e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(11); 1580-1583

Original Research Article

The Relationship between Sleep Apnea Severity and the Risk of Developing Cardiovascular Diseases, Including Hypertension, Arrhythmias, and Heart Failure.

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Received: 25-09-2023 / Revised: 23-10-2023 / Accepted: 18-11-2023

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Conflict of interest: Nil

Abstract:

Background: The correlation between sleep apnea severity and the development of cardiovascular diseases (CVD), including arrhythmias, hypertension, and heart failure (HF), remains a critical area of investigation in medical research. The study investigates the association between sleep apnea severity and cardiovascular diseases to better understand pathophysiological mechanisms and improve prevention and care for at-risk individuals.

Methods: The study involved 124 patients diagnosed with sleep apnea. Participants met inclusion criteria of adults aged 18 years and above with confirmed sleep apnea diagnosis and complete medical records. Data collection included demographic information, sleep apnea severity calculated by the apnea-hypopnea index (AHI), and cardiovascular outcomes determined through clinical diagnosis and diagnostic procedures. Statistical analyses were accomplished using SPSS.

Results: The study cohort had a mean age of 52.8 years and comprised 62% males and 38% females, with a significant proportion classified as overweight or obese. Sleep apnea severity varied, with 38% having mild, 29% moderate, and 33% severe sleep apnea. Hypertension was prevalent in 52% of patients at baseline, with 38% developing hypertension during follow-up. Arrhythmias were detected in 18% of participants, and HF diagnosed in 14%. There were significant associations between sleep apnea severity and the development of hypertension ($p < 0.001$), arrhythmias ($p = 0.023$), and HF ($p = 0.008$), independent of potential confounders.

Conclusion: The findings underscore the significant impact of sleep apnea on cardiovascular health, emphasizing the importance of early detection and management to mitigate risks of hypertension, arrhythmias, and heart failure. Comprehensive approaches integrating sleep and cardiovascular care are recommended to optimize outcomes in individuals with sleep apnea.

Recommendations: Healthcare providers should prioritize screening and management of sleep apnea in individuals with CV risk factors. Multidisciplinary collaboration between sleep medicine specialists and cardiologists is essential for comprehensive assessment and treatment of sleep apnea-related cardiovascular complications.

Keywords: Sleep Apnea, Cardiovascular Diseases, Hypertension, Arrhythmias, Heart Failure, Retrospective Cohort Study.

Introduction

Sleep apnea, a disorder depicted by frequent disturbances in breathing during sleep, has been increasingly recognized for its significant impact on cardiovascular health. The correlation among sleep apnea severity and the risk of developing cardiovascular diseases (CVD), including hypertension, arrhythmias, and heart failure (HF), is a critical area of research that has garnered substantial attention in the medical community [1].

Sleep apnea, particularly its most common form, obstructive sleep apnea (OSA), is categorized by episodes of complete or partial obstruction of the upper airway during sleep, leading to oxygen desaturation and fragmented sleep patterns [1]. The repetitive hypoxia and reoxygenation cycles associated with OSA are believed to contribute to systemic inflammation, oxidative stress, and endothelial dysfunction, which are critical pathways in the development of cardiovascular diseases (CVD) [2].

Several epidemiological studies have established a strong correlation between sleep apnea and

hypertension, a major risk factor for cardiovascular diseases. Peppard et al. [1] demonstrated that individuals with moderate to severe OSA had a notably greater risk of developing hypertension compared to those without OSA. This relationship was dose-dependent, with the risk increasing in tandem with the severity of sleep apnea.

Arrhythmias, including atrial fibrillation, are also closely linked to sleep apnea. The intermittent hypoxemia and sympathetic nervous system activation seen in OSA patients can lead to electrical instability in the heart, predisposing individuals to various types of arrhythmias [3]. Gami and colleagues found that the occurrence of atrial fibrillation was suggestively higher in people with untreated severe OSA compared to individuals without OSA, highlighting the importance of recognizing and managing sleep apnea to prevent arrhythmic complications.

Heart failure is another cardiovascular condition that has been shown to have a bidirectional relationship with sleep apnea. Central sleep apnea (CSA), considered by a lack of respiratory effort during sleep, is particularly prevalent among patients with HF, with the severity of CSA often worsening as HF progresses [4]. The presence of sleep apnea in HF people is related with increased mortality and morbidity, underscoring the need for comprehensive cardiovascular and sleep management strategies in this population.

The aim of the study is to examine the association between the severity of sleep apnea and the risk of developing cardiovascular diseases, including hypertension, arrhythmias, and heart failure, in order to better understand the pathophysiological mechanisms underlying these associations and to inform more effective prevention and management strategies for at-risk populations.

Methodology

Study Design: A retrospective cohort design.

Study Setting: The study was conducted at Jayadeva Instiute of Cardiovascular Sciences & Research, between January 2022 to March 2023.

Participants: The study cohort consists of 124 individuals who were diagnosed with sleep apnea.

Inclusion Criteria: Adults aged 18 years and above with a confirmed diagnosis of sleep apnea based on polysomnography results. Complete medical records, including sleep study data and cardiovascular outcomes, were required for inclusion in the study.

Exclusion Criteria: Patients with incomplete medical records, pre-existing cardiovascular diseases prior to sleep apnea diagnosis, and other chronic respiratory disorders were excluded.

Bias: To minimize bias, consecutive patients diagnosed with sleep apnea during the study period were included in the analysis. Information bias was addressed through rigorous validation of medical records to ensure accuracy and completeness.

Variables: The variable under investigation were sleep apnea severity, categorized as mild, moderate, or severe, the presence or development of cardiovascular diseases, specifically hypertension, arrhythmias, and heart failure.

Data Collection: Data were retrospectively collected from health records, including polysomnography reports, demographic information, medical history, and cardiovascular outcomes. Sleep apnea severity was determined based on the apnea-hypopnea index (AHI) derived from polysomnography. Cardiovascular outcomes were assessed through clinical diagnosis, laboratory tests, and diagnostic procedures such as blood pressure measurements, and electrocardiography (ECG).

Statistical Analysis: Statistical analyses were performed using SPSS version 24, with significance set at $p < 0.05$. Descriptive statistics were utilized to summarize demographic characteristics, sleep apnea severity, and cardiovascular outcomes. Subgroup analyses were conducted based on demographic or clinical characteristics as appropriate.

Ethical Considerations: The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

Result

Table 1: Baseline characteristics

Demographic Characteristics	Values
Age (years), Mean	52.8 (±8.6)
Sex	
Male	62%
Female	38%
Body Mass Index (BMI), Mean	30.2 kg/m^2 (±5.2)
Overweight (BMI 25-29.9)	48%
Obese (BMI ≥ 30)	36%
Smoking History	29%
Regular Alcohol Consumption	18%

Comorbidities	
Diabetes Mellitus	23%
Hyperlipidemia	17%
Obesity-related Hypoventilation Syndrome	12%
Sleep Apnea Severity	
Mild (AHI 5-15 events/hr)	38%
Moderate (AHI 15-30 events/hr)	29%
Severe (AHI > 30 events/hr)	33%

The study cohort had a mean age of 52.8 years (± 8.6) and comprised 62% males and 38% females. The mean BMI was 30.2 kg/m^2 (± 5.2), with 48% of patients classified as overweight and 36% as obese. Smoking history was reported in 29% of patients, while 18% reported regular alcohol consumption. The most common comorbidities were diabetes mellitus (23%), hyperlipidemia (17%), and obesity-related hypoventilation syndrome (12%).

Sleep apnea severity was classified based on the AHI from polysomnography. The distribution of sleep apnea severity in the study cohort was as follows: mild (AHI 5-15 events/hr) in 38%, moderate (AHI 15-30 events/hr) in 29%, and severe (AHI > 30 events/hr) in 33% of patients.

Hypertension was diagnosed in 52% of participants at baseline. Among individuals without hypertension at baseline, 38% developed hypertension during the follow-up period. There was a substantial correlation among sleep apnea severity and the development of hypertension ($p < 0.001$). Patients with severe sleep apnea had a greater occurrence of hypertension.

Arrhythmias were detected in 18% of patients during the study period. Atrial fibrillation was the most common type of arrhythmia observed. Sleep apnea severity was notably correlated with the presence of arrhythmias ($p = 0.023$). People with severe sleep apnea had a higher occurrence of arrhythmias.

Heart failure was diagnosed in 14% of participants during follow-up. The majority of cases were classified as HFpEF. There was a substantial association among sleep apnea severity and the development of heart failure ($p = 0.008$). Participants with severe sleep apnea had a higher occurrence of HF.

Logistic regression assessment was performed to adjust for potential confounders including age, sex, BMI, smoking status, alcohol consumption, and comorbidities. After adjustment, the association between sleep apnea severity and cardiovascular outcomes remained statistically significant, indicating an independent effect of sleep apnea on the development of hypertension, arrhythmias, and heart failure.

Subgroup analyses stratified by age, sex, and BMI were conducted to explore potential effect modification. The association between sleep apnea severity and cardiovascular outcomes was consistent across subgroups, suggesting that the relationship was not influenced by these demographic factors.

Discussion

The study findings reveal a cohort characterized by a middle-aged population with a notable prevalence of overweight and obesity, along with common comorbidities such as diabetes mellitus, hyperlipidemia, and obesity-related hypoventilation syndrome. Sleep apnea severity, determined by the AHI, demonstrated a substantial association with the development of hypertension, arrhythmias, and HF. Patients with severe sleep apnea exhibited a higher occurrence of these cardiovascular conditions compared to those with milder forms of sleep apnea.

Importantly, logistic regression analysis adjusting for potential confounders affirmed an independent effect of sleep apnea on cardiovascular outcomes. Subgroup analyses further supported these findings, suggesting that demographic factors such as age, sex, and BMI did not modify the relationship between sleep apnea severity and cardiovascular risks. These results underscore the clinical significance of identifying and managing sleep apnea to mitigate the associated cardiovascular complications, highlighting the need for targeted interventions to reduce the burden of cardiovascular diseases in individuals with sleep apnea.

Research on the interplay between OSA and CVD has highlighted the potential for innovative treatments and the necessity for integrated care approaches. Studies such as the systematic review on the prospects of mandibular advancement devices suggest these could become a standard treatment for OSA, potentially reducing cardiovascular comorbidities and mortalities [5]. Clinical practice recommendations emphasize the importance of collaborative efforts in the screening, diagnosis, and treatment of co-existing conditions like type 2 DM and OSA to enhance patient care and potentially mitigate cardiovascular risks [6].

Research findings indicate a significant correlation between the severity of OSA and the presence of comorbidities, including those related to cardiovascular health, underscoring the critical need for comprehensive managment strategies [7]. Moreover, studies evaluating OSA in the context of metabolic syndrome highlight the association with higher levels of metabolic dysfunction, further emphasizing the cardiovascular implications of OSA [8]. The growing body of evidence, including discussions on the urgent need for routine screening and the implementation of effective treatment strategies to alleviate OSA-related symptoms and decrease adverse cardiovascular risks, underscores the critical importance of addressing this condition [9].

Conclusion

The study provides evidence of a noteworthy association between sleep apnea severity and the risk of developing cardiovascular diseases, including hypertension, arrhythmias, and HF. These findings underscore the importance of early detection and management of sleep apnea in mitigating the cardiovascular consequences associated with the disorder. Further research is warranted to explore mechanisms underlying this association and to evaluate the impact of sleep apnea treatment on cardiovascular outcomes.

Limitations: The limitations of this study include a small sample population who were included in this study. The findings of this study cannot be generalized for a larger sample population. Furthermore, the lack of comparison group also poses a limitation for this study's findings.

Recommendation: Healthcare providers should prioritize screening and management of sleep apnea in individuals with CV risk factors. Multidisciplinary collaboration between sleep medicine specialists and cardiologists is essential for comprehensive assessment and treatment of sleep apnea-related cardiovascular complications.

Acknowledgement: We are thankful to the patients; without them the study could not have been done. We are thankful to the supporting staff of our hospital who were involved in patient care of the study group.

List of abbreviations:

1. CVD: Cardiovascular Diseases
2. HF: Heart Failure
3. HFpEF: Heart Failure with Preserved Ejection Fraction
4. HFrEF: Heart Failure with Reduced Ejection Fraction
5. OSA: Obstructive Sleep Apnea
6. AHI: Apnea-Hypopnea Index
7. BMI: Body Mass Index
8. DM: Diabetes Mellitus
9. ECG: Electrocardiography

Source of Funding: No funding received.

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