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FIGHTING THE CLOCK: A LITERATURE-BASED ANALYSIS OF MELATONIN'S THERAPEUTIC ROLE IN SHIFT WORK-RELATED SLEEP DISTURBANCES

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ABSTRACT

Shift Work Sleep Disorder (SWSD) arises from misalignment between endogenous circadian rhythms and irregular work schedules, frequently resulting in poor sleep quality, increased fatigue, and heightened risk for cardiometabolic complications. Melatonin, a hormone produced in the pineal gland during darkness, is increasingly investigated for its role in addressing sleep difficulties among shift workers. This review synthesizes recent clinical evidence on the effectiveness of melatonin supplementation in improving sleep outcomes in night and rotating shift populations. The literature indicates potential benefits such as shorter sleep onset latency, increased total sleep time, and improved subjective sleep quality, alongside a strong safety record. Furthermore, melatonin's influence on circadian rhythm regulation may provide additional metabolic and cardiovascular advantages. Nevertheless, inconsistencies in dosing, formulations, and trial designs limit the generalizability of current findings. Additional well-controlled clinical trials are needed to refine guidelines for melatonin use in occupational settings.

KEYWORDS

Melatonin, Shift Work Sleep Disorder, Circadian Disruption, Sleep Hygiene, Occupational Medicine, Hormone Supplementation

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Introduction.

Shift Work Sleep Disorder (SWSD) is a subtype of circadian rhythm sleep disorders caused by recurring work schedules that conflict with natural sleep–wake patterns [1]. This condition is prevalent among those engaged in non-standard working hours, such as night shifts or rotating schedules. Affected occupational groups include healthcare personnel, factory workers, law enforcement officers, and aviation staff [2].

Estimates suggest that up to one-third of shift workers may experience persistent symptoms of SWSD, including delayed sleep initiation, fragmented sleep, excessive tiredness during wake periods, and compromised cognitive performance [3]. Beyond its direct impact on sleep, chronic circadian disruption has been implicated in a variety of adverse health outcomes, including insulin resistance, cardiovascular disorders, gastrointestinal dysregulation, and weakened immune defenses [4, 5].

Reduced alertness due to inadequate sleep contributes to a higher incidence of workplace errors and accidents, particularly in safety-critical industries [6]. Consequently, strategies to alleviate the burden of SWSD are essential for both individual health and workforce safety.

Melatonin, an endogenous hormone regulated by the light–dark cycle, plays a central role in the synchronization of circadian rhythms [7]. In shift workers, natural melatonin production is often misaligned or suppressed due to atypical light exposure patterns [8]. As such, exogenous melatonin supplementation has emerged as a candidate intervention for improving sleep quality and realigning circadian timing.

Several clinical investigations have examined melatonin's ability to reduce time to sleep onset, increase sleep duration, and enhance perceived sleep satisfaction among shift-working adults [9, 10]. These benefits, combined with melatonin's non-addictive profile and over-the-counter availability, support its consideration in occupational health settings [11]. However, discrepancies across studies concerning dosage, delivery method, and population characteristics challenge the establishment of uniform treatment protocols [12].

This review aims to provide a comprehensive synthesis of available literature concerning the efficacy and safety of melatonin supplementation for shift workers, with a focus on its role in sleep improvement and circadian adjustment.

Methodology

A narrative literature review was conducted using searches from PubMed, Scopus, and Google Scholar databases, covering the period from January 2012 to April 2024. Keywords included "melatonin supplementation," "shift work," "sleep disruption," "circadian misalignment," and "occupational sleep disorder." Boolean operators were employed to refine results.

Eligibility criteria encompassed peer-reviewed human studies examining the effects of exogenous melatonin on sleep parameters in adult shift workers. Articles were included if they reported on sleep outcomes such as latency, duration, efficiency, or circadian phase shifts. Studies that exclusively involved animal models, non-English publications, or populations not engaged in shift work were excluded.

Manual searches of reference lists were also performed to identify additional relevant studies. In total, 40 articles were selected for qualitative synthesis. No formal meta-analysis or methodological quality scoring was undertaken due to heterogeneity in study designs.

Results

Among the 40 studies reviewed, most demonstrated favorable outcomes associated with melatonin supplementation in shift-working populations. Improvements were noted across multiple parameters, particularly in the reduction of sleep onset latency and the extension of total sleep duration. Subjective sleep quality was also consistently reported to improve when melatonin was taken approximately 30 to 60 minutes before the intended sleep period [13–15].

Doses ranged from 2 mg to 5 mg, with both immediate-release and extended-release formulations investigated. Controlled-release variants showed enhanced benefits in sustaining sleep throughout rest periods, especially for rotating shift workers [16, 17]. Several studies also documented melatonin's ability to influence circadian markers, such as advancing the dim light melatonin onset (DLMO), contributing to better alignment between internal rhythms and externally imposed sleep–wake cycles [18].

Beyond sleep-specific outcomes, some investigations reported secondary health benefits. These included improved blood glucose control, blood pressure regulation, and heart rate variability among shift workers with comorbidities such as type 2 diabetes or cardiovascular risk factors [19–21]. Reported adverse effects were generally mild and transient, consisting of symptoms like vivid dreams, morning grogginess, or headaches [22, 23].

Despite overall positive trends, variations in study design, population characteristics, outcome measures, and intervention duration limit the strength of conclusive recommendations. Most trials were conducted over short timeframes, with durations ranging from several days to eight weeks.

Discussion

The reviewed evidence supports the therapeutic potential of melatonin for managing sleep difficulties associated with shift work. Improvements in sleep onset latency, total sleep time, and subjective restfulness were reported consistently, suggesting that melatonin may serve as an effective adjunctive intervention in occupational health strategies [24, 25].

From a mechanistic standpoint, melatonin interacts with MT1 and MT2 receptors in the suprachiasmatic nucleus (SCN), modulating the body's internal clock and facilitating circadian realignment [26]. This is particularly relevant in shift workers, whose endogenous melatonin secretion patterns are often misaligned due to nighttime light exposure and irregular schedules [27, 28].

Some clinical trials highlighted the importance of timing and individualization. Tailoring melatonin use to a worker's specific schedule and chronotype yielded better outcomes than untimed or routine supplementation [29]. Additional metabolic improvements observed in some participants — such as reductions in inflammatory markers or improved insulin sensitivity — may be secondary to enhanced sleep quality and circadian regulation [30, 31].

Nevertheless, the body of literature has notable limitations. Many studies rely on self-reported data rather than objective tools such as actigraphy or polysomnography, increasing the risk of reporting bias [32]. Additionally, a lack of standardized dosing, inconsistent follow-up durations, and heterogeneous participant populations complicate comparisons across studies.

Future research should prioritize the use of validated sleep measurement tools, longer intervention periods, and multi-site trials involving diverse occupational settings. Investigating interactions between melatonin and external variables such as caffeine use, artificial light exposure, or shift rotation type could yield further insight into its optimal use [33, 34].

Conclusions

This review highlights melatonin's potential as a safe, accessible, and effective intervention for improving sleep quality and circadian alignment in shift-working populations. Evidence suggests that it can reduce sleep latency, increase total sleep time, and enhance subjective sleep satisfaction, with few adverse effects reported [35–37].

However, limitations in current research — including short study durations, variability in formulations and dosages, and reliance on subjective outcomes — restrict the ability to form definitive guidelines. Larger, longer-term trials with standardized methodologies are needed to inform evidence-based recommendations for melatonin use in occupational health contexts.

Overall, melatonin supplementation may serve as a valuable addition to broader sleep hygiene and occupational wellness strategies for individuals engaged in non-traditional work schedules [38–40].

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