



Sleep and Sleep Disorders in High-Level Athletes: a Scoping Review

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Abstract

Purpose of Review The importance of sleep to all human functions is indisputable. This is even more true for elite athletes who are required to fulfill their demanding training and competition obligations. The present study aimed to review the literature describing the importance of sleep in elite athletes, the sleep disorders they experience and methods of improving sleep. Selected studies were collected from PubMed in English from 2010 to 2024.

Recent Findings Disturbed sleep affects all aspects of an athlete's life, such as athletic performance, mental health, cognitive function, metabolism and the immune system. Conversely, the daily demands of an athlete's life due to training and competitions, frequent changes of environment and travelling, disturb the quality and quantity of sleep.

Summary High-level athletes are a special group of people who are more prone to sleep disorders due to their demanding daily lives. Nevertheless, the implementation of sleep hygiene by athletes can improve their sleep and ensuing disorders.

Keywords Elite athletes · Physical exercise · Sleep deprivation · Sleep disorders · Training

Introduction

Sleep is an important component of well-being in humans affecting somatic growth, mental health, cognitive functions and overall quality of life [1]. High-level athletes are a special group characterized by intense daily physical activity and strict timetable [2]. In addition to the contribution to rehabilitation, the quality and quantity of sleep is also related to sport performance and success. Moreover,

sleep aids in uninterrupted participation to training and competition reducing the injury risk and disease occurrence, improving mental health, and enhancing memory and learning [3].

It has been observed that athletes do not achieve the optimal quantity of sleep, which in turn affects their health and sport performance [4]. This observation might be due to demanding schedule of training and competitions, often traveling, change of environment and intense stress. An increasing number of studies focus on developing suggestions about ways to improve sleep including a strict schedule of sleep-awake, an increase of total sleep time, reduction of the exposition to the light before going to bed, creation of an optimal environment for sleep, nutritional habits, and recovery strategies after strenuous exercise [3, 4].

Understanding the multifaceted role of sleep in athletic performance is essential for athletes, coaches, and sports scientists seeking to maximize competitive potential. This article reviews the existing literature from 2010 to 2024 (searching the PubMed database for English entries) concerning the role of sleep in high-level athletic performance, the physiological and cognitive mechanisms underlying its effects, the consequences of sleep deprivation, and common sleep disorders in this population.

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The Role of Sleep in High-Level Athletes

Effect of Sleep in Training and Competition

Sleep plays a fundamental role in athlete's ability not only to attend and respond to an intense schedule of training, but also to exert maximal effort and stamina. Insufficient sleep, either in terms of duration or efficiency, might lead to a worsened sports performance indirectly (e.g., insufficient and ineffective training, increased frequency of injuries and diseases, and detrimental cognitive and mental health) or directly (e.g., lethargy, reduced reaction time, decreased accuracy, stamina and speed).

Peacock et al. [5] examined combat sport athletes during a 6-week training period and reported that improved quality and consistency of sleep were related with reduced loss of training units due to fatigue, disease and injury, and better sleep characteristics (e.g., reduced onset time), and sport performance. Similarly, Sargent et al. [6] showed that the first three in a cycling 5-day race slept more than the last three finishers confirming that an adequate sleep before and during competition period might improve performance.

It seemed that either total or partial sleep deprivation would limit the speed of transition of nervous impulse from the brain to the muscles influencing reflexes and reaction time. In the study of Reyner & Horne [7], partial sleep deprivation during a night (5 instead of 7.5 h) in semiprofessional tennis players led to decreased accuracy in service from 53 to 37%, whereas a prolongation of sleep time by 2 h improved service accuracy from 35 to 42% and sprint time.

Mah et al. [8] described the effect of sleep prolongation during a 6-week period on sports performance in basketball players and found ~ 9% improvement in free throws, 3-point shout and sprint ability, as well as reduced fatigue and daily somnolence. The same research group examined the effect of sleep prolongation (from 7 to 10 h) in swimmers during a 6-week period and reported improvement in swimming performance [9].

It should be highlighted that most of the relevant studies have focused so far in the effect of the total sleep deprivation on sports performance. Nonetheless, athletes are likely to encounter partial sleep deprivation. The relatively small number of studies that have examined the effect of partial sleep deprivation on sports performance showed that the aerobic capacity and muscle strength were influenced the less, whereas the executive performance, submaximal exercise and anaerobic power were affected the most. This observation might explain the small impact of prolongation of sleep time strategies on aerobic capacity and muscle strength [10].

Effect of Sleep on Cognitive Function and Mental Health

Executive ability is the most important parameter in sports performance and needs high level of brain activity in order the athlete to act carefully and strategically to make the optimal decisions. The existence of any inhibitions and limitation of risky decisions would be negatively affected by the deprivation of even one night of sleep.

The maximal sports performance, especially during competition, demands an optimal cognitive function. An inadequate sleep might deteriorate many aspects of cognitive function such as attention, executive function, awareness, decision making, memory and learning.

Sleep plays a crucial role on learning, memory and preparation of the brain to develop memory of the next day. In this way, athletes develop new abilities that use to improve performance. In a systematic review [11] of the relationship between sleep and cognitive function in adolescent athletes, it was found that (a) when the athletes slept immediately after learning, memory was improved, (b) when the sleep time in athletes with chronic sleep deprivation increased, memory was ameliorated, and (c) sleep deprivation led to decreased response to tasks demanding awareness.

Also, mental health and sleep have a strong reciprocal relationship, where sleep problems consist a symptom of existed mental disorder and vice versa. Most of the research on sleep deprivation highlighted a change in mood as an important symptom [12]. Reilly and Edwards [12] examined the sports performance of swimmers, who slept 2.5 h instead of 8 h, for four consecutive days. Their findings showed the athletes presented increased fatigue, angeriness, excitability and depression.

Effect of Sleep on Metabolism and Endocrine Functions

Clinical and epidemiological research supported the notion that a chronic partial sleep deprivation might increase the risk for obesity and diabetes. Possible mechanisms included changes in glucose metabolism regulation due to resistance to insulin, deregulation of neuroendocrine control of appetite and energy uptake. Many studies found that sleep deprivation might cause decrease in leptin (inhibition of appetite) and increase in ghrelin (stimulation of appetite) leading to increased food intake, especially carbohydrates [13].

In case of sleep deprivation, the hypothalamus-hypophysis-adrenals and hypothalamus-hypophysis-gonads axes increase the secretion of catabolic hormones, such as cortisol, and reduce the secretion of anabolic hormones such as testosterone and somatomedin (insulin-like growth factor 1). Meanwhile, they alter the excretion of growth hormone,

which is produced during the slow wave sleep (SWS). These changes lead to a decrease of protein synthesis and increase of proteolysis affecting muscle recovery, which might explain the reason that sleep deprivation induces generalized body pain. In this context, athletes might consume illegal performance-enhancing substances violating anti-doping rules, such as anabolic steroids and growth hormone to prevent catabolism and achieve recovery [13].

The swift from awareness to sleep consists swift from sympathetic to parasympathetic system. Sleep is characterized by a reduction of sympathetic activity, and considering catecholamines levels, it can affect negatively the responsiveness to adrenal cortex tropine hormone, adrenaline, noradrenaline and the sensitivity of the serotonin receptor (5- hydroxytryptamine) [13]. Studies focusing on pathophysiological responses of human body to exercise following sleep deprivation provide controversial results [13]. There is research supporting an elevation of heart rate, minute ventilation, lactate concentration during submaximal or maximal exercise after a partial sleep deprivation (3 h loss of sleep in the middle of the night) [13]. On the other hand, Martin et al. [14] reported that two nights of partial sleep deprivation (eight awakenings lasting 30–75 min) did not influence heart rate, oxygen consumption and body temperature during 30 m of fast walking on a treadmill. Furthermore, Azboy and Kaysig [15] observed that a night of sleep deprivation reduces the time that an athlete feels exhausted and increases oxygen consumption and carbon dioxide production at rest. Also, even a single night of partial sleep deprivation during a cycling race might increase heart rate, oxygen consumption and lactate concentration [16]. There has been also debate about the differentiating impact of acute and chronic sleep deprivation, where researchers tend to support that the latter might negatively impact on cardiorespiratory parameters more than the former one [17].

Effect of Sleep on the Immunity System

Interestingly, Fondell et al. [18] examined the function of immunity system in those who slept shortly (< 7 h), normally (7–9 h) and more than normal (> 9 h) during the night before being tested. Those who slept less had 49% more T lymphocytes as a response to an antigen and 30% less natural killers cells compared to those who slept normally. The presence of increased T lymphocytes might be related to autoimmune diseases or low systemic inflammation. An increased sleep duration (i.e., 8–10 h) or a short nap of 30 min following a night of sleep deprivation led lymphocytes level returning to physiological scores [13].

A reduced sleep time might induce immunosuppression and increase the sensitivity to infections. In Australian football players, Fitzgerald et al. [19] observed that a reduced

sleep time was related with higher prevalence of diseases. In another study [20], an intake of rhinovirus increased the risk of common cold in those who slept less than 7 h compared to those who slept more than 8 h during the following night of the intake.

With regards to the indices of acute inflammation, e.g., interleukin 1b, tumor necrosis factor alpha, interleukin 6 and C reacting protein (CRP), it has been shown that their levels increased after nights of sleep deprivation or in the presence of sleep apnea [21]. After a night of full sleep deprivation in an experimental group, Skein et al. [22] reported increased levels of CRP during post-exercise recovery following a demanding rugby match compared to a control group which slept 8 h.

Sleep Deprivation and Injury Risk

Sleep duration shorter than 8 h has been considered as the strongest predictor of injury in athletes; particularly, Milewski et al. [23] found an increased risk by 1.7 times in adolescent athletes practicing the abovementioned sleep duration compared to those who slept more than 8 h. Similar findings were shown by a study of Karolinska University in adolescent Swedish high-level athletes, where those who slept more than 8 h had less injury risk [24]. A higher injury risk has been observed when the training load increases and sleep duration decreases, a situation often occurred during periods of intense training or competition. An interpretation of the relationship of sleep deprivation with injury risk might include reduced concentration and attention, worsened reaction time and cognitive functions, and the sense of fatigue experienced athletes. This interpretation was in line with the findings of Luke et al. [25], where young athletes of various sports where young athletes in various sports (basketball, football, track and field) who experienced injuries related to physical and mental fatigue slept six or fewer hours the night before the injury. In another study [26] it was found that the risk of injury in athletes who play two matches per week is 6.2 times greater compared to those who play one match per week.

In addition to musculoskeletal injuries, insufficient sleep, either quantitatively or qualitatively, is a risk factor for concussion and can negatively affect the severity of the concussion, recovery time, and outcome. Concussion is occurs commonly in athletes, especially in certain sports, such as American football, rugby, and boxing, and its relationship to sleep has been studied more than other injuries. A study by the University of Pennsylvania on college athletes found that those who slept less than 6 h per day had twice the risk of suffering a concussion during their athletic activity than those who slept more than 7 h per day [27]. Sleep deprivation and disrupted sleep increase the likelihood of injury

and concussion, and conversely, concussion itself leads to disrupted sleep in the majority of athletes.

Impact of Sleep on Pain Perception

It is commonly accepted that individuals with chronic pain often report disrupted sleep (changes in sleep continuity and architecture). Conversely, sleep deprivation can cause or exacerbate chronic or acute pain, creating a vicious cycle [13]. Increased pain tolerance allows athletes to train more intensively and compete more focused on their goal. Sleep is directly linked to the regulation of pain threshold with a study by Onen et al. [28] showing an 8% reduction in pain threshold and others showing small but significant increases (5–10%) in spontaneous generalized pain after total and partial sleep restriction [29]. A systematic review [30] showed that a reduction in sleep quality and quantity was associated with a two- to three-fold increased risk of pain. Further studies [31, 32] showed that sleep deprivation causes hyperalgesia and chronic sleep deprivation is associated with an increased risk of chronic pain.

Hormonal changes - increase in catabolic hormones and decrease in anabolic hormones - after sleep deprivation, which cause a decrease in protein synthesis and an increase in proteolysis, affecting muscle recovery, may explain why lack of sleep together with increased physical activity leads to an increase in generalized body pain.

Common Sleep Disorders in High-Level Athletes

Sleep Deprivation and Insomnia Symptoms Due to Training and Competition

Sleep disorders in athletes occur mainly in two time periods - before the day of the competition and during the training period - affecting the quantity and quality of athletes' sleep, with reduced total sleep time being one of the most common disorders. Most studies to determine sleep quality are based on the Pittsburgh Sleep Quality Index (PSQI), while according to the National Sleep Foundation, the duration of sleep that is characterized as insufficient in adults is less than 7 h [33].

In a study by Mah et al. [34] in college athletes, one third of the athletes did not reach the recommended duration of sleep for adults on weekdays - namely 7 h - which is consistent with the findings of the study by Lastella et al. [35] regarding insufficient sleep in athletes. In the latter study, athletes reported daytime sleepiness as a symptom of insufficient sleep in more than one third. In contrast, in a study [36] conducted on high-level Dutch athletes of various

sports, of young age, based on the PSQI, the majority of athletes reported good sleep quality and the minority (41%) considered that they did not sleep well, while the average sleep duration was 8 h, which is longer than recommended. It is important to emphasize that the above study was based on the subjective assessment of the athletes for the quality of their sleep and although it is considered reliable, it often differs from objective methods (such as actigraphy), as there is a tendency to underestimate nighttime awakenings and overestimate the time until the onset of sleep. In the same study, based on the score on the Holland Sleep Disorder Questionnaire, 12% of the athletes showed a possible sleep disorder and more specifically, a small but significant number of athletes showed restless leg syndrome (RLS)/periodic limb movement.

Professional athletes are more prone to sleep hygiene disorders during intense training periods due to increased physical and mental fatigue, intense stress and demanding sleep schedules that require early morning training, resulting in reduced total sleep duration. In a study by Sargent et al. [37] in swimmers, it was observed that the earlier in the morning the training took place, the less sleep the athletes had the previous night (5 h and 24 min) compared to days without training (7 h and 5 min). In another study by Hague et al. [38] in 16 aerobic athletes, it was shown that sleep architecture changes on days without training with a decrease in SWS and an increase in rapid eye movement (REM) sleep. Finally, Teng et al. [39] in a study of 28 male athletes during a period of intense training, observed a decrease in total sleep time (from 7.3 h to 6.9 h), as well as some decrease in the feeling of efficient sleep (from 86.3% to 84.3%). Similar results were found in the study of Taylor et al. [40] in 7 swimmers after intense training, who also showed increased movements during sleep, increased SWS and decreased mood.

Intense training programs can lead to the so-called overtraining syndrome in which the balance between training work and the athlete's recovery is disrupted. While sleep is an important factor for the athlete's recovery, conversely, when the training work is increased by 30% of the usual, sleep is disrupted. This is also indicated by the study by Mason et al. [41] in 40 high-performance athletes who completed the Athlete Sleep Screening Questionnaire and the Athlete Sleep Behaviour Questionnaire during regular training, intensive training and an important competition. 62.5% of the athletes reported at least mild difficulty sleeping on the night of the competition and greater difficulty sleeping on nights of intensive training compared to the usual training period.

Regarding sleep disorders caused by competitions, Erlacher et al. [42] using a questionnaire to assess sleep disorders the night before a competition in 632 German

athletes showed that 66% (416) of them had experienced poor sleep quality at least once before an important competition. Then, of these 416, 70% had problems with sleep onset, 43% reported early morning awakenings and 32% woke up during the night. Factors such as intense thoughts about the competition (77%), anxiety (60%), unfamiliar surroundings (29%), and noise in the room (17%) were the reported reasons for the above sleep disorders. Another study by Biggins et al. [43] in 65 high-level, young athletes from various sports, where their sleep was assessed one month before the competition, at the end of the competition and one month after, 23% appeared to have moderate to severe sleep problems, with 82% reporting less than 8 h of sleep per night. Swimmers had more difficulty sleeping before and during the competition, compared to football and track and field athletes.

Chronic sleep disorders also occur in long-distance sailing athletes. Most report disrupted sleep due to frequent awakenings every 30 min. Some athletes have reported, in addition to disrupted sleep, hallucinations and frequent mistakes [44]. Although the start time of the race varies depending on the sport, races often start late at night in order to achieve greater spectacle. On the day of the race, there is a delay in the start time of sleep, shorter sleep duration, low sleep efficiency and an earlier morning awakening due to habituation from the previous days. Other studies have focused on the delay in sleep onset due to physical activity in the evening hours. Although in their meta-analysis, Kredlow et al. [45] concluded that sports activity 3 h before the usual bedtime may be beneficial and has been shown to reduce sleep onset time and stage N1, a corresponding study in professional soccer players who competed at an intense pace and in more stressful conditions did not have the same results. This can be explained as more intense activity leads to a greater need for recovery.

Sympathetic activity following exercise leads to persistently high heart rates for several hours after bedtime, while high core body temperature after exercise affects the thermoregulatory cascade that leads to sleep onset. Physical activity, and especially intense exercise, affects the individual's circadian rhythm. Studies have shown that even 1 h of exercise in the evening (19:00–22:00) causes a delay in melatonin secretion half an hour later than usual. In contrast, morning or afternoon activity (07:00 and 13:00–16:00) causes an early melatonin secretion comparable to that which would be secreted if the athlete were exposed to light [46].

Finally, a study [47] in Olympic athletes that examined sleep quality between genders showed that men had more sleep disorders than women. In a later study, Alves Facundo et al. [48] studied the stability of sleep parameters (Sleep Regularity Index – SRI) in Brazilian athletes based on

gender, athletic level and type of sport. They found higher stability of sleep parameters in women compared to men, in individual sports compared to team sports and in international-level athletes compared to athletes competing at the national level. Also, among sports such as football, swimming and track and field, football athletes had less stability of sleep parameters, while women and team athletes had longer sleep duration. Low-level athletes competing at the national level had earlier morning wake-up times than international athletes, due to the need to devote time to studies or work. Other studies, however, did not support these findings [49, 50].

Restless Leg Syndrome

RLS is a common cause of poor sleep quality, and is much more common in athletes than previously thought. Although mild exercise is recommended for people with RLS, a study of 61 marathon runners [51] found that 13% had RLS, compared to a prevalence of 7% in the general population, suggesting that it is more common in athletes than expected, despite the fact that they exercise daily. This is likely due to the intense daily exercise that professional athletes undergo, the physical fatigue, and the chronic muscle pain they experience even during sleep. In addition, a sex variation in RLS has been documented since women are at higher risk than men due to a wide range of psychological and physiological factors (e.g., iron deficiency without anemia, pregnancy, anxiety and depressive symptoms, and use of psychotropic medication) [52]. It should be highlighted that women are at higher risk of iron deficiency considering the physiological requirements for menstruation and pregnancy [53].

Sleep Disorders Due to Jet Lag and Often Trips

Contemporary athletes occasionally need to cover short national or international distances (less than 3 h) or less often larger distances (more than 3 h) sometimes traveling across many time zones. The most common disorders experienced by these athletes include travel fatigue and jet lag (disorder due to change of time zone), each one with different traits. The term travel fatigue refers to the sense of fatigue and exhaustion experienced immediately after a single long trip or accumulatively after repeated trips within a short period. It is a multifactorial disorder occurring in each trip independent from the covered direction or time zone, and is caused under conditions such being in for a long wait, reduced mobility (limited free space) and uncomfortable position during flight, exposure to noise, prolonged mild hypoxia, changes in environmental conditions due to latitude (winter vs. summer). Such conditions result in disturbance of the

sleep-awake cycle and negatively affects sleep quality and quantity. On the other hand, jet lag or chronic hysteresis of biological clock is induced by a rapid crossing of three or more time zones and is characterized from the deregulation of the biological circadian rhythm with regards to the new local time. After having crossed three or more time zones, the circadian rhythm cannot be adapted immediately to the light-darkness cycle. The biological clock needs about half a day for each crossed time zone traveling west (the relevant duration is one day for the eastern duration) to synchronize with the external environment. Similarly, concerning body temperature to time zone crossing, a day of adaptation is needed for each time zone [54]. Common symptoms of jet lag in athletes included daily fatigue, sleepiness, affected cognitive and somatic function, gastrointestinal disorders and poor sleep quality. Accordingly, the more time zones are crossed, the more intense are the symptoms. For instance, crossing eight time zones westbound, athletes experience fatigue, their performance is decreased in the evening, wake up earlier than usual in the morning. Conversely, crossing eight time zones eastbound, the athletes are expected to experience equally fatigue and have difficulties to sleep in their typical time and likely sleep later than usual. The adaptation of the athletes to the new conditions depends on the change in the light-to-darkness ratio – in addition to the number of crossed time zones – when approaching or moving away from equator since the sun is the strongest regulator of the circadian cycle. Finally, the chronotype of each athlete plays a role to the adaptation; e.g., night owls are adapted better traveling westbound, whereas morning larks adapt better traveling eastbound [55]. In National Football League players, a comparison between clubs competing in the East and West coast showed that although there was no difference in the afternoon matches, in the evening matches the clubs from the East competing in the West coast had repeatedly decreased performance [56]. This might be explained considering that their biological clock at the moment of the end of the match was 2 am. With regards to their evaluation, the subjective symptoms of jet lag are recorded using available questionnaires such as the Liverpool Jet Lag Questionnaire [57]. This questionnaire includes a visual scale of 15 subjective items about jet lag and its symptoms (sleep, fatigue, appetite, cognitive function, gastrointestinal function etc.) assessed at different time points of the day. Recommendations to treat jet lag might include increased exposure to sun, melatonin supplements and gradual matching of training and physical activities with the time zone of arrival in the case that the athletes arrive a few days before the competition [58].

Sleep Disorders Due to High Altitude

Athletes training or competing at high altitude in sports such as skiing or snowboard, or in team sports during away matches, in locations with altitude higher than 3,000 m are characterized by unquiet sleep with respiratory disorders and often awakenings resulting in complaints of insomnia and fragmented sleep [59]. Those who have not been adapted in high altitude are more prone to bad sleep quality and experience a feeling of suffocation due to apnea and are relieved when they awake taking deep breaths. In this way, a vicious cycle is created, where due to hypoxia of altitude, athletes hyperventilate, which in turn induces hypocapnia and reduced respiratory drive resulting in the appearance of apnea and so on.

In multi-record sleep studies at high altitude, frequent awakenings, decreased SWS, decreased REM, decreased oxygen saturation, periodic breathing with increased central apneas-hypopneas, without worsening of already diagnosed obstructive sleep apnea (OSA) were observed [60]. In particular, adolescent athletes competing at high altitude are more susceptible to experiencing symptoms such as fatigue, decreased appetite, headaches, poor quality and reduced quantity of sleep [61]. Acetazolamide can be given as a treatment, which, by reducing bicarbonate loss through diuresis and causing metabolic acidosis, stimulates ventilation and alveolar and arterial oxygenation, resulting in an improvement in the apnea-hypopnea index (AHI) and an increase in oxygen saturation [60]. It is also common practice for athletes to settle in at the venue days or even weeks before the competition, to allow time for athletes to acclimatize to the new conditions.

Sleep-Related Breathing Disorders and Obstructive Sleep Ppnea

In a recent review [62], the frequency of sleep-related breathing disorders (AHI ≥ 5 events/hour) varied from 7% to 86.5%, according to sport modality: (a) 24% to 86.5% in rugby players; (b) 8% to 62.5% in active football players; (c) 22% to 41% in retired football players; (d) 8% in basketball players ($n = 1$); (e) 30% in elite swimmers; (f) 61% in ice hockey players; (g) 68% in judo athletes; (h) 58.5% in golf players; (i) 7% in Brazilian Olympic athletes; and (i) 22% in para-athletes with spinal cord injury.

In another perspective observational study, Caia et al. [63] examined professional Australian and Polynesian rugby players using polysomnography at home and reported 10 cases of OSA, where the prevalence was higher in Polynesians than Australians, and in offensive than defensive players suggesting that the face anthropometric

characteristics of Polynesians (increased neck circumference, width of nose, height of face and backward position of jaw) predispose athletes to OSA [64]. Therefore, it is recommended that athletes practicing sports characterized by increased body mass, neck circumference and mostly men (e.g., football, ice hockey and rugby) should be screened for OSA before the starting preparatory period to obtain proper therapy improving performance.

Discussion

Sleep is a fundamental determinant of high-level athletic performance. While training, nutrition, and psychological preparation have been extensively studied, recent scientific attention has increasingly shifted toward understanding how sleep contributes to optimal physiological functioning and peak athletic achievement [13]. Sleep quantity and quality are not passive states but dynamic biological processes that significantly influence neural, hormonal, and metabolic regulation.

Sleep deprivation—even a reduction of just 1–2 h per night—can impair speed, explosive power, reaction time, and accuracy in skill-dependent sports. Concentration declines, while the risk of injury rises due to slower neuromuscular responses. Inadequate sleep also suppresses immune function, increasing susceptibility to illness and prolonging recovery after intense training or competition.

Moreover, during deep sleep (slow-wave sleep), the secretion of growth hormone increases, supporting muscle fiber repair, protein synthesis, and the regeneration of bodily tissues. REM sleep is associated with cognitive processing, memory consolidation, and the reinforcement of motor learning. For elite athletes, these mechanisms are crucial as they directly affect movement precision, acquisition of complex technical skills, and rapid decision-making under competitive pressure.

A particularly relevant issue for elite performers is “pre-competition sleep disturbance,” where athletes often sleep poorly before major events. Anxiety, schedule disruptions, travel, and jet lag can disturb circadian rhythms and significantly reduce sleep quantity and quality [65].

Finally, recent studies depicted that up to one in four athletes - depending on specific sport, assessment method, and competitive phase - may have a clinically significant sleep disorder, such as OSA or RLS, though this is often underreported [66]. Particularly sleep apnea remains an under-recognized and under-treated medical condition among athletes, which can have a negative impact on their sport performance, general health, and quality of life [62]. A limitation of the present study was that high-level athletes were considered; thus, caution would be needed to generalize these findings to groups of different performance levels such as recreational athletes.

Conclusions

The findings of the present literature review show that the high-performance-level athletes form a special group being prone to the risk of sleep disturbances and sleep disorders, due to increased daily demands. Routine screening with validated questionnaires, education on the importance of sleep health and healthy sleep strategies and collaboration between coaches, sports physicians, and psychologists can help athletes optimize their sleep, as a ‘good sleep’ is expected to improve their quality of life and sports performance.

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Data Availability No datasets were generated or analysed during the current study.

Declarations

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Competing interests The authors declare no competing interests.

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