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Overview of the impact of sleep monitoring on optimal performance, immune system function and injury risk reduction in athletes: A narrative review

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Abstract

Sleep is essential for a range of physiological and mental functions in professional athletes. There is proof that athletes may experience lower quality and quantity of sleep. While adequate sleep has been shown to have restorative effects on the immune system and endocrine system, facilitate nervous system recovery and the metabolic cost of wakefulness, and play a significant role in learning, memory, and synaptic plasticity, which can affect sports recovery, injury risk reduction, and performance. Sports performance may suffer significantly from a lack of sleep, especially under maximal and long-term exercise. Due to the potential harm, these factors may do to an athlete's endocrine, metabolic, and nutritional health, sports performance is impacted by reduced sleep quality or quantity. There are several neurotransmitters associated with the sleep–wake cycle that have been discovered. They comprise cholinergic hormone, orexin, melanin, galanin,

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serotonin, gamma-aminobutyric acid, histamine, and serotonin. Therefore, dietary modifications that affect the neurotransmitters in the brain also may affect sleep; particularly for athletes who require more physical and psychological recovery owing to the tremendous physiological and psychological demands placed on them during training and performance. This review explores the variables that influence the quantity and quality of sleep-in populations of athletes and assesses their possible effects. In addition, several recommendations for improving sleep are presented. Even though there has been much research on variables that impact sleep, future studies may highlight the significance of these aspects for athletes.

Keywords
Sleep, omega 3, immune system, injury, athletes

Introduction

One of the most crucial physiological demands of the body is sleep, a natural phenomenon controlled by the circadian rhythm.[1] Compared to the awake state, the body's physiological activity (brain activity, breathing, and heart rate slow down, body temperature drops, muscles relax, and eye movements stop) decreases during the non-rapid eye movement (NREM) stage. Although it is fundamentally distinct from other forms of sleep, the rapid eye movement (REM) stage is comparable to waking states in this instance.[2] The concept of unconscious and mental activities during REM sleep (directly related to concurrent dream experiences) has since been the subject of much research on sleep and REM sleep. The experiment results imply that dreaming creates psychic manifestations that are inactive by the neurological system that controls sleep.[3] Researchers have also noted tales of a person awakening drowsy (NREM).[3]

The primary distinction between being awake and asleep is believed to be between eye movements and visual experiences during REM sleep. However, sleep is much more than eye movement and visual experiences.[4] There are five sleep cycles, each lasting around 90 minutes, in a typical 7- to 8-hour sleep period. Each cycle has many phases of sleep: stage 1 (5–10 minutes), during which the brain is still functioning and generating theta waves (slow brainwaves);[5] stage 2 is a relatively light sleep; stages 3 and 4 are known as deep sleep, or "dead to the world" sleep; and stage 5 is REM sleep, in which the sleeper is very close to consciousness and probably dreaming.[6] These stages are considered crucial for physical and psychological restoration.[6] The sleeper passes through stage 2 twice throughout each cycle—once on the way "down" to slow-wave sleep and once again on the way "up" to REM sleep.[6] A significant function for catecholamines in the brain and most of the body's organs is played by getting enough sleep, which improves the immune system's performance, stabilizes memory, and slows down metabolic processes at the molecular level.[1]

Sleep is a common condition wherein consciousness terminates, and bodily activities slow down or cease.[7] Sleep is a different brain activity governed by precise processes, unlike waking up. Not only is sleep a condition of rest, but it also serves other essential and beneficial purposes. The physiological differences between sleep conditions and other states of relative inactivity, like aesthesia, coma, or hibernation, are significant.[7] Although sleep is a slower stage of loss of awareness and physical function, athletes should know that it plays a crucial part in the rest-activity cycle with highly specialized

roles during quality sleep.[7] The commencement of sleep depends on the athlete's choice, an interesting distinction between recovery therapies and recommended procedures like cold water immersion, wearing tight clothes, or electrical stimulation.[8] Due to its physiological and psychological restorative benefits, sleep is crucial for athletes to recover from exhaustion.[9] The quantity of sleep ideal for health and quality of life changes with time and gradually gets less restful as one age. According to the American Academy of Sleep Medicine, adults require 7 to 9 hours of sleep every night for optimal performance and health, but teenagers require more sleep, ideally between 8 and 10 hours.[10,11] The quantity of sleep needed differs widely from person to person and may change from an individual day-to-day variation depending on several conditions, including sickness, lack of sleep, and physiological or psychological stress.[11] While sleep quality is widely understood to be important for general health and well-being, sleep duration is simply one aspect of sleep. Athletes may be more susceptible to injury and disease when they get insufficient sleep (for instance, sleep less than 7 hours and quality of sleep). Thus, athletes and coaches have recognized sleep as one of the most crucial recovery techniques.[12]

However, athletes' adherence to formal training and competition schedules, heavy training loads, and competition's physical and emotional demands may affect the quantity and quality of their sleep throughout the competitive season.[13] Improvement in the quantity and quality of sleep shortens the healing period.[14] An imbalance may develop when exercises and contests are performed close to sleep.[15]

Daily monitoring of tiredness, stress, and recuperation is a typical strategy for improving athletes' performance.[16,17] Although there are different ways to affect each of them, sleep is a tactic that considerably improves some tiresome activities, such as cognitive and physiological tasks, and is a valuable tool in preventing excessive exercise.[18]

Lack of sleep negatively impacts performance, decreases motivation and arousal levels, cognitive processes that affect attention and focus, and increases feelings of effort and discomfort.[19] The immune system is weakened, glucose metabolism is reduced, endocrine nerve activity is disrupted, and cardiovascular function is lowered.[19] Sleep is crucial for the body to recuperate from training and prepare for the following training session or competition.[18] Athletes may also require extra sleep to recuperate adequately from injuries brought on by rigorous training and competition because excessive exercise changes to over-training/under-recovery.[20] Sleep disturbance and poor sleep can be caused by an increase in the level of catecholamines during the night, which can lead to cardiovascular discomfort. Hormones are secreted to heal. Growth hormone (GH) and androgens are crucial for bone growth, muscular growth, muscle repair, and increasing fat oxidation.[21] Athletes must understand how sleep impacts performance and recovery, what influences sleep quality, and how to establish the best sleep habits. These examples are shown in Figure 1.

The dangers of illness and harm from lack of sleep

In research involving 122 athletes, it was discovered that less than 8 hours of sleep per night increased the risk of injury by 65%.[22] According to recent systematic research in soccer, sleep deprivation may harm physical and match performance. The same

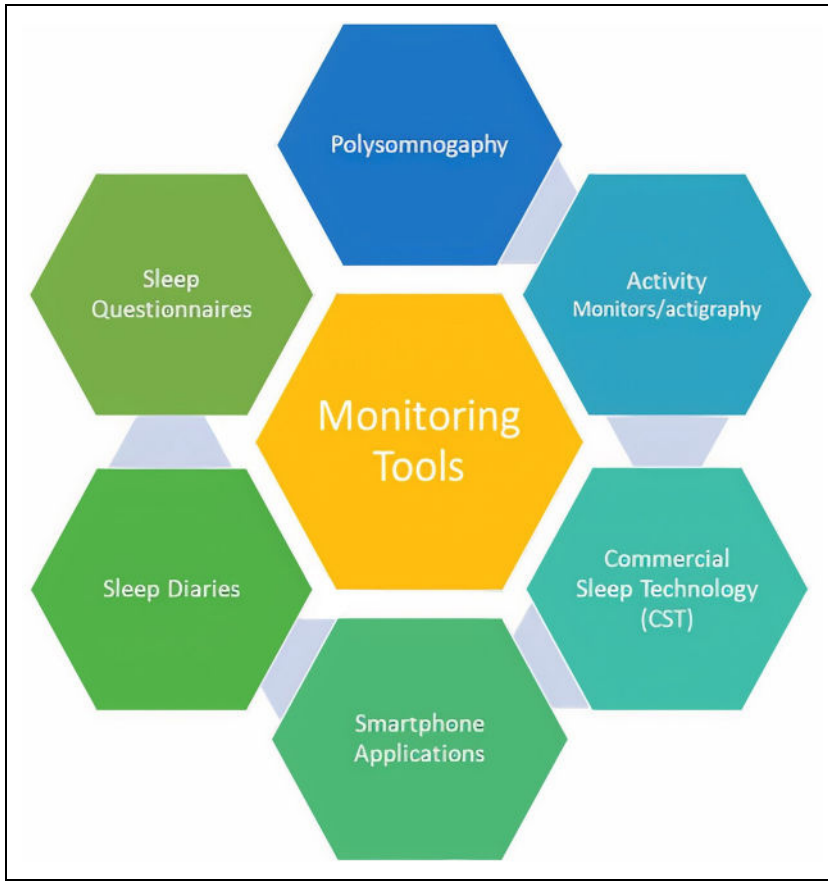

Figure 1. Sleep monitoring tools.

authors pointed out that the incidence and severity of musculoskeletal injuries can also rise due to sleep deprivation.[23] The complexity of sports injuries as an emergent phenomenon should also be noted. Risk factors for injuries include nonlinear interactions between numerous aspects, including biomechanics, training, and workloads, as well as psychological and physiological traits.[23]

As high-performance demands are likely to manifest the negative consequences of insufficient sleep, the impacts of poor sleep duration and quality on performance are anticipated to be more common in competitive athletes. Lack of sleep has been linked to poor sports performance and overall health, particularly regarding exhaustion time, muscular strength, and mood.[24,25] It was shown that endurance performance increased after three nights of sleep (about 8.4 hours per night) compared to normal sleep (about 6.8 hours per night) in one research conducted with endurance athletes.[26] It demonstrates that endurance athletes need to sleep for a more extended period each night to perform better.

The role of hormones on sleep

The neurotransmitter serotonin is triggered by darkness and subsequently released from the pineal gland overnight to induce sleep. It produces melatonin (melatonin, through increasing angiogenesis, increases blood supply and vascular endothelial growth factors for tissue formation).[27] A healthy sleep environment is crucial because melatonin has a broad spectrum of antioxidant capabilities[28] and is light-sensitive. This hormone also has an impact on alleviation and health. Hormonal activity during sleep significantly improves recovery.[29] Melatonin protects cells from oxidative damage, promotes tissue inflammation, and activates additional pro-inflammatory enzymes.[30] Melatonin regulates immune system activity via the neurological and endocrine systems. Lastly, low and high melatonin release governs circadian rhythms in response to light and dark cycles.[30]

The GH and androgens produced during stages 3 and 4 of deep sleep are critical for bone growth, muscular growth, and fat oxidation.[21] Sleep recovers the previous session's neurological system and metabolic costs, alleviates the immunological and endocrine systems, and enhances memory and learning capacity for the following workout.[31] It has been shown that the connection of different brain regions during deep sleep can reduce the possibility of damage compared to insomnia. Insufficient sleep has been linked to decreased body temperature, neurological and hormonal disorders, increased epinephrine and decreased thyroxine, weakened immune system function, stimulation of inflammatory agents, increased blood pressure, and an increased risk of cardiovascular disease.[32,33] The frequency of sleep disruptions alters the body's natural physiological state and elevates some metabolic processes to a new level. Production of inflammatory cytokines and reactive phase reactive proteins may be connected to these alterations.

Sleep and immune system

The behavior of sleep and wakefulness, or more specifically, the quality of sleep, is influenced by cytokines IL-1 beta (IL-1), which also includes anti-inflammatory cytokines.[34] The physiological roles of two substances, IL-1 and tumor necrosis factor-alpha (TNF), including their effects on cognition, synaptic plasticity, and immunological function, are well understood.[35] These drugs encourage NREM sleep and can cause symptoms of sleep deprivation, such as drowsiness, exhaustion, and impaired cognition. In response to extracellular ATP, glia produces IL-1 and TNF.[35] When they bind to their receptors on neurons, neurotransmitters, and receivers (such as adenosine and glutamate receptors) are up- or down-regulated, changing the excitability and function of the neurons and the local network's state. Emergent total brain oscillations, including sleep/wake cycles, are caused by the state synchronization between local networks.[35] To respond to infections, microbial invasions, and inflammation, it is released by macrophages, monocytes, and epithelial cells with inflammatory, metabolic, hematopoietic, and immunological properties.[36,37] They might result in inflammatory cells penetrating the target tissue or responses like fibrosis.[38]

Nonetheless, the quality of sleep is impacted by the C-reactive protein (CRP).[39] Although the exact mechanism behind this association is uncertain, it is known that in

healthy people, sleeplessness increases peripheral leukocyte and IL-6 circulation.[40] Lack of sleep may cause inflammation, and if it persists for a long time, it might put their heart in danger. The pentraxin protein family includes CRP. The liver responds fast to inflammatory circumstances brought on by trauma, infections, and thermogenesis, and the risk of cardiovascular disease, including myocardial infarction and commercial ischemia in females, increases.[41] Overall, the anti-inflammatory markers of CRP and IL-1 have changed noticeably to enhance sleep quality, showing the expected outcomes of consistent and consistent exercise activities in the middle of the year. To fully comprehend the processes by which physical activity reduces inflammatory agents and the indicator of sleep quality, additional study is needed.[41]

Sex differences in sleep

The majority of research have focused on how gender affects sleep. Young people who sleep more efficiently and with more outstanding sleep quality than elders do so more frequently.[42] Men function with fewer than seven hours of sleep than women (58% vs. 43%) was better, and elder groups report more significant sleep issues, such as insufficient sleep duration and insomnia.[43,44] This suggests that clinical symptoms are more common in women.[43,44] Specific hormonal and physical changes in women that raise the risk of alterations for sleep and sleep disorders worsen gender disparities in sleep and sleep disorders. Some of the variations are shown in Figure 2.[45]

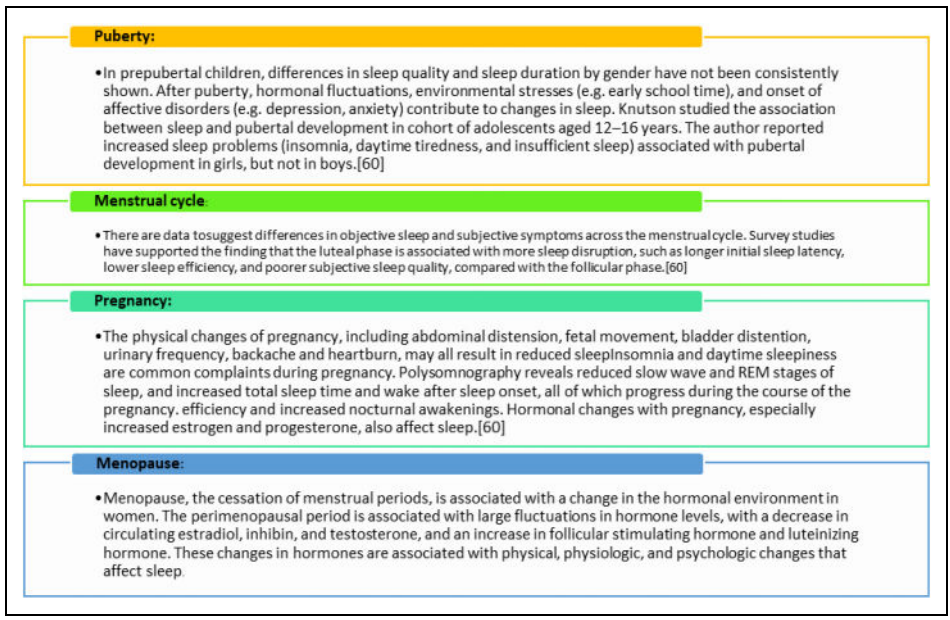

Figure 2. Factors affecting sleep.

Sleep monitoring

Filling out sleep questionnaires is a typical and cost-effective method for evaluating sleep during training and competition periods. Several types of questionnaires that exclusively concentrate on particular aspects of sleep, such as disorder, sleep length, sleep time, and waking time, have been advised in a prior study that studies sleep deprivation and sleep extension.[2] Examples of tools used to evaluate athletes' sleep quality before competitions include the Pittsburgh Competitive Exercise Questionnaire and the Pittsburgh Sleep Quality Index.[3] Additionally, the Activity Readiness Questionnaire's inclusion of sleep as a general component detects many components of stress, recuperation, and lifestyle factors in response to daily exercise. Self-reporting techniques are helpful in that they enable athletes to reflect and pinpoint problem areas, but they are inherently subjective.

The Hooper index (HI) is another questionnaire used to evaluate sleep quality.[46] This score is used to access wellness, including data on fatigue, stress, delayed onset muscular soreness, and sleep quality.[46] Before the training or match session, participants complete the questionnaire that captures their feelings and perceptions on the training day before. For the HI's sleep quality question, a subjective rating scale of 1 to 7 arbitrary units (AU) is often used, with 1 AU denoting "very, very bad" sleep quality and 7 AU denoting "very, very good" sleep quality. Additionally, the sum of the last four items may be used to display Hooper's overall score.[46]

Environmental aspects of sleep control

The athlete's comprehension of the training load placed on them during the season will determine how healthy they are. The perception of the load is influenced by several variables, including an athlete's experience, session intensity, weariness, and level of physical fitness.[5] In addition, examining the link between an athlete's well-being and training/competition load, as well as seasonal fluctuations on a daily and weekly basis, might light on how training and competition affect players.[5] Additionally, managing weekly training and competition loads might help lower the risk of injury.[5] Recently, HI values have been utilized to calculate acute: chronic workload ratios as well as monotony, strain,[6] and weekly cumulative values (per week).[7]

Athletes' sleep quality may alter due to various circumstances, including the demanding competition schedule, the low priority given to sleep compared to other training requirements, and a lack of understanding regarding the importance of sleep in enhancing sports performance. Factors like jet lag during international competitions, changes in sleeping habits like sleeping in hotels, the number of athletes in each room, and late hours make athletes frequently exposed to circadian rhythm disharmony matches.[12] Additionally, stress and muscle pain due to competition, intense training, and traveling contribute to this problem.

Moreover, objective sleep measurements may be recorded. However, requiring specific software and equipment comes at an additional cost. Information on many elements of sleep quality and quantity, including sleep efficiency, overall sleep time, frequency of awakenings, and duration of each sleep stage, is provided by polysomnography (PSG) as

a benchmark technique.[10] Due to the necessity of sleep monitoring, this procedure necessitates a high level of knowledge and is not especially useful for athletes. An alternative technique called octopography uses watches with motion-tracking sensors to track body movement and, when combined with sleep logs, may accurately calculate sleep duration, startle latency, wake-up time, and sleep quality.[11] This technique successfully measures sleep, is non-invasive, and can gather data for two weeks.[10] The usage of smartphone sleep applications may be considered due to the simplicity of integration it may offer in athletes' lives, but further testing is still required to determine the validity and dependability of such devices and apps.

A good night's sleep is a reliable indicator of physical and mental health, well-being, and general vigor.[12] However, the phrase "sleep quality" has not yet been adequately defined while often used by patients, doctors, and researchers. Since falling asleep should take no longer than 30 minutes, waking up no more than once per night, and remaining awake for no longer than 20 minutes after first falling asleep, the National Sleep Foundation assembled a panel of sleep experts and published the first report on sleep quality recommendations.[12] These factors should be followed.

A buildup of exhaustion, sleepiness, and mood swings may result from insufficient sleep.[8] Additionally, lack of sleep has been linked to decreased physical ability, such as speed and anaerobic power, neurocognitive function, such as attention and memory, and physical health, such as the risk of disease and injury.[8,9] The signs of over-training syndrome, the rise in inflammatory markers, and finally, immune system dysfunction, along with a decline in sleep quality and quantity, may cause an imbalance in the operation of the autonomic nervous system.[9]

Additionally, the amount (e.g. total sleep duration) and quality (e.g. sleep efficiency and sleep latency) of sleep for athletes might vary depending on whether they play individual or team sports. Night events or contests are sometimes staged in team sports to increase attendance (i.e. night football games). It makes sense that team sport players' ability to sleep is influenced by various variables, such as the sport they play, their training requirements, age, season, and culture.[13]

Furthermore, night games significantly contribute to sleep problems in team sports[9,13] because players frequently have to travel after competitions, the schedule is jam-packed with events, and training for sleep loss has a poor adaption rate.[13] Additionally, sportspeople occasionally spend the time following night games partying, and drinking with family and friends.[14]

These elements explain why sleep disorders impact the recovery time course for functional and psychological assessments. Over the past several years, there have been a significant number of researches on sleep involving athletes who compete in team sports, and three recent reviews have examined the function of sleep in the recovery of athletes who compete in team sports. The focus has so far been on employing various tools to monitor sleep in team sports athletes, such as PSG, actigraphy, questionnaires, and scales.[10] PSG is the benchmark. In any case, athletes in team sports have fewer field measures for sleep monitoring. Because they are affordable and straightforward to use in the field, questionnaires and scales for sleep monitoring (i.e. HI) are often utilized.[15] Moreover, other research has shown that various actigraphy measurements and PSG, another instrument that is simple to use in the field, have high a broad consensus (i.e. validity).[47]

Nevertheless, all of these measurements indicate that team sport athletes' sleep quality is inadequate due to competition schedules (such as late evening) and frequent travel, as well as negotiating factors like training times (such as the early morning or late evening), poor sleep habits, and competition schedules, such as late evening (e.g. light exposure, use of electronic devices, and caffeine consumption), factors cannot be changed.[47] Therefore, it may be helpful to appreciate better the contribution of these characteristics for scientists and medical professionals contemplating the significance of sleep quality metrics in an athlete's recovery process. An investigation is necessary to determine the parameters to utilize for team sport athletes to measure their sleep quality.[12] The instruments used to measure the state should be one of the issues related to sleep quality that should be addressed. Accelerometers are frequently employed in research to capture movement behavior (e.g. sleep, physical activity, and sedentary behavior). Several devices can convert data to different estimates of physical activity, energy consumption, sleep, and heart rate, for research[16] and the consumer market.[17] Due to their excellent capacity to record activity and ability to estimate physical activity and associated factors, activity trackers are widely employed in research.[18,20] When consumer-based activity trackers are more affordable, they have more battery life and storage capacity, as well as accelerometers and heart rate sensors that are based on research and are less obtrusive. Additionally, they have lower cooperation rates than self-reporting instruments like activity and sleep diaries, which might be challenging to monitor even if they are less expensive than PSG.[21]

Sleep diaries

Keeping a sleep diary is an easy and affordable approach to assessing sleep. It may contain evaluations of drowsiness and alertness and ratings of coffee, alcohol, exercise, and gadget usage.[48] It may also include ratings of sleepiness and alertness. A team of sleep specialists has developed a consensus sleep diary in response to the vast diversity of sleep diaries, many of which may be controlled using a smartphone app for at least one week.[48] However, diary use bias may arise due to social expectations, recollection, and attractiveness. Additionally, it is advised that diary entries and activity logs be done.[49]

Sleep questionnaires

The sleep questionnaire is another self-assessment tool for assessing various sleep factors in athletes. Due to their simplicity and low cost, these questionnaires are frequently utilized as the initial diagnostic examination. Several different questionnaires evaluate sleep disturbances, some of which may be helpful for athletes. Measures of daytime sleepiness include the Epworth Sleep Scale,[48] the Pittsburgh Sleep Quality Index,[48] the Health Index,[50] and the Pittsburgh Sleep Quality Index.[48] The Athlete Sleep Screening Questionnaire (ASSQ) (1997) and Athlete Sleep Behavior Questionnaire (ASBQ) may be more effective recently in examining sleep in athletes and providing professional athletes with relevant tools. Examine the sleep surveys that are accessible.[48]

Activity monitoring/actigraphy

Small wearable devices called activity monitors track movement over time[25] and utilize three-axis accelerometers to identify whether a person is awake or asleep.[26] The methods used to assess awake and sleep have been disclosed for research-grade activity monitors, such as the Philips Respironics ActiWatch 2. Activity tracking has received significant support from the sporting community.[49,51] The mean bias (with PSG) was 8.5 minutes for total sleep time, 1.8% for sleep proficiency, and -4.1 minutes for wakefulness after sleep started when the Philips ACTi Cal device was set to moderate to detect sleep or wakefulness.[49] Athletes have also shown good agreement (81–90%) and sensitivity (81–92%) between activity monitors (Philips ACTi Cal) and PSG.[52] The activity regulates over- and under-estimated waking duration (18–90 minutes), depending on the threshold (4–77 minutes). The highest agreement, sensitivity, and specificity were obtained when using high-sensitivity sleep thresholds (>80 activity counts = awake) in comparison to PSG.[51] Due to the minimal subject load compared to PSG and the removal of recollection and reporting biases, actigraphy is a standard tool in research and practice.[25] It also allows for longitudinal monitoring, which is beneficial for analyzing sleep or wake time over many days. In healthy sleeping participants, scoring algorithms for both sleep and alertness have been demonstrated to function effectively, with deficiencies mainly in the capacity to detect awake rather than sleep. Thus, they function poorly in individuals with fragmented sleep and a greater rate of nighttime awakenings.[25] Additionally, research-grade equipment is costly (around US$1000 per unit, plus software), and experience is needed to guarantee the data's correctness and combine it with other data to create a useful sleep report.

The role of nutrition on sleep

Nutrition is essential for both performance and recovery; it has been proven. It is still early to understand how meals, macronutrients, and micronutrients impact the pattern of sleep and waking hours. The main goals of sports nutrition have been to suit athletes' demands and hasten recuperation,[53] and emphasis has been placed on using dietary supplements to enhance sleep.[54]

Several nutrients have an impact on sleep, including carbohydrates (high glycemic index dinners reduce sleep delay), protein (dairy consumption may lengthen sleep), ethanol/alcohol consumption (associated with poor sleep quality),[48,55] and caffeine (lengthens sleep delay and total sleep time). Due to the relaxing effect of digestion, large quantities and afternoon meals might negatively affect sleep, impacting circadian rhythms as well.[27] Additionally, caffeine consumption rises as a result of poor sleep quality. Alcohol use is linked to poor sleep, reduced sleep, and greater sleep disruption in the second part of sleep. However, caffeine enhances alertness and antagonizes adenosine receptors, lessening the urge to sleep.[28] In order to provide athletes with the energy they need to compete in demanding and prolonged sports, carbohydrates have long been employed in sports.[29] Between training sessions or contests, the goal of carbohydrate supplementation is frequently to replenish muscle and liver glycogen stores.[30] While the need, kind, and timing of carbohydrate usage for recovery are supported by documentation.

A high-GI meal's timing might have an impact on sleep quality. Mechanisms suggested to enhance the building blocks for serotonin and melatonin, which promote sleep, include tryptophan, an essential amino acid. Following a high-GI meal, the plasma ratio of tryptophan to major neutral amino acids (TRP/LNAA) increases. TRP/LNAA levels are at their highest 2 to 4 hours after a high-carb meal, with no change in the first 2 to 3 hours.[31] This is so that tryptophan, which increases serotonin synthesis and melatonin production downstream,[32] may more easily bridge the blood-brain barrier. According to sports scientists ' research, a low-carb lunch four hours before bedtime, as determined by the Gold Standard Sleep Assessment, boosted athletes' share of slow-wave sleep.[33] Athletes could gain more slow-wave sleep to enhance performance recovery.[34] Decisions regarding prioritizing fuel over sleep promotion should consider the impact of a low-carb diet on muscle and liver glycogen retrieval. Protein is crucial for athletes' training and competition since it makes muscle repair and regeneration easier and promotes the immune system's healthy operation.[35,36] One of the usual procedures to improve whole-body protein synthesis during nocturnal recovery is the intake of protein post-workout and before bed.[36] In particular, a specific kind of alpha-lactalbumin, the same whey protein that has lately been researched as a dietary supplement before bed.[37] According to studies, the most naturally occurring tryptophan may be found in protein-rich dietary sources in alpha-lactalbumin.[37] Tryptophan, a critical amino acid, is a precursor to the manufacture of two hormones that regulate sleep, including serotonin and melatonin.[38]

According to the findings of this study, sleep quality may be enhanced by a considerable decrease in tiredness, and morning attention processes improved following an early-morning intervention.[39,40] According to independent research, women are more likely than males to develop sleep difficulties, and there is a substantial correlation between sleep and emotions of worry and despair.[41] During demanding team seasons, alpha-lactalbumin supplementation, which can improve sleep quality and lessen depressive symptoms, may be helpful. Kiwi, cherries, and herbal supplements are some other foods that might aid with sleep improvement. Kiwi has many nutrients that help with rest and alleviation. Two kiwis had eaten an hour before night during four weeks of enhanced sleep in adults with poor sleep.[56] The impact of kiwifruit consumption on the sleep and recovery of elite athletes.[57] Under the supervision of TST (16.9%) and SE (2.4%), it was considerably seen in wrist activation, while recording mental sleep memories revealed a significant decline in WASO and SOL. Kiwi's high folate content may lead to better sleep.[56] Sleep apnea and restless leg syndrome are severe sleep disorders linked to folate insufficiency and poor restorative sleep.[56] Some methods for enhancing sleep quality using supplements are shown in Table 1 below.

Bedtime routines

Before making general sleep pattern changes, following the best practices for improving sleep quality and quantity is critical. It is essential to get ready for bed in a dark room that is cold and quiet.[58] Melatonin is transferred in a dark environment since its secretion is sensitive to light and darkness. This lessens the likelihood of sleep disruption, especially in the first, lightest sleep phases. Pre-race anxiousness[59] and exercise are additional

Table 1. The physiological effect and dosage of the main dietary supplements are used to improve the quantity and quality of sleep.

Supplement	Physiological	Effect dosage
Tryptophan	Precursor to precursor to serotonin on a cerebral level, the hormone responsible for causing sensations like lethargy and drowsiness	1 g day^{-1}
B-complex vitamins	Vitamin B3 reduces the activity of the 2-3-dioxygenase, reducing the quantity of tryptophan designated to synthesize this vitamin, leaving a greater amount of tryptophan available to synthesize serotonin	DRI in cases of deficiency
Minerals	Magnesium and zinc intervene in the synthesis of melatonin	DRI in cases of deficiency
Melatonin	Hormone that induces sleep and lethargy	5–8 mg
Valerian	Reducer of the sympathetic nervous system activity	No positive effect has been demonstrated
L-Theamine	Reducer of the sympathetic nervous system activity	No positive effect has been demonstrated

DRI: dietary reference intakes.

factors that disturb sleep patterns, particularly at night. Numerous methods have been developed to address anxiety's negative impacts on the quality of sleep, from goal-setting and self-talk[60] to visual therapy techniques and mental exercise.

Using eye masks and earplugs may aid in improving the ability to fall asleep when traveling or somewhere other than the typical sleeping environment. It will work better if this time is combined with a regular bedtime every night. It also allows the athlete to arrange sleep-related activities, such as staying away from the computer and watching TV. Avoiding caffeine consumption, which can cause nighttime sleep problems, should also be a part of this exercise.[50] Finally, to avoid interfering with regular sleep time, nap time should be kept to a maximum of half an afternoon.[45] Another useful idea is to utilize light while awakening to speed up the process. Melatonin secretion is inversely connected to light,[60] inhibiting and transmitting more effectively than awakening.

Impact of sleep and injury reduce

Exercise-related injuries can range from acute end-of-season or end-of-work trauma to recurring microtrauma and are the most prevalent cause of injury in those who are school-age (i.e. overuse). Injuries occurred 1.7 times more frequently in adolescent athletes who slept fewer than eight hours per night on average than in those who slept eight hours or more. According to a different study,[61] teenage athletes were more likely to sustain injuries when competing after sleeping fewer than 6 hours each night.

Athletes who fatigue more quickly (in terms of enough sleep and mental issues) have a higher chance of injury and making more mistakes while training and making decisions.[57] This significantly influences our kids since more than 3.5 million young children

Table 2. Tips for sleeping.

Tip 1: Take a napping	When athletes have poor nightly sleep length and quality, naps can be used to make up for lost sleep. According to earlier studies, a 30-minute sleep is acceptable for enhancing cognitive functions and motor control.[45] However, additional time must be allowed while performing on a training day for athletes to awaken following this interval properly. Caffeine use, waking up in strong light, and washing the face right away are just a few tactics that may assist in waking up after brief periods of sleep.[17] Caffeine consumption before sleeping is reportedly the most effective way to improve cognitive functions, which can be assessed using memory function tests and response time.[62] Caffeine is quickly absorbed after ingestion, plasma concentrations peak after 30 to 75 minutes, and a single dose's half-life is advised to last 3 to 7 hours.[55] Because of this, it is crucial to consider the nap's duration and timing when it has combined with coffee. Athletes should think about using this strategy by drinking coffee, for instance, before naps during the day to encourage quick and efficient post-nap recovery, which enables a good integration into a scheduled exercise day. The window of opportunity for a daytime nap should also be taken into account. Moreover, it is advised against napping in the late afternoon and evening since it will affect how you sleep at night.
Tip 2: The amount of sleep	The standard advice is that athletes should get 7 to 9 hours of sleep daily at the very least.[63] Individual differences exist in this, albeit.[63] Due to heavy training loads and the stress of competitions, athletes generally require extra sleep to optimize their recuperation and recovery processes. Although research shows that professional athletes who train 4 to 6 hours a day may need as much as 10 hours of sleep, adolescents who engage in severe exercise may need 10 hours of sleep every night.[63] I require 12 hours of sleep every night. A smart strategy is for athletes to sleep the next day for whatever long it takes them to feel aware and awake.[63]
Tip 3: Regular sleep routine and sleep habits	It is suggested that everyone retires to bed at night and awakens in the morning at around the same hour every day. This facilitates the development of a consistent sleep schedule that improves sleep quality. Additionally, avoiding unhealthy sleep habits, including using a computer or TV in bed, is also recommended.[2] Before getting to sleep, putting the lights out will help to improve sleep quality.
Tip 4: Improve from practice/competition	Utilizing 2 of the most popular recovery techniques, such as submersion in cold water and wearing compression clothing, may enhance sleep quality by reducing discomfort, inflammation, and muscular soreness.[2]

and another 2 million high school students require associated medical care annually, and 60 million of them between the ages of 6 and 18 compete in organized sporting events. They include sports-related injuries. Sleep is thought to have a significant part in the recovery and safety of young athletes, especially in light of their chronic sleep

deprivation, since studies have shown that it is one of the most acceptable forms of recuperation accessible for elite athletes. GH, secreted by the pituitary gland during NREM sleep is crucial for tissue regeneration and wear-and-tear repair. Additionally, NREM sleep is linked to decreased protein synthesis, free fatty acid transfer, and oxygen consumption. All of them potentially hasten recovery.[61]

Sleep enhancement strategies

Athletes often need at least 7 hours of sleep per night.[61] This number will, however, differ for every athlete. Athletes require more sleep than non-athletes because they use many different training techniques.[61] Additionally, it is recommended that young athletes participating in this high-volume activity acquire at least 10 hours of sleep each night,[61] at least 7 hours, and enough sleep to get up without feeling sleepy on the next training day. Routines with the exact sleep–wake timing that improves sleep quality should be followed to make getting these hours of necessary sleep easier. Increasing sleep volume and decreasing sleep latency improve recovery and alertness by reducing sleep delay and speeding up the transition to various sleep phases. Table 2 provides some suggestions for enhancing sleep quality.

Conclusions

Athletes, coaches, and support staff must adopt a scientific approach to designing and monitoring training programs. Proper health and load monitoring are crucial to determine if a player adapts to a training program and minimizes the risk of overactivity, illness, or injury. Several potential indicators are available to understand the demands of training and competition and their effects on the player. Nonetheless, some of them have strong scientific evidence for their use. In addition, it is essential to note that athletes from various sports usually have insufficient duration and quality of sleep. From a sports point of view, a decrease in performance, decision-making ability, learning, and cognition can occur along with a decrease in safety performance and an increase in susceptibility to injury.

In this regard, sleep monitoring in athletes can be helpful for early diagnosis and intervention before observing performance and a significant reduction in health. Non-invasive and efficient methods/equipment, such as wearable ultrasound monitors, can provide accurate information about positive and negative adjustments during the competition season over short and long periods. In addition, any athlete can make recordings at home and in training facilities, adopting a "real-world scenario" to give high environmental credibility to research and practical interventions. Accumulated knowledge about the importance of sleep has made sleep monitoring a popular strategy among athletes, coaches, and (elite) support staff. However, these indicators have not yet been sufficiently documented due to the complexity of analyzing sleep patterns and the limited availability of athletes to participate in sleep studies.

In general, factors related to training and competition can change the sleep pattern of athletes. Thus, issues such as (a) sleep patterns and disorders among athletes; (b) sleep and optimal performance among athletes; (c) screening, tracking, and evaluating athletes'

sleep, and (d) interventions (e.g. sleep hygiene) to improve sleep should be further investigated.

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