STUDIA UBB EDUCATIO ARTIS GYMN., LXIX, 3, 2024, pp. 105-116
(RECOMMENDED CITATION)
DOI:10.24193/subbeag.69(3).24

THE INFLUENCE OF SLEEP ON ATHLETES' BODY RECOVERY AFTER EFFORT

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Article history: Received: 2024 October 21; Revised 2024 November 8; Accepted 2024 November 11; Available online: 2024 November 30; *Available print: 2024 November 30*

ABSTRACT. The recovery of athletes' body after effort is an essential component of sports training, alongside physical, technical, tactical, theoretical, and psychological preparation. Sleep is a natural and crucial means for post-effort recovery, if the quality and quantity requirements are met. The aim of this research is to investigate athletes' perceptions and behaviors related to sleep and rest and how these affect sports performance. The research methods used were literature review, questionnaire survey, statistical-mathematical analysis and graphical representation. By analyzing the responses to a 9-question survey, the study aims to highlight the factors that affect sleep quality and the impact on recovery and overall performance. Specifically, the research seeks to identify correlations between hours of sleep, bedtime and wake-up routines, relaxation techniques and perceptions of sleep's importance in physical recovery. The questionnaire included questions about sleep habits (sleep hours, bedtime, alarm use), perceived sleep quality and common issues (difficulty falling asleep, frequent waking); athletes' perceptions of sleep's influence on sports performance; factors that disrupt sleep and techniques used to improve sleep quality. The student-athletes who responded to our questionnaire do not have sufficient knowledge about sleep hygiene, meaning that coaches should focus more on providing information about athletes' lifestyle, which include the importance of sleep for post-effort recovery, for their health and implicitly for improving sports performance. Athletes must realize that sleep should be a priority in their lifestyle, placing it in the same place with nutrition and training.

Keywords: *effort, performance, recovery, sleep, athletes*

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REZUMAT. ***Influența somnului în refacerea organismului sportivilor după efort.*** Refacerea organismului sportivilor după efort este o componentă importantă a antrenamentului sportiv alături de pregătirea fizică, tehnică, tactică, teoretică și psihologică. Somnul este un mijloc natural esențial pentru refacerea după efort, cu condiția respectării cerințelor legate de calitatea și cantitatea acestuia. Scopul acestei cercetări este de a investiga percepțiile și comportamentele legate de somn și odihnă ale sportivilor, precum și influența acestora asupra performanței sportive. Metodele de cercetare utilizate au fost analiza literaturii de specialitate, ancheta prin chestionar, metoda statistico-matematică și metoda grafică. Prin analizarea răspunsurilor la un chestionar cu 9 întrebări, studiul își propune să evidențieze factorii care afectează calitatea somnului și impactul acestora asupra refacerii și performanței generale. În mod special, cercetarea vizează să identifice corelațiile între orele de somn, obiceiurile de culcare și trezire, tehnicile de relaxare, și percepțiile despre importanța somnului în contextul recuperării fizice. Chestionarul a inclus întrebări despre obiceiurile legate de somn (ore de somn, ora de culcare, folosirea alarmelor); calitatea percepută a somnului și problemele frecvente (dificultăți de adormire, trezire frecventă); percepția sportivilor asupra influenței somnului asupra performanței sportive; factorii care perturbă somnul și tehnicile folosite pentru îmbunătățirea acestuia. Studenții sportivi care au răspuns chestionarului nostru nu au suficiente cunoștințe despre igiena somnului, ceea ce înseamnă că ar trebui să existe o preocupare mai mare din partea antrenorilor în legătură cu transmiterea unor informații referitoare la regimul de viață al sportivilor, care include și importanța somnului pentru refacerea după efort, pentru sănătatea acestora și implicit pentru creșterea performanțelor sportive. Sportivii trebuie să conștientizeze faptul că somnul trebuie să reprezinte o prioritate în regimul lor de viață, punându-l pe același loc cu alimentația și cu antrenamentele.

Cuvinte-cheie: *efort, performanță, refacere, somn, sportive*

INTRODUCTION

Recovery after effort is a basic component of sports training that plays an essential role in optimizing the performance of athletes and increasing sport longevity. The recovery is addressed to healthy athletes, physically and mentally tired after work and training. When the training and competition effort are in the normal physiological limits of the body, natural recovery through rest is sufficient, but when the number of training sessions and / or competitions is high, the volume and intensity of the training are increased, it is compulsory to intervene with means of the guided restoration. Otherwise, athletes will accumulate fatigue, possibly reaching a state of overload, or, more seriously, over-training,

characterized by a long-lasting functional imbalance arising from repeated physical and psychological stresses, resulting in lower sports performance (Butnariu, 2018).

Recovering the body after effort is an essential part of sports training, to which field specialists must pay attention in order to achieve high performance in sports.

To recover the body after effort, athletes can use various methods of natural or guided recovery, such as passive rest (sleep), active rest, recovery nutrition, hydrotherapy, sauna, cryosauna, cryotherapy, massage, acupuncture, natural and artificial oxygenation, negative aeroionization, electrostimulation, psychotherapy, etc.

In human history, sleep was considered an inactive state when our mind and body simply shut down, disconnected from the external world. However, in recent decades, with the advancement of new technologies that allow researchers to measure brain activity (known as brain waves or EEG recordings), scientists have discovered that sleep is a dynamic state with its own intriguing processes (Gregg, 2009).

Sleep is a normal, periodic and reversible phase, driven by the body's vital need for periodic rest. It is not a time of relaxation for the brain; the brain remains highly active during sleep. Neurons can continue to process memories while the person sleeps (Ciobanu, 2005). Sleep has various functions: organizing thoughts, memory consolidation, stress reduction, muscle relaxation, regulating hormonal activity, lowering heart and respiratory rates, decreasing body temperature, boosting the immune system and tissue regeneration (Chiru, Chiru & Morariu, 2012).

Sleep is essential for athletes' recovery after the physical and mental effort made in training and competitions. Quality sleep aids in physical recovery, enhances concentration abilities and optimizes cognitive functions, all of these being vital for achieving maximum performance in both training and competition.

Sleep is especially important for athletes, contributing to tissue regeneration and muscle recovery; improving coordination and motor memory; reducing mental stress and anxiety; maintaining immune system health; lowering the risk of injuries; optimizing metabolism and energy levels etc.

For athletes, Drăgan (2002) recommends at least 8 hours of sleep per day, as it is the only natural way to recover the nervous system and eliminate fatigue. Sleep duration should increase during competition periods. The ideal hours are from 10-11 PM until 7-8 AM. It is also recommended that athletes rest, even without sleeping, for 1-2 hours after lunch.

For athletes, sleep is essential for recovery and performance. Yet, up to two-thirds of athletes report poor sleep quality (Vorster et al., 2024). Considering the paramount role of sleep health in the training, recovery, performance, and overall well-being of professional athletes, the unique challenges faced by

professional athletes that negatively impact sleep health, and the high prevalence of sleep problems and disorders among professional athletes, there is a clear need for accessible, tailored, and efective strategies and interventions to enhance sleep health in professional athletes (Cook & Charest, 2023). Monitoring athletes' subjectively perceived sleep and recovery is of great importance, especially during special sports events, to identify deviations as early as possible to then apply objective measures to examine sleep parameters and sleep architecture in more detail (Kiel et al., 2022). Regular sleepers had greater sleep efficiency, less variability in sleep efficiency and total sleep time, but similar total sleep time compared with irregular sleepers. Bedtime, sleep onset and sleep offset times influence sleep efficiency and total sleep time in athletes. While sleep behaviours only explained 22% of the variance in sleep efficiency, at the elite level, small changes may have large consequences for performance outcomes. As such, coaches and staff can assist their athletes by providing training schedules that allow for both regularity and sufficiency of time in bed where possible (Halson et al., 2022).

Based on current knowledge, restorative sleep may be considered the cornerstone of athletes' successful recovery. Previous studies have shown that sleeping problems have become common in professional athletes. This descriptive study compared the sleep between youth elite amateur athletes and professional athletes. Our results demonstrate that younger athletes have received more sleep counselling and experience less sleeping problems. Although there may be various factors affecting sleep, our findings indicate that early sleep counselling may play an important role in prevention of sleep problems in athletes. Therefore, sleep counselling should be recommended to be part of athletes' overall training process aiming at success (Penttilä et al., 2022). Sleep has fundamental physiological and cognitive functions that are crucial for athletes. However, athletes are particularly susceptible to sleep inadequacies such a poor-quality sleep and short sleep. In recent years, athletes, coaches, and support teams have exponentially increased their knowledge about sleep and recovery and its importance to athletic performance (Charest & Grandner, 2024).

To achieve outstanding sports results in any discipline, a large number of training sessions are required, often including two sessions per day. Under these conditions, insufficient sleep can lead to a decline in athletic performance because the body is unable to recover fully from the physical and mental effort exerted during training. Sleep deprivation among athletes leads to slower reaction times, reduced strategic thinking, and diminished decision-making abilities. It also impairs their capacity to efficiently perform multiple complex physical tasks. Additionally, sleep is crucial for muscle regeneration, especially considering the micro-injuries that occur after physical exertion. In this situation, if sleep is adequate in terms of quantity and quality, the risk of injuries decreases significantly.

We should not overlook the quality of sleep either, as athletes need to consolidate and perfect the motor skills and abilities they have acquired, continuously adapting to new techniques and game strategies. The most effective sleep is nighttime sleep, as daytime sleep is not as restful.

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 (Da Costa, 2023).

If athletes habitually obtain ~ 7 h of sleep per night, a general recommendation may be to increase sleep duration up to 2 h over 3–49 nights. Also, supplementing sleep during the day with a nap (20–90 min) can be implemented when necessary. In addition to improving the sleep duration, naps can improve performance outcomes after a regular night and restore performance decrements to baseline levels after a night with partial sleep restriction. For strategies such as sleep hygiene, mindfulness, or limiting the use of electronic devices before bedtime, it is plausible that such interventions can positively impact performance outcomes if they can improve sleep quality and/or duration (Cunha et al., 2023).

Practitioners, including coaches, sports scientists, and healthcare professionals, are encouraged to consider incorporating structured napping into athletes' training regimens, especially during periods of high physical demand or in preparation for competitions. This study not only highlights the importance of sleep duration in athletic training but also underscores the need for a holistic approach to athlete health and performance enhancement. By integrating napping strategies tailored to individual athletes' needs, practitioners can contribute to the improvement of respiratory parameters, thereby potentially enhancing overall athletic capacity and performance (Kurtoğlu et al., 2024).

PURPOSE OF THE STUDY

The aim of this study is to investigate the role of sleep and rest in the physical and mental recovery process of athletes, assessing how these factors influence athletic performance and overall health. The study seeks to determine how aware athletes are of the impact of sleep on their performance and to identify potential practices that contribute to better sleep quality.

MATERIAL & METHODS

The research methods used were the analysis of specialized literature, questionnaire survey, statistical-mathematical method, graphical method and tabular method.

To achieve the objective of the study, a questionnaire consisting of 9 multiple-choice questions was developed, being designed to cover the key aspects related to sleep duration and quality, sleep habits, the use of relaxation techniques and perceptions regarding the importance of sleep in recovery after training. The questionnaires were distributed to 100 students from the Sports and Motor Performance Study Program within the Faculty of Sciences, Physical Education and Informatics at National University of Science and Technology Polyethnica Bucharest. For the analysis and interpretation of the results, 92 questionnaires were used, as 8 had incomplete answers. The collected data were statistically analyzed, using correlation tests to identify relationships between variables, as well as frequency tests to determine the prevalence of certain behaviours and perceptions.

RESULTS

For interpreting the results, we analyzed the questionnaire and correlated the responses from several questions.

Table 1. Questions 1, 2, and 3 of the questionnaire

1.How important do you consider rest and sleep are for your athletic performance?	**Number of responses**	**2.What are the main reasons your sleep is disrupted?**	**Number of responses**	**3.What actions do you take to improve the quality of your sleep? (Check all that apply).**	**Number of responses**
a. Not important at all	0	a.Stress/anxiety	36	a.I avoid alcohol and caffeine before bed	64
b.Slightly important	0	b.Late training sessions	9	b.I make sure the bedroom is dark	39
c.Important	4	c.Use of electronic devices before bed	40	c.I avoid intense workouts a few	8
d.Very important	32	d.Other reasons (please specify)	7	d.I follow a consistent sleep	41
e.Extremely important	56	-	-	e.Other actions (please specify)	12

For question 1, the responses range from "a" (the least expected answer) to "e" (the favorable answer), with Figure 1 showing a clear increase in the number of "very important" and "extremely important" responses, confirming the expectation that athletes consider rest and sleep essential. Analyzing question 2, it is concluded that the main reasons for sleep disruption are "using electronic devices before bed" and "stress" (Table 1). For question 3, although the favorable answer is "e" – other actions, where I expected the activities undertaken to improve sleep would be related to stress and the use of electronic devices before bed, the most common responses were "avoiding alcohol and caffeine before bed" and "maintaining a consistent sleep routine."

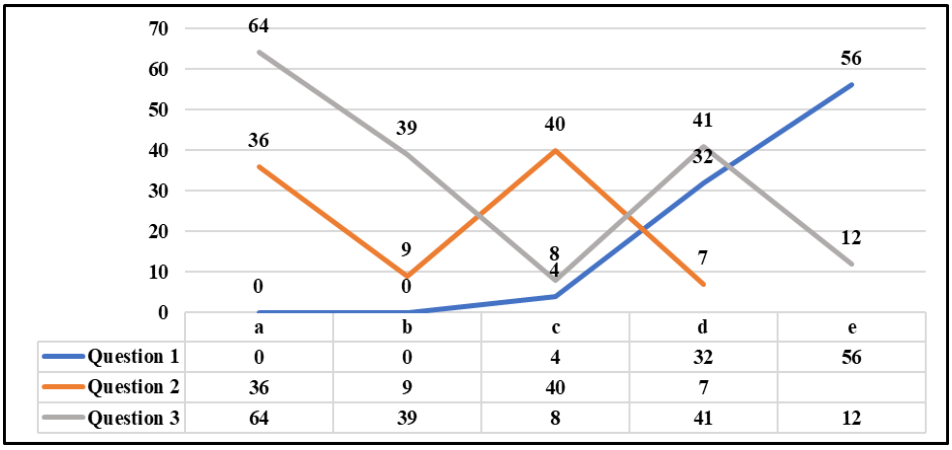

Figure 1. Graphical representation of the responses to questions 1, 2 and 3

Similarly, questions 4, 5, and 6 were coupled to determine the amount of sleep, i.e., the number of hours slept per night, and its quality (Table 2).

For question 4, although the favorable answer was "more than 8 hours," after analyzing the questionnaire, it was found that the most common responses were "7-8 hours" and "6-7 hours." The analysis of question 5 reveals that student athletes frequently feel sleepy and tired during the day. For question 6, we found out that student athletes sometimes feel rested and refreshed after sleep (Figure 2).

Questions 5 and 6 were included with the purpose of checking the attention and seriousness with which the questionnaire was completed. Considering that the answers to these two questions are very similar, this indicates that the respondents were attentive and answered correctly.

Table 2. Questions 4, 5, and 6 of the questionnaire

4. How many hours of sleep do you get on average per night?	Number of responses	5. Do you often feel sleepy or tired during the day?	Number of responses	6. How often do you feel rested and refreshed after sleep?	Number of responses
a. Less than 5 hours	0	a.Never	2	a.Never	4
b.5-6 hours	4	b.Rarely	24	b.Rarely	48
c.6-7 hours	28	c. Frequently	64	c.Sometimes	32
d.7-8 hours	44	d. Every day	2	d.Often	8
e. More than 8 hours	16	-	-	e. Very often	0

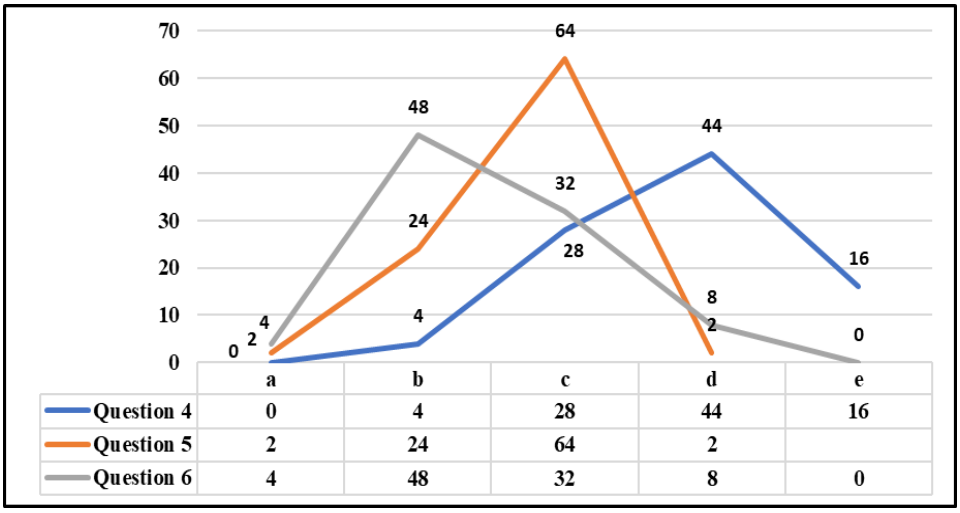

Figure 2. – Graphical representation of the responses to questions 4, 5 and 6

Attempting to establish a correlation between questions 7, 8, and 9, we found that those who go to bed later have more difficulties falling asleep or having restful sleep (Table 3). Athletes who fall asleep after 12:00 AM may experience sleep difficulties more frequently, indicating a potential link between bedtime and sleep quality. Additionally, those who go to bed late tend to have lower performance, being affected by the lack of sleep (Figure 3).

Table 3. Questions 7, 8, and 9 of the questionnaire

7. What time do you usually go to bed during the week?	**Number of responses**	**8. Do you have difficulty falling asleep or staying asleep during the night?**	**Number of responses**	**9. Have you noticed a connection between insufficient sleep and reduced athletic performance?**	**Number of responses**
a.Before 10:00 PM	0	a.Never	4	a.Yes, very often	28
b.Between 10:00 PM and 11:00 PM	48	b.Rarely	48	b.Yes, occasionally	52
c.Between 11:00 PM and 12:00 AM	41	c.Sometimes	32	c.No, almost never	5
d.After 12:00 AM	3	d.Often	8	d. I'm not sure	7
		e.Very often	0		

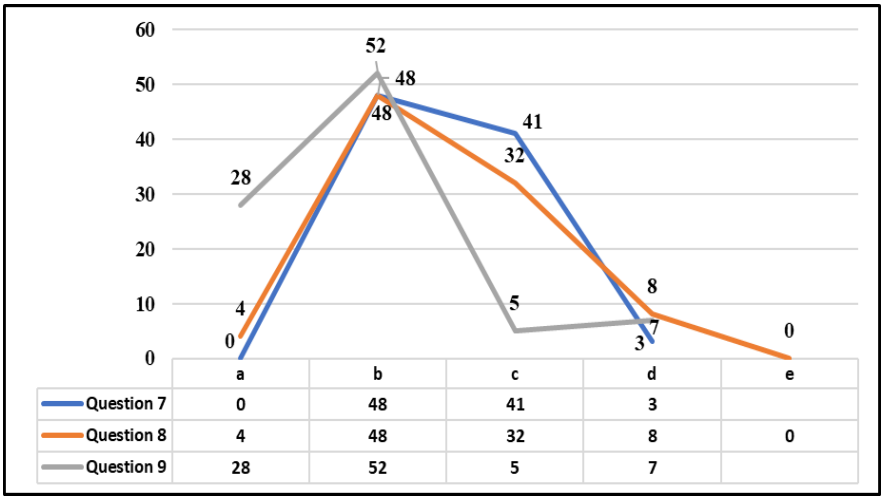

Figure 3. Graphical representation of the responses to questions 7, 8 and 9

DISCUSSION

Sleep is essential in terms of recovery, health, and peak performance by influencing physical, psychological, and cognitive functioning, whereas mindfulness-based techniques have been shown to improve sleep quality (Klier, Seiler & Wagner, 2021).

Acute sleep loss appears to have a negative impact on next day exercise performance. The magnitude of the effect may be greater when individuals experience either sleep deprivation or late restriction, and when performance tasks are conducted in the PM. Individuals can anticipate a ~ 0.4% decline in performance for every hour spent awake following acute sleep loss. Thus, incorporating lifestyle behaviours/strategies that limit the likelihood of experiencing sleep loss must be emphasised. However, if acute sleep loss is anticipated and unavoidable, individuals should, where possible, endeavour to mimic early-restriction sleep patterns rather than deprivation or late restriction and prioritise exercise to the morning in an effort to maintain performance (Craven et al., 2022).

Evaluating sleep quality among athletes is critical due to the adverse effects of sleep deprivation, including reduced capacity to think and react quickly, reduced communication skills, and reduced athletic performance. Examining the role of chronotype in athletic performance provides insight to optimize training, performance, and recovery (Grace et al., 2023). Technological advances in sleep monitoring have seen an explosion of devices used to gather important sleep metrics. These devices range from instrumented 'smart pyjamas' through to at-home polysomnography devices. Alongside these developments in sleep technologies, there have been concomitant increases in sleep monitoring in athletic populations, both in the research and in practical settings. The increase in sleep monitoring in sport is likely due to the increased knowledge of the importance of sleep in the recovery process and performance of an athlete, as well as the well-reported challenges that athletes can face with their sleep (Driller et al., 2023).

Pradzynska, Rylands & Canham (2023) concluded the findings of the scoping review suggest there are opportunities for coaches and practitioners to implements interventions that would reduce the effect of sleep deprivation on athletes prior and post competition. Coaches and practitioners should consider the timing of travel and allow for a climatization period prior to competition, this may have a positive impact on an athletes sleep patterns. While devising a psychological intervention strategy for athletes to cope with pre-competitions nerves may aid with sleep patterns and have a positive effect on performance. During times of heavy training load coaches may wish to consider prescribing training earlier in the day and avoid late night training session as this will help with sleep and aid recovery.

CONCLUSIONS

Athletes need to be aware that sleep should be a priority in their lifestyle, placing it on the same level as nutrition and training.

The student athletes who responded to our questionnaire do not have sufficient knowledge about sleep hygiene, which means that coaches should be more concerned with providing information regarding athletes' lifestyles, including the importance of sleep for recovery after effort, for their health and ultimately for improving athletic performance.

If athletes consider sleep is very important for performance, but report that it is frequently disrupted by factors such as stress or late training sessions, it is possible that they are aware of the importance of sleep but lack the necessary strategies to reduce the impact of disruptive factors.

The correlations made between the 9 questions of the questionnaire highlight the importance of a regular sleep schedule and quality sleep for maintaining athletic performance. Insufficient or poor-quality sleep can lead to fatigue and decreased performance and analyzing these connections can help develop personalized recommendations for improving sleep quality. Athletes could be encouraged to adopt healthier sleep habits, such as establishing an appropriate bedtime and engaging in practices that improve sleep quality, such as reducing stress before bed or avoiding screen exposure. Additionally, the correlations made can provide an overview of the factors that influence athletes' sleep quality and the measures they take to improve it, which can be useful for developing strategies to enhance athletic performance and reduce the risk of injuries.

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