

Sleep & Elite Athletic Performance

Elite athletes commonly have sleep disturbances and poor sleep quality made worse by the environmental demands of athletics.

By Scott Kutscher, MD



Introduction

Elite athletes—which for the purpose of this article will be defined as athletes capable of competing at a varsity or university level or higher—have long sought competitive advantages in sport. In recent years, sleep has increasingly been recognized as a controllable factor that can modify performance for elite athletes. Coinciding with advances in sport and sleep science, along with nutrition, mental health, and wellness, sleep is being recognized as an important part of an advanced training regimen rather than a static state of inactivity. This review provides an overview of current scientific research on sleep as a performance factor and how this knowledge can be applied in practice.

Sleep in the Elite Athlete

A range of factors that can influence sleep in athletes (Figure 1). Some factors are specific to an individual athlete, but many others are directly attributable to the athletic environment, which can significantly limit sleep particularly at an elite level. Although there are too many factors to name all, the

major factors to account for when considering athletes' sleep needs include season and off-season length, practice time and duration, competitive time, and travel. Complicating this further, many elite athletes are still amateur athletes, for whom sport must contend for time with school or work. At the individual level, variables that influence sleep include medical, psychologic, or sleep disorders, and underlying levels of pain. Individuals also have differing sleep needs, responses to sleep loss, and preferred sleep times (eg, the “morning lark” or a “night owl”).

Amount, Quality, and Timing

It should come as no surprise then, that athletes report high rates of sleep disturbance. In a survey study, 42% of collegiate athletes reported poor sleep, indicated by a score of more than 5 on the Pittsburgh Sleep Quality Index (PSQI).¹ In addition, 38% of athletes slept fewer than 7 hours per night, and more than 50% had symptoms of excessive daytime sleepiness as measured by the Epworth Sleepiness Scale.¹ In another study, self-reported sleep quality was again frequently poor, with 41% of athletes having abnormal PSQI scores of more than 5. Interestingly, this poor sleep quality was despite a seemingly

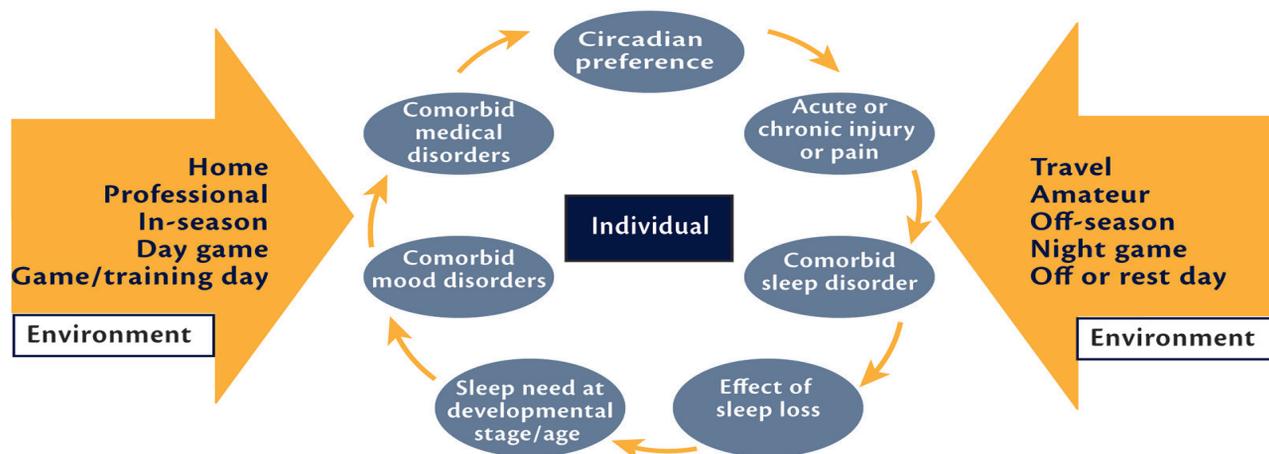


Figure 1. Factors that can influence, and in many cases impair, sleep in elite athletes include factors unique to the individual, their sleep hygiene, and health (blue ovals) and extrinsic environmental factors (large yellow arrows), many of which are engrained in sport.

adequate amount of sleep (mean sleep duration 8 hours, 11 minutes), albeit with elevated wakefulness after sleep.²

Total sleep time for elite athletes can often dip below the minimum 7 hours recommended for optimal health,³ especially during periods of high physical load. In a study, elite swimmers averaged 5.4 hours of sleep on nights before training, and 7.1 hours—a better but still seemingly inadequate amount—on rest days.⁴ Athletes in many sports must contend with persistently early morning competition times that restrict time spent in bed. For sports with more variable schedules, timing of practice and competition can still influence sleep. Elite football players slept on average 157 minutes less after nighttime matches than after daytime matches and 181 minutes less than after a training day.⁵ To supplement nighttime sleep, athletes may turn to napping. Although naps of up to 2 hours during the day may be effective in recovering lost sleep,⁶ naps that are too long, or too late in the day, may interfere with nighttime sleep, and thus, are not a long-term solution.

Recovery, Injury, and Performance

Paradoxically, many athletes appear to be sleeping less during intense workloads when they need sleep most. In a survey of almost 900 high-level athletes, sleep was consistently named as the single most important recovery tool, regardless of sex, sport, or level of competition.⁷ In another study, increased total sleep time was associated with higher perception of recovery after training or competition.⁸ Sleep loss may predispose individuals to injury; those sleeping fewer than 8 hours per night are 1.7 times likelier to sustain injury than those who sleep more than 8 hours,⁹ although decrease in sleep efficiency and increased latency to fall asleep may precede injury by up to 1 week.¹⁰ Impediments to full recovery and predisposition to injury are signals of overtraining, thus, quality and quantity of sleep may be surrogate measures of overtraining.¹¹

Sleep can also directly affect athletic performance. Numerous studies show variations in the physical and cognitive demands of athletics that vary with sleep-wake state. Aerobic, anaerobic, and cognitive performance change throughout the day in accordance with the circadian rhythms of the body. Generally mirroring core body temperature, these functions are typically maximal in the late afternoon and early evening (Figure 2). Superimposed on these fluctuations, performance will degrade with sleep loss.¹² A recent example demonstrated slower cycling times following just 1 night of sleep restriction (mean sleep of 2.4 hours) vs a full night of rest (mean sleep of 7.1 hours).¹³ In another study examining how jet lag disrupts circadian variations of performance, teams in Major League Baseball were found to perform worse when crossing 2 or more time zones.¹⁴ These studies, along with those discussed previously, demonstrate how real-world conditions—excessive practice, travel, and unusual competition times—can quickly and profoundly degrade performance by reducing sleep and

performance at times other than the physiologic peak.

Collegiate basketball players allowed to sleep up to 10 hours per day (mean = 8.5 hours/night) over 7 weeks had increased sprint speed and shooting accuracy.¹⁵ Collegiate tennis players increased serving accuracy after sleep time was increased by 2 hours.¹⁶ After extending sleep from 6.3 to 6.9 hours per night for 5 nights, professional baseball players showed improved visual attention and cognition,¹⁷ both of which are key features for pitch recognition when in the batter's box. It is unclear whether performance improvements are from recovery of a baseline sleep deficit, or because “banking” extra sleep provides added value. Also unsettled is the correct amount of sleep necessary for full recovery and optimal performance. What the studies referenced do suggest is that many elite athletes' performance benefits from sleeping more.

Sleep Disorders and Screening Tools

Even if allowed the opportunity for adequate rest, some athletes have sleep disorders that compromise sleep quality. Elite athletes also face unique circumstances that may predispose them to sleep disorders. Performance anxiety is common; more than 60% of athletes reported insomnia the night before competition.¹⁸ Even without this, the elite-athlete lifestyle can include frequent travel, variable schedules, and injury or pain, that can predispose individuals to insomnia. Football players, weight lifters, and others who rely on body mass as an advantage, may have risk for obstructive sleep apnea, which has been found in 8% of collegiate football players tested, although up to 50% of them were considered high risk based on body habitus.¹⁹ Still more sleep disorders, such as circadian rhythm disorders and restless legs syndrome, will undoubtedly be found in athlete populations due to their high prevalence in the general population, although exact rates have not been evaluated.

To help understand the role of sleep in athletes, the Athlete Sleep Behavior Questionnaire was designed to identify maladaptive sleep practices in elite athletes²⁰ and provides good

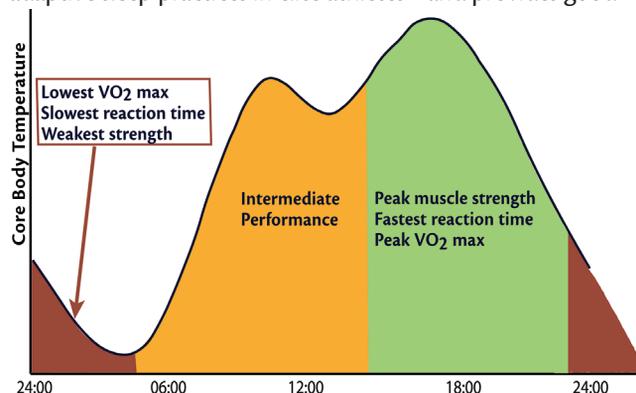


Figure 2. Variations in physical performance during a 24-hour period closely mirror fluctuations in core body temperature, including changes in aerobic output (VO_{2max}), anaerobic output (muscle strength), and reaction time.

insight into abnormal sleep behaviors that may require intervention. The Athlete Sleep Screening Questionnaire was designed to identify athletes at high risk for sleep disorders, to direct them toward appropriate specialists and testing.²¹ Because athletes generally report worse scores on commonly available sleep surveys,^{1,2} specialized assessments addressing their unique circumstances and needs may be more specific.

Meeting the Sleep Needs of Elite Athletes

Clearly, optimization of sleep in elite athletes can be complicated. With numerous competing demands for time, it can be easy for sleep to be deprioritized. This is why, although the science is advanced, the message to athletes should be simple: thinking about how you sleep can help you perform better when you are awake. A framework for this (Table 1) may include adjustment of training schedules to allow for maximum sleep for proper recovery, planning travel and activity so that the sleep opportunity and competition times match circadian cycles, and review of sleep hygiene and other techniques to help with wind-down and relaxation before bedtime.²² Individual athletes may present with unique challenges, or persistent difficulties with sleep or wakefulness, at which time referral to a sleep practitioner with experience in elite athlete populations may be indicated.²¹ Often, little can be done regarding frequency and timing of competitions that, in many cases, have become either institutionalized or driven by financial incentives. It should be noted, however, that several organizations in the US have recently adopted changes (Table 2) to allow for more recovery time between contests and easier travel schedules. Although these changes

TABLE 1. SLEEP OPTIMIZATION FOR ELITE ATHLETES

Parameter	Specific optimization steps
Amount of sleep	Adjust training/travel times to allow more sleep Use naps to supplement nighttime sleep
Healthy sleep habits	Match sleep opportunity to sleep need Keep a comfortable sleep environment free of light, noise, and other distractions Create a wind-down routine or use relaxation strategies 30-60 minutes before bed Avoid naps and caffeine in the afternoon and evening and alcohol late at night
Travel	Maintain healthy sleep habits while traveling If changing time zones, start adjusting immediately, including timing meals and activity Early exposure to light at destination can help adjust to a new time zone
Sleep disorders	Use screening tools to evaluate for potential sleep disorders Refer athletes to experienced sleep practitioners

TABLE 2. RECENT CHANGES IN US PROFESSIONAL ATHLETICS AFFECTING SLEEP TRAINING

Year	Change
National Hockey League	
2013	Realigned conferences to reduce travel and allow for less travel across time zones
National Basketball Association	
2014	Extended all-star break from 3 days to 1 week
2015	Guaranteed 2 off days between games when changing cities during playoffs
2017	Increased length of season by 1 week for same amount of games played
Major League Baseball	
2018	Increased length of regular season by 5 days
2019	Moved the start of Sunday night games 1 hour earlier

are by no means comprehensive, they do suggest that sleep and recovery needs are becoming better recognized.

Current Limitations and Future Directions

As sleep science continues to grow among elite athletes, to best serve our patients we should understand that several limitations remain. Symptoms of disturbed sleep are common, and athlete sleep remains highly variable, dependent on many factors often outside their control, including competition and training schedules. Sleep education and access to sleep services or practitioners, even at the highest levels of competition, can be fragmented or incomplete. Elite athletes may still receive information and instruction second or thirdhand or rely on unproven or untested measures or substances. In some circles, a “warrior” mentality persists in which sleep is viewed as a weakness or limitation to success. Sleep in elite athletes is often difficult to study, and the available literature is dominated by studies with very small sample sizes or larger population studies without proper controls. Often, sleep research in normal healthy controls (itself often limited by sample size) is applied to elite athlete populations, but it remains unclear if sleep demands in elite athletes are the same or different as in the general population, or even if sleep principles for athletes in sports that hinge on very different skill sets can be applied to each other (eg, long-distance runners vs weight lifters).

Despite these limitations, the future for sleep as a foundational aspect of performance in elite athletes appears strong. There is a demonstrable relationship between sleep/circadian principles and performance. There is still much to be learned about the nature of this relationship, underscoring the potential for much basic science and clinical research. Even beyond research into direct performance effects, there is great need for understanding of the role of sleep in nutrition, injury, pain, mental health, and

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wellness. With this, there will continue to be an increase in the promotion of sleep among athletes at all levels of competition.

Conclusion

With a small margin between success and failure, elite athletes need to consider how they sleep, when they sleep, and how much they sleep for peak performance. Athletes' sleep can be disturbed for myriad reasons, many of which are ingrained in the environment of athletics. However, as research in the field advances, barriers to optimal sleep are decreasing, and sleep is increasingly recognized as a performance and recovery tool among athletes, as well as coaches and the health care providers who support their performance. ■

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