Review paper

The impact of sleep duration and sleep disorders on the occurrence of cardiovascular diseases: a review of current literature

Julia Domańska-Poboża[1], Kamil Poboży[2], Paweł Domański[3], Wojciech Konarski[3], Tomasz Poboży[3]

[1]National Medical Institute of the Ministry of Interior and Administration, Warsaw, Poland
[2]Faculty of Medicine, Medical University of Warsaw, Poland
[3]Department of Orthopedic Surgery, Ciechanów Hospital, Ciechanów, Poland

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Abstract

Cardiovascular diseases (CVDs) are a leading cause of mortality worldwide, prompting research into potential risk factors. Sleep disorders (SDs), affecting a significant proportion of the population, may contribute to cardiovascular risk. This review examines key studies on the relationship between sleep duration, SDs, and CVDs. Wang *et al*. demonstrated that short sleep (< 6–7 hours) increases the risk of coronary artery disease (OR = 1.24) and myocardial infarction (OR = 1.20), while Yin *et al*. reported a U-shaped relationship between sleep duration and CVD risk. Additionally, Zheng *et al*. found that insomnia symptoms significantly elevate risks of ischemic heart disease and stroke, and Li *et al*. confirmed that obstructive sleep apnea doubles the risk of stroke (RR = 2.10). These studies underline the importance of both adequate sleep duration and effective management of sleep disorders to mitigate cardiovascular risk. Healthcare professionals should incorporate sleep assessment into routine cardiovascular risk evaluation.

Introduction

Cardiovascular diseases (CVDs) encompass a broad spectrum of heart and circulatory system pathologies, including coronary artery disease (CAD), stroke, heart failure (HF), aortic disease, and peripheral artery disease (PAD). CVDs have a significant impact on the quality of life and are the leading cause of mortality globally. In 2016, CVDs were responsible for more than 17.9 million deaths, representing over one-third of all global deaths [1, 2]. Identifying risk factors is essential to decrease the occurrence rate of cardiovascular diseases.

Sleep disorders (SDs) are a group of conditions that affect the quality, quantity, and pattern of a person's sleep. SDs can disrupt the normal sleep-wake cycle, leading to difficulties falling asleep, staying asleep, or experiencing restorative sleep. SDs affect one-third of the population and are more common among women [3, 4]. Factors contributing to their occurrence include older age, coexisting medical conditions and mental disorders [4].

The ICSD-3-TR (International Classification of Sleep Disorders – Third Edition, Text Revision) [5] from 2023 divides SDs into six major categories: insomnia, sleep-related breathing disorders, central disorders of hypersomnolence, circadian rhythm sleep-wake disorders, parasomnias, and sleep-related movement disorders. The diagnosis is primarily based on patient's history and polysomnographic examination [6].

Sleep disorders decrease the quality of life for patients and can also lead to serious health consequences. There is a growing interest among researchers in exploring the connection between SDs and the occurrence of cardiovascular events. Establishing a compelling association between them may engender increased awareness regarding the crucial need for early identification and management of sleep disorders.

This paper aims to provide an overview of several significant studies addressing this subject to investigate various SDs as potential risk factors for cardiovascular diseases. In addition, we are investigating the correlation between sleep duration and various CVDs.

Sleep duration and cardiovascular risk

In 2022, Wang *et al.* [7] published a systematic meta-review and meta-analysis of observational and Mendelian randomization studies. The research investigated the impact of sleep duration on the risk of cardiovascular and all-cause mortality as well as specific CVDs, including coronary artery disease, heart failure, and stroke. The research contributes valuable insights into the complex correlation between sleep duration and cardiovascular diseases.

The majority of the analyzed studies characterized short sleep duration as less than 6 or 7 hours per

day, and long sleep duration as more than 9 hours per day. The analysis provides evidence that short sleep duration is associated with increased risk for CAD (OR [odds ratio] = 1.24, 95% CI [confidence interval] = 1.15–1.34, $p < 0.001$) and myocardial infarction (MI, OR = 1.20, 95% CI = 1.12–1.28, $p < 0.001$). No significant correlation was observed between short sleep duration and either ischemic stroke (OR = 0.97, 95% CI = 0.86–1.10, $p = 0.64$) or primary intracranial hemorrhage (OR = 0.81, 95% CI = 0.53–1.24, $p = 0.33$). Long sleep duration is associated with certain cardiovascular risks but may not have direct causal links with stroke and CAD. Overall, the study underscores the importance of adequate sleep for cardiovascular health [7].

Yin *et al.* [8] summarized prospective cohort studies published before December 2016 and demonstrated a U-shaped association between sleep duration and the risk of all cardiovascular diseases, ischemic heart disease, strokes, deaths from any cause, and cardiovascular-related deaths. The lowest risk was associated with 7 hours of sleep per day. When individuals slept less than 7 hours per day, the pooled relative risk (RR) for all-cause mortality was 1.06 (95% CI: 1.04–1.07) per 1-hour reduction in sleep duration. On the other hand, when individuals slept more than 7 hours per day, the pooled RR for all-cause mortality was 1.13 (95% CI: 1.11–1.15) per 1-hour increase in sleep duration. Similarly, for cardiovascular diseases, the pooled RR was 1.06 (95% CI: 1.03–1.08) per 1-hour reduction in sleep duration, and 1.12 (95% CI: 1.08–1.16) per 1-hour increment in sleep duration. For coronary artery disease, the pooled RR was 1.07 (95% CI: 1.03–1.12) per 1-hour reduction in sleep duration, and 1.05 (95% CI: 1.00–1.10) per 1-hour increment in sleep duration. Finally, for stroke, the pooled RR was 1.05 (95% CI: 1.01–1.09) per 1-hour reduction in sleep duration, and 1.18 (95% CI: 1.14–1.21) per 1-hour increment in sleep duration [8].

These results indicate that both shorter and longer sleep durations may be associated with increased risks of various cardiovascular conditions, highlighting the importance of maintaining an optimal sleep duration for overall health [8].

Stroke is one of the leading causes of death and disability worldwide, and its incidence is likely to increase with the aging of the population. The association between stroke and SDs has been addressed in several studies. In the realm of cohort investigations concerning stroke risk, a notable focus has been devoted to the impact of both insufficient and excessive sleep durations. The meta-analysis conducted in 2017 by He *et al.* [9], encompassing twelve prospective studies, revealed that sleep duration of less than 6 hours was associated with a 15% (RR = 1.15; 95% CI: 1.07–1.24) increase in the risk of stroke occurrence compared to 6–8 hours of sleep. Conversely, within the same study, a sleep duration of 8 to 9 hours was linked to a 45% increase in the risk of strokes compared to 6–8 hours of sleep (RR = 1.45; 95% CI: 1.30–1.62). Notably, concerning/as to prolonged sleep duration, considerable heterogeneity was observed among the studies ($I^2 = 54\%$; $p = 0.003$) [9].

Insomnia

Insomnia is the most frequent sleep disorder [3]. According to the American Academy of Sleep Medicine [10], insomnia is characterized as a perceived difficulty in falling asleep, staying asleep, maintaining sleep duration, or experiencing restful sleep, even with sufficient chances to sleep, accompanied by noticeable daytime impairment. The condition is classified as chronic if it persists for a minimum of 3 months [10]. Insomnia can lead to pronounced daytime impairments, including fatigue, irritability, cognitive deficits, and impaired social and occupational functioning [11, 12].

Understanding insomnia's intricate relationship with cardiovascular risk has become an area of increasing interest in the medical community. Notable research has suggested that insomnia may serve as an independent risk factor for CVDs, impacting factors such as blood pressure, heart rate variability, and systemic inflammation [13].

Over the past years, a growing body of evidence has established a connection between insomnia and coronary heart disease [14–16], heart failure [17, 18] and hypertension [19, 20]. The association between insomnia and cardiovascular-related mortality cannot be disregarded [21]. It is essential to note, however, that the definition and measurement of insomnia vary widely among studies, leading to conflicting data.

The pathophysiological mechanism linking insomnia to CVD may be associated with dysregulation of the hypothalamic-pituitary axis, increased sympathetic nervous system activity, and increased inflammation [13]. Another factor linking insomnia to CVD is depression [13].

The study conducted by Zheng *et al*. in 2019 [22] encompassed a population of nearly half a million Chinese residents without diagnosed heart disease, prior heart attack, or stroke history. Three insomnia symptoms, including morning awakening, difficulties in initiating or maintaining sleep, and daytime dysfunction, were associated with an increased risk of developing cardiovascular diseases. The corresponding hazard ratios were 1.09 (95% CI: 1.07–1.11), 1.07 (95% CI: 1.05–1.09), and 1.13 (95% CI: 1.09–1.18), respectively. Participants with these symptoms also exhibited higher risks of ischemic heart disease (HR = 1.13, 1.09, and 1.17, $p < 0{,}05$) and ischemic stroke (HR = 1.06, 1.07, and 1.09, $p < 0.05$) but not hemorrhagic stroke [22]. Those with all 3 symptoms had an 18% higher risk of CVDs, with 22% higher risk of ischemic heart disease and 10% higher risk of ischemic stroke, respectively, compared to asymptomatic

adults. The associations between the 3 symptoms and the occurrence of cardiovascular diseases consistently showed stronger effects in younger adults or those without baseline hypertension ($p < 0.05$) [22].

Dean *et al*., in a study published in 2023 [23], revealed a strong link between insomnia and the occurrence of myocardial infarction. The relative risk of MI in patients with insomnia was 1.69, with a 95% confidence interval of 1.41–2.02, indicating a significant association. When considering sleep duration, the highest association with MI was found among those who slept for ≤ 5 hours compared to those who slept for 7–8 hours (RR = 1.56, 95% CI = 1.41–1.73). Insomnia subtypes related to difficulties in initiating and maintaining sleep were also linked to an increased risk of MI (RR = 1.13, 95% CI = 1.04–1.23, $p = 0.003$) [23].

The study conducted by Helbig *et al.* [24] examined surveys conducted between 1984 and 2001, involving 17,604 men and women aged 25 to 74 years, to investigate the association between insomnia symptoms and strokes. Two studies assessed symptoms of insomnia, difficulty falling asleep, and difficulty staying asleep, and showed no significant relationship with any incident stroke outcome in either men or women.

Effective management of insomnia is crucial to reducing its impact on cardiovascular risk [25, 26]. Cognitive behavioral therapy for insomnia (CBT-I) is recommended as the first-line treatment for chronic insomnia in adults of all ages. CBT-I encompasses techniques such as stimulus control, sleep restriction, cognitive restructuring, and relaxation training, which collectively improve sleep patterns and reduce insomnia symptoms [27]. Light therapy and structured exercise programs may complement CBT-I, enhancing its effectiveness and supporting overall health improvements.

For patients who do not respond adequately to CBT-I or when such therapy is unavailable, short-term pharmacological treatment may be considered. Benzodiazepines, benzodiazepine receptor agonists, prolonged-release melatonin, low-dose sedating antidepressants, and daridorexant, a dual orexin receptor antagonist, have demonstrated efficacy in the short-term management of insomnia. Longer-term treatment may be appropriate in selected cases, weighing benefits and risks [26].

Sleep-related breathing disorders

Sleep apnea is a condition characterized by repetitive breathing pauses and shallow breaths during sleep, and it is associated with an increased risk of stroke in the general population [28]. In a meta-analysis conducted in 2014 by Li *et al.* [29], the impact of obstructive sleep apnea (OSA) on ischemic and hemorrhagic stroke incidents was investigated in eleven prospective cohort studies. The study revealed that the OSA was linked to an increase in the risk of stroke occurrence (RR = 2.10; 95% CI: 1.5–2.93).

Furthermore, research and data provide strong evidence linking sleep apnea to the development and severity of conditions such as hypertension [30], coronary heart disease, arrhythmia [31, 32] and heart failure [33].

Effective management of OSA is critical for reducing cardiovascular risk [34]. Obesity is a significant risk factor for OSA, and weight reduction should be a cornerstone of treatment [35]. Continuous positive airway pressure (CPAP) therapy is the first-line treatment for moderate to severe OSA. Evidence supports its role in reducing blood pressure, particularly in patients with resistant hypertension, and improving outcomes in conditions such as atrial fibrillation. Adherence to CPAP therapy, ideally for more than 4 hours per night, is essential to maximize its cardiovascular benefits [34, 35]. For patients intolerant to CPAP or with mild to moderate OSA, mandibular advancement splints are a viable alternative. While less effective in reducing the Apnea–Hypopnea Index (AHI), they offer comparable improvements in blood pressure and daytime symptoms in the short term [35, 36].

Positional therapy, such as devices preventing supine sleep, can benefit patients with position-dependent OSA, who frequently exhibit poor compliance with CPAP treatment [36].

In select patients with anatomical abnormalities, surgical procedures like uvulopalatopharyngoplasty may be considered. Hypoglossal nerve stimulation (HNS) represents an innovative surgical approach to managing OSA, particularly in patients who cannot tolerate CPAP therapy. By targeting the hypoglossal nerve, which innervates key pharyngeal dilator muscles, HNS effectively reduces upper airway collapse during sleep [36].

Other sleep disorders

Periodic limb movements during sleep (PLMS) is another condition with unclear impact on the risk of cardiovascular incidents [37]. In a study involving 2,911 men [38], authors hypothesized that periodic limb movement index (PLMI) and periodic limb movement arousal index (PLMAI) are predictive of cardiovascular diseases. However, after stratification, risk of incident all-cause CVDs among high PLMI and PLMAI groups was significantly elevated only for men without prevalent hypertension. In another study, increased PLMAI was found to be associated with elevated diastolic blood pressure [39]. Medications like clonazepam, melatonin, selegiline, and valproate can help reduce PLMS in some patients. However, given the limited evidence supporting pharmacological treatments for periodic limb movement disorder (PLMD), selecting an appropriate therapy requires careful clinical judgment [40].

A study on 4,000 men aged 18–64, discovered that individuals with restless legs syndrome (RLS) more commonly reported hypertension (OR = 1.5; 95% CI: 0.9–2.4) and heart problems (OR = 2.5; 95% CI: 1.4–4.3) [41]. Another study comparing 487 patients with primary RLS and 354 controls, discovered no correlation between RLS and CVDs in most patient groups [42]. At present, an independent association between restless legs syndrome and ischemic stroke remains uncertain [43]. For some individuals with RLS, non-pharmacological approaches such as massage or temperate baths provide sufficient symptom relief. First-line treatments include iron-replacement therapy for those with low body iron stores, as well as medications like gabapentin, pregabalin, or dopamine agonists [44].

In a cohort study from 2017 [45], the impact of REM sleep behavior disorder (RBD) on the risk of stroke was investigated. It was demonstrated that individuals with RBD have a higher risk of both ischemic (HR = 1.93; 95% CI: 1.07–3.46) and hemorrhagic (HR = 6.61; 95% CI: 2.27–19.27) strokes compared to those without RBD [45]. There is insufficient data regarding the impact of RBD on other cardiovascular incidents. Melatonin and clonazepam are potential treatment options for RBD, though evidence supporting their use is limited [46].

Parasomnias encompass a group of sleep disorders characterized by unwanted physical events or experiences that occur during the onset of sleep, throughout sleep, or during the process of awakening [47]. The involvement of parasomnias in increasing cardiovascular risk still appears to be inconclusive.

Patients with narcolepsy type 1 were observed to have a higher frequency of obesity and dyslipidemia [48]. However, there is a lack of data regarding the direct relationship between narcolepsy and the occurrence of cardiovascular diseases.

Certain sources propose that excessive daytime sleepiness (EDS) and hypersomnia might act as autonomous risk factors for cardiovascular diseases [49]. Nonetheless, there is insufficient evidence to substantiate this claim.

Summary

Cardiovascular diseases pose a significant global health challenge, exerting a considerable impact on mortality rates and the quality of life for patients. Sleep disorders, which affect a substantial portion of the population, have emerged as potential risk factors for specific cardiovascular events. This article provides a summary of research studies that investigate the connection between SDs and CVDs, emphasizing the critical importance of early detection and management to reduce potential cardiovascular consequences.

The influence of sleep duration on cardiovascular health is substantial, with both shorter and longer sleep durations linked to an increased risk of cardiovascular conditions. Insomnia, the most prevalent sleep disorder, has been implicated as a risk factor for ischemic heart disease and ischemic stroke. Sleep-related breathing disorders, such as obstructive sleep apnea, have been associated with an elevated risk of stroke and various cardiovascular conditions. However, the role of many other sleep disorders as risk factors for cardiovascular events remains uncertain and necessitates further investigation.

Identifying risk factors and comprehending the relationships between sleep disorders and cardiovascular incidents are crucial for early intervention and management. Healthcare providers must remain vigilant in monitoring and addressing these conditions to enhance cardiovascular health outcomes and overall well-being.

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Conflict of interest

The authors declare no conflict of interest.

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Address for correspondence

Kamil Poboży
Faculty of Medicine
Medical University of Warsaw
Banacha 1, 01-938 Warsaw, Poland
E-mail: tomasz.pobozy@onet.pl

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