

# Sleep, Recovery, and Athletic Performance: A Brief Review and Recommendations

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## ABSTRACT

SLEEP HAS BEEN IDENTIFIED AS AN IMPORTANT FACTOR CONTRIBUTING TO OPTIMAL ATHLETIC PERFORMANCE. HOWEVER, THE PSYCHOSOCIOPHYSIOLOGICAL STRESSES PLACED ON ELITE ATHLETES MAY RESULT IN AN INABILITY TO GAIN APPROPRIATE SLEEP. IMPROVING AN ATHLETE'S SLEEP HYGIENE IS SEEN AS A KEY STRATEGY THAT COULD HAVE POWERFUL IMPLICATIONS FOR ATHLETIC PERFORMANCE. THEREFORE, THE PURPOSE OF THIS ARTICLE IS TO (A) OVERVIEW THE IMPACT OF SLEEP ON RECOVERY AND ATHLETIC PERFORMANCE; (B) OUTLINE SLEEP HYGIENE STRATEGIES; AND (C) PROVIDE SLEEP RECOMMENDATIONS FOR ATHLETES AND COACHES. THE SLEEP HYGIENE STRATEGIES PRESENTED IN THIS ARTICLE REPRESENT A PRACTICAL APPROACH TO IMPROVE SLEEP IN ELITE ATHLETES.

## INTRODUCTION

For elite athletes, to achieve optimal athletic performance, they must follow a systematic approach to training centered on the fundamental principle of the “training

response” (16), which focuses on obtaining a balance between stress, fatigue, and recovery, termed the stress/fatigue state (1). Kentta and Hassmen (10) described the stress/fatigue state as a psychosociophysiological phenomenon (9) with psychological, social, and physiological factors recognized to have the greatest impact on this state. Therefore, athletes must consider strategies with the potential to promote recovery, thereby reducing the stress/fatigue state. However, one such strategy is sleep; despite the importance of sleep in optimizing recovery and athletic performance (8), sleep as a recovery strategy is often inadequately addressed and/or overlooked by athletes (3,25). This is surprising as Fallon (6) reported that sleep not only ranked as the most prominent problem among athletes when asked to identify main causes of fatigue and tiredness but also (its characteristics such as quality and quantity) ranked first when asked about the aspects they thought were important causes of short-term fatigue.

Although sleep is recognized as an essential component of recovery from athletic training and anecdotally reported to be the single most efficacious recovery strategy (8), assessment of sleep quality in competitive athletes reveals a substantial prevalence of poor sleep quality (19). In

support, Venter et al. (26) reported that 41% of elite South African athletes indicated that they experience problems falling asleep, whereas 60% experienced problems waking in the morning, which in part could indicate sleep deprivation. Similar data are presented by Erlacher et al. (5) with 79% of elite German athletes reporting problems falling asleep before an important competition or game, whereas 32% experienced frequent nighttime waking.

These data indicate that athletes may have an increased need for sleep with general recommendations suggesting 7–9 hours to ensure adequate physiological and psychological recovery following training, of which 80–90% should be during the night (3). Furthermore, adequate sleep is particularly important for athletes who are injured, traveling, or in heavy periods of training or competition phases (23). Of particular concern when training elite athletes is the identification of signs and symptoms of poor sleep quality, indicative of sleep deprivation, which may result in an inability to appropriately recover from training.

## KEY WORDS:

sleep; recovery; sleep deprivation; athletic performance

Reductions in cognitive and motor performance, reaction times, and mood state/emotional stability are often observed in sleep-deprived athletes (27), although a range of metabolic and immunologic process are also reported to be negatively affected (19). Poor sleep quality, particularly during high training loads and competition periods, has been identified as a marker of underrecovery and an early sign of overreaching (13). Therefore, sleep quality monitoring is recommended through the progressive stages of the stress/fatigue state continuum (4). Collectively, this highlights the importance of sleep in fatigue management through psychological and physiological recovery (18) and provides a potential link between sleep and the direct and indirect effects on athletic performance (Figure 1).

## SLEEP AND ATHLETIC PERFORMANCE

### NAPPING

Athletes exhibiting acute and chronic effects of sleep loss may benefit from sleep supplementation in the form of napping (8). Examining the effects of a postlunch nap on subjective sleepiness, alertness, and performance, Waterhouse et al. (28) reported that a 30-minute postlunchtime nap (13:00–13:30 hours) after partial sleep loss (4 hours less than

normal) significantly improved 20-m sprint performance (3.97 versus 3.87 seconds) and subjective alertness, while decreasing sleepiness. From an athletic performance perspective, the authors suggest that napping is of potential benefit to athletes during training and in a competitive environment, especially in athletes experiencing sleep deprivation.

### SLEEP EXTENSION

A study conducted on the Stanford University men's varsity basketball team, under the assumption that the majority of collegiate athletes carry a sizable sleep debt (sleep deprivation), had 11 players obtain extra sleep with a goal of 10 hours per day for a 5- to 7-week period (12). The players were found to have significantly enhanced basketball performance in all measures after habitual sleep extension. Total sleep times increased ( $110.9 \pm 79.7$  minutes), and the players demonstrated faster sprint times (282-ft sprint: 16.2 versus 15.5 seconds) and shooting accuracy in both free throws out of 10 (7.9 versus 8.8) and 3-point shots out of 15 (10.2 versus 11.6). Players also reported improved alertness and mood, and less sleepiness and fatigue, leading the investigators to conclude that optimizing sleep need through sleep

extension has a positive impact on basketball athletic performance (Figure 2).

### SLEEP HYGIENE

Sleep hygiene refers to behaviors that promote improved quantity and quality of sleep (11). Typically, this involves avoiding behaviors that interfere with sleep patterns and/or engaging in behaviors that promote good sleep (22). Sleep hygiene strategies should be incorporated into the athlete's sleep routine and used every night before bed (Table) and during flights (Table) in an attempt to promote optimal sleep conditions.

### SLEEP RECOMMENDATIONS

#### RECOMMENDATION 1: AMOUNT OF SLEEP

A frequent and generalized recommendation is that athletes need at least 7–9 hours of sleep per day (3); however, this will vary between individuals (27). Generally, athletes will require more sleep to promote recovery and restoration processes as a result of high training loads and competitions stress (23). Adolescent athletes undertaking heavy training may require up to 10 hours sleep per night (3), although Scott (20) suggests that elite athletes who train 4–6 hours a day may require between 10 and 12 hours of sleep per

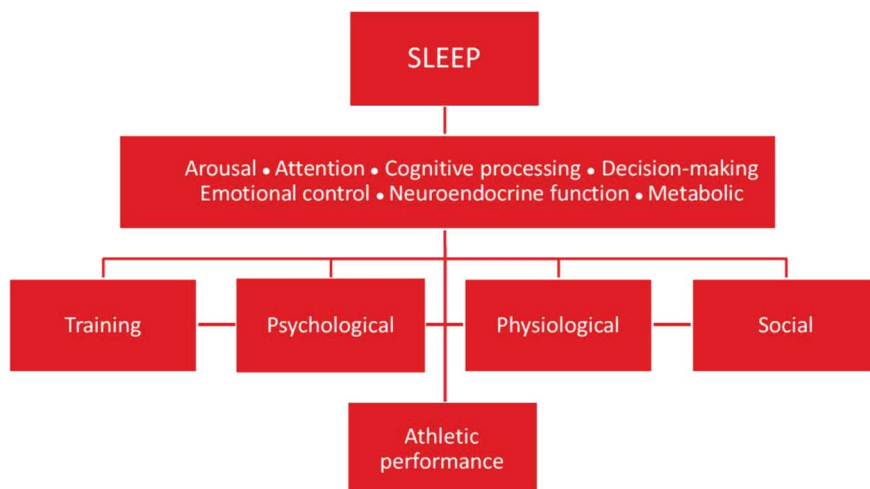


Figure 1. Variables theoretically involved in mediating the relationship between sleep and athletic performance (2).

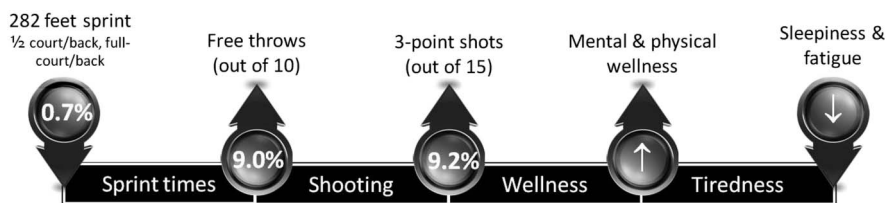


Figure 2. Improvements in measures of basketball performance after sleep extension. Data adapted from reference 12.

night. A good approach is for athletes to sleep for the amount of time that is required to feel wakeful and alert throughout the following day.

### RECOMMENDATION 2: REGULAR SLEEP ROUTINE AND SLEEP HABITS

Ensure going to bed at night (retiring) and morning waking (rising) are around the same times each day as often as possible. This helps form a regular sleep routine, which promotes good-quality sleep. Avoid forming bad sleep habits, such as watching television or using

a computer in bed. It is important that an athlete's sleep environment facilitates positive sleep habits.

### RECOMMENDATION 3: NAPPING

Having demonstrated physiological and perceptual improvements of the postlunchtime nap, Waterhouse et al. (28) suggested that naps be limited to around 30 minutes and be avoided in the late afternoon/evening. This is related to the beneficial effects of napping in reducing the "postlunch dip" in performance that is linked to drowsiness at that time of

day (17). Although napping may also provide an opportunity to repay sleep debt (17), it is important that time is allowed to overcome "sleep inertia" (i.e., the short-term impairment in wakefulness when woken) (28). Finally, Reilly and Edwards (17) highlight that the benefits of napping depend on their timing and duration, prior wake time, setting, and individual differences.

### RECOMMENDATION 4: RECOVERY FROM TRAINING/COMPETITION

Adequate recovery after training sessions has been reported to enhance restoration of physiological and psychological processes (9), which are important factors contributing to improved sleep (8,24). Reductions in muscle soreness, inflammation, and pain may allow for improved sleep quality with 2 of the most commonly used recovery strategies being cold water immersion and compression garments (24). For example, Montgomery et al. (14) reported that cold water immersion (ice baths at 11°C; 5 × 1 minute exposures with 2 minutes passively rest in ambient air [~23°C]) and full leg compression garments (18 mmHg; postgame and overnight period ~18 hours) reduced the amount of muscle soreness and inflammation resulting from 3 days of basketball tournament play (one full 48-minute game per day). Jeffreys (9) recommends a multidimensional approach to proactive recovery with several postworkout/postgame strategies targeting neural, muscular, substrate, and psychological recovery presented. For athletes, implementing such an approach to proactive recovery is easily achieved through the 100-point weekly recovery checklist (1), where

Table  
Sleep hygiene strategies

|   |
|---|
| General sleep hygiene strategies  |
| Maintain a regular schedule of going to bed and waking up                           |
| If you cannot sleep within 15 min, get out of bed and try performing a mundane task |
| Eliminate the bedroom clock   |
| Avoid coffee, alcohol, and nicotine in the hours before bed                         |
| Avoid watching television, eating, working, or reading in bed                       |
| Be conscious of food and fluid intake before bedtime                                |
| Nap appropriately (30 min and not late in the afternoon)                            |
| Maintain a room temperature comfortable for sleeping (~18°C)                        |
| In-flight sleep hygiene strategies  |
| Adjust watch to destination time zone as soon as you board                          |
| Create a comfortable environment using pillows                                      |
| Eyeshades and earplugs should be used   |
| Avoid coffee, alcohol, and nicotine   |
| In-flight meals should be eaten on the destination schedule                         |
| Maintain proper hydration   |
| Data adapted from Halson (8) and Stepanski and Wyatt (22).                          |

numerical recovery point values are assigned to each recovery strategy used during the week.

## RECOMMENDATION 5: WORRY AND ANXIETY BEFORE SLEEP

Elite athletes may experience worry and anxiety while trying to sleep in response to training, competition, and/or lifestyle factors outside of sport. Excessive worry and anxiety related to training and/or competition can cause severe emotional reactions that decrease sleep quality (21). Fletcher and Hanton (7) suggested that psychological skills of relaxation, goal setting, imagery, and self-talk emerged as particularly pertinent in influencing the competitive anxiety response in athletes. Engaging athletes in a mental rehearsal of the optimal performance in their sport may sharpen an athlete's focus and restore confidence in their ability to perform (15). Specifically, relaxation techniques such as positive suggestion/creative visualization (visualization therapy) are recommended as part of the sleep routine to ensure a clear mind and relaxed state when going to bed. The following visualization therapy techniques for improved athletic performance are adapted from Newmark (15). (a) Ask the athlete to close their eyes and focus on letting go of all muscular tension, beginning with the top of the head, progressing then to the forehead, face, neck, back, abdomen, stomach, legs, and feet; (b) Simultaneously, have the athlete control their breathing, allowing his or her breathing to become slower and deeper; (c) Have the athlete describe their optimal performance if they were competing right now; and (d) Reiterate the use of key words such as calm and confident, and relaxed and focused (15).

## CONCLUSION

As elite athletes continually search for ways to optimize recovery from training and competition, improving sleep characteristics (i.e., quantity and quality) through the implementation of sleep hygiene strategies presents a practical intervention to

promote physiological and psychological recovery. Interestingly, although sleep has been identified as an important aspect of recovery (8,19), information regarding the current practice in elite sport is limited compared with other recovery modalities (24). The sleep hygiene strategies and practical recommendations presented in this article provide guidelines that aim to improve sleep characteristics and perceptions of recovery in elite athletes. Teng et al. (23) provides support for such an approach highlighting that improving sleep characteristics and importantly an athlete's perception of sleep can have major implications for athletic performance, especially because psychological factors are linked to both cognitive and physical performance. As such, athletes should recognize the importance of sleep in recovery and athletic performance and constantly strive to improve their sleep hygiene practices.

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