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Mitigating the Adverse Effects of Night Shifts: A Review of Strategies for Enhancing Health Outcomes in Shift Workers

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Abstract

Introduction and Purpose

Shift work, essential for continuous operation in industries like healthcare, transportation, and security, disrupts circadian rhythms and adversely affects health. This review consolidates findings on the multifaceted impacts of night shift work, emphasizing interventions to mitigate these effects and improve worker health and well-being.

Brief Description of the State of Knowledge

Night shift work disrupts circadian rhythms, leading to cognitive decline, sleep disorders, mental health risks, cardiovascular issues, metabolic disturbances, and cancer susceptibility. Effective interventions include limiting shift lengths and frequency, incorporating rest breaks and napping, aligning meal times with circadian rhythms, using melatonin supplementation and light therapy to improve sleep quality, engaging in regular aerobic exercise, and employing stress management techniques.

Summary

Implementing proposed interventions can mitigate the adverse health effects of night shift work, enhancing worker well-being, efficiency, and job satisfaction. Tailoring strategies to different age groups optimizes effectiveness, with structured approaches beneficial for older workers and flexible options suitable for younger workers. Further research should explore long-term intervention effects and develop personalized strategies for diverse populations.

This review provides comprehensive guidelines for managing the health impacts of night shift work, supporting improved patient safety, reduced accidents, and enhanced work performance across various industries.

Key words:

work schedule; circadian rhythm; healthcare workers; shift work;

Introduction and purpose

Shift work is characterized by working daytime hours, which consist of fluctuating or rotating patterns among night, early morning or evening schedules[1]. Twenty-four-hour services constitute an important part of our community. The necessity of being available round the clock, in some industries like healthcare, transportation or security services, is definitely

unquestionable. Shift work establishes a rotation work schedule among employees, maintaining continuous functioning of these important fields[2].

However it is widely known, that working in shifts, consequently leads to an alteration of a worker's biological clock causing health-related disorders[3-37]. Furthermore, results of a significant number of studies indicate numerous areas affected by circadian disruption. Topics raised in those papers include mainly deterioration of cognitive function, sleeping and an increased risk of developing mental health disorders, especially depression and anxiety[22-25]. Although, areas of concern cover further subjects associated with shift working, like cardiovascular problems[26,27], metabolic, hormonal and immune function impairment[28-32], fertility and pregnancy issues[33], gastro-esophageal reflux disease[34] or cancer[35]. Additionally, recovery after retiring from shift work takes approximately five years. [36] Noteworthy is the fact that problems caused by working at night significantly impair people's quality of life and are affecting personal relationships[37]. Working permanent night shift, compared to day-shifts only, is associated with higher long-term sickness absence[38]. Moreover, in healthcare workers, it might have a harmful impact on the patient's safety[39].

Peripheral Blood Mononuclear Cells (PBMCs) are a diverse group of blood cells that possess a single, round nucleus. This group primarily includes lymphocytes (such as T cells, B cells, and natural killer cells) and monocytes. PBMCs play a crucial role in the immune system by mediating immune responses and protecting the body against infections and diseases. These cells are commonly isolated from whole blood using density gradient centrifugation for various immunological and biomedical research applications[40]. They are pivotal in studies involving immune function, disease mechanisms, gene expression, and the effects of therapeutic interventions. PBMCs express circadian clock genes, which regulate the body's internal biological clock. Measuring gene expression in these cells helps researchers understand how circadian rhythms influence immune function and other physiological processes[41].

Melatonin, a hormone primarily generated in the pineal gland, is regulated by the body's circadian clock. Its production is influenced by exposure to light and darkness, and its levels in the blood convey this information to nearly all organs and tissues. Consequently, it is crucial for maintaining internal circadian alignment and managing the sleep-wake cycle.[42]

Night shift workers are exposed to light-at-night, which has previously been linked with developing breast cancer through suppression of melatonin[35].

The dimension of shift work in modernized society continues to be regularly growing [31], therefore the necessity to determine reasonable health-improving solutions for workers is significantly demanded. While most studies, investigating the problem of working non-standard hours, focus on the consequences of disrupted biological clock, there is quite a limited number of studies that emphasize possible solutions to those medical issues. In the present study, we aim to assemble prior results and suggested interventions that will enable us to establish a list of actions shift-workers can possibly take to support their health.

Methods

Search Strategy

A comprehensive literature search was conducted using the PubMed database to identify relevant studies on the impact of night shifts on health-related human well-being. The search strategy included the following key terms: "night shifts." To refine the search, filters were applied to include only articles that were available as free full text and categorized as Clinical Trial, Meta-Analysis, Randomized Controlled Trial, or Review. Additionally, the search was limited to publications from the last five years.

Inclusion Criteria

The inclusion criteria for the review were based on study design (PICOS) criteria and included studies assessing the effects of shift work, specifically night shifts, on health-related human well-being, articles that provided clear recommendations for solutions to the issues identified, and studies involving human subjects only.

Exclusion criteria

The exclusion criteria were non-English-language articles that did not satisfy the PICOS criteria or for which the full-text article was not available. Studies involving shift workers of 18 years of age or younger were not considered. To ensure the collected data remains current and relevant, studies published earlier than 15 years ago (before year 2009) were also excluded.

Search Results

The initial search yielded 132 articles. Each article was screened for relevance based on the inclusion criteria. 45 were screened for full-text review after reviewing titles and abstracts. After a thorough review, a total of 31 studies were selected for inclusion in this review. These studies met the rigorous inclusion criteria and provided valuable insights into the health implications of night shifts and potential solutions.

Results

Work schedule and sleep interventions

This review study[43], comparing regulations on residents' working hours in 14 high-income countries, showed that attempts to limit the shift length or the weekly working hours resulted in modest improvements in residents' quality of life. To reduce adverse outcomes of long working hours, the policy implemented most often is limiting resident's work hours. Study confirms that limited shift length, reduced number of night shifts per month and shortened weekly hours, rest breaks, napping and short consecutive night shifts are effective solutions respected by many countries' policies. Sleep interventions successfully demonstrate the efficacy of both pharmacological and non-pharmacological approaches in improving sleep health within the rotating night shift work environment[44,46].

Studies have shown that forward-rotating shifts (morning to evening to night) are less disruptive compared to backward-rotating shifts, as they align better with the natural circadian progression[46]. Nap breaks and work-control during night shifts are associated with lowered risk of insomnia occurrence[47]. Taking two naps during a night shift can help reduce sleepiness and fatigue while preserving performance. This randomized controlled trial[48], investigating subjective and cognitive performance in 12 healthy females, discovered that a 90-minute nap followed by a 30-minute nap decreases fatigue and reaction times, whereas a 30-minute nap followed by a 90-minute nap helps sustain cognitive performance in the early morning hours.

Light therapy

Interventions analyzed in the studies included intermittent bright light therapy[49-52], a combination of bright light and sunglasses[51] and glasses with short-wavelength filters[54].

The impact of light therapy on improving sleep was found to be positive in all investigated studies. Wearing glasses with short-wavelength filters for 8 weeks significantly enhanced both sleep quality and duration[54].

In this recent randomized controlled trial[55], intermittent light therapy did not affect inflammatory markers or glucose tolerance in a specific group of rotating night shift workers. However, there were significant changes in the expression of circadian clock genes in the PBMCs of these individuals receiving light therapy, suggesting that this straightforward and non-pharmacological strategy might be used to restore disruptions to the circadian clock.

Further review study[56] reveals that light interventions with blue-enriched white light effectively reduce sleepiness among night-shift healthcare workers. Exposure to medium-intensity light for a brief period during the night decreases sleepiness, while exposure to high-intensity light enhances sleep by realigning the circadian phase[57].

Melatonin supplementation

Carriedo-Diez et al. conducted a systematic review to assess the effects of exogenous melatonin on Shift Work Sleep Disorder (SWSD) among healthcare workers[58]. The review included multiple studies and found that melatonin administration significantly improved sleep quality and reduced sleep onset latency in shift workers suffering from SWSD. Most studies utilized doses between 2 mg and 5 mg. These dosages were aimed at enhancing sleep quality and mitigating the carcinogenic risks associated with night shift work by stabilizing circadian rhythms and leveraging melatonin's antioxidant properties . The timing of melatonin administration in the studies assessed was primarily aimed at aligning with the individual's sleep schedule. Most studies recommended taking melatonin shortly before the desired sleep time to maximize its efficacy in promoting sleep and adjusting circadian rhythms. Specifically, melatonin was typically administered 30 to 60 minutes before bedtime, whether that was in the evening for day sleepers or in the morning for night shift workers after their shifts ended. This timing helps to mitigate the disruption of circadian rhythms caused by night shift work, potentially offering protective benefits against the associated carcinogenic risks . However, the optimal dosage and timing of melatonin administration varied across the studies, suggesting the need for individualized treatment protocols to maximize its efficacy.

This narrative review[59] highlights the potential protective role of melatonin against the carcinogenic effects associated with night shift work. Melatonin might mitigate the risk of

cancer development in night shift workers by counteracting the disruptions in circadian rhythm caused by exposure to light at night. The antioxidant properties of melatonin, along with its role in regulating the sleep-wake cycle, were emphasized as key mechanisms contributing to its protective effects .By mimicking the body's natural melatonin production, exogenous melatonin can help shift workers fall asleep faster and achieve deeper sleep. Research supports its efficacy in adjusting circadian rhythms and reducing shift work-related sleep disturbances.

Nogueira et al. investigated the impact of melatonin on the eating habits of female night workers with excessive weight[60]. The study found that exogenous melatonin supplementation led to significant improvements in eating behavior. Specifically, melatonin was associated with
a reduction in late-night eating and a decrease in overall caloric intake among the participants. These changes were attributed to melatonin's role in regulating circadian rhythms, which in turn improved the timing of meals and reduced the tendency for night-time snacking. Additionally, participants reported better management of their weight, suggesting that melatonin could help mitigate some of the metabolic challenges faced by night shift workers. In a related study [61], Albreiki et al. examined the effects of melatonin on glucose tolerance, insulin sensitivity, and lipid profiles following a late evening meal in healthy young males. Their findings demonstrated that melatonin supplementation improved glucose tolerance and insulin sensitivity, with notable reductions in postprandial glucose levels. The study also reported beneficial effects on lipid profiles, including lower levels of triglycerides and improved cholesterol ratios. These results indicate that melatonin may enhance metabolic regulation in the context of late-night eating, which is particularly relevant for night shift workers who often face irregular eating patterns and increased risk of metabolic disorders.

Overall, the evidence suggests that melatonin supplementation can positively influence eating habits and metabolic parameters among night shift workers. It appears to help regulate meal timing, improve glucose and insulin responses, and positively affect lipid profiles, thereby addressing some of the common metabolic challenges faced by this population.

Eating schedule

Studies have shown that aligning eating patterns with daytime biological rhythms, even while working at night, can mitigate negative health impacts.

Takahashi and Tahara discussed the health benefits of timing food and nutrient intake to align with the body's circadian rhythms[62]. Their review highlighted that consuming meals at times consistent with the body's internal clock can improve metabolic health and overall well-being. For night shift workers, adjusting meal times to better synchronize with the night shift schedule may mitigate some of the adverse health effects associated with irregular eating patterns.

Qian et al. demonstrated that daytime eating could reduce mood vulnerability in night workers. [63] The study found that aligning eating times with the daytime, even when working night shifts, helped maintain mood stability and cognitive function. This suggests that eating during conventional daytime hours, even if it requires unconventional meal scheduling, can positively affect emotional and psychological well-being. However, this randomized controlled trial [64] showed that having a meal or snack during the night shift improved post-shift driving performance compared to not eating.

Cunha et al. examined the effects of high-protein meals on postprandial metabolic responses among night workers[65]. Their results indicated that while high-protein meals did not significantly improve postprandial glucose and insulin responses compared to other meals, they still contributed to a better overall metabolic profile. This suggests that meal composition, in addition to timing, plays a role in managing metabolic disturbances associated with night shift work.

Sooriyaarachchi et al. explored the experiences of shift workers participating in a low-calorie meal replacement intervention[66]. The qualitative findings revealed that participants found meal replacements helpful in managing their calorie intake and maintaining energy levels during shifts. However, individual experiences varied, with some workers noting challenges related to taste and satiety. This study underscores the potential of low-calorie meal replacements as
a practical strategy for managing dietary intake and mitigating some negative effects of shift work.

Overall, the evidence supports the notion that modifying eating patterns—through appropriate timing, meal composition, and meal replacements—can help alleviate some of the adverse effects of night shift work. Adjusting meal times to better align with circadian rhythms,

incorporating daytime eating strategies, and optimizing meal content are all effective approaches for improving health outcomes and performance in night shift workers.

Physical activity

The review study by Easton et al.[67] investigates the role of physical activity in facilitating adaptation to shift work, with a focus on how exercise can help mitigate the negative effects of working non-standard hours.

The study found that engaging in regular physical activity can positively influence circadian rhythms, which are often disrupted by shift work. Exercise, particularly when timed appropriately, can help resynchronize the body's internal clock, leading to improved sleep patterns and alertness during shifts. The findings support the idea that structured physical activity plays a role in enhancing circadian alignment and overall sleep quality among shift workers.

Regular exercise was shown to improve sleep quality and reduce the time required to fall asleep, even among those working night shifts. The research highlights that physical activity, especially when performed earlier in the day, can help mitigate the sleep disturbances commonly associated with shift work. This effect is likely due to the influence of exercise on the regulation of sleep-promoting hormones and overall sleep architecture.

The study also reported that physical activity positively impacts mood and cognitive function, which are often compromised by the irregular hours of shift work. Exercise was associated with lower levels of fatigue and higher levels of overall well-being. This improvement in mood and cognitive function is crucial for maintaining performance and mental health during night shifts.

The research emphasizes the importance of the timing and type of exercise for shift workers. While any form of regular physical activity is beneficial, the study suggests that aerobic exercises performed during the day can be particularly effective in helping workers adapt to night shifts. In contrast, intense exercise close to bedtime may negatively affect sleep onset and should be avoided in the hours leading up to sleep.

Based on the study’s findings, incorporating physical activity into a shift worker’s routine is recommended as a strategy to facilitate adaptation to night shifts. Recommendations include engaging in moderate aerobic exercise such as brisk walking or cycling during the day, and

maintaining a consistent exercise schedule to support circadian rhythm realignment and overall health.

Overall, the evidence underscores the significant benefits of physical activity in helping shift workers adapt to non-standard work hours. Regular exercise improves circadian rhythm alignment, enhances sleep quality, supports mood and cognitive function, and is a valuable component of a comprehensive strategy to manage the challenges associated with shift work.

Stress management

Liu et al. evaluated a complex interactive multimodal intervention tailored for healthcare workers[68]. The intervention combined personalized stress management techniques, including digital tools and educational components. Results indicated that this comprehensive approach effectively reduced stress levels and improved psychological resilience among participants. The intervention's success suggests that combining various stress management techniques in
a personalized manner can mitigate the adverse effects of night shift work.

Implementing stress management techniques is essential for night shift workers to reduce the risk of burnout and mental health issues. Mindfulness-based stress reduction, cognitive-behavioral therapy, and relaxation techniques have proven effective in managing stress and improving overall well-being among shift workers.

Ha et al. assessed the effectiveness of a mobile wellness program for nurses with rotating shifts during the COVID-19 pandemic[69]. The pilot cluster-randomized trial demonstrated that the mobile program significantly improved mental health outcomes, including reduced stress and enhanced overall well-being. The program, which provided access to wellness resources and support via mobile technology, highlighted the importance of flexible, accessible tools in managing the challenges of shift work.

Miyoshi investigated the impact of restorative yoga on occupational stress among Japanese female nurses working night shifts[70]. The randomized crossover trial revealed that participants who engaged in restorative yoga experienced significant reductions in stress and improvements in overall well-being. Yoga sessions helped to alleviate the physical and psychological strain associated with night shifts, suggesting that incorporating yoga can be an effective strategy for managing shift work-related stress.

Mahdood et al. explored the effects of inhalation aromatherapy with Rosa damascena (Damask Rose) on state anxiety and sleep quality among operating room personnel[71]. The randomized controlled trial showed that aromatherapy significantly reduced anxiety levels and improved sleep quality among participants. This indicates that aromatherapy can be a valuable tool for enhancing relaxation and sleep, addressing common issues faced by shift workers.

Ning et al. conducted a study [72] on the effects of acupuncture on shift work sleep disorder using neuroimaging techniques. The study protocol aimed to evaluate the efficacy of acupuncture in improving sleep quality and managing sleep disorders associated with shift work. Although the study was still in the protocol stage, the anticipated results suggest that acupuncture may offer benefits in mitigating sleep disturbances related to night shifts.

Age significance

This review study [73] explores strategies to reduce the impact of night shifts on health, with a focus on age as a significant factor, revealing that age plays a crucial role in modulating the effectiveness of various interventions. Age significantly influences sleep quality among shift workers, with varying impacts on the effectiveness of strategies designed to mitigate the negative effects of night shift work.

Chang and Peng conducted a meta-analysis examining differences in sleep quality between day and night shift workers, highlighting the moderating effect of age. Their findings indicated that older shift workers generally experience poorer sleep quality compared to younger workers. This age-related decline in sleep quality suggests that older individuals may be more susceptible to the adverse effects of night shifts and may require tailored interventions to manage sleep disturbances effectively.

The review of various strategies to manage the impact of night shifts indicates that age-related factors should be considered when implementing these interventions. For instance, younger workers may benefit from more flexible and dynamic approaches, such as mobile wellness programs and physical activity, which can be more adaptable to their schedules. In contrast, older workers might require more structured interventions like restorative yoga or targeted sleep therapies to address age-related declines in sleep quality.

The meta-analysis underscores the need for age-specific adaptations in intervention strategies. Older shift workers may benefit more from interventions that include additional support for sleep hygiene and relaxation techniques, such as aromatherapy and acupuncture, which can help mitigate age-related sleep issues. Additionally, multimodal interventions that combine various methods may be particularly effective for older workers, providing comprehensive support for both physical and psychological well-being.

Based on the findings, it is recommended that strategies to reduce the impact of night shifts should be customized according to age. For older workers, incorporating elements that specifically address sleep quality and circadian rhythm disruptions, such as guided relaxation exercises and sleep-focused interventions, may enhance the effectiveness of these strategies. Younger workers might benefit from a broader range of flexible options, including mobile wellness programs and physical activity, which can be more easily integrated into their lifestyle.

Discussion

The presented review offers a thorough examination of the multifaceted impacts of night shift work on health, emphasizing the interplay between disrupted circadian rhythms and various physical and psychological outcomes. The findings underscore the complexity of managing shift work's adverse effects and suggest a range of interventions to mitigate these impacts.
Our study highlights the health issues linked to night shift work, including cognitive decline, mental health problems, and metabolic disorders.

Key results and interventions indicate that limiting shift lengths and frequency can improve quality of life and reduce health risks; melatonin and light therapy help realign circadian rhythms and improve sleep, with melatonin also benefiting metabolic health; aligning meal times with circadian rhythms can enhance metabolic responses and mood stability; regular exercise supports circadian rhythm alignment and enhances sleep quality; techniques like mindfulness, yoga, and aromatherapy are effective in managing stress and improving well-being; and tailoring interventions to age can optimize their effectiveness, with older workers potentially needing more structured approaches.

These findings can be utilized to enhance patient safety (when applied to healthcare), decrease accidents, and improve work efficiency and job satisfaction.

Further studies should focus on the long-term effects of these interventions and develop personalized strategies for different age groups.

Practical implications

Based on the review findings, proposed guidelines for managing the health impacts of night shift work include several practical implications: limit shift lengths to 8-12 hours and schedule no more than 2-3 consecutive night shifts per week, incorporating at least two 15-minute breaks, ideally including a nap, and using forward-rotating shifts to align with natural circadian rhythms. For sleep management, melatonin supplementation of 2-5 mg should be taken 30-60 minutes before desired sleep time, and light therapy with a minimum intensity of 1,000 lux should be applied for 30 minutes at the beginning of the night shift. Align eating patterns with the night shift schedule, consuming main meals during the shift and a high-protein snack before it ends, while focusing on high-protein meals and limiting high-calorie snacks, and incorporating one daytime meal to aid in mood stability and metabolic health. Engage in moderate aerobic exercise for 30 minutes during the day, ideally several hours before the shift starts, and avoid intense exercise within 2 hours of planned sleep time. Implement stress management techniques daily, including mindfulness-based stress reduction, restorative yoga 2-3 times per week, and aromatherapy with essential oils like lavender before sleep. Tailor strategies to different age groups, with structured interventions like guided relaxation and sleep-focused strategies for older workers and flexible options, including mobile wellness programs and varied physical activities, for younger workers.

Implementing these guidelines—ranging from scheduling adjustments and sleep management to dietary changes, physical activity, and stress reduction—can help mitigate the negative health effects associated with night shift work. Personalization and consistency in applying these strategies are key to improving overall well-being and performance.

Summary

This review synthesizes the current state of knowledge on the health impacts of night shift work, highlighting significant disruptions to circadian rhythms and subsequent effects on physical and mental health, including cognitive decline, sleep disorders, increased mental health risks, cardiovascular issues, metabolic disturbances, and cancer. Key interventions identified to mitigate these impacts include limiting shift lengths and frequency, incorporating rest breaks and napping, adopting forward-rotating shifts, using melatonin supplementation and light therapy to improve sleep quality and circadian alignment, aligning meal times with biological rhythms, consuming high-protein meals, engaging in regular aerobic exercise, and employing stress management techniques such as mindfulness, yoga, and aromatherapy. Additionally, tailoring strategies to different age groups, with structured interventions for older workers and flexible approaches for younger workers, enhances effectiveness. Implementing these comprehensive guidelines can improve overall well-being, work efficiency, and job satisfaction among night shift workers. Further research should explore the long-term effects of these interventions and develop personalized strategies for different populations.

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