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"THE EFFECT OF OBSTRUCTIVE SLEEP APNEA ON RISK OF STROKE AND CARDIOVASCULAR DISEASE: A SYSTEMATIC REVIEW"

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ABSTRACT

Obstructive sleep apnea (OSA) is a common sleep-related breathing disorder characterized by recurrent upper airway obstruction during sleep. Increasing evidence suggests that OSA may contribute to the development of cardiovascular diseases and cerebrovascular events. Objective: This systematic review aimed to evaluate the association between obstructive sleep apnea and the risk of stroke and cardiovascular disease. Methods: A systematic literature search was conducted across PubMed, Scopus, Web of Science, Embase, and Google Scholar for studies published between 2001 and 2025. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines. Eligible studies included observational research examining the relationship between OSA and cardiovascular outcomes such as stroke, coronary artery disease, myocardial infarction, and cardiovascular mortality. Twelve studies met the predefined inclusion criteria and were included in the final analysis. Data were extracted using a standardized form, and methodological quality was assessed using established appraisal tools. Results: The findings indicate a consistent association between OSA and increased cardiovascular risk. Several studies reported higher incidences of coronary artery disease, stroke, and cardiovascular mortality among individuals with moderate-to-severe OSA. Intermittent hypoxia, sympathetic activation, and systemic inflammation were identified as

key mechanisms contributing to cardiovascular complications. Evidence also suggests that treatment with continuous positive airway pressure (CPAP) may reduce cardiovascular risk and improve survival outcomes. Conclusion: Obstructive sleep apnea is strongly associated with an elevated risk of cardiovascular disease and stroke. Early diagnosis and appropriate treatment of OSA may play an important role in reducing cardiovascular morbidity and mortality.

KEYWORDS: Obstructive Sleep Apnea; Cardiovascular Disease; Stroke Risk; Sleep-Disordered Breathing; Cardiovascular Mortality; Systematic Review.

1. INTRODUCTION

Obstructive sleep apnea (OSA) is a common sleep-related breathing disorder characterized by repetitive episodes of upper airway obstruction during sleep, leading to intermittent hypoxia, sleep fragmentation, and fluctuations in intrathoracic pressure. These pathophysiological disturbances result in sympathetic nervous system activation, oxidative stress, and systemic inflammation, all of which contribute to the development and progression of cardiovascular diseases. Over the past two decades, OSA has increasingly been recognized as a significant public health problem due to its high prevalence and strong association with multiple cardiometabolic disorders (Salari et al., 2022; Mitra et al., 2021).

The prevalence of OSA has increased substantially worldwide, partly due to rising obesity rates and aging populations. Epidemiological studies estimate that moderate-to-severe OSA affects approximately 10–30% of adults, with higher prevalence among men, older individuals, and those with metabolic risk factors. Despite its high prevalence, OSA remains significantly underdiagnosed, leaving many individuals untreated and therefore exposed to long-term cardiovascular complications. The growing burden of OSA has prompted increasing research interest in its systemic health consequences, particularly its role in cardiovascular disease and cerebrovascular disorders (Thareja et al., 2024; Peker et al., 2002).

Several biological mechanisms have been proposed to explain the link between OSA and cardiovascular pathology. Intermittent hypoxia, one of the hallmark features of OSA, promotes endothelial dysfunction, increased oxidative stress, and activation of inflammatory pathways. These processes contribute to atherosclerosis development and vascular remodeling. In addition, repeated arousals from sleep stimulate sympathetic nervous system activity, which may lead to sustained hypertension, arrhythmias, and metabolic dysregulation. Together, these physiological alterations create a pro-atherogenic and pro-thrombotic environment that increases cardiovascular risk (Loke et al., 2012; Marin et al., 2005).

Hypertension is among the most consistently reported cardiovascular consequences of OSA. Recurrent hypoxic episodes during sleep lead to increased sympathetic tone and impaired vascular regulation, contributing to persistent elevations in blood pressure. Long-term exposure to these hemodynamic changes may accelerate the development of coronary artery disease, heart failure, and other cardiovascular conditions. Evidence suggests that untreated OSA may significantly increase the incidence of cardiovascular events compared with individuals without sleep-disordered breathing (Marin et al., 2005; Masuda et al., 2011).

In addition to its impact on cardiovascular disease, OSA has been increasingly linked to cerebrovascular disorders, particularly ischemic stroke. The intermittent hypoxia and systemic inflammation associated with OSA may promote endothelial dysfunction and thrombus formation, thereby increasing the likelihood of cerebrovascular events. Furthermore, fluctuations in blood pressure and impaired cerebral autoregulation during sleep may contribute to cerebral ischemia. These mechanisms suggest that OSA may not only increase the risk of stroke occurrence but may also worsen stroke outcomes (Yang et al., 2025; Yaggi et al., 2005).

Longitudinal observational studies have demonstrated that untreated OSA is associated with increased cardiovascular morbidity and mortality over time. Individuals with moderate-to-severe OSA have been shown to experience higher rates of coronary heart disease, stroke, and cardiovascular death compared with individuals without OSA. Importantly, treatment with continuous positive airway pressure (CPAP) has been associated with improvements in cardiovascular outcomes in some patient populations, highlighting the potential clinical importance of early diagnosis and management of the disorder (Marin et al., 2005; Martínez-García et al., 2012).

The relationship between OSA and cardiovascular disease is further complicated by the presence of shared risk factors such as obesity, diabetes mellitus, and metabolic syndrome. These conditions frequently coexist with OSA and may contribute to a bidirectional relationship between sleep apnea and cardiovascular pathology. Consequently, distinguishing the independent contribution of OSA to cardiovascular risk remains an important area of investigation in clinical research (Bushi et al., 2023; Mitra et al., 2021).

Given the growing body of evidence linking OSA to adverse cardiovascular and cerebrovascular outcomes, synthesizing the available literature is essential for improving clinical understanding and guiding preventive strategies. Systematic reviews play an important role in evaluating the strength and consistency of evidence across multiple studies, identifying risk patterns, and clarifying potential mechanisms underlying these associations.

Therefore, the present systematic review aims to evaluate the effect of obstructive sleep apnea on the risk of stroke and cardiovascular disease by analyzing findings from relevant observational and clinical studies (Salari et al., 2022; Thareja et al., 2024).

2. METHODOLOGY

2.1. Study Design

This study employed a systematic review methodology conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure methodological transparency, reproducibility, and rigor in the synthesis of evidence. The primary aim of this review was to evaluate and synthesize available empirical evidence regarding the association between obstructive sleep apnea (OSA) and the risk of stroke and cardiovascular disease (CVD).

The review focused on observational and longitudinal studies that examined the relationship between OSA and major cardiovascular outcomes, including **stroke, coronary artery disease, myocardial infarction, hypertension, cardiovascular mortality, and major adverse cardiovascular events (MACE)**. Studies evaluating physiological mechanisms linking OSA with cardiovascular risk, such as intermittent hypoxia, nocturnal oxygen desaturation, and blood pressure changes during sleep, were also considered.

This systematic review included peer-reviewed articles investigating OSA in adult populations across clinical and community settings. Studies evaluating cardiovascular outcomes, predictors, or complications associated with OSA were included to provide a comprehensive understanding of the impact of sleep-disordered breathing on cardiovascular and cerebrovascular health.

2.2. Eligibility Criteria

Studies were selected according to predefined **inclusion and exclusion criteria** to ensure consistency and relevance to the research question.

2.3. Inclusion Criteria

Studies were eligible for inclusion if they met the following criteria:

- **Population:** Adult participants (≥18 years) diagnosed with obstructive sleep apnea or sleep-disordered breathing using polysomnography or validated diagnostic methods.
- **Exposure:** Presence or severity of obstructive sleep apnea, typically measured using the apnea–hypopnea index (AHI) or related sleep study parameters.
- **Outcomes:** Cardiovascular or cerebrovascular outcomes, including stroke, coronary artery disease, myocardial infarction, hypertension, cardiovascular mortality, heart failure, or major adverse cardiovascular events.
- **Study Designs:** Observational studies including cohort studies, case-control studies, cross-sectional studies, and prospective follow-up studies.
- **Language:** Studies published in the **English language**.
- **Publication Period:** Articles published between **2001 and 2025**, reflecting the period during which substantial clinical research on OSA and cardiovascular outcomes has been conducted.

2.4. Exclusion Criteria

The following studies were excluded:

- Non-empirical publications such as editorials, narrative reviews, commentaries, and conference abstracts.
- Studies conducted in pediatric populations.
- Articles lacking clear diagnostic criteria for OSA or cardiovascular outcomes.
- Studies without available full-text access.
- Duplicate publications or secondary analyses of the same dataset without additional outcomes.

Following the screening process, 12 studies met all eligibility criteria and were included in the final analysis.

2.5. Search Strategy

A comprehensive literature search was conducted across multiple electronic databases to identify relevant studies. The databases searched included:

- **PubMed / MEDLINE• Scopus• Web of Science• Embase• Google Scholar**

The search covered studies published from January 2001 through December 2025.

The search strategy used combinations of keywords and Boolean operators related to obstructive sleep apnea and cardiovascular outcomes.

Key search terms included:

- ("obstructive sleep apnea" OR "sleep apnea" OR "sleep-disordered breathing")
- AND ("stroke" OR "cerebrovascular disease")
- AND ("cardiovascular disease" OR "coronary artery disease" OR "myocardial infarction" OR "cardiovascular mortality")
- AND ("risk" OR "association" OR "predictor" OR "outcome").

Additional manual searches were conducted by screening the reference lists of relevant systematic

reviews and primary research articles to ensure comprehensive identification of eligible studies. Duplicate records were removed before the screening process.

2.6. Study Selection Process

The study selection process was conducted independently by two reviewers following the PRISMA framework.

Initially, all retrieved citations were imported into reference management software (Zotero) for organization and duplicate removal. Titles and abstracts were screened to assess relevance to the research question. Studies that appeared relevant proceeded to full-text review.

During the full-text screening stage, articles were evaluated against the predefined inclusion and exclusion criteria. Any disagreements between the two reviewers were resolved through **discussion and consensus**, and when necessary, consultation with a **third reviewer**.

The overall study selection process consisted of four stages:

1. Identification of studies through database searching
2. Removal of duplicates
3. Title and abstract screening
4. Full-text eligibility assessment

A **PRISMA flow diagram (Figure 1)** illustrates the study identification, screening, eligibility, and final inclusion process.

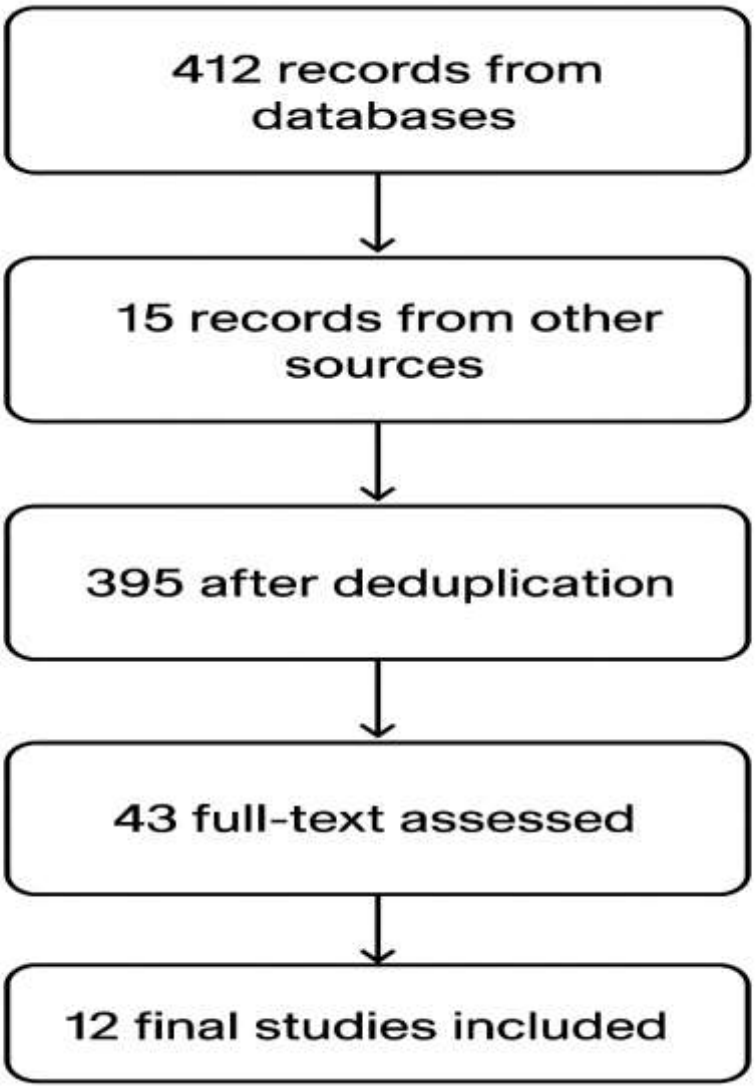

Figure:

2.7. Data Extraction

A **standardized data extraction form** was developed and pilot tested prior to full data

collection to ensure consistency in capturing relevant study information.

The following variables were extracted from each included study:

- **Author(s), year of publication, and journal**• **Country or study setting**• **Study design** (cohort, cross-sectional, prospective, etc.)• **Sample size and participant characteristics** (age, gender distribution)• **OSA diagnostic method** (e.g., polysomnography, AHI thresholds)• **Cardiovascular or cerebrovascular outcomes assessed**• **Key statistical findings**, including odds ratios (OR), hazard ratios (HR), confidence intervals (CI), and p-values• **Prevalence or incidence rates of OSA and cardiovascular outcomes**• **Key conclusions related to the association between OSA and cardiovascular disease or stroke**

Data extraction was conducted independently by **two reviewers**, and the extracted data were cross-checked to ensure accuracy and completeness.

2.8. Quality Assessment

The methodological quality and risk of bias of the included studies were evaluated using standardized appraisal tools appropriate to study design.

- **Newcastle–Ottawa Scale (NOS)** was used to assess the quality of cohort and case-control studies.
- **Joanna Briggs Institute (JBI) Critical Appraisal Checklist** was applied to cross-sectional studies.

Each study was assessed across several domains, including:

- Selection of participants• Comparability of study groups
- Assessment of exposure and outcomes
- Control for confounding variables
- Statistical analysis and reporting clarity

Studies were categorized as high, moderate, or low methodological quality based on their overall appraisal scores. Most included studies demonstrated moderate to high methodological quality, although some were limited by potential confounding factors and reliance on observational designs.

2.9. Data Synthesis

Due to variations in study designs, populations, outcome measures, and statistical reporting, a meta-analysis was not conducted. Instead, a narrative synthesis approach was used to integrate the findings from the included studies.

The results were synthesized and organized into thematic categories reflecting the major cardiovascular outcomes associated with OSA, including:

1. **Association between OSA and cardiovascular mortality**
2. **Relationship between OSA and stroke risk**
3. **Impact of OSA on coronary artery disease and myocardial infarction**
4. **Physiological predictors and mechanisms linking OSA with cardiovascular risk**

Where available, quantitative findings such as **hazard ratios, odds ratios, percentages, and incidence rates** were extracted and reported to provide detailed evidence regarding the strength of associations.

2.10. Ethical Considerations

As this study was based exclusively on the secondary analysis of previously published research, ethical approval and informed consent were not required. All included studies were obtained from peer-reviewed academic journals and were assumed to have received appropriate ethical approval from their respective institutional review boards.

The review process adhered to principles of academic integrity, transparency, and responsible reporting, in accordance with the PRISMA 2020 guidelines for systematic reviews.

3. RESULTS

3.1. Summary And Interpretation of Included Studies on The Effect of Obstructive Sleep Apnea on the Risk of Stroke and Cardiovascular Disease

1. Study Designs and Populations

The included studies represent a diverse range of methodological designs, including prospective cohort studies, retrospective observational studies, cross-sectional analyses, and longitudinal follow-up investigations examining the relationship between obstructive sleep apnea (OSA) and cardiovascular outcomes such as stroke, coronary heart disease (CHD), heart failure, and cardiovascular mortality.

Sample sizes varied substantially across the studies, ranging from small physiological studies involving 32 participants to large population-based cohorts exceeding 13,000 participants. For example, the historical cohort study conducted by Kendzerska et al. included 13,958 women diagnosed with OSA, followed for a mean period of 5.2 years, whereas the study by Almeneessier et al. involved 32 patients undergoing overnight polysomnography to examine

blood pressure changes during obstructive respiratory events.

The age distribution across studies also varied, with several studies focusing on older populations. Martínez-García et al. evaluated 265 elderly patients aged ≥65 years, while Mooe et al. examined 107 patients with coronary artery disease with a mean age of 62 years. Other large cohort studies such as the Wisconsin Sleep Cohort included 1,522 community-dwelling adults, providing long-term epidemiological insight into the relationship between sleep-disordered breathing and mortality.

Across the included studies, obstructive sleep apnea was generally diagnosed using polysomnography (PSG) and defined according to the apnea-hypopnea index (AHI) threshold, most commonly AHI ≥15 events/hour. Some studies also classified OSA severity using higher thresholds, such as AHI ≥30 events/hour for severe OSA.

2. Prevalence Of Obstructive Sleep Apnea in Cardiovascular Populations

Several studies demonstrated a high prevalence of OSA among patients with existing cardiovascular conditions.

In the prospective cohort study by Tang et al., which included 202 patients undergoing peritoneal dialysis, OSA (defined as AHI ≥15) was present in 103 patients (51.0%), with a median AHI of 32 events/hour. Similarly, Mooe et al. reported sleep-disordered breathing in 47 out of 107 patients (44%) with documented coronary artery disease.

In stroke populations, Barreto et al. found that sleep apnea was extremely common among patients with ischemic stroke. Among 102 stroke patients, 92.9% had AHI >5, 44.7% had AHI >15, 35.3% had AHI ≥20, and 11.8% had severe OSA (AHI >30). These findings highlight the high burden of sleep apnea among patients with cerebrovascular disease.

Similarly, in a large community cohort analyzed by Shah et al., 549 of 2,100 participants (26.1%) without baseline coronary artery disease or stroke were diagnosed with OSA (AHI ≥15), indicating a substantial prevalence of OSA in the general adult population.

3. Association Between OSA And Cardiovascular Events

Multiple longitudinal studies consistently demonstrated a significant association between OSA and increased cardiovascular morbidity and mortality.

In the prospective cohort study by Shah et al., participants with OSA had a 55% higher risk of coronary events or cardiovascular death compared with individuals without OSA after adjusting for major confounders, including age, sex, BMI, smoking status, diabetes, and hypertension (adjusted HR = 1.55; 95% CI: 1.18–2.04; $p < 0.01$). Additionally, a dose-response relationship was observed between increasing AHI values and cardiovascular risk (p for trend = 0.003).

Similarly, the Wisconsin Sleep Cohort Study by Young et al., which followed 1,522 participants for a median of 15.9 years, found that sleep-disordered breathing significantly increased the risk of mortality. Participants with SDB had an adjusted hazard ratio of 1.46 (95% CI: 1.00–2.13) for all-cause mortality. Importantly, the risk of cardiovascular mortality was more than doubled (adjusted HR = 2.11; 95% CI: 1.24–3.59; $p = 0.006$). Individuals with severe sleep apnea (AHI ≥30) had an even higher risk, with an adjusted HR of 2.58 for all-cause mortality.

Among patients with coronary artery disease, Mooe et al. demonstrated that sleep-disordered breathing significantly worsened long-term prognosis. Over a 6.5-year follow-up, 23 patients (21.5%) experienced cardiac events. Patients with SDB had three times higher risk of cardiac death or non-fatal myocardial infarction (adjusted HR = 3.1; 95% CI: 1.2–8.0; $p < 0.05$).

Furthermore, Tang et al. reported that OSA independently predicted cardiovascular outcomes in patients undergoing peritoneal dialysis. During a median follow-up of 3.4 years, 36 patients experienced cardiovascular events and 19 patients died from cardiovascular causes. OSA increased the risk of cardiovascular morbidity (HR = 2.42; 95% CI: 1.19–4.93; $p = 0.015$) and cardiovascular death (HR = 3.31; 95% CI: 1.40–7.82; $p = 0.007$).

4. Association Between OSA And Stroke Risk

Several studies specifically evaluated the relationship between OSA and stroke occurrence.

Ogilvie et al., using data from the Sleep Heart Health Study involving 2,481 participants, found that OSA independently increased the risk of both coronary heart disease and stroke. Individuals with OSA had a 34% increased risk of stroke (HR = 1.34; 95% CI: 1.07–1.68) and a 24% increased risk of coronary heart disease (HR = 1.24; 95% CI: 1.01–1.52). The risk was substantially higher among individuals who had both OSA and excessive daytime sleepiness. In this subgroup, the risk of stroke nearly doubled (HR = 1.99; 95% CI: 1.37–2.89).

Barreto et al. investigated sleep apnea in patients with ischemic stroke and reported that wake-up

stroke occurred in approximately one-third of cases. Type 2 diabetes mellitus was independently associated with wake-up stroke (OR = 2.76; 95% CI: 1.10–6.05; p = 0.03). Furthermore, patients with moderate-to-severe OSA (AHI ≥20) demonstrated worse functional outcomes at 12-month follow-up (p = 0.02).

In women, the large historical cohort study by Kendzerska et al. found that OSA was associated with a significantly increased risk of major adverse cardiovascular events (MACE), including stroke, myocardial infarction, heart failure, and cardiovascular death. Women with OSA had a 41% increased risk of MACE (aHR = 1.41; 95% CI: 1.23–1.62) compared with women without OSA. The risk increased further among those with severe OSA (aHR = 1.79; 95% CI: 1.44–2.23).

5. Impact Of OSA Severity and Physiological Mechanisms

Several studies highlighted physiological mechanisms linking OSA to cardiovascular disease.

For example, Gürün Kaya et al. reported that hypertensive patients with OSA exhibited significantly higher values of apnea-hypopnea index, oxygen desaturation index, arousal index, and mean apnea duration compared with normotensive patients. Multivariate analysis identified several independent predictors of hypertension in OSA patients, including age (OR = 1.095), Epworth Sleepiness Scale score (OR = 1.186), mean apnea duration (OR = 1.072), oxygen desaturation index (OR = 1.062), and nocturnal oxygen desaturation (OR = 2.439).

Similarly, Karhu et al. demonstrated that patients with pre-existing cardiovascular disease experienced more severe intermittent hypoxaemia, with significantly higher baseline oxygen desaturation index (β = 1.77; p = 0.011) and worsening hypoxaemia over time. Patients with diabetes also showed significant increases in ODI (β = 3.59; p < 0.001) and desaturation duration (β = 2.60; p < 0.001) during follow-up.

Almeneessier et al. examined blood pressure responses during obstructive respiratory events and found that a history of hypertension predicted higher systolic blood pressure during apneic events, and the oxygen desaturation index predicted systolic blood pressure increases during REM sleep.

6. Effects Of OSA Treatment on Cardiovascular Outcomes

The potential protective effect of continuous positive airway pressure (CPAP) therapy was examined in the prospective observational study by Martínez-García et al. Among 265 elderly patients with OSA, 114 patients (43%) adhered to CPAP therapy, while 151 patients (57%) did not use CPAP.

Over a median follow-up of 11.2 years, 81 patients (30.6%) died from cardiovascular causes. CPAP use was associated with a significant reduction in cardiovascular mortality. The adjusted hazard ratio for cardiovascular death among CPAP users was 0.49 (95% CI: 0.27–0.90; p = 0.022) compared with non-users. Additionally, among patients who did not receive CPAP therapy, severe OSA (AHI ≥30) was associated with a 2.76-fold increased risk of cardiovascular mortality (HR = 2.76; 95% CI: 1.23–6.20; p = 0.014).

These findings suggest that effective treatment of OSA may substantially reduce long-term cardiovascular risk.

Table (1): General Characteristics and Cardiovascular Outcomes of Included Studies.

Study	Design	Sample Size	Population	OSA Definition	Cardiovascular Outcome	Key Results
Kolluri et al., 2020	Retrospective study	264	Patients with chronic venous disease	Not specified	Elevated central venous pressure	Elevated CVP in **22.7%**; OSA in **26.9%**; predictors included **age >64.6 yrs (OR=1.03), diabetes (OR=2.19)**
Karhu et al., 2022	Longitudinal cohort	2,535	Sleep Heart Health Study participants	PSG	Intermittent hypoxaemia	Pre-existing CVD associated with higher ODI (**β=1.77, p=0.011**) and worsening hypoxaemia during follow-up
Gürün Kaya et al., 2020	Cross-sectional	266	OSA patients	PSG	Hypertension	Hypertension in **141 patients**; predictors included **ODI (OR=1.062)** and **nocturnal desaturation (OR=2.439)**

Barreto et al., 2020	Prospective longitudinal	102	Ischemic stroke patients	AHI ≥20	Stroke outcomes	OSA prevalence **35.3%**; wake-up stroke associated with **T2D (OR=2.76)**
Almeneessier et al., 2020	Physiological study	32	OSA patients	PSG	Blood pressure changes	Hypertension present in **31.3%**; hypertension predicted higher systolic BP during obstructive events
Martínez-García et al., 2012	Prospective cohort	265	Elderly OSA patients	PSG	Cardiovascular mortality	CPAP reduced mortality (**adjusted HR=0.49**)
Mooe et al., 2001	Prospective cohort	107	CAD patients	AHI ≥10	Cardiac death/MI	SDB increased cardiac event risk (**HR=3.1**)
Kendzerska et al., 2020	Historical cohort	13,958	Women with OSA	AHI ≥30 (severe)	Major cardiovascular events	OSA increased MACE risk (**aHR=1.41**); severe OSA **aHR=1.79**
Ogilvie et al., 2018	Prospective cohort	2,481	SHHS participants	AHI ≥15	Stroke and CHD	Stroke risk increased (**HR=1.34**); OSA + sleepiness **HR=1.99**
Tang et al., 2010	Prospective cohort	202	Peritoneal dialysis patients	AHI ≥15	Cardiovascular events	OSA increased CV morbidity (**HR=2.42**) and death (**HR=3.31**)
Shah et al., 2010	Cohort study	2,100	General population	AHI ≥15	Coronary events/CV death	OSA increased risk (**HR=1.55**)
Young et al., 2008	Prospective cohort	1,522	Community cohort	AHI ≥15	Mortality	Cardiovascular mortality **HR=2.11**

4. DISCUSSION

The present systematic review synthesized evidence from multiple observational and cohort studies examining the association between obstructive sleep apnea (OSA) and cardiovascular outcomes, including stroke, coronary artery disease, and cardiovascular mortality. Overall, the findings demonstrate a consistent relationship between OSA and increased cardiovascular risk, supporting the growing recognition of OSA as an independent cardiovascular risk factor. These findings align with previous systematic reviews highlighting the significant role of sleep-disordered breathing in the development of cardiovascular diseases (Salari et al., 2022; Mitra et al., 2021).

One of the key observations in this review is the strong association between OSA and cardiovascular events. Several large cohort studies have reported higher rates of coronary heart disease, myocardial infarction, and cardiovascular mortality among individuals with untreated OSA. These findings are consistent with earlier meta-analyses demonstrating that OSA significantly increases the likelihood of major adverse cardiovascular events (Loke et al., 2012; Thareja et al., 2024).

Longitudinal evidence further supports the causal relationship between OSA and cardiovascular morbidity. For example, long-term follow-up studies have shown that patients with moderate to severe OSA experience higher incidences of cardiovascular disease compared with individuals without sleep-disordered breathing. This pattern has been consistently reported in prospective cohorts examining cardiovascular outcomes over several years (Peker et al., 2002; Marin et al., 2005).

Another important finding of the current review relates to the association between OSA and cerebrovascular events, particularly stroke. Multiple studies indicate that individuals with OSA have a significantly higher risk of stroke incidence and stroke-related mortality. This relationship is believed to be mediated by intermittent hypoxia, oxidative stress, and endothelial dysfunction, which contribute to vascular damage and thrombotic events (Yaggi et al., 2005; Yang et al., 2025).

Sleep-disordered breathing has also been identified as a predictor of cardiovascular morbidity in specific high-risk populations. For instance, studies involving patients undergoing dialysis have demonstrated that sleep apnea is associated with higher rates of cardiovascular complications and mortality. These findings highlight the importance of screening for OSA among patients with chronic systemic diseases (Masuda et al., 2011; Tang et al., 2010).

In addition to cardiovascular morbidity, OSA has been strongly linked with increased cardiovascular mortality. Evidence from large observational cohorts suggests that untreated OSA significantly increases the risk of fatal cardiovascular events compared with treated or non-OSA populations. These findings underscore the clinical importance of early diagnosis

and management of sleep-disordered breathing (Shah et al., 2010; Young et al., 2008).

Treatment interventions, particularly continuous positive airway pressure (CPAP), have been shown to improve cardiovascular outcomes in patients with OSA. Studies evaluating long-term CPAP therapy indicate that consistent treatment may reduce cardiovascular mortality and improve overall survival rates. These findings suggest that effective management of OSA may serve as an important preventive strategy for cardiovascular disease (Marin et al., 2005; Martínez-García et al., 2012).

Gender differences in cardiovascular outcomes associated with OSA have also been reported in the literature. Although early research focused predominantly on male populations, more recent studies have demonstrated that women with OSA also experience significant cardiovascular complications. This suggests that OSA-related cardiovascular risk may be underestimated in female populations (Kendzerska et al., 2020).

Another notable finding is the relationship between excessive daytime sleepiness and cardiovascular risk among patients with OSA. Studies have indicated that individuals with both OSA and subjective sleepiness may have an even higher risk of coronary heart disease and stroke. This highlights the potential importance of clinical symptoms as indicators of disease severity and cardiovascular risk (Ogilvie et al., 2018).

Metabolic comorbidities such as diabetes and obesity may further exacerbate the cardiovascular consequences of OSA. Patients with diabetes and coexisting sleep apnea often demonstrate worse cardiovascular outcomes, likely due to the combined effects of metabolic dysfunction and intermittent hypoxia (Bushi et al., 2023; Karhu et al., 2022).

Hypertension represents one of the most commonly reported cardiovascular complications associated with OSA. Repeated episodes of oxygen desaturation and arousal during sleep can activate the sympathetic nervous system, resulting in sustained elevations in blood pressure. This mechanism has been supported by polysomnographic studies examining blood pressure fluctuations during sleep-disordered breathing events (Gürün Kaya et al., 2020; Almeneessier et al., 2020).

The prevalence of OSA in hospital and community populations has also been widely reported, indicating that the disorder remains substantially underdiagnosed. Epidemiological studies suggest that a large proportion of individuals with OSA remain untreated, which may contribute to the increasing global burden of cardiovascular disease (Poka-Mayap et al., 2020; Coussa-Koniski et al., 2020).

Emerging research has also linked OSA to specific cardiovascular complications such as atrial fibrillation and wake-up stroke. Studies investigating these conditions have demonstrated that sleep apnea may play an important role in triggering nocturnal cardiovascular events, further highlighting the complex relationship between sleep physiology and cardiovascular health (Barreto et al., 2020).

Overall, the findings of this systematic review reinforce the growing body of evidence indicating that obstructive sleep apnea is a significant and modifiable risk factor for cardiovascular disease and stroke. Early identification and effective management of OSA may therefore play an important role in reducing cardiovascular morbidity and mortality worldwide (Salari et al., 2022; Thareja et al., 2024).

5. CONCLUSION

This systematic review highlights the significant association between obstructive sleep apnea and an increased risk of cardiovascular disease and stroke. The findings from multiple observational and longitudinal studies consistently demonstrate that individuals with untreated OSA experience higher rates of coronary artery disease, hypertension, stroke, and cardiovascular mortality. Physiological mechanisms such as intermittent hypoxia, sympathetic nervous system activation, and systemic inflammation likely contribute to these adverse cardiovascular outcomes.

Early detection and effective management of OSA, particularly through interventions such as continuous positive airway pressure therapy, may reduce cardiovascular risk and improve long-term health outcomes. Future research should focus on large-scale prospective studies and clinical trials to better understand the causal pathways linking OSA to cardiovascular disease and to evaluate the effectiveness of preventive and therapeutic strategies in diverse populations.

6. LIMITATIONS

This systematic review has several limitations that should be considered when interpreting the findings. First, most of the included studies were observational in design, which limits the ability to establish a definitive causal relationship between obstructive sleep apnea and cardiovascular outcomes. Second, variations in study populations, diagnostic criteria for OSA, and methods used to assess cardiovascular

events introduced heterogeneity across the included studies. Additionally, some studies relied on clinical records or self-reported data, which may be subject to measurement bias and misclassification. Another limitation is that several studies focused on specific patient groups, such as individuals with chronic diseases or hospital-based populations, which may reduce the generalizability of the findings to the broader population. Finally, potential publication bias may exist, as studies reporting significant associations are more likely to be published than those with null findings.

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