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The Impact of Sleep on Athletes Performance and Injury Risk: A Narrative Review

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Abstract

Introduction and purpose

Sleep is a critical component of an athlete's health, significantly influencing injury risk, performance, and recovery. It plays a vital role in the healing process, contributing to growth, repair, regeneration, and immunity. Current literature suggests that sleep quality impacts various aspects of athletic performance, including physical and cognitive abilities, recovery, injury risk, and mental well-being. This narrative review aims to explore the impact of sleep on the musculoskeletal system of athletes, particularly focusing on injury risk, performance, and recovery. It seeks to synthesize existing research to highlight the importance of sleep quality and duration in maintaining and enhancing athletic performance.

Description of the state of knowledge

The findings indicate that less than 7 hours of sleep is consistently associated with an increased risk of musculoskeletal injury, with athletes experiencing a 1.7 times higher risk if this sleep pattern persists for at least 14 days. Some studies also highlight that athletes obtaining fewer than 6 hours of sleep per day show significant performance declines and higher injury rates.

Summary

While evidence clearly links certain sleep behaviors to increased musculoskeletal injury and pain, it is crucial to consider sleep as one aspect of an athlete's overall health and well-being. Adequate sleep is essential for optimal athletic performance, injury prevention, and recovery. Tailored sleep strategies should be integrated into training and recovery protocols to enhance the overall health and performance of athletes.

Key words: sleep; rest; sport; athlete; injury risk; performance;

Introduction and purpose

Emerging evidence underscores the significance of sleep in athletes' performance, recovery, and injury risk. Research indicates that sleep deprivation can notably impair athletes' overall performance. Inadequate sleep negatively affects cognitive functions, such as executive function, attention, learning, mental performance, and mental health [1]. Additionally, insufficient sleep impacts various performance metrics, including muscle strength, speed, and endurance [2, 3]. Acute disruptions in sleep have varying impacts on athletic performance depending on the type of activity. Precision tasks are particularly affected, whereas endurance activities like ultra cycling and anaerobic exercises such as weightlifting show relatively

smaller effects. Sleep interventions tailored for athletes not only enhance performance in precision tasks but also improve muscle strength, speed, cognitive function, reaction time, and mental well-being [4, 5]. Various factors related to their sport, such as training intensity, travel schedule, and competition demands, can affect the quality of sleep in athletes. Additionally, sleep patterns can be influenced by non-sport-related factors such as gender and psychological stress, including anxiety [6]. Research indicates that athletes generally experience lower-quality sleep compared to their non-athlete counterparts, with approximately 22% to 30% reporting highly disrupted sleep patterns [6, 7]. Sleep is vital for sustaining both physical and mental well-being. It has been shown take important part in various functions, such as memory [8], regulating emotions [9], enhancing metabolic functions [10], improving energy balance, and moderating the immune system [11], and may play a pivotal role in the stress–recovery balance, via its influence on the activity of the hypothalamic–pituitary–adrenal axis [12]. Despite this knowledge, ~ 45% of the Western adult population fail to obtain the recommended 7–9 h of sleep each night [13].

Description of the state of knowledge

Good night sleep

Defining a good night's sleep can be complex due to the variety of factors involved and the absence of a universally accepted definition. However, several parameters are commonly used to assess sleep quality. These include sleep latency, the number of nighttime awakenings, the duration of wakefulness after sleep onset (wake after sleep onset), and sleep efficiency. Sleep latency refers to the time it takes to transition from being awake to sleeping, ideally being 15 minutes or less. Sleep efficiency, another critical measure, is defined as the ratio of the total time spent sleeping to the total time spent in bed, with a good sleep marked by an efficiency of 85% or higher [3]. The National Sleep Foundation provides clear guidelines for a good night's sleep, suggesting that in addition to short sleep latency and high sleep efficiency, having one or fewer awakenings per night and a wake after sleep onset of 20 minutes or less are indicative of high-quality sleep. Conversely, indicators of poor sleep quality include a sleep latency of more than 60 minutes, four or more awakenings per night, more than 51 minutes of wake after sleep onset, and a sleep efficiency of 64% or less. While napping patterns also play a role in determining sleep quality, with fewer naps per 24-hour period generally indicating better nighttime sleep quality, there is no consensus on their overall impact. Moreover, emerging technologies like wrist actigraphy and smartphone applications

are increasingly used to monitor sleep, though their accuracy compared to traditional methods like polysomnography has yet to be validated. Clinicians must be aware of these limitations when utilizing such technologies to assess sleep quality [3, 14].

Exploring the dimensions of sleep loss: duration, quality and types of sleep deprivation

Sleep has two distinct dimensions: quantity and quality. However, sleep loss is more often measured in terms of duration, given the challenges associated with accurately determining sleep quality in most situations [15].

Sleep deprivation broadly refers to an extended period of wakefulness, typically when an individual cannot sleep for 24 hours or longer [16].

Restricted sleep, also termed 'partial sleep deprivation,' happens when an individual can sleep, but the amount of sleep is less than their normal routine [16].

It frequently arises from delayed sleep onset (termed ‘early restriction’), waking up earlier than usual (termed ‘late restriction’), or fragmented sleep, which involves one or more nighttime awakenings [17].

The quantity (e.g., deprivation or restriction) and type (e.g., early restriction or late restriction) of sleep loss can affect the extent to which insufficient sleep impacts physical performance [18-21].

Sleep loss and its effects: lifestyle choices to athletic performance

Sleep loss is often driven by lifestyle choices that reduce available sleep time, such as evening social activities, exposure to artificial light prior to sleep [22], consumption of caffeinated beverages [23], and smoking [24]. Insufficient sleep can result in a significant personal and societal burden, including adverse effects on wellbeing [25], productivity [26] and safety [27].

For individuals who are physically active or participate in athletic pursuits, sleep deprivation can impact short-term training adaptations and exercise performance results [28-30].

The effects of sleep loss, including changes in training adaptations and a higher incidence of workplace accidents [31], are likely driven by multiple underlying factors.

Adverse effects may stem from a decline in muscular strength [32] and/or endurance [33], as well as mood alterations (e.g., reduced motivation) [34].

The interplay between sleep and injury risk in sports

The relationship between sleep quality, duration, and injury risk in athletes is a multifaceted area of study, reflecting significant implications for athletic health and performance. Research underscores a consistent link between inadequate sleep and an increased risk of musculoskeletal injuries across diverse athletic populations [3].

Studies targeting both adolescent and adult athletes reveal that shorter sleep durations are correlated with heightened injury risks. Specifically, individuals averaging less than seven hours of sleep per night experience increased injury rates, with some findings indicating up to a 1.7 times greater likelihood of injury [5, 35]. Conversely, achieving more than eight hours per night can significantly mitigate this risk, reducing it by 61% [36, 37]. These observations align with the recommendations of the American Academy of Sleep Medicine and the Sleep Research Society, which advise adults to secure at least seven hours of sleep nightly [38]. Such recommendations are reinforced by systematic reviews that establish a clear association between chronic sleep reduction and elevated risks of sports injuries [39].

The influence of sleep on injury risk extends beyond just duration to include sleep quality and timing. For instance, in military populations, soldiers obtaining four hours or less of sleep were found to be 2.35 times more susceptible to musculoskeletal injuries than those who slept for eight hours or more [39]. Moreover, the compounding effects of increased training intensity and reduced sleep are particularly evident during periods such as the return from offseason in sports, where injury rates spike, further emphasizing the critical role of sleep in injury prevention [40].

Despite these findings, several studies using self-reported data or limited samples have reported inconsistencies in the sleep-injury relationship, suggesting the need for more objective measures and larger-scale research to fully understand these dynamics [41, 42]. Additionally, while sleep interventions have shown potential in enhancing sports performance [43], their effectiveness in directly preventing injuries remains less certain.

Beyond musculoskeletal injuries, suboptimal sleep has been linked to increased risks of concussions, with individuals experiencing severe insomnia or excessive daytime sleepiness facing significantly higher risks. This points to a broader impact of poor sleep on overall athlete health, exacerbating other conditions such as anxiety and depression, which in turn may elevate the risk of injuries [44].

Considering the overall balance necessary for optimal athletic performance, the concept of overtraining syndrome highlights the importance of adequate recovery, of which sleep is a

crucial component. Disturbed sleep can be both a symptom and a cause of overtraining, indicating its leading role in athletic readiness and recovery [45, 46].

Sleep health, thus, encompasses more than just duration; it also involves quality and timing, all of which are influenced by individual and environmental factors. Achieving optimal sleep is complicated by the unique physiological and psychological demands placed on athletes, underscoring the need for tailored sleep strategies that address these complex interdependencies [47-50].

In conclusion, the cumulative evidence points to sleep as a pivotal factor in both injury prevention and overall health in athletic populations. Adequate sleep, characterized by sufficient duration, quality, and proper timing, is essential not only for immediate athletic performance but also for long-term well-being.

Impact of sleep loss on various sports performance metrics

Overall Negative Impact of Sleep Loss on Exercise Performance: across various exercise categories, sleep loss consistently demonstrated a significant negative effect on overall exercise performance. This was evidenced by a 7.56% average decrease in performance, reinforcing the importance of adequate sleep for optimal physical functioning [51, 52].

Anaerobic Power: Sleep loss significantly decreased anaerobic power by 6.26%. Subgroup analyses showed that this effect was particularly pronounced with sleep deprivation, sleep restriction, and late restriction, while early restriction did not show a significant impact. Performance tasks conducted in the afternoon were more negatively affected than those in the morning [51].

Speed/Power Endurance: the negative influence of sleep loss on speed/power endurance was evident with a mean decrease of 2.90%. This effect was stable across various analyses, particularly under sleep restriction and late restriction conditions. However, the effect of sleep restriction was sensitive to specific studies, as evidenced by the one-out analysis [51, 52].

Strength: sleep loss reduced overall strength performance by 2.85%. This negative influence was significant for sleep deprivation but not for other sleep restriction protocols. The effect was more pronounced for tasks performed in the afternoon and for lower-body strength tasks compared to upper-body tasks [51].

Endurance: endurance performance was significantly affected by sleep loss, with a mean decrease of 5.55%. This effect was consistent across different sleep protocols and was unaffected by the time of day when the exercise tasks were performed. Sleep loss thus appears

to broadly impair endurance capabilities [51, 52].

Sleep and recovery

The relationship between sleep and recovery is integral to the training process, aimed at progressively developing the required qualities of the sport to enhance performance. Achieving this involves balancing an appropriate training dose with sufficient time for recovery to ensure sustained adaptations [53]. When an overloading training dose is applied, it disturbs homeostasis, leading to reduced performance and fatigue. Fatigue, with its multifaceted origins, is generally characterized by the inability to produce or maintain the required force or power output, influenced by central and peripheral factors such as motor command activation and intracellular processes [54].

Despite the physical aspects, the mental component of fatigue also plays a crucial role and must be considered. Fatigue, whether physical or mental, can only be evaluated through self-reporting and may be categorized as a trait characteristic or a state variable [55]. It encompasses an impairment of physical performance, mental fatigue, or excessive psychological distress [56]. Proper recovery following an appropriate training dose leads to adaptations that protect against future fatigue from similar training doses.

The complexity of the training–recovery cycle is further compounded by various internal psycho-physiological responses and adaptations occurring during training, which affect the accuracy of assessing this cycle [57]. This creates a complex relationship between training dose, performance outcomes, injury, and illness [58]. Therefore, a multi-dimensional approach is necessary to evaluate individual responses to training stressors, considering the athlete's internal environment [59].

Sleep interventions and their effects

Various sleep interventions have been studied to determine their effectiveness in improving athletic performance and reducing injury risk. These interventions range from sleep hygiene education to practical strategies such as scheduled napping and sleep environment modifications [60].

Sleep Hygiene Education:

Educating athletes on the principles of good sleep hygiene, including maintaining a regular sleep schedule, creating a sleep-conducive environment, and minimizing exposure to screens

before bedtime, has shown promising results. Athletes who follow these guidelines often report better sleep quality and improved daytime performance [60].

Scheduled Napping:

Incorporating short naps into the daily routine of athletes can help mitigate the effects of sleep deprivation. Studies have found that napping can enhance cognitive function, mood, and physical performance, especially when athletes are unable to achieve the recommended nightly sleep duration [60].

Sleep Environment Modifications:

Adjusting the sleep environment to reduce noise, light, and other disturbances can significantly improve sleep quality. The use of blackout curtains, white noise machines, and comfortable bedding are common modifications that have been linked to better sleep outcomes in athletes [60, 61].

Cognitive Behavioral Therapy for Insomnia (CBT-I):

CBT-I has been employed to address chronic sleep issues among athletes. This intervention focuses on changing sleep-related behaviors and thoughts, resulting in longer sleep duration and improved sleep quality [61].

Summary

This review underscores the critical role of sleep in the musculoskeletal health, performance, and recovery of athletes. Sleep is essential for healing processes, contributing to growth, repair, regeneration, and immune function. The quality and duration of an athlete's sleep significantly impacts various performance metrics, including physical and cognitive abilities, recovery, injury risk, and mental well-being. Consistently obtaining less than seven hours of sleep is linked to a 1.7 times higher risk of musculoskeletal injury, with the risk increasing for sleep durations below six hours.

The literature emphasizes that sleep deprivation impairs both physical and mental performance, with acute sleep disruptions particularly affecting precision tasks. Various factors, such as training intensity, travel schedules, and competition demands, influence sleep quality in athletes. Additionally, non-sport-related factors, including psychological stress, further impact sleep patterns.

Despite the evidence highlighting the importance of sleep, many athletes report lower-quality sleep compared to non-athletes, with a significant percentage experiencing highly disrupted sleep patterns. Given the integral role of sleep in physical and mental health, it is vital for

athletes to achieve optimal sleep to support memory, emotional regulation, metabolic functions, energy balance, and immune moderation.

Understanding the relationship between sleep and recovery is essential for developing effective training and recovery strategies. Fatigue, a multifaceted condition encompassing physical and mental aspects, can significantly impair performance if not responsibly managed. Adequate recovery following appropriate training doses leads to protective adaptations against future fatigue.

Overall, sleep is a pivotal factor in both injury prevention and overall health in athletic populations. Ensuring adequate sleep, characterized by sufficient duration, quality, and proper timing, is crucial not only for immediate athletic performance but also for long-term well-being. Tailored sleep strategies that address the unique physiological and psychological demands of athletes are necessary to optimize their health and performance.

Disclousures

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Software: not applicable

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