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Review Article

Relationship between circadian disruption and mood instability in shift workers

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ABSTRACT

Shift work has become a structural necessity in modern economies, yet its impact on mental health remains a growing concern. Circadian disruption, a core consequence of working non-standard hours, has been consistently linked to mood instability. This misalignment between internal biological rhythms and externally imposed work schedules affects key physiological systems involved in emotional regulation, including sleep-wake cycles, hormonal rhythms, and neurotransmitter activity. Disturbed sleep architecture, altered cortisol patterns, and impaired serotonergic function all contribute to heightened vulnerability to mood disorders such as depression, anxiety, and emotional lability among shift workers. The relationship between circadian misalignment and mood is not uniform across individuals. Genetic predispositions, diurnal preference, social environment, and occupational conditions play a substantial role in modulating emotional outcomes. Evening chronotypes may adapt more efficiently to night shifts, while certain polymorphisms in circadian genes increase sensitivity to rhythm disruption. Social support and perceived control over work schedules further influence psychological resilience in these populations. Clinical interventions targeting circadian health have shown efficacy in improving emotional outcomes. Light therapy, melatonin, and behavioral strategies such as cognitive behavioral therapy for insomnia have demonstrated benefits in regulating both sleep and mood. Preventive measures, including forward-rotating shift schedules, extended recovery periods, and fatigue risk management systems, also contribute to mitigating psychological harm. Addressing mood instability in shift workers requires a multidimensional approach that considers biological rhythms, individual risk modifiers, and systemic workplace design.

Keywords: Circadian disruption, Mood instability, Shift work, Sleep regulation, Chronotype

INTRODUCTION

The 24-hour operational demands of modern society have led to a significant increase in shift-based occupations, encompassing sectors such as healthcare, transportation, law enforcement, and manufacturing. While shift work is essential to sustaining productivity and public service, it often requires individuals to work during biologically inappropriate times, thereby disrupting their endogenous circadian rhythms. The circadian system regulates a host of physiological and behavioral functions, including the sleep-wake cycle, hormonal secretion, body temperature, and cognitive performance. Misalignment between internal circadian timing and external environmental or occupational cues, often referred to as circadian disruption, has been implicated in a variety of adverse health outcomes, particularly in relation to mental health and mood regulation.[1]

Mood instability, encompassing symptoms such as irritability, emotional lability, anxiety, and depressive episodes, is frequently reported among shift workers. This phenomenon has been associated with the repeated alteration of sleep patterns, reduced sleep duration, and poor sleep quality, which are direct consequences of circadian misalignment. The suprachiasmatic nucleus (SCN) in the hypothalamus orchestrates circadian rhythms by synchronizing peripheral clocks across the body. However, irregular light exposure patterns experienced by shift workers can lead to desynchronization of the SCN with external time cues, as well as internal physiological processes, contributing to neurochemical imbalances that affect emotional regulation.[2]

Neurobiologically, circadian disruption may alter the regulation of neurotransmitters critical to mood stability, such as serotonin, dopamine, and gamma-aminobutyric acid. These changes can reduce the brain's resilience to stress and impair reward processing, which increases vulnerability to mood disorders. Shift work has also been shown to influence the hypothalamic-pituitary-adrenal (HPA) axis, resulting in abnormal cortisol secretion patterns that may exacerbate emotional dysregulation.[3] Additionally, circadian disruption has a bidirectional relationship with sleep disturbances, which independently elevate the risk of psychiatric disorders. The chronic sleep debt accumulated in shift workers often leads to increased fatigue and cognitive impairments that further undermine emotional stability.

Epidemiological studies have reported higher rates of depression, anxiety, and bipolar disorder among night shift workers compared to their day-working counterparts. A longitudinal analysis by Vetter et al. demonstrated that long-term exposure to rotating shift schedules was associated with elevated depressive symptom scores and greater mood variability.[4] Furthermore, vulnerable populations, such as those with a genetic predisposition to circadian rhythm sensitivity or pre-existing mood disorders, may be particularly affected by the emotional consequences of shift work.

REVIEW

Circadian disruption in shift workers exerts a profound influence on emotional regulation through complex interactions between neurobiological, behavioral, and environmental factors. Recurrent misalignment between endogenous circadian rhythms and externally imposed work schedules can impair the functioning of brain regions implicated in mood control, such as the prefrontal cortex and amygdala. This misalignment may lead to altered regulation of neurotransmitters like serotonin and dopamine, which play critical roles in maintaining emotional stability. Sleep deprivation, a frequent consequence of irregular work schedules, further amplifies this effect by reducing emotional resilience and increasing sensitivity to stressors.

Individuals exposed to long-term shift work are more likely to experience sustained alterations in cortisol secretion patterns, leading to chronic dysregulation of the stress response system. This persistent hormonal imbalance contributes to the onset and maintenance of mood disorders. A study by Kalmbach et al. highlighted that shift workers with irregular sleep schedules reported higher levels of mood instability and depressive symptoms, partly mediated by poor sleep efficiency and insomnia symptoms.[5] Additionally, a meta-analysis by Yuan et al. confirmed a significant association between night shift work and increased risk of depressive symptoms across diverse occupational groups, supporting the hypothesis that circadian disruption has a consistent negative effect on mood health.[6]

CIRCADIAN MISALIGNMENT AND MOOD DYSREGULATION

Disruptions to the circadian system are increasingly recognized as a contributing factor to emotional instability among shift workers. The human circadian clock, governed by the SCN, coordinates physiological rhythms through synchronization with environmental cues, primarily light. When external schedules repeatedly conflict with these internal biological signals, a desynchronization occurs that influences not only physical health but also psychological wellbeing. This misalignment has been observed to interfere with emotional processing, impulse control, and stress reactivity. Research into the biological pathways connecting circadian disruption and mood has identified several potential mechanisms. Key among these is the impact on monoaminergic neurotransmission. Misaligned circadian signals can impair the rhythmicity of serotonin and dopamine pathways, which are integral to mood stabilization. In animal models, alterations in the expression of clock genes such as PER2 and BMAL1 have shown downstream effects on these neurotransmitter systems, contributing to anxiety-like and depressive

behaviors.[7] Such changes are mirrored in human studies where irregular circadian patterns correlate with reduced serotonergic tone, suggesting a common pathway for the mood disturbances seen in shift workers. Sleep fragmentation and irregular sleep timing, which often accompany circadian misalignment, may also contribute to mood dysregulation. Reduced slow-wave sleep and REM sleep deprivation have been linked to heightened emotional reactivity and impaired cognitive appraisal of stress. Furthermore, variability in sleep timing, commonly seen in rotating shift schedules, can reduce the stability of emotional responses across days. Emotional blunting or labile effect may arise from this persistent oscillation in sleep-wake patterns. In a polysomnographic investigation involving hospital nurses, those exposed to night shifts demonstrated diminished sleep efficiency and elevated mood variability over a three-week period.[8] These findings align with emerging evidence that irregular sleep, even in the absence of total sleep loss, can compromise affective regulation through destabilization of neural circuits responsible for mood monitoring.

Photoperiod exposure has also been implicated in the connection between circadian disruption and mood. Artificial light at night, a common feature of shift work environments, can suppress melatonin secretion and delay circadian phase. This disruption is not limited to nighttime shifts. Early morning shifts, for instance, may require waking during the biological night, when alertness and mood regulation systems are still at reduced capacity. Studies in aviation workers found that pilots operating on eastward flights reported significantly higher levels of mood irritability compared to those flying westward routes.[9] This illustrates how circadian phase direction and the timing of environmental cues can modulate emotional outcomes.

Social and behavioral rhythms that normally provide time cues to the circadian system also become irregular due to shift schedules. These disruptions may prevent the full synchronization of peripheral clocks, exacerbating internal misalignment and further impairing mood regulation. A large-scale occupational health survey among European shift workers reported that variability in daily routines predicted higher levels of perceived stress and emotional fatigue, independent of sleep duration.[10]

RISK MODIFIERS IN SHIFT WORK MOOD OUTCOMES

Not all individuals exposed to shift work experience the same degree of emotional disruption. Certain personal and environmental variables appear to influence how circadian misalignment translates into mood-related symptoms. Chronotype, for instance, has emerged as a consistent moderator in studies examining the psychological consequences of nonstandard work hours. People with an evening chronotype tend to tolerate night shifts with greater ease compared to those with morning preferences, whose biological rhythms resist late activity and delayed sleep timing. In a population-based analysis, evening types working night shifts reported fewer depressive symptoms and less subjective fatigue than early chronotypes under identical schedules.[11] While this adaptability may offer some buffering effect, it does not completely eliminate the risk, as cumulative exposure often undermines initial resilience. Genetic variation in circadian clock genes also influences individual responses to shift work. Polymorphisms in genes such as CLOCK, PER3, and NPAS2 have been associated with both diurnal preference and vulnerability to mood disorders. Carriers of the PER3 5/5 genotype, for example, exhibit increased sleep fragmentation and impaired mood regulation during night shifts. Laboratory studies suggest this genotype alters sleep homeostasis and responsiveness to sleep loss, thereby enhancing susceptibility to mood instability under circadian strain.[11,12] Understanding these genetic influences may allow for more personalized strategies in scheduling and prevention, though implementation in workplace settings remains limited.

Psychosocial context further shapes mood outcomes among shift workers. Social isolation and reduced access to support networks often follow irregular work schedules, particularly for those working during common leisure or family hours. The erosion of regular social interaction can amplify feelings of disconnection and emotional exhaustion. Marital strain, difficulties in child caregiving, and exclusion from social rituals are frequently reported. Workers who report higher levels of perceived social support generally show fewer symptoms of depression and anxiety in the context of rotating shifts. This buffering effect has been demonstrated in a cross-sectional study of emergency responders, where those with stronger familial and coworker support reported lower rates of emotional dysregulation despite high shift irregularity.[13] Emotional resilience appears to be reinforced by consistent interpersonal engagement, even if the amount of time available is limited.

Occupational characteristics also serve as critical modifiers. Job control, task predictability, and workload can either mitigate or exacerbate the psychological burden of shift work. High-demand, low-control jobs have been consistently linked with worse mood outcomes among shift workers. The stress resulting from lack of autonomy and frequent schedule unpredictability may amplify the impact of circadian misalignment on emotional functioning. Evidence from longitudinal workforce studies indicates that shift workers with little input into their scheduling report greater emotional fatigue and higher incidence of depressive episodes than those with flexible or self-managed schedules.[13]

CLINICAL AND PREVENTIVE IMPLICATIONS

The clinical management of mood instability among shift workers requires approaches that account for the underlying circadian disruption rather than focusing solely on symptomatic treatment. Traditional

pharmacological strategies, such as antidepressants or anxiolytics, offer limited benefit when the root misalignment between biological and social time remains unaddressed. Chronotherapeutic interventions have gained increasing attention in this context. Light therapy, timed melatonin intake, and sleep-wake rescheduling protocols aim to realign circadian rhythms with external demands. Controlled trials have shown that timed exposure to bright light during night shifts and darkness in the morning can shift circadian phase and stabilize mood-related outcomes. A randomized crossover study among rotating shift nurses demonstrated reduced depressive symptoms and improved vigilance after a three-week light therapy regimen adjusted to individual circadian profiles.[14]

Melatonin supplementation offers another option, particularly in reducing sleep onset latency and promoting better adaptation to night shifts. Its role as a chronobiotic, rather than a sedative, positions it as a tool for phase shifting rather than just sleep induction. Meta-analyses have reported mild to moderate benefits of melatonin in improving sleep efficiency and reducing subjective fatigue in night workers. However, optimal dosing and timing vary significantly depending on shift patterns and individual circadian tendencies. Clinical guidelines still lack standardized protocols for melatonin use among occupational populations, which limits its integration into routine practice.[15]

Behavioral interventions focused on schedule regularity and sleep hygiene have shown promising effects in mitigating emotional instability. Cognitive behavioral therapy for insomnia (CBT-I), adapted for shift workers, includes components that address the irregular sleep-wake cycles and anticipatory anxiety linked to upcoming shifts. Pilot studies report reductions in emotional lability, sleep disturbances, and occupational burnout following structured CBT-I sessions delivered in workplace settings. These outcomes appear most pronounced when interventions also include psychoeducation on circadian biology, allowing individuals to understand and manage the physiological impacts of their work patterns more effectively.16 The use of digital health platforms has further expanded the reach of such interventions, providing scalable and cost-effective tools for sleep and mood regulation among dispersed shift-based populations.

From a preventive standpoint, organizational strategies that prioritize circadian health may reduce the long-term psychiatric burden associated with shift work. Rotational systems designed to follow a forward (morning to evening to night) rather than backward direction are better tolerated physiologically, as they align more closely with the natural tendency of the human clock to delay. Similarly, minimizing the frequency of shift changes and extending rest intervals between rotations improves circadian stability and supports emotional recovery. Employers implementing such adjustments have reported reductions in sick leave, mood-related complaints, and staff turnover. In large transportation and logistics sectors, fatigue risk management systems have been developed to integrate biological, behavioral, and operational data in scheduling design. These systems not only address safety concerns but also have downstream benefits on workers' psychological well-being.[17]

CONCLUSION

Circadian disruption plays a pivotal role in shaping mood outcomes among shift workers, influenced by biological, psychological, and occupational factors. Individual vulnerability and workplace conditions both modulate the extent of emotional dysregulation. Clinical and preventive strategies targeting circadian alignment show promise in mitigating these effects. Addressing this issue requires integrated efforts across healthcare, policy, and organizational systems.

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