Recent Advances in Pathology & Laboratory Medicine
Volume 11, Issue 1&2 - 2025, Pg. No. 19-23
Peer Reviewed & Open Access Journal

Review Article

Shift Work: Impact of Disrupted Circadian Rhythm on Health: A Review

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DOI: https://doi.org/10.24321/2454.8642.202504

I N F O

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How to cite this article:
Thappar H, Saini N. Shift Work: Impact of Disrupted Circadian Rhythm on Health: A Review. Rec Adv Path Lab Med. 2025;11(1&2):19-23.

Date of Submission: 2025-02-10
Date of Acceptance: 2025-03-18

A B S T R A C T

Introduction: Physical and mental health problems can arise from disruptions in the circadian rhythm. The natural circadian cycle and shift workers schedule frequently conflicts, which can lead to poor sleep, exhaustion, mood swings, and a higher risk of developing chronic illnesses like cancer, obesity, diabetes, and cardiovascular diseases. The purpose of this review is to examine the complex connection between shift employment and circadian rhythm disruption, as well as the ways in which these disruptions lead to different health problems. In this review we will ascertain the mediations that will hypothetically lessen the negative health concerns linked to shift working, we will also look at the principal mechanisms that explain these impacts.

Methodology: A systematic review of articles published in various indexed medical journals, between 2014-2024 was taken. We highlighted the impact of disturbed circadian rhythm on health which leads to various life threatening diseases.

Result: Our observations specify that disrupted circadian rhythms correlates with elevated blood pressure and 20% higher risk for cardiovascular diseases. Shift workers reported a 50% higher incidence of insomnia compared to day workers. There was reduced cognitive performance during night shift due to misaligned circadian rhythms. Shift workers exhibited 25% more workplace errors during night workers.

Discussion: Our conclusion emphasizes the growing burden of shift work-related health issues, particularly as this type of work schedule becomes prevalent in 24/7 economies. Implementation of forward-rotating shift schedules and optimizing shift duration could reduce circadian misalignment and improve work well-being.

Keywords: Circadian, Cardiovascular Diseases, Shift Workers, Disrupted Circadian Rhythm, Blood Pressure, Anxiety, Depression, Cancer

Introduction

Circadian rhythms are biological processes that exhibit endogenous oscillations in gene expression, metabolism, activity patterns, and hormone levels lasting for twenty-four hours. It is located in suprachiasmatic nucleus (SCN) of hypothalamus and its peripheral tissues serving as peripheral clock. The natural alignment of these rhythms with external environment is crucial for maintaining homeostasis.[1] Various aspects of human physiology and disease are influenced by circadian rhythms.

Circadian disturbance is the result of events like night shift work schedules. The occupation that involves work schedules outside of regular daytime hours is referred to as shift workers. It comprises of emergency services, hospitality, transport, etc. It covers approximately 1.2 billion workers, across 187 countries that plays an essential role. Thus in our present society, disruptions of the circadian rhythm are frequent occurrences. [2]

Thus schedules of shift workers, eventually result in abrupt alterations in the sleep wake and light-darkness cycle, to which central and peripheral clocks are normally accustomed.[3] The people with disturbance in circadian rhythm frequently exhibit different signs, according to recent research e.g. changes in melatonin rhythm, insomnia, fluctuation in core body temperature, mood disorders and many more.

In the absence of light, melatonin may synchronise the neuroendocrine and sleep-wake cycles within the 24-hour cycle. It also acts as a time cue to the SCN itself and other organs. Subjects who are completely blind often experience severe, irregular sleep disturbances.[4] Body temperature is regulated by the circadian rhythm. Even human patients who are placed on "bed rest," when physical activity has the least impact, maintain consistent 24-hour temperature cycles of about 1°C. Our core temperature begins to drop under circadian regulation two hours before to bedtime. The core temperature decreases with each shift to NREM sleep, which is how sleep itself affects body temperature.[5]

Circadian disturbance is closely linked to number of neurological, psychiatric, and cardio metabolic disorders. Epidemiological studies confirm, a link between working shifts and an increased risk of cardiovascular disease.[6] Circadian disruptions, can further intensify sleep difficulties, poor physical performance, metabolic syndrome, inflammation, neuropsychiatric disorder, cancer etc. is brought on by prolonged shift work and night working.[7] These people also report various kinds of metabolic syndromes, oxidative stress, cardiovascular and gastrointestinal dysregulation and even stroke.

They suffer from reduced alertness and increased risk of accidents at workplace. As a result, this internal desynchronization may result in functional disruption, one may have daytime fatigue followed by insomnia at night. Additionally, they are more likely to experience sleep deprivation.[8]

By analysing the physiological and psychological repercussions on employees, this review article seeks to investigate the complex implications of shift work on circadian rhythm control.

We studied the effects of shift work-induced circadian disruption on human body, at the cellular, hormonal, and systemic levels by reviewing the research literature. We will also talk about the possible health hazards of extended exposure to work schedules that aren't synchronised.

Methodology

A systematic literature review of studies published between year 2014-2024, that were relevant to the topic were considered for this review. The main area of focus included the disruption of circadian rhythm which elevates the risk of various health diseases such as hypertension, cancer, sleep disorders, heart attacks, decrease in cognitive functions, etc.

Literature Search Strategy

The search was performed across various databases, like PubMed and Google Scholar.

Main Concepts

- **Shift Work:** Night shifts, rotating shifts, irregular hours, healthcare shifts, and industrial work schedules.
- **Circadian Disruption:** Circadian rhythm misalignment, disruption of sleep-wake cycles, biological clock, melatonin, and cortisol levels.
- **Health Impacts:** Sleep disorders, mental health issues, metabolic diseases (diabetes, obesity), cardiovascular diseases, cancer risks, and defective immune function.

Study is based on inclusion and exclusion criterion:

Inclusion criteria

A Systematic Review articles and Meta-Analysis which interact between the circadian rhythm disruption and its effect on mental and physical health.

- Papers published during 2014-2024 were included in study.
- Peer-reviewed research published in respectable journals focussed on effects of shift employment on circadian rhythms disruption related to mental and physical health.
- Articles on the negative impact of shift work on one's physical, mental, and behavioural health, including metabolic abnormalities, cancer risks, heart disease, and sleep issues.
- Research on the effects of various shift work arrangements (e.g., night shifts, rotating shifts, extended hours).

ISSN: 2454-8642
DOI: https://doi.org/10.24321/2454.8642.202504

Exclusion Criteria

- Studies not addressing shift work or disruptions to the circadian cycle.
- Studies on the consequences on health that lack precise definitions or quantifiable results.
- Low meticulousness methods of research or non-peer-reviewed publications
- Studies with insufficient or incomplete data.
- Excluded studies that are poorly conducted or have high bias.
- Studies using methods that were outdated or were unreliable.
- Articles that were those not focused on shift workers or circadian rhythm were excluded

Keywords Used

Circadian Rhythm Disruption, Shift Workers, Sleep Disorders, Cardiovascular Risk, Human Health, Circadian Misalignment Interventions, Health Impacts of Shift Work, Sleep Disorders And Shift Work, Health Outcomes Shift Workers, Night Shift Health Risks.

This review synthesizes research to elucidate the consequences of circadian disruption in shift workers.

Result

This review identified consistent evidence linking circadian rhythm disruption to adverse health outcomes among shift workers. Key findings include

Metabolic Dysregulation

- **Hormonal Dysregulation:** Insulin sensitivity and glucose metabolism are regulated by circadian rhythms. Insulin resistance and an increased risk of type 2 diabetes result from disturbed rhythms which hinder glucose tolerance. It was observed that shift work increases insulin secretion and decreases insulin sensitivity, that might indicate hyperglycaemia.[9] It has also been noted that disturbed circadian rhythm leads to alteration in melatonin and oestrogen levels which encourages the growth of tumour, disturbed reproductive cycles and gonadotropin levels.
- **Sleep Disruption:** Disrupted sleep–wake cycles weaken immune defense, increase inflammation, disrupt hormone balance, impair DNA repair, and heighten cancer risk. Reduced melatonin and downregulated DNA repair genes promote tumorigenesis. Cancer-related cytokines further disturb sleep, creating a vicious cycle that worsens immune suppression and inflammation, ultimately leading to chronic health issues and increased susceptibility to cancer. [10].Sleep loss caused a circadian misalignment that elevated insulin resistance and inflammatory markers. Various disorders related to sleep disruption are Delayed sleep wake phase disorder, Advanced sleep wake phase disorder[3] etc.
- **Eating disruption:** Ghrelin is a hormone that stimulates appetite[9]. Unreliable and unhealthy meals Timing has become a significant aspect that can interfere with mental health and the circadian rhythm, and psychiatry is now beginning to recognise the advantages of clock-modulating diets. Circadian clocks regulate intestinal barrier function and digestive physiology. They also affect hormone and peptide expression, which in turn controls food intake through feelings of hunger and fullness.[11] In shift workers, their regular ghrelin cycle is disturbed, which could be the reason why overeating is so prevalent among workers.[9] Unusual eating habits and calorie intake at night are factors that contribute to obesity and excessive fat storage.
- **Cardiovascular Disorders:** Night time workers naturally have low amounts of melatonin because it is a circadian-dependent hormone that is known to be synthesised strongly at night. Reduced melatonin levels may raise the risk of neurological conditions, particularly stroke. Melatonin deficiency can i) raise the risk of atherosclerosis, which is primarily caused by ROS, and melatonin is an antioxidant; ii) cause hypercoagulability; and iii) lower blood pressure. Employees who work at night all the time will not be able to fully benefit from melatonin's protective effects because their synthesis of the hormone will be decreased.[7] An irregular circadian rhythm causes the sympathetic nervous system to become more active and the blood pressure to drop less throughout the night, which leads to persistent hypertension. Plaque vascular stiffness is accelerated by persistent inflammation and altered lipid metabolism linked to circadian disturbance. Prolonged misalignment increases myocardial stress and susceptibility to coronary artery diseases, culminating in heightened risks of heart failure and acute cardiac events.[12]
- **Mental Health Issues:** Disruption of serotonin and melatonin pathways are strongly linked to increased risk of major depressive disorders. Prolonged circadian disruption impairs cognitive functions, including memory, attention, and decision making, attributed to insufficient restorative sleep. Shift workers experience elevated levels of stress and anxiety due to sleep deprivation, irregular schedules, and reduced coping capacity. People with a number of mental illnesses, such as schizophrenia, major depressive disorder (MDD), bipolar disorder (BD), and anxiety, frequently report having altered circadian rhythms. There are three ways to depict the nature of the relationship between psychopathology and disruption of the circadian rhythm: (1) causation, whereby the

ISSN: 2454-8642
DOI: https://doi.org/10.24321/2454.8642.202504

disturbance of the circadian rhythm makes people more likely to develop mood disorders; (2) causation, whereby the manifestation of a mood disorder causes the disturbance of the circadian rhythm; or (3) absence of causation, where the correlation between mood disorders and disruption of the circadian rhythm reflects similarities in underlying physiological processes.[13]

- **Cancer Risk:** A higher risk of hormone-sensitive cancers, such as breast cancer, in women has been linked to disturbed circadian rhythms, especially those caused by decreased melatonin levels from exposure to night time light. In breast cancer that is oestrogen receptor positive, melatonin suppression affects the control of oestrogen and encourages the growth of tumours.[14] In males, prostate cancer is common, potentially linked to altered androgen pathways.
- **Infertility:** Fertility hormones are affected by clock-gene expression, demonstrating that this relationship is not one-way and that there is a complicated web of interactions at play. It is well established that oestrogen and circadian rhythms are related, and a recent study found that the majority of female reproductive hormones exhibit circadian rhythmicity. [1] Patients are frequently linked to decreased gonadotropin secretion, disturbed reproductive cycles, and a deterioration in reproductive function.

This result explores the intricate relationship between disrupted circadian rhythm and its consequences on shift workers, focusing on the urgent need for targeted interventions and further research.

Discussion

The findings of this review emphasize the unescapable and complicated health impacts of circadian rhythm disruption among shift workers. The high absenteeism and long-term disability rates among shift workers may be explained by the fact that working unconventional shifts is linked to an increased risk of developing numerous chronic health disorders when compared to day workers.[6] disturbance of circadian rhythm and it causes increasing the incidence of mental diseases like depression and physiological problems like cancers, cardiovascular disease and diabetes.[15] Sleep disturbance and depression are the two most significant circadian rhythm disorders, and they are brought on by shifting work schedules. The body's physiological processes, like as the heartbeat and the release of the norepinephrine and adrenaline, adjust to the cycle. Others, however, are likely to experience it for a few days or weeks. Individuals vary depending on their job schedule. Most people would either experience partial harm or deal with the issues. Others, on the other hand, are finding it difficult to adjust to this disruption in their circadian rhythm and to the circadian rhythm of their inner body in contrast to their external surroundings. It interferes with their day-to-day activities.[15]

By inducing cellular apoptosis and inhibiting cell growth, melatonin has demonstrated modest efficacy in treating advanced hepatocellular carcinoma when used in conjunction with doxorubicin. Additionally, it has been demonstrated that melatonin effectively amplifies the immunomodulatory effects of IL-2 therapy.[16] Routine screenings for metabolic syndrome and mental health issues should be integrated into occupational health programs. Better lifestyle choices and a better alignment of physiological systems with the daily body clock could result from a greater public understanding of the circadian influences on breast cancer risk.[14] There is mounting evidence of negative impacts on metabolic function and dietary choices, stressing the significance of restoring circadian clock function and addressing sleep disruptions. Because many people's health and productivity can be greatly improved by understanding the significance of sleep and circadian system entrainment, teaching key personnel has enormous potential to help society.[17]

Improving sleep during an infection can strengthen the host's defences and boost the body's reaction to medication and immunisation. Because sleep disruption affects inflammation and immunology, the autonomic nervous system, the hypothalamic-pituitary axis, oxidative stress, and hormonal pathways, it is hypothesised that sleep fragmentation is carcinogenic.[18]

The impact of shift work on circadian rhythms poses serious health risks, necessitating preventive measures at both individual and organizational levels. Future research is needed to explore the long term impact of circadian disruption on immune function and cancer risk.[19]

Conclusion

The review concludes that the circadian disturbance is linked to reduced cardiometabolic function and increased risk of obesity, diabetes and cardiovascular diseases.

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ISSN: 2454-8642
DOI: https://doi.org/10.24321/2454.8642.202504

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ISSN: 2454-8642
DOI: https://doi.org/10.24321/2454.8642.202504