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IMPACT OF SHIFT WORK ON CIRCADIAN RHYTHM AND THE RISK OF CHRONIC DISEASES

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ABSTRACT

Introduction and Aim of the Study: Shift work, especially night shifts, disrupts the circadian rhythm, causes sleep disturbances, and alters hormonal and metabolic function. These disturbances are associated with an increased risk of metabolic syndrome, type 2 diabetes, cardiovascular diseases, and mental health disorders. This study aims to present the current knowledge on the impact of shift work on circadian rhythm and the risk of chronic diseases.
Review Methods: The review draws on evidence identified through searches of PubMed, Web of Science, and Scopus using predefined keyword combinations related to shift work, circadian rhythms, and metabolic, cardiovascular, and psychiatric outcomes. The selection process prioritizes original studies of adult workers with clearly defined shift-work exposure and uses review articles primarily to explain biological mechanisms and outline theoretical frameworks.
Summary of Current Knowledge: Studies indicate that shift work is associated with shortened and fragmented sleep, circadian desynchronization, adverse blood pressure patterns, and elevated inflammatory markers. Numerous cohort studies have found higher rates of metabolic syndrome and type 2 diabetes among shift workers compared with daytime workers, as well as more severe depressive and anxiety symptoms among night-shift workers.
Conclusion: Shift work is an important, modifiable risk factor for circadian rhythm disturbances and chronic diseases. Study findings justify reducing exposure to night shifts, optimizing work schedules, and implementing preventive programs to improve sleep, lifestyle, and early detection of cardiometabolic complications.

KEYWORDS
Circadian Rhytm, Sleep Wake Disorders, Hypertension, Metabolic Syndrome, Work Schedule Tolerance

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Introduction

The circadian rhythm is an endogenous, approximately 24-hour regulatory system governing sleep and wakefulness, hormone secretion, metabolism, and cardiovascular function. The suprachiasmatic nucleus is the central pacemaker of the circadian rhythm, synchronized primarily by the light-dark cycle and by regular activity and food intake[1]. Circadian disruption is associated with an increased risk of metabolic, cardiovascular, and psychiatric disorders, as well as impaired cognitive function[1,2].

Shift work, particularly night shifts, is one of the most significant environmental factors leading to chronic desynchronization of biological rhythms[4,5]. In recent years, numerous cohort and interventional studies have demonstrated that long-term exposure to shift work is associated with a substantially increased risk of metabolic syndrome, type 2 diabetes, cardiovascular diseases, chronic respiratory disorders, and psychiatric conditions[5-14].

This review aims to provide a concise overview of current knowledge on the mechanisms of circadian disruption in shift work, the effects of shift work on sleep and cognitive function, its association with metabolic and cardiovascular risk, links with other chronic conditions, and available strategies for prevention and risk modification.

Review Methods

The search covered PubMed, Web of Science, and Scopus for the period 2017-2025, using the following keywords: shift work, night shift, circadian disruption, metabolic syndrome, type 2 diabetes, cardiovascular disease, COPD, asthma, mental health, intervention, melatonin, exercise.

Inclusion criteria comprised original research articles - cohort, cross-sectional, clinical, and interventional studies, and selected mechanistic reviews. The population of interest included adults engaged in shift work. Studies were eligible if they assessed at least one of the following outcomes: metabolic syndrome, type 2 diabetes, cardiovascular diseases, respiratory diseases, mental health disorders, sleep parameters, or circadian rhythm biomarkers. The review considers only English-language full-text publications from 2017 onwards.

Exclusion criteria comprised articles that were exclusively reviews, except mechanistic or intervention-focused reviews, pediatric studies, studies lacking a distinct group of shift workers, and those without a clearly defined exposure to shift work.

The final selection comprises 23 representative publications of the highest methodological quality - large cohorts, objective exposure assessment, multivariable statistical adjustment.

State of Knowledge

1. Circadian Rhythm Disruption in Shift Work – Biological Perspective

Night work leads to chronic desynchronization between endogenous circadian rhythms and external schedules of activity and sleep. Light exposure at night suppresses melatonin secretion, shifts circadian phase, and alters the diurnal profile of cortisol[1,2,15]. Experimental studies show that even a few consecutive night shifts markedly reduce nocturnal melatonin levels, disrupt diurnal blood pressure variability, and increase sympathetic activity[1,2].

A review by Ungurianu and Marin, focusing on healthcare workers, demonstrated that burnout and chronic stress among shift workers are associated with suppression of nocturnal melatonin levels and dysregulation of the hypothalamic-pituitary-adrenal axis[15]. These hormonal changes contribute to sleep disturbances, elevated inflammatory markers, and impaired metabolic function, forming a potential link between shift work and chronic diseases[2,15].

2. The Impact of Shift Work on Sleep, Rest Quality, and Cognitive Function

In a study by Ganesan et al. involving 52 Intensive Care Unit (ICU) workers, night shifts markedly reduced total sleep duration, heightened daytime sleepiness, and impaired vigilance and cognitive performance compared with daytime schedules[4]. Evidence from both healthcare and non-healthcare populations corroborates these findings, showing that shift work consistently shortens sleep, increases nocturnal awakenings, and diminishes subjective sleep quality[3,16].

In the study by Sanjaykumar et al., healthcare workers engaged in shift work had significantly worse Pittsburgh Sleep Quality Index scores than daytime workers, indicating a high prevalence of sleep disorders[3]. Markiewicz et al., in a study on Polish nurses, confirmed associations between night work and insomnia, excessive daytime sleepiness, and anxiety and depressive symptoms[16].

Chronic sleep restriction and disruptions in sleep architecture adversely affect executive function, working memory, cognitive performance, and reaction time[4,17].

3. Shift Work, Metabolic Syndrome, and Type 2 Diabetes

Multiple cohort studies demonstrate that night and rotating shift work increase the risk of metabolic syndrome (MetS). In a 4-year retrospective study among industrial workers, shift work was significantly associated with incident metabolic syndrome compared with daytime work[5]. Similarly, Lin et al. found that night shift work was independently associated with a higher prevalence of MetS[6].

Studies in other Asian populations confirm these findings. Yu et al. reported that young women working shifts had a significantly higher prevalence of metabolic syndrome compared with daytime workers, even after adjusting for age, alcohol intake, and physical activity[18]. In the study by Chai et al., MetS risk was higher among shift workers than among daytime workers; the authors proposed that prolonged exposure to shift work may contribute to this association[7].

Regarding type 2 diabetes (T2D), extensive cohort studies provide key evidence. In the *Nurses' Health Study*, rotating night shift work significantly increased T2D risk, with the highest risk observed among women who combined shift work with an adverse lifestyle - low physical activity, a high-calorie diet, and smoking[19].

Viklund et al. prospectively analyzed a cohort of healthcare workers. They found that intensive shift work and permanent night work during the previous year were associated with a 60-70% increase in T2D risk compared with daytime work[8].

Table 1. Selected Objective Sleep Disturbance Indicators in Shift Workers (data from original studies 2019–2025)[4,5,20,21]

Parameter	Shift workers	Day workers	Difference	Source
Total sleep time (TST)	5.2-5.9 h	6.8-7.2 h	↓ 60-90 min	Ganesan 2019; Esmaily 2022
Sleep latency	35-45 min	12-18 min	↑ 2-3×	Esmaily 2022
Deep sleep	-20-35%	-	significant reduction	Yook 2024
ESS* score (daytime sleepiness)	10-14 pts	6-8 pts	↑ 3-5 pts	Ye 2023
Reaction time (PVT)	+20-60 ms	stable	impaired vigilance	Ganesan 2019

ESS - Epworth Sleepiness Scale

4. Shift Work and the Cardiovascular System

Chellappa et al. emphasized that circadian disruption disrupts normal diurnal cardiovascular regulation, potentially increasing cardiovascular risk beyond the typical morning hours[1]. Observational studies report higher inflammatory markers and increased arterial stiffness among shift workers. Some studies have not demonstrated adverse changes in lipid profiles[15,16], whereas others have shown a higher prevalence of dyslipidaemia among shift workers than daytime workers[7].

In a six-year study by Skogstad et al., shift workers experienced a gradual increase in blood pressure, level of inflammatory marker - C-reactive protein, arterial stiffness, intima-media thickness, and glycated hemoglobin, along with a decline in maximum oxygen intake compared with daytime workers, indicating poorer aerobic capacity[13].

The five-year Gutenberg Health Study observed a trend toward higher cardiovascular event incidence among night-shift workers. However, the association was not statistically significant after multivariable adjustment[12]. In contrast, a meta-analysis by Xi et al. confirmed a moderate but statistically significant increase in cardiovascular risk among shift workers[11].

5. Shift Work, Respiratory Diseases, and Other Chronic Conditions

A study by Li et al. using UK Biobank data showed that long-term night work increases the risk of chronic obstructive pulmonary disease (COPD) and that the magnitude of this risk rises with both the duration of exposure and the frequency of night shifts. The authors propose several contributing mechanisms, including circadian disruption, chronic inflammation, and lifestyle factors such as higher smoking rates and lower physical activity among night-shift workers[9].

Maidstone et al. demonstrated that night work is associated with an increased risk of asthma, with risk rising with both the number of night shifts and cumulative exposure[10].

Population studies also report a higher prevalence of depressive and anxiety disorders among night-shift workers[3,16,17]. The underlying mechanisms likely include chronic sleep restriction, circadian dysregulation, and social desynchronization - all key contributors to mood disorders in shift workers[2,15].

6. Prevention and Risk Modification Strategies

Research on circadian- and lifestyle-oriented interventions is increasing. A review by Kalkanis et al. indicates that schedule optimization - limiting the number of consecutive night shifts, extending rest periods, and avoiding backward rotation can reduce fatigue accumulation and mitigate circadian desynchronization[17].

Evidence regarding physical activity is mixed. Hannemann et al. found that high-intensity interval training performed before a cycle of night shifts improved physical capacity but did not shift circadian phase or improve sleep parameters[22]. In contrast, a recent study by Wu et al. suggests that regular moderate-intensity exercise may partially alleviate sleep disturbances associated with night work[23].

A review by dos Reis et al. indicates that programs promoting physical activity and healthy eating among shift workers yield moderate benefits - slight weight reduction, improved sleep quality, reduced fatigue - though results are inconsistent and overall evidence quality is moderate[24].

Educational interventions (sleep hygiene, planned naps, limiting blue-light exposure) and schedule modifications may improve subjective sleep quality and reduce fatigue and burnout[17,25]. However, high-quality evidence of their impact on hard endpoints, for example cardiometabolic outcomes, is lacking.

Researchers have also explored pharmacological approaches. In a randomized, double-blind clinical trial by Khanjani et al., melatonin supplementation in shift workers with poor sleep quality significantly improved sleep parameters - shorter latency, increased efficiency - and selected measures of vigilance during night work. Melatonin showed a favourable safety profile and appears to be a promising supportive therapy for selected shift workers[26].

Conclusions

Although available interventions-including schedule modification, physical activity programs, melatonin supplementation, and sleep hygiene education - show promising effects on intermediate outcomes - sleep, fatigue, risk markers, long-term randomized trials evaluating their impact on hard endpoints - type 2 diabetes, cardiovascular events, mortality - are still lacking.

From a practical standpoint, current evidence supports identifying high-risk workers, implementing organizational solutions to minimize consecutive night shifts, promoting physical activity, sleep hygiene, healthy diet among shift workers, and considering targeted chronobiological interventions for those with significant sleep disturbances.

Summary

Evidence since 2017 clearly shows that shift work - particularly involving night duties - is a significant risk factor for circadian rhythm disruption and numerous chronic diseases. Biologically, night work suppresses melatonin secretion, alters cortisol rhythms, promotes chronic inflammation, and dysregulates glucose metabolism. Effects on lipid metabolism are more heterogeneous and depend on population and exposure duration.

Shift workers consistently exhibit chronic sleep restriction, reduced sleep quality, impaired cognitive performance, and increased stress and burnout. Large cohorts demonstrate a higher risk of metabolic syndrome and type 2 diabetes, often with a dose-response pattern based on years of exposure. Observational data and meta-analyses indicate increased risk of atherosclerosis and cardiovascular events. Growing evidence links night work with respiratory diseases such as COPD and asthma, as well as psychiatric disorders.

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