazi, 2008). The score is based on

the report of episodes of sleepiness in different situations and environments, being equal to or greater than 10 points, the evaluated person is classified as sleepy, the reliability coefficient (Cronbach's α) of the eight items of the scale was 0.83, indicating a high degree of internal consistency (Bertolazi *et al.*, 2011).

Recovery monitoring was performed using the Total Quality of Recovery Scale (QTR), proposed by KENTTÄ *et al.* (1998) used to assess the athlete's perception of their psychophysiological recovery (Brink *et al.*, 2010). The scale is composed of a range of six to 20 points, where six corresponds to "nothing recovered" and 20, "totally well recovered", where the athletes answered the question "How do you feel about your recovery?" The athletes chose a value and a descriptor that represented how they felt about their recovery.

Data were collected 21 days before the target competition; therefore, the athletes were already in the process of previous training. On the first day of collection, at the athletes' training site (water park), body measurements were obtained (body mass and height), followed by sleep quality (PSQI) and sleepiness (Epworth) questionnaires. athletes received verbal instructions and guidelines to answer the Total Quality of Recovery (TQR) scale, and 30 minutes before the training session, the athletes answered the question: "How do you feel about your recovery?", answering before each training session.

Statistical analysis

Prior to the analysis, the normality and homogeneity of the data were performed using the Shapiro-Wilk and Levene tests, showing no normality in the distribution. Thus, non-parametric statistics were used for inferential data analysis through Spearman's correlation for sleep quality and recovery; sleep quality and sleep variables (TTS, efficiency, and sleep latency). Descriptive analysis (mean and SD) was performed to characterize the sample. The established significance level was 5% ($p < 0.05$) for all analyses. Data were collected using the Statistical Package for Social Sciences – SPSS version 20.0 software (IBM, USA).

Results

The sample consisted of 18 swimming athletes (eight men and 10 women), mean age 13.40 ± 0.51 years. Table 1 presents general characteristics of the sample and stratified by gender for age, height, weight, and BMI variables. It is possible to observe that the sample is within the standard of normality for athletes of the modality in relation to the values established by the World Health Organization (OMS, 2005), regarding the variables of weight, height and BMI.

Table 1 - Mean $\pm$ standard deviation of anthropometric characteristics of body composition (age, height, weight and BMI).

Variables	Sample Mean $\pm$ SD (n= 18)	Female Mean $\pm$ SD (n= 10)	Male Mean $\pm$ SD (n= 8)	P Value*
Age (years)	13.40 $\pm$ 0.51	13.40 $\pm$ 0.51	13.50 $\pm$ 0.53	0.001
Height (cm)	1.63 $\pm$ 7.57	1.59 $\pm$ 3.29	1.68 $\pm$ 8.55	0.024
Weight (kg)	54.20 $\pm$ 7.89	52.20 $\pm$ 6.41	56.70 $\pm$ 9.24	0.028
BMI (%)	20.30 $\pm$ 2.05	20.60 $\pm$ 2.07	19.90 $\pm$ 2.11	0.075

Table 2 shows the differences between gender (female and male) with the estimate of sleep quality and its components (TTS, ES and LS) and recovery by weeks. No difference was evidenced in the total sample for recovery in week 2 ($p > 0.05$). However, when compared by gender, significant mean values were observed in females for sleep quality, TTS, sleepiness and recovery at week 1 ($p < 0.05$), while in males differences were found in sleep quality and in ES ($p < 0.05$).

Table 2 - Data regarding sleep quality and its components (TTS, EF, and LS), sleepiness and recovery scale for the total sample and stratified by gender.

Variables	Median $\pm$ SD (Total n= 18)	P Value*
Sleep quality	1.11 $\pm$ 0.32	<0.001*
TTS (hrs)	9.04 $\pm$ 1.54	0.013*
ES (%)	93.00 $\pm$ 7.65	0.009*
LS (min)	13.20 $\pm$ 7.89	0.043*
Sonolência	2.17 $\pm$ 0.857	<0.001*
TQR week 1	14.20 $\pm$ 1.74	0.009*
TQR week 2	14.10 $\pm$ 2.01	0.107
TQR week 3	14.10 $\pm$ 1.88	0.028*
Female (n= 10)		
Sleep quality	1.10 $\pm$ 0.31	<0.001*
TTS (hrs)	8.89 $\pm$ 1.60	0.007*
ES (%)	94.50 $\pm$ 7.43	0.059

LS (min)	14.20±9.93	0.239
Sonolência	2.10±0.99	0.001*
TQR week 1	14.40±2.00	0.008*
TQR week 2	14.60±2.36	0.316
TQR week 3	14.10±2.49	0.158
Male (n= 8)		
Sleep quality	1.13±0.35	<0.001*
TTS (hrs)	9.22±1.56	0.450
ES (%)	91.00±7.96	0.018*
LS (min)	11.90±4.58	0.324
Sonolência	2.25±0.70	0.056
TQR week 1	14.00±1.44	0.513
TQR week 2	13.6±1.46	0.435
TQR week 3	14.20±0.80	0.653

Legends: TTS = Total sleep time; ES = Sleep efficiency; LS = Sleep latency; hrs = hours; min = minutes; TQR = Total Quality of Recovery Scale; * = $p < 0.05$.

Table 3 presents the main correlated variables, it was possible to observe that sleep quality did not present a significant correlation with the components of sleep variables (TTS, ES and LS), nor with recovery (TQR weeks 1, 2 and 3), however, there was a negative correlation between TTS and ES ($r = -0.64$) and a positive correlation between recovery from week 2 to week 3 ($r = 0.0223$).

Table - 3 - Spearman correlation, r and (p -value) between sleep quality and its dimensions and recovery.

Variables	TTS (hrs)	ES (%)	LS (min)	TQR 1 (week)	TQR 2 (week)	TQR 3 (week)
Sleep quality	0,40 (0,098)	-0,13 (0,58)	0,38 (0,112)	-0,42 (<0,075)	-0,05 (0,837)	0,12 (0,632)
TTS (hs)	(-)	-0,64 (0,003)*	-0,11 (0,632)			
ES (%)		(-)	-0,216 (0,383)			
LS (min)			(-)			
TQR 1 (week)				(-)	0,389 (0,108)	0,257 (0,297)
TQR 2 (week)					(-)	0,533 (0,0223)*
TQR 3 (week)						(-)

Dicussion

The present study aimed to verify the influence of sleep quality on the recovery of young swimmers during the tapering period. Regarding the total sample, there was a significant difference in all sleep components (quality, TTS, ES and LS), sleepiness and recovery in the first and third weeks. Showing recovery rating as reasonably recovered. When segmented by gender, sleep quality remained common for both, in the sense that there was a significant difference. For females, TTS and sleepiness were different at week 1. While for males, only ES was different.

Mong and Cusmano (2016) reported that female athletes have a significantly better sleep quality than males, who have a longer awake time and lower sleep efficiency, as found in the present study. In contrast, another study points out that women are more likely to have more sleep disorders than men, due to periods of hormonal changes throughout life, especially in adolescence (Pengo, Won, Bourjeily, 2018).

In the analysis of sleep quality, it was classified as "good" for both genders, and for women TTS decreased in relation to men, SS in men decreased in relation to women. On the contrary, a study on sleep and training with elite athletes in individual and collective sports showed a predominance of low sleep quality, being higher in females. Furthermore, on the eve of competitions, a worsening of sleep has been reported (Bleyer *et al.*, 2015).

When analyzing daytime sleepiness, a significant indicator was observed in women, described as "moderate chance of dozing off", while in men this relationship was not significant. On the contrary, Silva *et al.* (2019) in their study with elite athletes in individual sports, demonstrated a prevalence of sleep complaints in men, who reported a greater number of complaints, including greater daytime sleepiness, compared to men. the female gender. In addition, studies show that 64% of high-performance athletes reported disturbed sleep the night before the competition, a fact observed in the present study when relating TTS and ES, presenting a significant negative correlation, in addition to the perception of recovery decreasing in the third week of training (Erlacher *et al.*, 2011).

It is known that the tapering phase is an important competitive strategy, which aims to psychophysiologically attenuate the stress caused by the long and intense training that precedes this phase, with repercussions on the athletes' recovery (Mujika, Padilla, Pyne, 2002). The recovery measured through a scale that quantified how the athlete felt the next day, before starting the training, showed that the female gender had better recovery in week 1, unlike the male.

On the contrary, Nogueira *et al.* (2015) showed in their study, there is no significant difference in the recovery values, throughout the training sessions, when compared between genders, despite having presented a statistical difference between the transformation and tapering in a ratio of reduced load and greater recovery. Similarly, the studies by Costa *et al.* (2022) and Conde (2014) demonstrated that in young athletes recovery levels occurred significantly and quickly for physical and cognitive recovery, with values in the descriptor ranging from "well recovered" and "reasonably well recovered".

By correlating the sleep quality of the total sample with the other variables, it was observed that this did not present an important relationship with any of the variables. But by breaking down the sleep components (TTS, ES and LS), it was possible to perceive a (negative) relationship between total sleep time and sleep efficiency. What can be explained by variations in loads, training period. And in the recovery between weeks, there was a positive correlation between week 2 and week 3, being classified as reasonably recovered. The quality of sleep is closely related to the recovery of athletes, a good night's sleep is a powerful tool for reducing muscle pain, improving performance, in addition to improving concentration levels and alertness (De Assis Santana *et al.*, 2022). While a bad night's sleep increases pain sensitivity, changes mood, influencing levels of concentration and perception of recovery (De Assis Santana *et al.*, 2022).

In a study that compared individual and collective sports, athletes in individual sports had less quality and quantity of sleep due to the particularities of training, results, methods (Lastella *et al.*, 2015). Agreeing with this, Narciso *et al.* (2020) finds that athletes in individual sports such as swimming, rowing, diving demonstrate a more fragmented sleep and a worse efficiency of this, compared to team athletes. What determines by influencing the degree of recovery and consequently the performance in training and competitions, which corroborates with this study.

Furthermore, the sleep pattern can vary according to age, with the TST for a healthy population varying between 9-11 hours/night, for the age groups of 6-13 years, (Ferrara and De Gennaro, 2001). While for elite athletes, this variation can range from 6.5 to 8.5 hours/night (Lastella *et al.*, 2015; Gupta *et al.*, 2017). Additionally, the nature of the exercise itself and its duration and intensity characteristics seem to have a direct influence on the relationship between recovery and sleep quality, provoking different responses between genders, as well as equivalent physiological adaptations (de Faria *et al.*, 2009).

Evidence of more expressive results not demonstrated in this study reflect some limitations of the same, which in turn was presented through a cross-sectional approach, longitudinal studies that deepen through a sample quantity and greater duration present traces of representative comparative responses when related to the sleep quality and recovery.

Conclusions

The results obtained in the present study suggest that there was a significant difference in all sleep components: with good sleep quality, TTS, ES, LS, sleepiness, and recovery (reasonably recovered) in the first and third week for the total sample. When stratified by gender, good sleep quality was evidenced, remaining in common for both, showing a significant difference.

Good sleep quality and recovery were observed among women in the first week, while men showed no significant changes. Sleep quality and its variables showed good quality in relation to recovery, described as reasonably recovered in the second week close to the competition

Studies that show the relationship between recovery and sleep quality are still few, so longitudinal research may reflect evidence that emphasizes the findings of the present investigation, reinforcing the importance of care and measures that include sleep hygiene in young athletes, as a way of get the most out of performance and sleep quality care to promote health and quality of life in adulthood.

Conflicts of interest - The authors declare no conflict of interest.

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