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How Insufficient Sleep May Increase the Risk of Injury in Athletes

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Abstract. Sleep constitutes a fundamental component of athletic health and recovery. Nevertheless, demanding training schedules, academic commitments, competitive stress, frequent travel, and early-morning training sessions can make it difficult for athletes to obtain sufficient, high-quality sleep. While research has studied the links between sleep, performance, recovery, and injury risk, these topics are often discussed separately. As a result, it can be unclear how issues like trouble focusing, weaker muscles and bones, and slower muscle recovery combine to raise the chance of injury for athletes. This review addresses how insufficient sleep affects the risk of sports-related injuries through these combined effects. Ten studies from PubMed, using different types of research and reviews, were considered. The main findings show that athletes who do not get enough sleep tend to have worse attention and slower reactions, which may impair their safety during fast-paced play and increase their risk of concussion. Ongoing poor sleep is also linked with more frequent sports and muscle injuries, and sleep loss can slow down the body's recovery. Overall, the current evidence suggests that sleep should be included in injury prevention plans. Further controlled research is therefore required to clarify the causal mechanisms and evaluate sleep-targeted preventive interventions. However, because most studies show an association rather than a direct cause, more controlled research is still needed.

Keywords: insufficient sleep, athletes, injury risk, musculoskeletal injury, recovery

1. Introduction

Sleep plays a key role in sports medicine, as athletes must recover from physical effort while staying sharp, making quick decisions, and keeping their emotions in check [1]. Yet, it's still common for athletes to lack enough sleep. Late games, travel, early practices, schoolwork, technology use, pain, and anxiety can all take a toll on sleep length and quality. Existing literature on sleep mostly focuses on motor performance, with less integration of the interaction pathways between cognition, injury, and recovery. While recent research has examined the relationships among sleep, concussion, performance, recovery, and injury, these topics are usually examined separately. As a result, coaches and athletes might understand that sleep matters for performance but not see how trouble focusing, injury patterns, and slower recovery can all work together to raise the risk of getting hurt. This essay examines a major question: How can insufficient sleep increase an athlete's risk of injury? To answer it, I reviewed 10 academic studies from PubMed, including cohort and observational studies,

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systematic and narrative reviews, and a meta-analysis on athletes and how their sleep relates to injuries and recovery. Studies were included when they reported an injury, concussion, or recovery-related outcome; studies focused only on performance without an injury or recovery outcome were excluded. The review examines how sleep may influence attention, the risk of concussion and musculoskeletal injury, muscle repair, and injury prevention. One important reason for focusing on sleep is that it can be changed. Sleep represents a modifiable risk factor, which makes it a valuable target for injury-prevention efforts. Unlike non-modifiable risk variables such as chronological age and prior injury history, sleep habits and training schedules can feasibly be adjusted. By synthesizing current evidence, this review aims to assist athletes, parents, coaches, athletic trainers, and clinical practitioners in identifying sleep-related red flags early. Unlike things like age or past injuries, sleep habits and practice routines can often be improved. Pulling together the evidence can help athletes, parents, coaches, trainers, and healthcare professionals spot sleep issues early and include sleep checks among broader plans to keep athletes safe from injuries.

2. Effects of insufficient sleep on brain function

2.1. Reduced attention and speed of information processing

Athletes are often required to attend to multiple stimuli simultaneously, identify the most relevant information, and respond appropriately within seconds. Insufficient sleep can impair these processes. Daytime tiredness, trouble focusing, and slower thinking are more likely when athletes are sleep-deprived. This could mean noticing an opponent too late, misjudging speed, or using poor technique when reacting suddenly to a fall or collision. Importantly, attentional deficits do not directly cause injury; instead, they increase the probability of hazardous exposure and faulty movement patterns that create injury-prone circumstances. Not all attentional deficits will culminate in injury, yet they narrow the safety margin during fast-paced competitive play. Of course, not every lapse in attention results in injury. Still, these situations show how a lack of sleep can lower the room for error in high-speed, unpredictable sports.

Research with college athletes supports this. In one study, college athletes who typically slept fewer than 6 hours per night were more likely to sustain a concussion than those who slept more than 7 hours per night. About 16% of the short-sleep group had a concussion, compared to only 9% in the well-rested group. More telling, athletes who both lacked sleep and later suffered a concussion also performed worse on tests for focus and reaction speed before the season even started. This suggests that sleep time alone isn't the only concern—the combination of short sleep and slow thinking could indicate that athletes are less likely to react safely during games [2].

Numerous studies indicate that sleep is vital for mental sharpness, emotional health, physical performance, and recovery [1]. These items are all linked. If an athlete loses focus, they might make poor choices on the field. Feeling tired often leads to clumsy or off-balance movements. Irritability can push someone to take unnecessary risks. Consequently, cognitive deficits are not purely psychological; they alter motor execution and may predispose athletes to awkward landings, delayed defensive responses, and otherwise preventable harm. Thus, problems with attention and cognitive function extend beyond the mental domain and can affect motor performance, at times leading to awkward landings, delayed reactions, or even preventable injuries. Such cognitive impairment further increases an athlete's susceptibility to sport-related concussion, which is discussed in the following section.

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2.2. Increased risk of sport-related concussion

An external force usually causes concussion, so sleep deprivation cannot directly create the injury in the same way as a collision. It may, however, influence the likelihood that an athlete will enter a dangerous situation or fail to prepare for contact. Raikes et al. studied 190 NCAA Division I athletes and found that clinically moderate-to-severe insomnia was associated with a 3.13-fold risk of a future sport-related concussion [3]. Excessive daytime sleepiness occurring at least twice per month was also associated with greater concussion risk. Both relationships remained significant after adjustment for sport participation. Importantly, the study evaluated sleep as a potential risk factor for a subsequent concussion, rather than simply describing poor sleep following concussion. Riegler et al. similarly found that athletes with insufficient sleep at baseline were almost twice as likely as those with sufficient sleep to sustain a subsequent concussion [2]. Together, the two studies strengthen the temporal argument that poor sleep can precede injury. However, the mechanism remains partly inferential. For instance, concussion exposure differs by sport and playing time, potentially confounding the relationship between sleep and injury incidence. Additionally, prior concussion history may affect both sleep quality and future risk, which introduces the possibility of reverse causality. Self-reported sleep data, as used in these studies, can also be subject to recall bias and may not accurately reflect objective sleep patterns. The predominantly observational nature of the evidence limits the ability to draw causal conclusions, as uncontrolled variables such as stress, training load, and pre-existing health conditions might likewise influence both sleep and concussion risk. Therefore, while the evidence justifies enhanced screening and increased awareness of sleep-related risks, it does not support a direct causal claim that sleep loss alone causes concussion. A more defensible conclusion is that insomnia, daytime sleepiness, and poor attention may constitute a cluster of modifiable factors that increases susceptibility to concussion when an athlete is exposed to collisions or situations requiring rapid decision-making.

3. Epidemiological evidence of musculoskeletal injuries

3.1. Short sleep duration and injury risk in adolescent athletes

Adolescent athletes are particularly important to consider because they must balance biological growth with school schedules and sports training. Their opportunities for sleep are often limited despite their high recovery needs. Athletes who slept less than eight hours per night were 1.7 times more likely to have experienced an injury than those who slept at least eight hours [4]. Sleep duration and school grade were the strongest independent predictors in the analysis. School grade was included because the study found that injury risk increased as students progressed through school, when academic and athletic demands may also increase. Although the retrospective design cannot establish causation, the result provides a clear, understandable threshold that can be communicated to young athletes and families.

Viegas et al. added objective sleep measurement by using actigraphy across training, competition, and school-vacation periods in adolescent track-and-field athletes [5]. Measures of sleep continuity were associated with both previous and subsequent musculoskeletal injuries, and total sleep time improved during school vacation compared with more demanding periods. However, because the sample included only 19 athletes, the statistical power of the findings is limited, and the results should be interpreted with caution given the increased risk of Type I and Type II errors in small samples. Additionally, confounding variables such as training intensity and individual sleep need could affect the observed associations. Taken together, these findings suggest that both sleep quality

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and sleep quantity may be relevant to musculoskeletal injury risk in young athletes. The findings show that spending enough time in bed does not guarantee restorative sleep if sleep is fragmented or nonrestorative. Frequent waking can disrupt the continuity of recovery and leave the athlete tired even when the recorded sleep window appears acceptable, highlighting the need for more rigorous, large-scale research to further clarify the impact of sleep characteristics on injury risk. A systematic review and meta-analysis by Gao et al. combined evidence from seven eligible studies of adolescents [6].

3.2. Chronic poor sleep as a contributor to musculoskeletal injury

Huang and Ihm [7] reviewed evidence linking sustained suboptimal sleep with musculoskeletal pain and sports injury. They reported that sleeping seven hours or less per night for at least 14 days was associated with an approximately 1.7-fold increased risk of musculoskeletal injury. Chronic poor sleep may operate through several overlapping routes: greater fatigue can reduce neuromuscular control, pain sensitivity may increase, and incomplete recovery can accumulate across training sessions. The athlete may then begin a new session without fully recovering from the previous one, narrowing the difference between the load a tissue can tolerate and the load imposed on it. A reasonable counterargument is that poor sleep may be a marker of a demanding situation rather than an independent risk factor for injury. Heavy training, competition stress, academic pressure, travel, and existing pain can all disturb sleep while also raising injury risk. The evidence on acute sleep loss is also inconsistent: in the Gao et al. review [6], one acute sleep study reported a significant association with injury, whereas another did not. The results prevent a simple causal statement. However, the counterargument does not make sleep irrelevant. Even when poor sleep reflects other stressors, it can serve as a practical warning sign that total load is exceeding recovery capacity. The most balanced interpretation is that chronically inadequate sleep contributes to a broader risk profile and should be assessed alongside training volume, previous injury, nutrition, mental stress, and competition exposure.

4. Harm of insufficient sleep to muscle repair and physical recovery

4.1. Sleep loss inhibits muscle protein synthesis and hormonal recovery

Training deliberately creates physiological stress. Recovery requires the body to repair damaged structures, replace energy stores, regulate inflammation, and adapt muscle tissue to tolerate future loads. Sleep is an active period within this process rather than simply time without exercise. Dattilo et al. proposed that sleep debt can create a more catabolic environment by increasing cortisol and reducing testosterone and insulin-like growth factor 1 [8]. These hormonal changes may decrease protein synthesis and increase protein degradation pathways, making muscle recovery after exercise or injury less effective. Although the article presents a mechanistic hypothesis rather than a direct injury trial in athletes, the proposed hormonal pathway provides a plausible link between insufficient sleep and an increased practical risk of injury, as impaired recovery may leave athletes more vulnerable to tissue damage in subsequent training or competition.

Mason et al. similarly describe sleep as participating in growth, repair, regeneration, and immune function [9]. Their review notes that adolescent athletes sleep an average of approximately 6.3 hours per night, considerably less than the commonly recommended 8-10 hours for adolescents. This gap is important because adolescence is already a period of rapid maturation. A young athlete who trains intensely while sleeping too little may have insufficient time for both normal development and

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sport-specific recovery. Moreover, an athlete's sleep need may exceed the general population recommendation when training load is high, making an individualized assessment more useful than a single universal target. The cognitive and physiological pathways can reinforce one another. If poor sleep reduces attention, an athlete may perform a movement less efficiently and create more tissue stress. If sleep loss also weakens recovery, the tissue may be less prepared to tolerate that stress the next day. Repeated exposure to this cycle during a congested training or competition schedule may contribute to persistent fatigue or soreness, impaired force control, and, ultimately, injury. This interaction helps explain why a sleep-centered analysis should include both instant performance effects and slower recovery processes.

4.2. Compromised muscle recovery indirectly increases cumulative injury risk

Evidence from elite soccer illustrates the relationship between sleep quality and injury burden. Silva et al. [10] prospectively followed 23 elite male players for 6 months after assessing preseason sleep using diaries and wrist-worn activity monitors. Lower sleep efficiency was associated with a greater number and greater severity of musculoskeletal injuries, as well as more days of absence from training or competition. In regression analyses, sleep efficiency accounted for 44% of the variance in injury number, 24% of the variance in absence time, and 47% of the variance in injury severity. These percentages describe associations within the study's regression models rather than the independent contribution of sleep efficiency alone. Training load, previous injury, nutrition, and other confounding factors may also have influenced the results; therefore, they do not mean that improving sleep would automatically prevent the same proportion of injuries. Still, sleep efficiency may be useful because it captures how much time in bed is actually spent asleep. Two athletes can schedule the same eight-hour sleep window but recover differently if one experiences repeated waking or long periods of wakefulness. Monitoring only bedtime and wake time could therefore miss a meaningful problem. When low sleep efficiency is combined with muscle soreness, increased perceived effort, declining performance, or a sudden rise in training load, the pattern may justify recovery adjustments before a more serious injury occurs. In this sense, sleep is both a biological recovery process and a practical indicator of whether the athlete is adapting successfully.

5. Clinical implications and sleep-centered injury-prevention strategies

The evidence supports adding sleep assessment to routine sports-health practice. A brief preseason screen can include questions about usual sleep duration, insomnia symptoms, daytime sleepiness, nighttime awakenings, and whether the athlete feels refreshed on waking. Raikes et al. [3] specifically recommend attention to insomnia risk factors, sleep-disordered breathing, sleep hygiene, and daytime sleepiness. Athletes with persistent symptoms should be referred to an appropriately qualified health professional rather than being told to try harder to sleep. Screening is most useful when repeated during high-risk periods, such as examinations, travel, congested competition schedules, or rapid increases in training load. Prevention should also address the sporting environment. Coaches can avoid repeatedly scheduling very early sessions after late competition, plan recovery after travel, and treat adequate sleep as part of training rather than a sign of low commitment. Athletes can maintain consistent sleep, reduce avoidable late-night stimulation, and use a simple diary to connect sleep with fatigue, soreness, and performance. Athletes can maintain consistent sleep schedule, reduce avoidable late-night stimulation, and use a simple diary to track relationships between sleep, fatigue, soreness, and performance. For adolescents, families and schools may need to help manage the combined demands of homework and sport. Because

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individual needs vary, the goal should be sufficient duration, good continuity, appropriate timing, and daytime alertness, rather than compliance with a single number.

6. Conclusion

This review examined how insufficient sleep may contribute to injury risk in athletes. The ten selected studies support three connected explanations. First, inadequate sleep is associated with poorer attention and slower information processing, which can reduce safe reactions and may increase susceptibility to sport-related concussion. Second, epidemiological evidence, particularly in adolescents, links chronic short or interrupted sleep with higher rates of sports and musculoskeletal injury. Third, sleep debt may alter hormonal regulation, impair muscle protein synthesis, and disrupt broader recovery processes, potentially allowing fatigue and tissue stress to accumulate. Sleep should therefore be treated as a meaningful and modifiable component of injury prevention, rather than as an isolated cause of injury. The evidence has important limitations. Several studies used self-reported sleep, some samples were small or limited to one sport, and observational associations may be influenced by training load, stress, previous injury, or pain. The effects of a single night of poor sleep also remain less certain than the effects of chronic restriction. To address these gaps, future research should recruit larger, more diverse multi-sport cohorts, use objective sleep-monitoring methods such as actigraphy or polysomnography, and implement uniform protocols for injury surveillance.

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