

SLEEP TO SHINE — NEW TRENDS AND OLD 'SECRETS'

A FOCUS ON OLYMPIC TRACK AND FIELD ATHLETES

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THE IMPORTANCE OF SLEEP FOR ATHLETES
Sleep plays a critical role in the intricate workings of the human body, encompassing vital functions such as the regulation of hormones and emotions, memory consolidation, the modulation of immune responses, and the facilitation of muscle growth¹. In the context of athletic performance, sleep stands as a crucial pillar contributing to the overall well-being, recovery, and optimal function of athletes, with its importance extending across several critical physiological and psychological domains¹⁻²:

1. **Physical recovery:** adequate sleep promotes muscle growth, crucial for athletes aiming to optimize their physical performance and enhance their muscular strength. In addition, quality sleep aids in the recovery process by reducing inflammation and promoting the repair of muscle tissue, leading to a faster recovery between training sessions.
2. **Hormonal balance:** sleep has a significant impact on hormone regulation, including the secretion of growth hormone and testosterone, which are essential for muscle development, strength, and overall physical performance. Further, plasma cortisol levels are at the lowest levels during the sleep period.
3. **Metabolic regulation:** sleep influences various metabolic processes, including glucose metabolism and appetite regulation (through leptin and ghrelin). Proper sleep patterns contribute to maintaining a healthy body composition, which is vital for athletes striving to achieve peak physical performance.
4. **Cognitive function:** sleep is crucial for cognitive function and mental skills acquisition, including focus, concentration, motivation, mental resilience, and reaction time. For athletes, optimal cognitive function is imperative for making split-second decisions, maintaining strategy, and executing complex motor skills.
5. **Injury prevention:** fatigue and inadequate sleep can impair coordination and reaction time, potentially increasing the risk of injuries during training and competitions. Sleep helps athletes maintain peak physical and mental condition, reducing the likelihood of avoidable injuries. Further, sleep is intricately linked to the immune system and a strong immune system is essential for athletes to prevent illnesses that could impede their training and performance.
6. **Psychological well-being:** sleep plays a critical role in emotional regulation and psychological resilience. Adequate sleep helps athletes manage stress, anxiety, and mood fluctuations, fostering a positive mindset and enhancing their overall mental well-being.



Image: Illustration.

HOW TO ASSESS ATHLETES' SLEEP?

Various methods can be employed for comprehensive sleep assessment in athletes, each offering unique advantages and insights. There are both subjective and objective methods of sleep assessment and they are both essential to have a comprehensive overview of an athlete's sleep.

Concerning subjective methods, sleep diaries and sleep questionnaires allow athletes to self-report their sleep patterns, including sleep duration, quality, and any disturbances. These methods are relatively easy to administer, cost-effective, and provide insights into the athlete's perception of their sleep, including subjective experiences and sleep-related behaviours. Sleep diaries are typically administered for a duration of at least 1 week, better if in conjunction with activity monitoring, whereas the most utilized sleep questionnaires are the Pittsburgh Sleep Quality Index (PSQI) to assess sleep quality, the Sleep Hygiene Index (SHI) to assess sleep hygiene, and the Morningness-Eveningness Questionnaire (MEQ) to assess the chronotype. In addition, two questionnaires have been recently developed to specifically examine sleep in athletes: the Athlete Sleep Screening Questionnaire (ASSQ) and the

Athlete Sleep Behaviour Questionnaire (ASBQ).

On the other hand, the most common objective sleep assessment methods are polysomnography (PSG) and actigraphy. PSG involves the simultaneous recording of various physiological parameters, including brain waves, eye movements, muscle activity, and heart rhythm. It provides important and accurate information on sleep architecture and sleep staging, but it requires hospitalization (even if home-based PSG is also available), and familiarization, and it is extremely expensive. Actigraphy does not provide information on sleep staging since it just involves the use of a wrist-worn device to monitor sleep-wake patterns based on movement and light exposure. It allows long-term sleep monitoring, up to 3 consecutive months, in natural environments (at home) with associated medium costs, and for these reasons, actigraphy has been widely utilized with top-level athletes.

Lastly, since the popularity of sleep monitoring is increasing worldwide, many companies are now creating inexpensive and user-friendly monitoring devices that are available to the general public too. These last-generation commercial sleep devices (e.g., Fitbit, Oura or Whoop) utilize similar

principles of actigraphy, they are typically inexpensive, but scientific information regarding accuracy and reliability is still limited³. However, nowadays, they represent a valid option for athletes since many of them are starting to use such devices daily.

HOW DO ELITE ATHLETES SLEEP?

Despite its paramount significance, the quality and quantity of sleep among elite athletes often falls short of the recommended standards. In detail, the National Sleep Foundation recommends sleeping 7-9 hours per night with a sleep efficiency (the most important parameter of sleep quality) higher than 85%. Insufficient sleep may be explained by several factors in athletes, such as: post-match or post-training muscle pain, elevated cortisol levels, fluctuations in core body temperature, the athletes' chronotype, pre-competition anxiety, unfavourable training session schedules, the disruptive impact of travel fatigue and jet lag, and the pervasive influence of excessive social media use^{4,5}. Manifesting in various forms, poor sleep commonly manifests as insufficient sleep duration, frequent nocturnal awakenings, prolonged periods of wakefulness before falling asleep, daytime fatigue, and persistent drowsiness. Recent investigations underscore that a staggering

50% to 78% of elite athletes encounter general disruptions in their sleep patterns, with 22% to 26% grappling with severe sleep disturbances. Nevertheless, noteworthy is that the incidence of sleep disturbances may vary a lot in male and female athletes and in different sports disciplines.

Sex differences in sleep pattern

Differences in sleep patterns between males and females have been observed and studied extensively, with several factors contributing to these distinctions. These differences can include variations in sleep duration, sleep architecture, circadian rhythms, and susceptibility to certain sleep disorders; however, previous studies showed conflicting results on gender differences in athletes' sleep behaviour. Typically, female athletes demonstrate overall higher sleep duration compared to their male counterparts however, women often experience higher levels of sleep fragmentation and exhibit lower sleep quality. A recent study conducted among collegiate athletes demonstrated that the objective total sleep time did not significantly differ between genders, with both male and female athletes averaging approximately 6.7 hours of sleep. Notably, female athletes exhibited higher sleep efficiency in comparison to their male colleagues (87% females vs 82% males)⁶. Similarly, a study by Silva et al. showed that male athletes generally displayed poorer sleep patterns, characterized by an increased sleep latency of approximately 15 minutes (e.g., the time required to fall asleep after bedtime) and a reduced sleep efficiency of about 6.3% in comparison to their female counterparts⁷.

Differences in sleep among sports disciplines

The interplay between sleep characteristics and specific athletic disciplines adds another layer of complexity. In general, endurance athletes (e.g., runners, cyclists, or triathletes) tend to display earlier bedtime and wake-up time, to obtain lower total sleep time and to be more morning-oriented than athletes of team sports disciplines (e.g., soccer, basketball, or rugby). For instance, in our previous studies⁸⁻⁹, we analysed the sleep behaviour of top-level triathletes, revealing a notable phase advance of their rest-activity circadian rhythm: triathletes demonstrated an earlier sleep onset time (23:59) and a correspondingly earlier sleep

offset time (06:13) when compared to soccer and volleyball players. In detail, triathletes went to bed 63 and 45 minutes earlier than soccer and volleyball players, respectively and as expected, they also woke up around 50 minutes before team sport players. Interestingly, despite these variations in sleep timing, no substantial differences in sleep quality and quantity were detected among these athlete groups. Similarly, other studies conducted a comprehensive examination of the sleep patterns among various athletic disciplines, highlighting the distinct sleep behaviours of swimmers, cyclists, and triathletes, who were observed to constantly engage in morning training sessions. These endurance athletes reported earlier bedtimes and wake-up times compared to their counterparts in basketball, football, and other team sports¹⁰. Furthermore, the research indicated a higher prevalence of morning-types in athletes involved in sports that required morning training, further emphasizing that the differences in sleep timing (and in athletes' chronotype too) among sports disciplines can be explained by training or competition schedules.

THE SLEEP OF TRACK AND FIELD ATHLETES

Surprisingly, limited information exists regarding the sleep patterns of track-and-field athletes. Moreover, prior research focusing on this specific population has predominantly centred on non-elite adolescent athletes or has assessed sleep in specific environmental conditions that diverge significantly from the "real life condition" of elite athletes, such as the recent example of home confinement during the COVID-19 pandemic¹¹. Such disparities underline the pressing need for comprehensive investigations that capture the true intricacies of the sleep dynamics within this specialized athletic cohort. Recently, sleep characteristics of 16 elite track-and-field athletes (8 males and 8 females) were assessed during an entire season preceding the Olympic Games of Tokyo 2021 using actigraphy and sleep diaries, and a total of 702 nights were analysed¹². The sample was composed by jumpers, throwers, short-, medium-, and long-distance runners and, as a side note, 3 of these athletes obtained the gold medal in Tokyo 2021. A notable portion of athletes, comprising 18.8% (3 out of 18), were found to have poor sleep quality, denoted by a sleep

efficiency lower than 85%, while 31.3% (5 out of 18) were classified as short sleepers, with a total sleep duration of fewer than 7 hours. This recent study's findings align closely with these prior research results, underscoring the prevalence of inadequate sleep patterns among athletes and reinforcing the importance of addressing and understanding the dynamics of sleep within this population. Further, it was also observed that female track and field athletes had higher sleep efficiency, an additional 15 minutes of total sleep time, and tended to go to bed earlier compared to their male counterparts¹². In addition, as highlighted in paragraph 3.2, many differences in sleep characteristics were observed among athletes of short-term (jumpers, throwers, and sprinters) and long-term disciplines (racewalkers and middle-distance runners).

TABLE 1

1. *Optimize bedroom*
 - *Ensure a comfortable mattress and pillows.*
 - *Maintain a cool and cozy temperature.*
 - *Block out any incoming light.*
 - *Minimize disruptive noise.*

2. *Set a sleep schedule and nightly routine*
 - *Maintain a fixed wake-up time.*
 - *Give priority to quality sleep.*
 - *Gradually adjust your sleep schedule.*
 - *Allocate 30 minutes for a relaxing wind-down.*
 - *Use dim lights during the evening.*
 - *Experiment with various relaxation techniques.*
 - *Avoid tossing and turning.*
 - *Disconnect from electronic devices.*
 - *Limit the frequency and duration of daytime naps.*

3. *Adopt healthy daylight habits*
 - *Get regular exposure to natural daylight.*
 - *Avoid engaging in activities while in bed.*
 - *Refrain from late-night dining.*
 - *Reduce alcohol consumption.*
 - *Incorporate regular physical activity.*
 - *Refrain from smoking.*

Table 1: The most common and evidence-based Sleep Hygiene Strategies.

Looking ahead, it is essential to conduct further comprehensive studies focusing specifically on track-and-field athletes. By gaining a deeper understanding of how sleep dynamics shift under different circumstances, a more nuanced and targeted approach to optimizing sleep for these athletes can be developed, ultimately contributing to their overall well-being and athletic performance.

COUNTERMEASURES

Given the prevalence of sleep-related challenges among athletes, it becomes imperative for coaches and medical professionals to proactively advocate evidence-based strategies and solutions to counteract the potentially deleterious impact of sleep deprivation on athletic performance and overall health.

Sleep Hygiene Strategies

Originally rooted in the guidance aimed at ameliorating insomnia, the term “sleep hygiene” has evolved to encompass a spectrum of recommendations designed to enhance both the quantity and quality of sleep³. Table 1 shows the main and widely recognized sleep hygiene strategies, classified in 1) optimizing the bedroom, 2) setting a sleep schedule and a nightly routine, and 3) adopting healthy habits⁴.

While these practices have exhibited efficacy across diverse populations, their precise long-term and immediate effects on athletes’ sleep patterns still warrant deeper exploration. In a study conducted by Vitale and colleagues⁵, the impact of a single session of sleep hygiene education on the sleep patterns of soccer players was examined, particularly following a late-evening high-intensity training session. The results indicated that, after the immediate sleep hygiene education, the players experienced a significant reduction (-49.5%) in the time needed to fall asleep compared to the previous night. This result underscores the potential effectiveness of brief, targeted sleep education interventions in improving sleep quality and duration, particularly in the context of intense training and competitive sports schedules. Similarly, the same research group tested the long-term effect (e.g., three consecutive weeks) of sleep hygiene strategies on sleep parameters in Olympic-level track and field athletes and the authors observed a positive impact on sleep quantity (+22 minutes) and sleep

onset latency (-3.6 minutes) but not on sleep quality in this specific population. Based on these results, it becomes imperative for coaches and medical staff to prioritize the integration of tailored sleep education initiatives, supported by individualized sleep hygiene strategies too, within the daily routines of high-level athletes.

Napping

Aside from sleep hygiene strategies, daytime napping may also represent a strong “weapon” for athletes to recover from

sleep disturbances or sleep restrictions. In its essence, a nap is characterized as any sleep period lasting less than 50% of an individual’s average primary sleep period. Naps can be classified into three primary types: a) prophylactic naps, taken to preempt sleep deprivation; b) replacement naps, in response to sleep loss; and c) appetitive naps, taken for the sake of convenience and pleasure. A recent systematic review highlighted that napping is an ay common strategy among athletes to increase sleep duration over a 24-hour period⁵. Table 2

TABLE 2

<i>Athlete ID</i>	<i>Nap frequency</i>	<i>Average nap duration</i>	<i>Total daytime sleep volume</i>
<i>ID 1</i>	<i>69 naps / 111 nights</i>	<i>56 minutes</i>	<i>64.4 hours</i>
<i>ID 2</i>	<i>19 naps / 67 nights</i>	<i>36 minutes</i>	<i>12.7 hours</i>
<i>ID 3</i>	<i>27 naps / 97 nights</i>	<i>48 minutes</i>	<i>27.8 hours</i>
<i>ID 4</i>	<i>22 naps / 67 nights</i>	<i>31 minutes</i>	<i>32.6 hours</i>
<i>ID 5</i>	<i>88 naps / 97 nights</i>	<i>73 minutes</i>	<i>108.1 hours</i>

Table 2: Napping characteristics (frequency and duration) of 5 Olympic-level track and field athletes.

TABLE 3

Key concepts for Sports physicians / physiotherapists working with track and field athletes

Sleep is a crucial pillar for athletes’ overall well-being, recovery, and performance.

Athletes should sleep 7-9 hours per night with a sleep efficiency higher than 85%.

50% to 78% of elite athletes experience general disruptions in sleep.

Surprisingly, limited information exists regarding the sleep patterns of track-and-field athletes.

18-20% of track and field athletes have poor sleep quality and 30-35% have a total sleep duration of fewer than 7 hours.

Track and field female athletes have higher sleep duration but lower sleep quality than males.

Endurance athletes display earlier bedtime and wake-up time and obtain lower total sleep time than athletes of short-term disciplines.

“Sleep hygiene strategies” have been shown to enhance both the quantity and quality of sleep in track and field athletes.

Athletes should target naps lasting between 20 and 90 minutes, ideally taken between 1:00 PM and 4:00 PM to avoid negative effects of nap on the following night-time sleep.

Table 3: Take-home messages for Sports physicians / physiotherapists working with track and field athletes.

shows the napping frequency and duration of five track and field athletes facing the Olympic Games of Tokyo 2021.

While napping allows athletes to complement their regular nighttime rest, research also suggests that it can contribute positively to various aspects, including physical performance, cognitive abilities, and mood among athletes. However, coaches and athletes need to consider that the timing and duration of naps are particularly important in determining their recuperative value. Scientific data indicate that athletes should target naps lasting between 20 and 90 minutes, ideally taken between 1:00 PM and 4:00 PM to avoid negative effects of nap on the following night-time sleep. Additionally, athletes should allocate 30 minutes to diminish sleep inertia (which is a transitional state of impaired cognitive performance and reduced alertness upon waking) before training or competing to achieve improved performance results.

CONCLUSION

Coaches and medical staff should be aware that sleep quality and quantity characteristics are typically suboptimal in elite athletes. Sleep shows huge inter- and intra-individual variability in humans and many factors need to be evaluated, or controlled, to better picture the sleep behaviour in athletes, such as: athletes' chronotype, the training schedules, and the different sport disciplines. Nowadays, there are several cost-effective methods to collect sleep data and so athletes' staff should monitor sleep characteristics during the different periods of the competitive season (in-, off-, and pre-season) to highlight potential areas of improvement. The correct "administration" of daytime napping and the implementation of sleep hygiene strategies represent two non-invasive and non-pharmacological solutions to sleep issues that should be included in the daily routine of elite athletes.

References

1. Halson S. *Sleep and the elite athlete*. *Sport Sci*. 2013;26:1-4.
2. Vitale JA, Bonato M, Petrucci L, Zucca G, La Torre A, Banfi G. *Acute sleep restriction affects sport-specific but not athletic performance in junior tennis players*. *Int J Sports Physiol Perform*. 2021; 16(8):1154-1159. doi:10.1123/ijsp.2020-0390.
3. Halson, S.L. *Sleep Monitoring in Athletes: Motivation, Methods, Miscalculations and Why it Matters*. *Sports Med* 49, 1487-1497 (2019). <https://doi.org/10.1007/s40279-019-01119-4>
4. Janse van Rensburg DC, Jansen van Rensburg A, Fowler PM, et al. *Managing travel fatigue and jet lag in athletes: a review and consensus statement*. *Sports Med*. 2021;51(10):2029-2050. doi:10.1007/s40279-021-01502-0.
5. Vitale JA, Galbiati A, De Giacomi G, Tornese D, Levendowski D, Ferini-Strambi L, Banfi G. *Sleep Architecture in Response to a Late Evening Competition in Team-Sport Athletes*. *Int J Sports Physiol Perform*. 2022;17(4):569-575. doi: 10.1123/ijsp.2021-0292.
6. Carter JR, Gervais BM, Adomeit JL, Greenlund IM. *Subjective and objective sleep differ in male and female collegiate athletes*. *Sleep Health*. 2020;6(5):623-628. doi:10.1016/j.sleh.2020.01.016
7. Silva A, Narciso FV, Rosa JP, et al. *Gender differences in sleep patterns and sleep complaints of elite athletes*. *Sleep Sci*. 2019; 12:242-248. doi:10.5935/1984-0063.20190084
8. Vitale JA, Banfi G, Sias M, La Torre A. *Athletes' rest-activity circadian rhythm differs in accordance with the sport discipline*. *Chronobiol Int*. 2019;36(4):673. doi:10.1080/07420528.2019.1569673
9. Vitale JA, La Torre A, Banfi G. *If RAR's acrophase is influenced by the sport discipline, how actigraphy-based sleep parameters vary in triathlon, volleyball and soccer athletes?* *Chronobiol Int*. 2019; 36(6):735-738. doi:10.1080/07420528.2019.1594246.
10. Lastella M, Roach GD, Halson SL, Sargent C. *The chronotype of elite athletes*. *J Hum Kinet*. 2016;54:219-225. doi:10.1515/hukin-2016-0049.
11. Vitale JA, Borghi S, Codella R, et al. *Are elite track-and-field athletes on track? The impact of COVID-19 outbreak on sleep behavior and training characteristics*. *Biol Sport*. 2021;38(4):741-751. doi:10.5114/biolSport.2021.109950.
12. Vitale JA, Borghi S, Piacentini MF, Banfi G, La Torre A. *To Sleep Dreaming Medals: Sleep Characteristics, Napping Behavior, and Sleep-Hygiene Strategies in Elite Track-and-Field Athletes Facing the Olympic Games of Tokyo 2021*. *Int J Sports Physiol Perform*. 2023 Sep 20:1-8. doi: 10.1123/ijsp.2023-0144. Epub ahead of print. PMID: 37730209
13. Vitale JA, La Torre A, Banfi G, Bonato M. *Acute sleep hygiene strategy improves objective sleep latency following a late-evening soccer-specific training session: a randomized controlled trial*. *J Sports Sci*. 2019;37(23):2711-2719. doi:10.1080/02640414.2019.1661938
14. Irish, L. A., Kline, C. E., Gunn, H. E., Buysse, D. J., & Hall, M. H. (2015). *The role of sleep hygiene in promoting public health: A review of empirical evidence*. *Sleep Medicine Reviews*, 22, 23-36.
15. Lastella M, Halson SL, Vitale JA, Memon AR, Vincent GE. *To Nap or Not to Nap? A Systematic Review Evaluating Napping Behavior in Athletes and the Impact on Various Measures of Athletic Performance*. *Nat Sci Sleep*. 2021 Jun 24;13:841-862. doi: 10.2147/NSS.S315556.

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