

# **Sleeps' Effect on the Recovery of Athletes**

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## **Abstract:**

Athletic recovery often involves a meticulous balance of training, nutrition, and rehabilitation strategies; yet surprisingly little is known about the critical role that sleep plays in this equation. This research paper provides a comprehensive review of the role of sleep recovery in athletes' physical and cognitive performance. It examines the critical hormonal responses and growth hormone release during non-rapid eye movement (NREM) sleep, essential for muscle growth and repair. The disrupted hormonal profiles and sleep patterns observed during and after competition underscore the need for improved sleep management strategies. The paper highlights various sleep hygiene practices, sleep extension protocols, and daytime napping as potential interventions to enhance athletes' sleep quality and quantity, leading to improved performance and reduced injury risk. The findings emphasize the importance of sleep as a crucial component of athletic preparation, indicating the need for athletes to prioritize sleep and adopt healthy sleep practices to optimize their physical and cognitive potential. Further research is warranted to develop evidence-based protocols and to understand the circadian aspects of sleep and recovery in specific situations like jet lag. Tailored and effective recovery strategies are needed to enhance athletic performance and overall well-being.

## **Introduction:**

Optimal post-exercise recovery is essential for athletes, as it plays a crucial role in maximizing adaptation and performance during subsequent training sessions or competitions [1,2]. The rigorous demands of a competitive season can challenge athletes both physiologically and psychologically. Thus, striking a balance between training stress and physical recovery becomes crucial. Athletes need to implement effective recovery strategies that address fatigue, promote recovery, and ultimately enhance their performance in subsequent training or competitions [1]. In the realm of athletic recovery, sleep has consistently been identified as the primary and most crucial recovery method, as reported by both professional and recreational athletes [1, 3, 4]. Moreover, it has been recognized as an emerging frontier in optimizing athletic performance [5]. The impact of sleep on the body is profound, contributing to the restoration of the immune and endocrine systems [6, 7, 8], recuperating the strain on the nervous and metabolic systems caused during wakefulness, and playing a vital role in enhancing cognitive function [9].

Sleep is a critical function that often doesn't get enough attention when the athlete's recovery is considered as a whole. Neglecting adequate sleep can lead to adverse effects on muscle recovery, athletic performance, and overall health. Surprisingly, a significant number of individuals suffer from various sleep disorders, with many remaining undiagnosed and untreated [10].

Understanding the crucial link between sleep and muscle recovery is essential for athletes and their healthcare providers. This comprehensive review intends to serve as a valuable resource for improving athletic performance, promoting overall well-being, and highlighting the significance of prioritizing sufficient sleep in the pursuit of optimal health and recovery. As this paper delves into the various facets of sleep's influence on recovery, I hope to emphasize the importance of addressing this critical aspect of health for athletes and the broader population.

## Methods:

A scoping literature review was performed using PubMed. The search included studies from 2013 through 2023. Studies were identified using the keywords “athletes,” “sleep,” “muscle recovery,” “sports performance,” (n=347) and were further narrowed down using the inclusion criteria that studies must contain the key words “sleep extension,” “athletic performance,” “circadian rhythm,” and “sleep deprivation.” Studies that included nutrition and various supplements as their main focus were excluded. Six articles were retrieved based on their focus and relevance to sleep’s function in athletic recovery and performance (Figure 1).

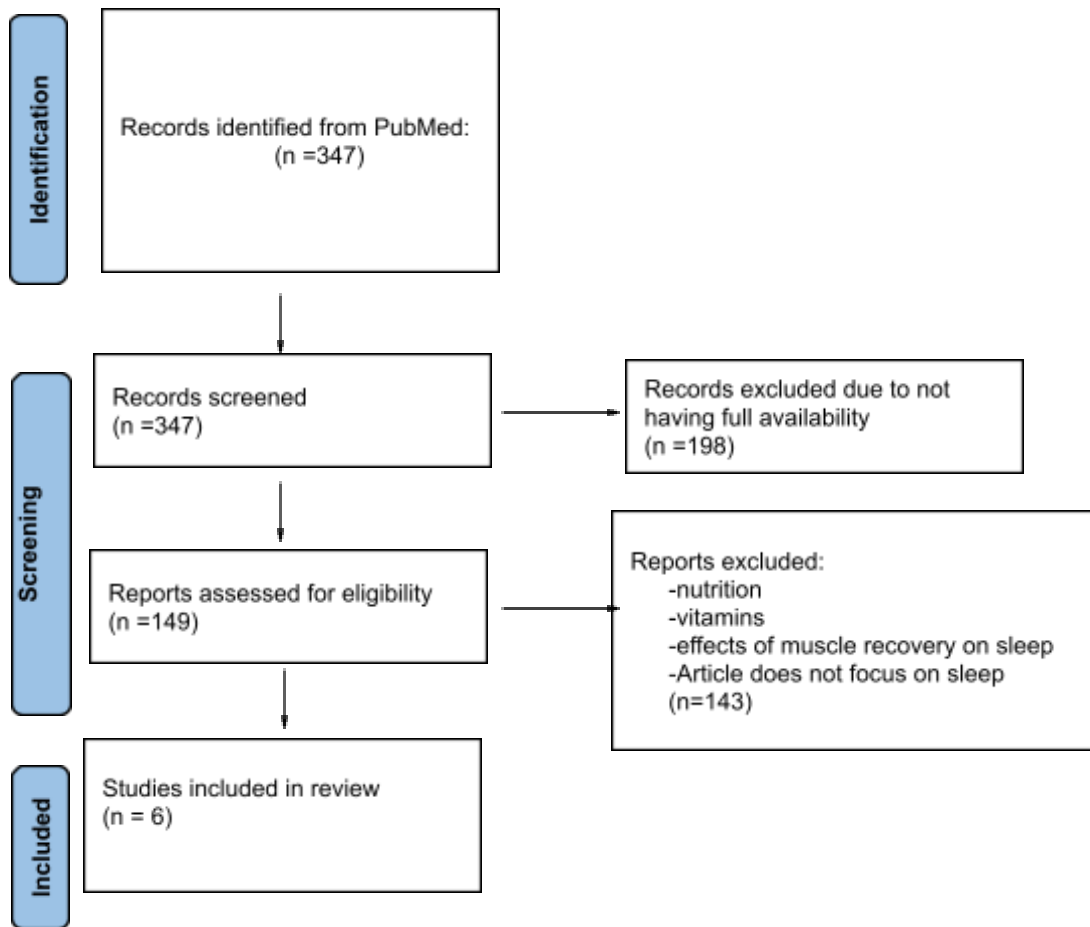


Figure 1. PRISMA flow chart identifying the selection process of gathering articles from PubMed.

## Results:

Sleep was found to be an important component to athletic recovery and increased performance. Many of the studies explored the effects of mental and physical health (Table 1).

Vitale et al. assessed how sleep plays a critical role in both physical and cognitive recovery in athletes [11]. The research involved analyzing the sleep habits of elite athletes across various sports disciplines, including individual and team sports, as well as strength and endurance sports. It was observed that elite athletes tend to get less total sleep than non-athletes, with many Olympic athletes sleeping significantly less than the recommended 8 hours per night. Factors contributing to this sleep deprivation include rigorous training schedules, travel demands, and the use of electronic devices, which disrupt sleep patterns due to blue-light emissions. It showed physical performance was also affected by lack of sufficient sleep, with reductions in running performance, muscle glycogen concentration, strength, endurance, and accuracy in sports like tennis and soccer. Additionally, the study addressed hormonal responses during sleep, highlighting that growth hormone increases during deep, slow-wave sleep, aiding in muscle repair and overall recovery, while cortisol decreases during early sleep, and melatonin and testosterone levels rise, contributing to restorative processes.

Moreover, O'Donnell et al. supported that sleep plays a critical role in both physical and cognitive recovery in athletes [12]. Hormonal responses during sleep, especially growth hormone released during NREM sleep, are vital for muscle growth and repair, making sleep an essential aspect of post-training and post-competition recovery. The disrupted hormonal profiles and sleep patterns observed in athletes during and after competition highlight the need for better sleep management strategies.

Cook et al. delved into how the quality of sleep affects athletic performance, including training, recovery, and overall well-being [13]. This study summarized and reviewed the findings from various studies conducted on the relationship between sleep and the performance of professional athletes. It discussed the literature and research articles related to sleep and its impact on training, injury risk and recovery, performance, and mental health in professional athletes. It was reported that sleep health has shown a positive trend in some athletes, indicating that awareness and education might be making a difference. Good sleep not only enhances physical and cognitive performance during competitions but also contributes to consistent and high-quality training, reduced injury risk, improved mental health, better motivation, attention, and emotional regulation. Furthermore, healthy sleep can help athletes cope with the pressures and stresses of their profession and be more resilient to the negative effects of travel. The findings also highlight the unique challenges faced by professional athletes, such as intense training demands, increased risk of injury, constant pressure, and travel-related factors.

On the other hand, Altarriba-Bartes et al. focused on the effects of various recovery strategies on post-match performance outcomes in soccer players [14]. They performed a systematic review and meta-analysis of randomized controlled trials (RCTs) assessing the effects of recovery strategies, such as compression garments, cold-water immersion, and sleep hygiene, on physical and psychological performance indicators. They found that these recovery strategies showed larger effects on jumping performance at 48 hours compared to the control group. The meta-analysis indicated that compression garments and cold-water immersion led to moderate improvements in jump performance at 48 hours post-match. However, there were only small to moderate non-significant effects on sprint performance and muscle strength at 24 hours and 48 hours. On the other hand, recovery strategies showed medium to large effects on muscle soreness and markers of muscle damage at both 24 hours and 48 hours.

Doherty et al. utilized a large cohort of elite and sub-elite athletes to understand the quality, quantity, and timing of sleep among athletes and their recovery and nutrition practices [15]. The

study utilized the Consensus Sleep Diary-Core (CSD-C) to monitor sleep patterns on training and competition days compared to rest days. Interestingly, athletes reported improved sleep quality and quantity on rest days, suggesting the importance of incorporating rest days into an athlete's training schedule. The rest days provided an opportunity for athletes to partially recover the sleep debt accumulated during intense training. Stress, pain, injury, and anxiety were identified as factors impairing an athlete's sleep, indicating the need for monitoring athletes' mood and implementing sleep-related interventions when necessary. Additionally, individual differences in chronotype (morningness/eveningness) were observed, and training time may influence sleep quality.

The systematic review presented by Sirohi et al. provides valuable insights into the effects of daytime napping as a recovery strategy in athletes [16]. The findings suggest that daytime napping has a favorable impact on sports performance in physically active individuals, as evidenced by various sports-related variables. Many studies reported positive results on sports performance after napping, including improvements in endurance exercises, shuttle run tests, leg strength, and attention. These findings highlighted the importance of sleep as a crucial component of athletic preparation, aiding in achieving adequate recovery and optimizing performance.

### **Discussion:**

In exploring the critical role of sleep recovery in athletic performance and overall well-being, athletes must prioritize sleep and adopt healthy sleep hygiene practices to optimize their physical and cognitive potential [13]. While promising results have been observed with sleep extension and specific recovery strategies in improving performance and reducing muscle damage, further research is needed to establish evidence-based protocols [13].

A notable limitation of existing research lies in the heterogeneity of outcome variables, restricting the possibility of a direct pooled analysis and impacting the study's overall validity [13]. Methodological limitations, such as the lack of allocation concealment, blinding, and small sample sizes, raise concerns about potential bias in several reviewed studies. Moreover, the predominance of male participants in these studies may limit the generalizability of results to the female athlete population. Despite these challenges, the research provides valuable implications and recommendations, emphasizing the importance of larger sample sizes, proper allocation concealment, and blinding in future studies. A more comprehensive understanding of the effects of daytime napping on sports performance requires consideration of participants' chronotype and travel history. At the same time, future studies should incorporate female participants to investigate potential gender differences [13].

Examining the limitations of another study reveals a relatively short duration of sleep diaries and a lack of a healthy control group for comparison [11]. Future research should replicate this investigation using a combination of objective and subjective measures of sleep and recovery over an extended period. Additionally, exploring specific nutritional recovery strategies and their impact on sleep in athletes is a crucial avenue for further inquiry [11].

Despite providing valuable insights into the effects of specific recovery strategies, the scarcity of research meeting inclusion criteria for meta-analysis presents a significant limitation in O' Donnell's article [12]. The shortage of available randomized controlled trials in team sport environments, particularly in professional soccer, hinders the provision of extensive evidence on recovery protocols. Challenges in standardizing the analysis due to varying time frames used by some studies further underscore the need for more comprehensive research in this area [12].

These challenges can directly and indirectly impact sleep health and performance, with factors such as evening competitions and late-night use of electronic devices disrupting athletes' sleep patterns. Addressing these considerations is crucial for optimizing sleep health [14].

In conclusion, the literature underscores the importance of sleep in athletes and the necessity for further research to develop tailored and effective recovery strategies. Athletes' commitment to sleep hygiene, extension protocols, and strategic napping during the day can potentially enhance

sleep quality and quantity, thereby reducing the risk of injury and improving overall performance [10,9]. The disrupted hormonal profiles and sleep patterns observed in athletes during and after competition emphasize the need for better sleep management strategies in post-training and post-competition recovery [10]. Ultimately, cohesive efforts in research and practice are essential for optimizing sleep-related interventions in the realm of athletic performance.

Author	Study Title	Physical Effects	Results	References
Vitale et. al	Sleep Hygiene for Optimizing Recovery in Athletes: Review and Recommendations	Improved performance	<p>Athletes' physical and cognitive performance decreases with reduced sleep.</p> <p>Extending sleep improves athletes' physical and cognitive performance.</p> <p>Circadian aspects and jet lag influence athlete performance.</p>	[11]
O'Donnel et. al	From pillow to podium: a review on understanding sleep for elite athletes	Increases athletic recovery	<p>Sleep is crucial for athletic recovery, especially during NREM stage three, enabling active repair and restoration.</p> <p>Growth hormone release during sleep aids muscle growth and repair.</p> <p>Cortisol and testosterone levels follow circadian rhythm, affected by sleep loss.</p>	[12]
Cook et. al	Sleep and Performance in Professional Athletes	Increases athletic recovery	<p>Sleep hygiene education has been shown to improve sleep behavior but the durability of the effects is limited.</p> <p>Improved sleep health characteristics in the intervention group compared to the control group.</p>	[13]
Altarriba-Bartés et. al	Post-competition recovery strategies in elite male soccer players. Effects on performance: A systematic review and meta-analysis	<p>Increases athletic recovery</p> <p>No performance increase</p>	<p>Recovery strategies lead to higher CMJ values after 48 hours, no significant difference in sprint and MVC at 24/48 hours.</p> <p>Intervention group has less DOMS at 24/48 hours for QUAD, HAMS, and CALF, lower CK and CRP levels.</p>	[14]
Doherty	The Sleep and Recovery Practices of athletes	Improved performance	Individualized recovery plans including sleep, nutrition, and support can enhance athletes' well-being and performance.	[16]
Sirohi et. al	A systematic review of effects of daytime napping strategies on sports performance in	<p>Increases athletic recovery</p> <p>Improved performance</p>	<p>Napping strategies enhance sports performance for active individuals, longer naps (~90 min) offer more benefits.</p> <p>Daytime naps are cost-efficient self-recovery methods for athletes.</p>	[16]

	physically active individuals with and without partial-sleep deprivation			
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**Table 1: The high yield results of the articles included in the review.**

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