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The Impact of Jet Lag on Athletic Performance and Evidence-Based Management Strategies: A Comprehensive Review

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Abstract. Jet lag, resulting from rapid travel across time zones, disrupts athletes' circadian rhythms, leading to negative effects—for example, sleep disturbances, hormonal imbalances, and impaired cognitive and physical performance. The direction of travel significantly influences the severity of symptoms. The research showed that eastward travel generally causes more pronounced and prolonged deficits than westward travel. To mitigate these effects, evidence-based management strategies are essential. These involve planned light exposure for circadian re-entrainment, judicious use of supplements such as melatonin and caffeine, and an emphasis on sleep and recovery. A real effective intervention should be implemented proactively with an individualized approach that merges basic fundamental practices with specific therapies aimed at optimizing readiness in athletes while maintaining competitiveness post long-haul travel.

Keywords: Jet Lag, Circadian Rhythms, Athlete Performance

1. Introduction

Jet lag, or rapid time zone change syndrome, took place when somebody dashed across several time zones. The disparity between 'body clock time' and the present moment now simply would allow sleep to be disturbed and a range of physiological and psychological processes [1]. Athletes are among the groups of professionals who travel frequently and therefore become highly sensitive to the effects of jet lag. The demanding schedules in professional leagues such as basketball, with about 41 away games per season, make them very vulnerable to the effects [2]. This review aims to consolidate findings on how jet lag impacts the performance of athletes in two aspects, physiological and psychological impact and also discuss practical treatments. This review advances circadian science and offers practical strategies for optimizing athlete performance across time zones. This helps athletes achieve more consistent performance and contributes to fairer competition outcomes.

2. Circadian rhythms and jet lag

2.1. Biological basis of circadian rhythms

The human circadian rhythms are self-sustaining oscillations with a period close to 24 hours, governed by the suprachiasmatic nucleus (SCN) of the hypothalamus [3,4]. These rhythms regulate

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a wide range of physiological and behavioral processes. Some of these processes include core body temperature (CBT), hormone secretion-for example, melatonin and cortisol-and sleep-wake cycle [3]. The SCN synchronizes the peripheral clocks throughout the body to the external 24-hour day-night cycle. There are two key hormones, melatonin and cortisol, that regulate sleep.

2.2. Mechanism of jet lag

Jet lag syndrome is a temporary mismatch between the internal body clock and the new external time. It usually occurs after a destination following rapid transmeridian travel (typically across three or more time zones) [3,5]. Circadian disruption caused by jet lag adversely affects multiple bodily systems, leading to negative symptoms. For example, the sleep-wake cycle may have to resynchronize within a few days, and deeper rhythms like CBT can take over a week to fully adjust. These are the classic symptoms of jet lag.

3. Impact of jet lag on athletes

3.1. Physiological impact

Hormonal Levels: The circadian disruption affects the normal secretion of key hormones. The jet lag would cause the hormone imbalance and directly impact two key hormones -- melatonin and cortisol [3]. Melatonin, secreted by the pineal gland at night, helps synchronize our biological clock, signaling when it is time to sleep. Cortisol, secreted by the adrenal glands, plays a crucial role in transitioning from the sleep phase to the wake phase [6]. The melatonin production is suppressed if athletes are exposed to light at the wrong time, and the cortisol rhythm would be desynchronized. Some other hormones can be disrupted. For example, in female athletes, severe disruption of hormones can contribute to secondary amenorrhea [3]. They may feel tired and cannot perform well.

Sleep Quality: Sleep disruption is the main result of jet lag. Athletes experience sleep initiation and maintenance difficulties, reducing total sleep time, decreased sleep efficiency, and non-restorative sleep. This effect in sleep is the main conductor to the performance decrements [6].

Immune Risk: Travel stress and sleep loss can lead to high immune risk. One review highlighted illness prevention as a critical, though often overlooked, component of travel management, as getting sick can severely exacerbate the symptoms of jet lag and travel fatigue [4]. The athlete cannot perform stably.

3.2. Psychological impact

Mood Fluctuations: Athletes frequently report increased irritability, mental fatigue, and feelings of depression or general malaise following long-haul travel. This altered emotional state can negatively impact the team and lead to harmful effects.

Cognitive Function: The jet lag would lead to impaired attention and vigilance. Studies using the Psychomotor Vigilance Task (PVT) show that sleep deprivation and circadian disruption significantly slow reaction times and increase lapses in attention. It also causes reduced motivation and mood instability. Athletes have lower vigor and increased subjective fatigue, which can diminish competitive drive and team cohesion [3,4].

Physical performance: Athletic output is always reduced after a flight. Intermittent sprint capacity, reaction time, and strength measures-more significantly within 48 to 72 hours post-flight. Maximal strength and power may also be more reduced, they often return less rapidly. There exists huge individual variability and team sports appear to be very much susceptible [7].

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A study of 11,481 NBA games used the rebounding differentials to measure efforts and used effective field goal percentage to measure motor performance. They found that eastward jet lag significantly reduced effective field goal percentage (eFG%)—a measure of shooting accuracy—by 1.2% ($p < 0.01$) and a significant decline in rebound differential ($\Delta = -1.29$ rebounds, $p < 0.0001$). The result showed a negative correlation between jet lag severity and physical output [2].

4. The effect of travel direction

4.1. Eastward travel

Eastward travel, which has a phase advance of the circadian system (sleeping and waking earlier), is consistently reported as more challenging for athletes. The human free-running circadian period is naturally longer than 24 hours making it more difficult for athletes to advance the clock than to delay it [3]. Therefore, symptoms are worse and last longer after eastward travel. They include greater disruption of sleep, larger performance decrements in sprinting and intermittent exercise, worse subjective ratings of jet lag and fatigue that can persist for up to 7 days [7]. The eastward jet lag leads to greater sleep loss and performance decline. The research showed that home teams playing with eastward jet-lag won marginally less than home teams playing with no jet-lag. The team's winning percentage with eastward jet-lag decreased by about 8% and the point differential decreased 50% [2].

4.2. Westward travel

Westward travel necessitates a phase delay (sleeping and waking later), which aligns more naturally with the body's internal tendency. Symptoms are generally milder and usually peak within the first 3 days. Performance metrics, particularly intermittent sprint capacity, may have minimal negative effects, especially if the athletes arrive in the morning. The research shows that the teams playing with westward jet lag ($M=58.48\%$, $SD=0.49$) won at a similar rate to home teams playing with no jet lag [2]. It also proves that there are no significant negative effects of jet lag caused by westward travel.

5. Management strategies for athletes

5.1. Light therapy

Strategic exposure to light is a powerful behavioral tool for circadian realignment. The timing is critical and revolves around the estimated core body temperature minimum (CBTmin) [5]. To phase delay (for westward travel), athletes should experience bright light in the evening after arrival. To phase advance (for eastward travel), exposure to bright light in the morning is required. While natural sunlight is ideal, portable light boxes (~2500 lux) can be used for controlled sessions [4]. Integrating training sessions with these light exposure periods can be a practical implementation strategy.

5.2. Pharmacological aids

Melatonin: Exogenous melatonin can stimulate chronobiotic (phase-shifting) and hypnotic (sleep-inducing) effects. It is most effective for eastward travel when taken in the evening at the destination. Doses of 0.5-5 mg are standard, but product quality and purity are significant concerns

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[5]. Athletes must use it under medical supervision to ensure it does not contravene anti-doping regulations.

Hypnotics: Short-acting non-benzodiazepine sedatives (e.g., zolpidem) can be considered for short-term management of insomnia in athletes with no history of adverse reactions. Hypnotics should be highly individualized and restricted to the first few nights to promote sleep, with caution regarding next-day residual effects [3].

Caffeine: A strategic tool for combating daytime sleepiness and fatigue [3,5]. Caffeine can enhance alertness and maintain cognitive performance in the local morning.

However, it should be avoided in the late afternoon and evening. Or, it may affect the further disruption of nocturnal sleep [3,5].

6. Conclusion

Jet lag can give different symptoms, which affect other parts of the human body in athletes. For example, the physiological state, psychological readiness, and overall performance. The direction of travel is a key determinant of the severity and duration of these effects. Different directions lead to varying treatments for athletes. A successful management strategy must be proactive and individualized. Prioritizing sleep protection and illness prevention forms the foundation and the more advanced interventions like timed light exposure and cautious, short-term pharmacological support can assist. Future research should focus on personalized intervention projects and the efficacy of combined strategies in real-world, high-performance settings.

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