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Sleep Duration and Reaction Time in Athletes: The Impact of Sleep Deprivation and Sleep Quality on Cognitive-Motor Performance – A Narrative Review

Maciej Wojtarowicz , Weronika Świt, Bartosz Cichoń, Krzysztof Zachwieja, Jakub Wodnicki, Krzysztof Prokop, Patryk Dąbrowski, Eliza Pyla, Marcelina Guzik

Maciej Wojtarowicz
The University Hospital in Krakow, Macieja Jakubowskiego 2, 30-688 Kraków
ORCID: https://orcid.org/0009-0004-9883-5213
E-mail: maciejkov@gmail.com

Weronika Świt
The University Hospital in Krakow, Macieja Jakubowskiego 2, 30-688 Kraków
ORCID: https://orcid.org/0009-0000-1783-6013
E-mail: weronikajuliaswit@gmail.com

Bartosz Cichoń
The University Hospital in Krakow, Macieja Jakubowskiego 2, 30-688 Kraków
ORCID: https://orcid.org/0009-0000-0513-337X
E-mail: Bartexcichon@gmail.com

Krzysztof Zachwieja
The University Hospital in Krakow, Macieja Jakubowskiego 2, 30-688 Kraków
ORCID: **https://orcid.org/0009-0007-8851-053X**
E-mail: krzysiekz2413@gmail.com

Jakub Wodnicki
The University Hospital in Krakow, Macieja Jakubowskiego 2, 30-688 Kraków
ORCID**: https://orcid.org/0009-0007-9802-9299**
E-mail: jakubwodnicki2@gmail.com

Krzysztof Prokop
The University Hospital in Krakow, Macieja Jakubowskiego 2, 30-688 Kraków
ORCID: **https://orcid.org/0009-0001-0653-3305**
E-mail: Krzysztof.prokop@protonmail.com

Patryk Dąbrowski
The University Hospital in Krakow, Macieja Jakubowskiego 2, 30-688 Kraków
ORCID: https://orcid.org/0009-0004-5388-8581
E-mail: patrykdabrowskiuj@gmail.com

Eliza Pyla
Medical University of Gdansk, Gdańsk, Poland
ORCID: **https://orcid.org/0009-0002-3345-1572**
E-mail: drpylatrycholog@gmail.com

Marcelina Guzik
The University Hospital in Krakow, Macieja Jakubowskiego 2, 30-688 Kraków
ORCID: **https://orcid.org/0009-0001-4882-8494**
E-mail: marcysiaguzik@gmail.com

Corresponding author:
Patryk Dąbrowski
The University Hospital in Krakow, Macieja Jakubowskiego 2, 30-688 Kraków
ORCID: **https://orcid.org/0009-0004-5388-8581**
E-mail: **patrykdabrowskiuj@gmail.com**

Abstract

Background. Rapid perception, response selection and motor execution are the fundament of many sports, yet these processes may be vulnerable to insufficient or disrupted sleep.

Aim. To critically synthesize evidence on the relationships between sleep duration, sleep deprivation, sleep quality and reaction-related cognitive-motor performance in athletes.

Material and methods. A focused narrative literature search was carried out mainly in PubMed/MEDLINE, with additional sources identified through publisher databases and reference-list screening. Athlete-specific experimental and observational studies, systematic reviews, meta-analyses and expert consensus publications

were prioritized.

Results. Acute total sleep deprivation consistently impairs vigilance and several reaction-time domains, whereas findings after partial sleep restriction are more heterogeneous. Sport-specific accuracy, response inhibition and complex cognitive-motor performance appear particularly susceptible. Sleep extension can improve vigilance and technical performance, but available intervention studies are generally small. Evidence linking habitual sleep quality independently of sleep duration to reaction time remains limited.

Conclusions. Adequate sleep appears important for maintaining cognitive-motor performance in athletes, particularly when tasks require sustained attention, rapid response selection and technical precision. Individualized sleep strategies are preferable to a universal duration threshold.

Key words: sleep deprivation; sleep duration; athletes; reaction time; psychomotor vigilance; cognitive performance; sleep quality; sport performance

Introduction

Athletic performance is frequently described in terms of strength, power, aerobic capacity or technical proficiency, but many competitive actions depend equally on the ability to detect a relevant stimulus, select an appropriate response and execute that response within a narrow temporal window. In racket sports, combat sports, team games and other open-skill disciplines, delays of even relatively small magnitude may alter interception, defensive positioning, tactical choices or movement execution. Reaction time therefore represents more than an isolated laboratory measure: it is one component of a broader cognitive-motor system involving vigilance, selective attention, response inhibition, visuospatial processing, decision-making and motor coordination. Sleep is increasingly regarded as an important and potentially modifiable factor influencing these processes. Expert consensus emphasizes that elite athletes are exposed to multiple circumstances capable of reducing sleep duration or continuity, including early training, late competition, travel, pre-competition arousal and non-sport stressors. Importantly, athlete sleep requirements are unlikely to be adequately represented by a single universal threshold. Consequently, the 2021 expert consensus on sleep in athletes advocated an individualized approach rather than assuming that a universal sleep duration of seven to nine hours is optimal for all athletes. [1] Objective monitoring indicates that insufficient or fragmented sleep is not unusual in athletic populations. A systematic review encompassing 1,830 athletes monitored across 18,958 nights reported an average total sleep time of approximately 7.2 ± 1.1 hours and mean sleep efficiency of 86.3 ± 6.8%, with substantial variation according to age, training period and sport characteristics. [2] Competition can further disturb habitual sleep. In a systematic review and meta-analysis of elite athletes, total sleep time was approximately 60 minutes shorter on the night of competition than on preceding nights, with particularly pronounced reductions after evening competition. [3] Although not all athletes experience chronic sleep deprivation, training and competition schedules may repeatedly limit their opportunities for adequate sleep. The relevance of these sleep disturbances to performance is not uniform across performance domains. Earlier reviews noted that some short-duration maximal physical efforts may be relatively resistant to a single night of sleep loss,

whereas cognitive performance and sport-specific technical outcomes appear more vulnerable. [4,5] A systematic review of competitive athletes similarly concluded that sports emphasizing speed, tactical strategy and technical skill appeared particularly sensitive to sleep-duration manipulation. [5] Thus, the question is not simply whether sleep deprivation reduces "performance," but which components of performance deteriorate, under what degree of sleep loss, and whether deterioration observed in computerized reaction-time tasks translates to competitive cognitive-motor behavior. Reaction time provides a useful framework for examining these distinctions. Simple reaction time primarily reflects detection and response initiation, whereas choice reaction time requires stimulus discrimination and response selection. Psychomotor vigilance tasks place additional demands on sustained attention over repeated trials, while stop-signal, Go/No-Go and sport-specific decision tasks involve inhibitory control or contextual response selection. Therefore, two studies can both report "reaction time" yet evaluate substantially different neurocognitive operations. Sleep quality adds another level of complexity. Short sleep duration concerns sleep quantity, whereas poor sleep quality may reflect prolonged sleep latency, repeated awakenings, reduced efficiency or a subjective sense that sleep is non-restorative. For the purposes of this review, total sleep deprivation (TSD) refers to complete or near-complete absence of sleep for a defined period, whereas partial sleep restriction (PSR) refers to a reduction in the duration of the sleep opportunity without complete sleep loss [27]. Sleep disruption refers to impaired sleep continuity characterized by repeated awakenings or interruptions and is also referred to as sleep fragmentation [27]. The broader term "sleep loss" is used as an umbrella term when the specific type of sleep disturbance is not the focus [27]. Systematic reviews have identified substantial sleep complaints among elite athletes, with training, travel and competition repeatedly emerging as relevant influences. [6] However, the direct evidence connecting sleep quality itself to reaction time is much less developed than the experimental literature on sleep deprivation. This narrative review therefore aimed to critically evaluate the evidence linking sleep duration, total sleep deprivation and partial sleep restriction, sleep continuity and sleep extension with reaction time and related cognitive-motor outcomes in athletes. Particular attention was given to differences between simple laboratory measures and sport-specific performance, the relative vulnerability of cognitive and physical outcomes, and methodological limitations that influence interpretation.

Research Materials and Methods

A targeted narrative literature search was conducted in September 2026, primarily using PubMed/MEDLINE. Publisher records and reference lists from relevant systematic reviews and meta-analyses were additionally examined to verify bibliographic information and identify important primary studies. Search concepts included combinations of *athlete*, *sport*, *sleep duration*, *sleep deprivation*, *sleep restriction*, *sleep quality*, *sleep extension*, *nap*, *reaction time*, *psychomotor vigilance*, *response inhibition*, *decision making* and *technical performance*. Priority was given to studies involving competitive, collegiate, elite or trained athletes. Experimental crossover studies were considered particularly informative for acute sleep manipulation, while prospective or repeated-measures observational research was used to evaluate naturally occurring sleep variation. Systematic reviews, meta-analyses and expert consensus documents were used to contextualize the overall evidence. Foundational studies in healthy non-athlete populations were included selectively when they directly addressed the dose-response relationship between sleep restriction and psychomotor vigilance. Outcomes of interest included simple and choice reaction time, psychomotor vigilance, inhibitory control, visuospatial processing, sport-specific decision-making and technical accuracy. Physical performance outcomes were considered where they provided a

comparison between cognitive-motor and purely physiological responses to the same sleep manipulation. This was a narrative rather than systematic review. No PRISMA screening procedure, formal record count, prospective protocol or standardized risk-of-bias instrument was used. Accordingly, conclusions are based on critical narrative synthesis rather than a de novo quantitative meta-analysis.

Results

Sleep duration and sleep disturbance in athletic populations

Athlete sleep is characterized by substantial interindividual and situational variability. The systematic review by Vlahoyiannis et al. found that average sleep duration across included athlete datasets remained below eight hours, while sleep efficiency varied with age, competitive level and training period. [2] A separate systematic review of elite sport concluded that sleep complaints were common but also emphasized that the underlying literature was generally of limited methodological quality. Commonly reported sleep-related problems included difficulties with sleep initiation, disrupted sleep continuity, unrefreshing sleep, and increased daytime fatigue. [6] These observations argue against if athlete status itself guarantees either good or poor sleep; instead, sleep appears to fluctuate according to the sporting environment and individual susceptibility Competition schedules create a particularly relevant exposure. Roberts et al. included 54 studies and showed that sleep was commonly reduced around competition, especially when competition occurred late in the day. Early-morning training, large increases in training load, travel schedules, eastward travel and altitude were also identified as potential sleep-disrupting factors. [3] These conditions differ fundamentally from experimental total sleep deprivation. An athlete is more likely to experience several nights of shortened, mistimed or fragmented sleep than 24–36 hours of uninterrupted wakefulness, which is important when judging the ecological validity of experimental evidence.

Neurobehavioral sensitivity to sleep loss

Evidence from non-athletic populations provides an important mechanistic and methodological framework for interpreting findings in athletes. A meta-analysis by Lim and Dinges showed that acute total sleep deprivation impairs performance across several cognitive domains, with attention emerging as one of the most consistently affected functions. [7] Experimental dose-response research further shows that psychomotor deficits can accumulate during repeated partial sleep restriction. Van Dongen et al. randomized healthy adults to 4, 6 or 8 hours of time in bed for 14 consecutive nights and demonstrated cumulative neurobehavioral impairment in the restricted conditions. [8] Belenky et al. similarly found progressive deterioration in psychomotor vigilance with severe restriction and persistent reductions in performance after milder restriction. [9] Although these participants were not athletes, the studies establish that chronic partial sleep loss cannot be assumed to be equivalent to one isolated short night. These findings are relevant because the psychomotor vigilance task (PVT) is commonly used in athlete sleep research. The PVT emphasizes sustained attention and rapid responses to unpredictable stimuli and is highly sensitive to sleep loss. However, it does not replicate the perceptual complexity or motor demands of competition. Poorer PVT results mainly indicate reduced vigilance and do not necessarily reflect a decline in sport-specific performance.

Total sleep deprivation and reaction time in athletes

Athlete-specific experiments generally support an adverse effect of severe sleep deprivation on reaction-related performance. Taheri and Arabameri reported a dissociation between cognitive and short-duration physical responses to overnight sleep loss in male college athletes. Choice reaction-time performance deteriorated after sleep deprivation, whereas peak and mean anaerobic power remained largely unchanged [10]. This pattern

suggests that an athlete may retain brief maximal power output despite measurable deterioration in response-related cognitive performance. More recent neurophysiological studies provide evidence that sleep loss affects processes extending beyond simple response speed. Prolonged wakefulness also appears to compromise inhibitory control. Xu et al. compared table-tennis athletes with non-athlete students and found that the athletes demonstrated superior stop-signal performance under rested conditions. Following 36 h without sleep, however, stop-signal reaction time deteriorated in both groups [11]. The accompanying electrophysiological findings suggest that sleep loss affected neural mechanisms involved in motor inhibition rather than merely slowing a simple motor response. Related findings indicate that prolonged sleep loss affects more than response inhibition. In table-tennis athletes, 36 h of wakefulness impaired spatial cognitive performance and produced behavioral slowing alongside neurophysiological evidence of reduced attentional resource allocation and weaker coordination between frontal and occipital brain regions [12]. These results are relevant to open-skill sports because successful performance depends on rapidly integrating spatial information before selecting and executing an appropriate response. However, 36 hours without sleep is very different from the shorter or more fragmented sleep that athletes typically experience during training and competition. A crossover study of 13 young recreational runners exposed participants to 26 hours of wakefulness before a 3-km trial. The investigators reported deterioration in attention and reaction-time performance together with slower endurance performance and poorer psychological measures. [13] The simultaneous deterioration of physical, cognitive and subjective outcomes indicates that sufficiently severe deprivation can impair multiple systems, although the small male sample limits generalizability. At the evidence-synthesis level, a meta-analysis of 27 studies reported an overall adverse effect of acute sleep deprivation on athletic performance, with particularly substantial effects in high-intensity intermittent and skill-control outcomes. [14] Overall, the meta-analysis indicates that acute sleep deprivation has a negative effect on athletic performance. However, because the included studies assessed different types of performance, the size of this effect cannot be applied equally to all sports.

Partial sleep restriction: a more heterogeneous picture

Partial restriction is more representative of real-world athlete sleep loss, but its effects are less consistent. This heterogeneity probably reflects differences in the amount and timing of sleep removed, baseline sleep status, time of testing and cognitive task.

Acute restriction to five hours or less of sleep selectively affected tennis-specific skill in junior players. Accuracy declined across serving and groundstroke tasks, whereas repeated-sprint ability was essentially maintained [15]. The magnitude of the technical impairment was substantial, including reductions of approximately 14–18% in serving accuracy. These findings suggest that visuomotor precision may be more vulnerable to a shortened night than repeated high-intensity physical output. A similar pattern was reported in performance tennis players by Reyner and Horne. Serving accuracy worsened after a five-hour sleep condition, supporting the sensitivity of precision-based sport skills to acute restriction [16]. In a separate caffeine condition, 80 mg of caffeine failed to prevent this decline, suggesting that increased alertness from a modest caffeine dose did not compensate for the loss of sleep-dependent technical performance. Not all partial-restriction studies demonstrate slower cognitive responses. Wannell et al. found that reducing sleep by 50% impaired aspects of repeated-sprint performance in university team-sport athletes, with more pronounced effects when sleep was interrupted rather than delayed [17]. In contrast, Go/No-Go reaction time remained stable across conditions. The finding illustrates that sleep restriction can affect physical and cognitive outcomes differently and that a null

reaction-time result should not be generalized to other forms of cognitive-motor performance. This result shows that partial sleep restriction does not necessarily impair reaction-time performance across all cognitive tasks. Differences in task sensitivity, timing and individual vulnerability may partly explain the discrepancy. Evidence from combat sport suggests that exertion may interact with the cognitive effects of restricted sleep. In international-level karate athletes, a four-hour sleep condition impaired simple reaction time and Stroop performance, whereas deterioration in choice reaction time became more apparent after exercise [18]. Thus, cognitive deficits that are modest under rested laboratory conditions may become more detectable when testing is performed in a physiologically demanding state. Taken together, studies of partial sleep restriction show that its effect on reaction time depends largely on the task used to assess performance. Highly standardized simple reaction tasks, inhibitory-control paradigms and complex sport-specific technical actions should not be treated as equivalent indicators of cognitive-motor performance.

Sleep quality and fragmentation

The relationship between sleep quality and cognitive-motor performance remains less firmly established than the effect of experimentally imposed sleep loss. Sleep quality is itself multidimensional: a participant can obtain an apparently adequate duration but experience frequent awakenings, long sleep latency or poor subjective restoration. Conversely, a short sleeper may report acceptable subjective quality. Athlete studies frequently use actigraphy, sleep diaries or questionnaires, each capturing different aspects of this construct. Expert consensus has therefore highlighted limitations in sleep assessment methodology as an important weakness in the existing literature. [1] Small observational studies suggest that continuity may matter. Pourhassan et al. monitored 21 soccer players for seven nights using wearable devices and reported that greater sleep interruption correlated with poorer performance on a backward Corsi task ($r=0.66$, $p=0.010$). [19] Because the design was observational and the sample small, the result supports an association rather than demonstrating that fragmentation caused the slower responses. Similarly, Stieler et al. monitored eight Paralympic swimmers during a 17-day pre-competition period. Increased total sleep time during tapering was accompanied by improvement in reaction-time and performance measures, and sleep duration from the previous night correlated with reaction time. [20] However, changes in training load, fatigue and sleep occurred together; the independent contribution of sleep therefore cannot be separated experimentally. Moreover, available evidence does not support the conclusion that subjective sleep quality independently determines reaction time in athletes. Poor or insufficient sleep has been associated with worse cognitive performance, but few studies in athletes have examined sleep fragmentation independently of total sleep duration

Sleep extension and cognitive-motor performance

If sleep deprivation impairs alertness, increasing sleep time should theoretically improve performance, particularly in athletes carrying a pre-existing sleep debt. Evidence supports this possibility but remains based largely on small trials. Mah et al. reported improvements across both cognitive and basketball-specific outcomes during a prolonged sleep-extension period in collegiate players [21]. Participants increased their nightly sleep by almost two hours on average and subsequently demonstrated faster psychomotor-vigilance responses, improved sprint performance and greater shooting accuracy. The convergence of cognitive and technical improvements is encouraging, but causal interpretation is limited by the absence of a parallel randomized control group and by the possibility of training, expectancy or time-related effects. A shorter sleep-extension intervention in collegiate tennis players produced a similar directional finding. Compared with the preceding habitual-sleep week, athletes

slept approximately 1.7 h longer per night and serving accuracy increased by about six percentage points [22]. Because sleep exposure was largely self-reported and the intervention followed baseline sequentially rather than in a randomized parallel design, the result should be considered supportive rather than definitive. A systematic review of sleep-extension studies concluded that the available evidence was sparse and generally of low to moderate certainty, despite signals of performance benefit. [23] A broader systematic review encompassing 25 studies on sleep interventions in athletes similarly identified sleep extension and napping as some of the most consistently beneficial strategies; however, substantial methodological heterogeneity limited the ability to establish definitive recommendations regarding optimal protocols. Sleep extension may be beneficial, particularly in athletes who do not obtain sufficient sleep, but current evidence does not support recommending the same amount of additional sleep for all athletes.

Napping as a countermeasure

A short nap appears to provide only partial compensation after nocturnal sleep loss. In collegiate soccer players exposed to three hours of sleep restriction, a 20-min nap improved selected physical outcomes, but auditory reaction time and neurophysiological measures did not return to values observed after normal sleep [25]. Thus, the intervention provided incomplete recovery rather than functioning as a substitute for an adequate night of sleep. Longer naps may produce more noticeable cognitive benefits when prior sleep loss is severe. In elite Kung-Fu athletes kept awake for 36 h, both decision accuracy and response speed deteriorated markedly, while a subsequent 45-min nap attenuated several cognitive, mood and physical deficits [26]. The experimental contrast was substantial, but 36 h of continuous wakefulness is uncommon in routine sport. These findings therefore cannot establish that a similar nap would offset the effects of mild or habitual sleep restriction.

Discussion

The principal finding of this review is that insufficient sleep does not affect all components of athletic performance equally. Sustained attention, reaction-related processing, inhibitory control, and technically precise sport actions, as well as technically precise actions appear more consistently vulnerable than isolated measures of brief maximal power. This distinction explains why some sleep-restriction experiments can report preserved sprint or anaerobic performance while simultaneously detecting impaired reaction time, serving accuracy or cognitive control. [4,10,15] The strongest evidence concerns severe sleep deprivation. Across athlete-specific studies, 26–36 hours of wakefulness generally impair reaction-time performance and related cognitive processes, including inhibitory control and visuospatial processing. [11–14] The consistency is supported by the broader experimental sleep literature, in which sustained attention and vigilance are highly sensitive to sleep loss. [7–9] Nevertheless, complete sleep deprivation has limited ecological validity for most athletes. More clinically and practically relevant is the cumulative effect of several nights of modest restriction, fragmented sleep surrounding competition, or repeated early training sessions. Athlete-specific evidence under these conditions remains considerably less developed.

Partial restriction produces mixed results. Tennis studies demonstrate large reductions in technical accuracy after one shortened night, and recent karate data suggest that reaction-time impairment may become more evident when cognitive testing follows exercise. [15,16,18] By contrast, Go/No-Go reaction time was unchanged in university team-sport athletes exposed to 50% sleep loss despite measurable deterioration in repeated-sprint power. [17] These differences should not be considered as contradictions. The studies assessed different cognitive operations, used different restriction protocols, and tested athletes in different physiological states.

Go/No-Go reaction time measured during recovery periods between repeated sprints assesses a different cognitive process from stop-signal inhibition or sport-specific visuomotor accuracy. Consequently, the complexity of a task may dictate the extent to which sleep deprivation manifests. In some situations, a highly practiced automatic action may remain stable despite shortened sleep. In others, performance requires continuous integration of visual cues, anticipation, inhibitory control and error correction. Such processes place greater demands on attention, which is a domain consistently affected by sleep deprivation. Electrophysiological studies in table-tennis athletes support this interpretation by demonstrating changes in P3 amplitude, inhibitory processing and fronto-occipital functional connectivity after prolonged wakefulness. [11,12] These neural measures remain surrogate outcomes, however, and cannot by themselves demonstrate reduced competitive success. A further issue is whether "reaction time" should be considered an adequate endpoint for sport. Laboratory reaction time has excellent experimental utility because it isolates a specific cognitive process and permits repeated measurement. Competitive behavior is more complex. A response can be fast but tactically incorrect, or slower but better adapted to the developing situation. Technical accuracy, response selection and movement execution may therefore have greater ecological validity in many sports than milliseconds of simple reaction time. The fact that sleep loss has been associated with both poorer vigilance and reduced sport-specific accuracy suggests that its effects extend beyond laboratory reaction-time tests. Future studies should assess cognitive performance alongside validated sport-specific tasks. Sleep quality requires equally careful interpretation. Athletes commonly report poor sleep or experience reduced sleep efficiency, yet the independent causal effect of fragmentation remains uncertain. [1,6] Observational correlations between sleep interruption and slower cognitive responses are hypothesis-generating but susceptible to confounding by stress, training load, pain, competition anxiety and fatigue. [19,20] Future experimental work should manipulate sleep continuity while holding total sleep opportunity as constant as possible, thereby separating quantity from quality. Sleep extension offers a potentially useful countermeasure, particularly because some athletes may begin experiments with an unrecognized sleep debt. Improvements in PVT reaction time, shooting accuracy and tennis serving after extended sleep are encouraging. [21,22] However, the best-known trials are small and frequently use sequential baseline-intervention designs. Systematic reviews consequently judge the overall certainty of evidence as limited. [23,24] It remains too early to consider ten hours of sleep a universal recommendation based only on studies of basketball players, or nine hours the optimal amount of sleep based on data regarding tennis players. The athlete consensus instead supports individualized sleep planning based on habitual need, schedule, daytime function and sporting demands. [1] Naps should be approached with the same amount of caution. On one hand, napping may reduce sleepiness and partially restore performance, especially after substantial nocturnal restriction, however it should be considered as a complementary strategy rather than evidence that inadequate nighttime sleep can routinely be compensated for during the day. Nap duration, sleep inertia, circadian timing and the interval between awakening and competition may modify the response. Several limitations characterize the literature. Samples are typically small, and many investigations include only male athletes. Sleep manipulation varies from a few hours of restriction to more than a day of sustained wakefulness. Outcome measures range from computerized reaction tasks to sprint tests and technical sport skills, complicating comparison. Blinding to sleep conditions is generally impossible, creating potential expectancy effects. Baseline sleep is sometimes self-reported rather than objectively verified, and actigraphy, consumer wearables and questionnaires are not interchangeable measures of sleep. These methodological concerns are consistent with athlete-specific consensus

recommendations calling for stronger study designs, more representative participant samples and better validated approaches to sleep assessment. [1] Future studies should prioritize randomized crossover protocols using objectively verified sleep exposure, adequately powered male and female cohorts, ecologically realistic partial restriction, and standardized reporting of baseline sleep. Cognitive testing should distinguish simple reaction time, choice reaction time, inhibition, vigilance and decision accuracy rather than combining them as a generic cognitive-performance outcome. Combining validated laboratory measures with sport-specific tasks performed during or immediately after exercise may clarify whether sleep-related deficits observed experimentally translate into competitive disadvantage.

Conclusions

Current evidence supports a meaningful relationship between inadequate sleep and cognitive-motor performance in athletes. The evidence gathered, points out that sleep deprivation generally impairs reaction-related cognition, sustained attention and response control. Partial sleep restriction produces more heterogeneous effects, but technical accuracy and complex cognitive-motor skills may deteriorate even when gross physical performance remains relatively preserved. Sleep extension has been associated with improvements in psychomotor vigilance and sport-specific accuracy, although small samples and limited randomized evidence prevent definition of a universal optimal sleep duration. Napping can mitigate some consequences of sleep loss but does not reliably restore performance to normal-sleep levels. Evidence concerning sleep quality independently of sleep duration is comparatively weak. Fragmented sleep is associated with poorer cognitive outcomes in some athlete studies, but causal inference is limited by observational designs and confounding. For sports requiring rapid perception, response selection, inhibition and precise motor execution, sleep should therefore be regarded as an important component of performance preparation. The available evidence favors individualized assessment of sleep duration and continuity rather than a single prescriptive sleep target for all athletes.

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Author's contribution:

Conceptualization: Weronika Świt, Maciek Wojtarowicz

Methodology: Eliza Pyla, Maciek Wojtarowicz

Software: Patryk Dąbrowski, Weronika Świt, Jakub Wodnicki

Check: Weronika Świt, Maciek Wojtarowicz

Formal analysis: Weronika Świt, Jakub Wodnicki

Investigation: Bartek Cichoń, Eliza Pyla

Resources: Maciek Wojtarowicz, Marcelina Guzik

Data curation: Weronika Świt, Krzysztof Zachwieja

Writing – rough preparation: Bartek Cichoń, Krzysztof Prokop

Writing – review and editing: Maciek Wojtarowicz, Marcelina Guzik
Visualization: Maciek Wojtarowicz, Patryk Dąbrowski
Supervision: Eliza Pyla, Weronika Świt
Project administration: Bartek Cichoń, Krzysztof Zachwieja

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