

## ORIGINAL RESEARCH

### **To evaluate the relationship between the severity of obstructive sleep apnoea and systemic hypertension**

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Received: 21 September, 2020

Accepted: 4 October, 2020

#### **ABSTRACT**

**Background:** Patients with obstructive sleep apnoea (OSA) have a strong association with acute cardiovascular events and chronic conditions such as systemic hypertension, coronary artery disease, and heart failure.

**Aim and objectives:** To evaluate the relationship between the severity of obstructive sleep apnoea and systemic hypertension.

**Materials and Methods:** This study employed a cross-sectional design to assess the correlation between the severity of obstructive sleep apnoea (OSA) and systemic hypertension in adults. A total of 100 adult participants aged 30 to 65 years, diagnosed with obstructive sleep apnoea, were included in the study. The inclusion criteria consisted of adults diagnosed with obstructive sleep apnoea confirmed by polysomnography, participants with a diagnosis of systemic hypertension confirmed by at least three measurements taken on different days, and participants who provided informed consent. The severity of OSA was determined using overnight polysomnography. Three readings were taken at each visit using a calibrated sphygmomanometer, and the average of these readings was recorded.

**Results:** The severity of OSA among participants was categorized based on the Apnoea-Hypopnea Index (AHI). The distribution was as follows: 30% of the participants had mild OSA (AHI 5-14, n=30), 40% had moderate OSA (AHI 15-29, n=40), and 30% had severe OSA (AHI  $\geq$  30, n=30). The distribution was: 20% had normal blood pressure (n=20), 25% were classified as having prehypertension (n=25), 35% had hypertension stage 1 (n=35), and 20% had hypertension stage 2 (n=20). This distribution shows a significant portion of the study population suffering from elevated blood pressure, with a majority falling into the prehypertension and hypertension categories. The correlation analysis between AHI and blood pressure levels revealed significant positive correlations. The Pearson's correlation coefficient for AHI versus systolic blood pressure was 0.45 ( $p < 0.001$ ), and for AHI versus diastolic blood pressure, it was 0.41 ( $p < 0.001$ ). These results indicate a moderate positive correlation, suggesting that as the severity of OSA increases, both systolic and diastolic blood pressure levels tend to increase. The statistical significance ( $p < 0.001$ ) underscores the robustness of this association, highlighting the potential impact of OSA on systemic hypertension.

**Conclusion:** We concluded that the significant correlation between the severity of obstructive sleep apnoea and systemic hypertension. The positive correlations and significant regression coefficients suggest that as the severity of OSA increases, so do the levels of both systolic and diastolic blood pressure.

**Keywords:** Obstructive sleep apnoea, Hypertension, Systolic, Diastolic blood pressure.

#### **Introduction**

Obstructive sleep apnoea (OSA) is a prevalent sleep disorder characterized by repetitive episodes of complete or partial obstruction of the upper airway during sleep, leading to intermittent hypoxia, sleep fragmentation, and reduced sleep quality. The condition affects millions of individuals worldwide and is increasingly recognized as a significant public health issue due to its association with various adverse health outcomes. One of the critical health concerns linked to OSA is systemic hypertension, which is a major risk factor for cardiovascular diseases, including heart attacks, stroke, and heart

failure.<sup>1,2</sup> It is now well known that obstructive sleep apnea (OSA) is one of the most common secondary causes of blood pressure (BP) elevation.<sup>3</sup> OSA contributes to the development and exacerbation of hypertension through several mechanisms. The intermittent hypoxia caused by repeated apnoea's and hypopneas can activate the sympathetic nervous system, leading to increased blood pressure. Additionally, the frequent arousals from sleep can result in sleep fragmentation, which further stimulates sympathetic activity and impairs the body's ability to regulate blood pressure. Chronic exposure to these stressors can lead to sustained hypertension and associated cardiovascular complications.<sup>4</sup>

Given the potential for OSA to significantly impact blood pressure regulation and contribute to the development of systemic hypertension, it is essential to understand the correlation between the severity of OSA and hypertension. Determining this relationship can provide valuable insights into the management and treatment of patients with OSA, particularly those who are at risk for or already have hypertension. It can also inform clinical guidelines and public health strategies aimed at reducing the burden of these interrelated conditions.<sup>5,6</sup>

This study aims to assess the correlation between the severity of OSA, as measured by the Apnoea-Hypopnea Index (AHI), and systemic hypertension in a cohort of adults. By evaluating the degree to which OSA severity influences blood pressure levels, the study seeks to clarify the extent of this relationship and identify key factors that may contribute to the observed associations. Understanding these dynamics can help in developing targeted interventions to manage both OSA and hypertension more effectively, ultimately improving patient outcomes and reducing the risk of cardiovascular diseases.

#### **Aim and objectives**

To evaluate the relationship between the severity of obstructive sleep apnoea and systemic hypertension.

#### **Materials and Methods**

The present cross-sectional study included 100 adult participants aged 30 to 65 years, diagnosed with obstructive sleep apnoea of both genders in the Department of Cardiology, Indira Gandhi Institute of Medical Sciences, Sheikhpura, Patna, Bihar, India. The duration of the study was from July 2016 to June 2017. The research protocol received approval from the Institutional Ethical Committee. All research participants who were included in the trial provided informed written consent. Data such as name, age, gender, etc. was recorded.

#### **Inclusion criteria**

- Patient's age between 30 to 65 years, diagnosed with obstructive sleep apnoea, were included in the study.
- Patients diagnosed with obstructive sleep apnoea confirmed by polysomnography.
- patients with a diagnosis of systemic hypertension confirmed by at least three measurements taken on different days.
- Patients to give written informed consent.
- Available for follow up.

#### **Exclusion criteria**

- Patients with other sleep disorders or significant comorbid conditions such as chronic obstructive pulmonary disease (COPD) or heart failure.
- Patients on medication that significantly alters blood pressure, such as corticosteroids or beta-blockers.
- Pregnant women.
- Patients who do not give written informed consent.
- Those unable to attend follow-up.

This study employed a cross-sectional design to assess the correlation between the severity of obstructive sleep apnoea (OSA) and systemic hypertension in adults. Participants were recruited from the sleep clinics and general outpatient departments of the affiliated hospitals. Patients who met the inclusion criteria were approached, and those willing to participate were enrolled after providing informed consent. The severity of OSA was determined using overnight polysomnography. The Apnoea-Hypopnea Index (AHI) was calculated, which is the number of apnoea's and hypopneas per

hour of sleep. Based on AHI, participants were categorized into three groups: mild OSA (AHI of 5-14 events per hour), moderate OSA (AHI of 15-29 events per hour), and severe OSA (AHI  $\geq$  30 events per hour). Blood pressure was measured using a standardized protocol. Three readings were taken at each visit using a calibrated sphygmomanometer, and the average of these readings was recorded. Participants were categorized based on the following criteria: normal blood pressure (systolic BP < 120 mmHg and diastolic BP < 80 mmHg), prehypertension (systolic BP 120-139 mmHg or diastolic BP 80-89 mmHg), hypertension stage 1 (systolic BP 140-159 mmHg or diastolic BP 90-99 mmHg), and hypertension stage 2 (systolic BP  $\geq$  160 mmHg or diastolic BP  $\geq$  100 mmHg). Data were collected on demographic variables (age, sex, body mass index), clinical history (duration of OSA, treatment history), and lifestyle factors (smoking, alcohol consumption). The main variables of interest were the severity of OSA (measured by AHI) and the level of systemic hypertension (measured by systolic and diastolic blood pressure).

**Statistical Analysis**

Data were analyzed using SPSS and Microsoft excel. Descriptive statistics, including mean and standard deviation, were used to describe continuous variables, while frequencies and percentages were used for categorical variables. Pearson’s or Spearman’s correlation coefficient was used to assess the relationship between AHI and blood pressure levels. Multiple linear regression analysis was performed to evaluate the association between the severity of OSA (independent variable) and systemic hypertension (dependent variable), adjusting for potential confounders such as age, sex, BMI, and lifestyle factors. A p-value of <0.05 was considered statistically significant.

**Results**

**Table I: Demographic and Clinical Characteristics**

Variable	N=100, Mean $\pm$ SD	Percentage (%)
Mean age (years)	47.8 $\pm$ 8.5	
Body Mass Index (BMI), Kg /m <sup>2</sup>	28.4 $\pm$ 3.6	
Male	58	58%
Female	42	42%
Smoking	35	35%
Alcohol Consumption	40	40%

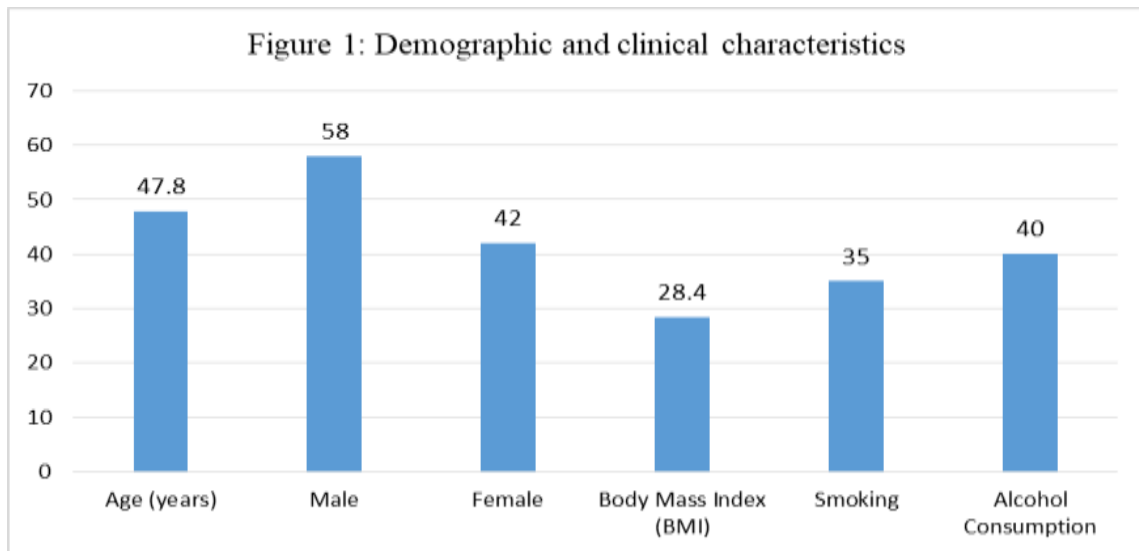


Table I and figure 1 shows the demographic and clinical characteristics of 100 participants, the mean age is 47.8 years (SD = 8.5). The gender distribution showed that 58% of the participants were male (n=58) and 42% were female (n=42). The mean Body Mass Index (BMI) of the participants was 28.4 kg/m<sup>2</sup> (SD = 3.6), indicating that the average participant was overweight. Lifestyle factors revealed that 35% of the participants were smokers (n=35) and 40% consumed alcohol (n=40). These

demographic and clinical characteristics provide a comprehensive overview of the participant population, highlighting the presence of common risk factors such as smoking and high BMI, which are relevant to both obstructive sleep apnoea (OSA) and hypertension.

**Table II: Severity of Obstructive Sleep Apnoea**

OSA Severity	Number (%)
Mild (AHI 5-14)	30 (30%)
Moderate (AHI 15-29)	40 (40%)
Severe (AHI ≥ 30)	30 (30%)

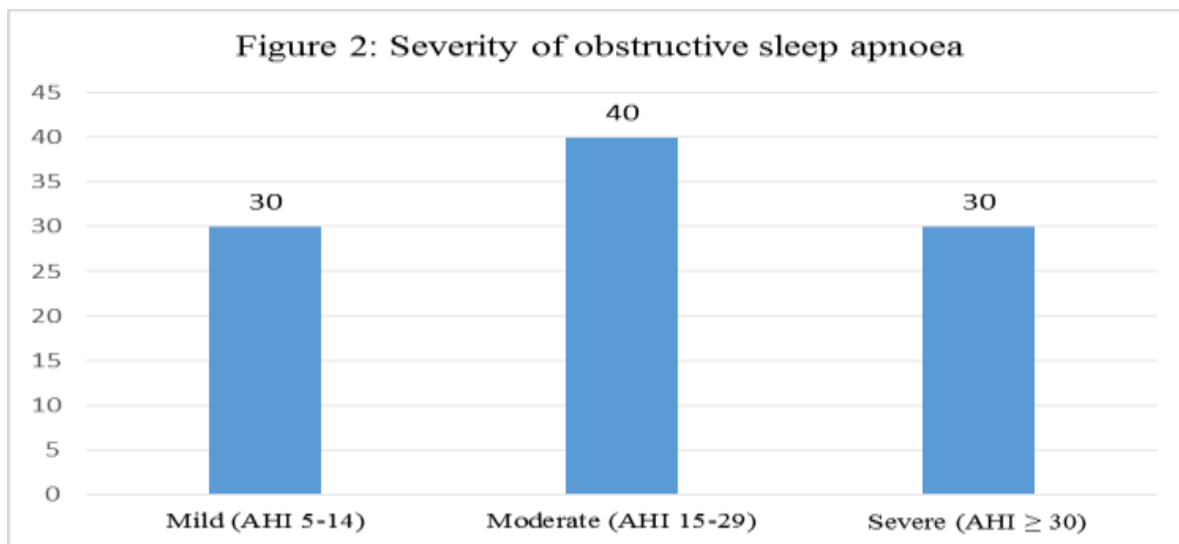
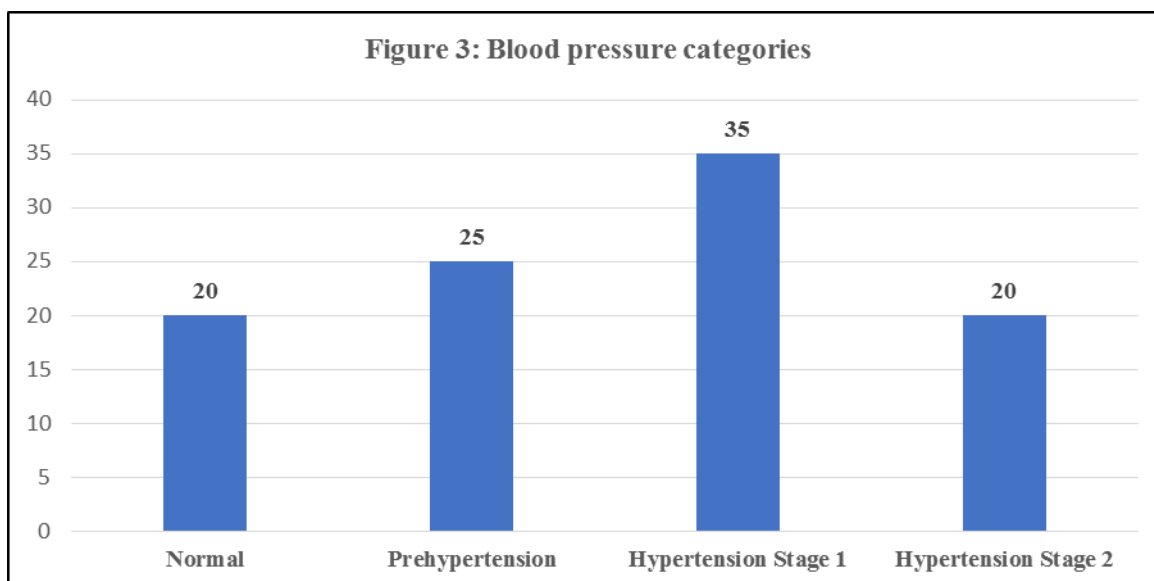


Table II and figure 2 shows the severity of OSA among participants was categorized based on the Apnoea-Hypopnea Index (AHI). The distribution was as follows: 30% of the participants had mild OSA (AHI 5-14, n=30), 40% had moderate OSA (AHI 15-29, n=40), and 30% had severe OSA (AHI ≥ 30, n=30). This indicates a balanced representation of all severities of OSA within the study population, allowing for a robust analysis of how varying levels of OSA severity correlate with systemic hypertension.



**Table III: Blood Pressure Categories**

Blood Pressure Category	Number (%)
Normal	20 (20%)
Prehypertension	25 (25%)
Hypertension Stage 1	35 (35%)
Hypertension Stage 2	20 (20%)

Participants were also categorized based on their blood pressure levels showed in table III and figure 3. The distribution was: 20% had normal blood pressure (n=20), 25% were classified as having prehypertension (n=25), 35% had hypertension stage 1 (n=35), and 20% had hypertension stage 2 (n=20). This distribution shows a significant portion of the study population suffering from elevated blood pressure, with a majority falling into the prehypertension and hypertension categories. This is critical for examining the relationship between OSA severity and the extent of hypertension.

**Table IV: Correlation Analysis**

Variable	Pearson's Correlation Coefficient (r)	p-value
AHI vs. Systolic BP	0.45	<0.001
AHI vs. Diastolic BP	0.41	<0.001

The correlation analysis between AHI and blood pressure levels revealed significant positive correlations in table IV. The Pearson's correlation coefficient for AHI versus systolic blood pressure was 0.45 ( $p < 0.001$ ), and for AHI versus diastolic blood pressure, it was 0.41 ( $p < 0.001$ ). These results indicate a moderate positive correlation, suggesting that as the severity of OSA increases, both systolic and diastolic blood pressure levels tend to increase. The statistical significance ( $p < 0.001$ ) underscores the robustness of this association, highlighting the potential impact of OSA on systemic hypertension.

**Table V: Multiple Linear Regression Analysis**

Predictor Variables	Coefficient ( $\beta$ )	Standard Error (SE)	p-value
AHI	0.52	0.10	<0.0001
Age	0.18	0.05	0.00032
BMI	0.32	0.08	0.00006
Smoking	0.15	0.06	0.0124
Alcohol Consumption	0.12	0.07	0.0872

Table V shows the multiple linear regression analysis which was conducted to further explore the relationship between OSA severity and blood pressure levels, while adjusting for potential confounders such as age, BMI, smoking, and alcohol consumption. The results showed that AHI was a significant predictor of both systolic and diastolic blood pressure levels, with a coefficient ( $\beta$ ) of 0.52 (SE = 0.10,  $p < 0.0001$ ). This strong association suggests that higher AHI values are associated with higher blood pressure levels, even after controlling for other variables. Other significant predictors included age ( $\beta = 0.18$ , SE = 0.05,  $p = 0.00032$ ), BMI ( $\beta = 0.32$ , SE = 0.08,  $p = 0.00006$ ), smoking ( $\beta = 0.15$ , SE = 0.06,  $p = 0.0124$ ), and alcohol consumption ( $\beta = 0.12$ , SE = 0.07,  $p = 0.0872$ ). These findings indicate that older age, higher BMI, smoking, and alcohol consumption also contribute to higher blood pressure levels. However, the effect of AHI remains significant and strong, reinforcing the critical role of OSA severity in influencing systemic hypertension.

## Discussion

In this study, the demographic profile of the participants, including a mean age of 47.8 years and a predominant male representation (58%), aligns with the typical population affected by obstructive sleep apnoea (OSA). This finding is consistent with other studies, such as Young et al.<sup>6</sup> which identified a higher prevalence of OSA in middle-aged men. The mean BMI of 28.4 kg/m<sup>2</sup> indicates that the participants were generally overweight, a common risk factor for both OSA and hypertension. This association between BMI and OSA has been extensively documented, with Peppard et al.<sup>7</sup> noting that higher BMI is a significant predictor of OSA severity.

The prevalence of smoking (35%) and alcohol consumption (40%) among participants also reflects established risk factors for OSA. Smoking has been shown to increase the risk of developing OSA by promoting upper airway inflammation and increasing fluid retention, as reported by Wetter et al.<sup>8</sup>

Similarly, alcohol consumption, particularly before bedtime, exacerbates OSA symptoms by relaxing the upper airway muscles, as noted by Taasan et al.<sup>9</sup> These lifestyle factors are critical in understanding the overall health profile of individuals with OSA and their potential impact on systemic hypertension.

The distribution of OSA severity in this study (30% mild, 40% moderate, 30% severe) provides a balanced representation, enabling a robust analysis of the correlation between OSA severity and hypertension. This distribution is comparable to findings in other research, such as the study by Punjabi et al. (2004),<sup>10</sup> which also reported similar proportions of mild, moderate, and severe OSA in their cohort. The balanced representation is crucial for examining the gradation of risk associated with increasing OSA severity.

The categorization of participants based on blood pressure levels revealed that a significant portion of the study population had elevated blood pressure, with 35% in hypertension stage 1 and 20% in hypertension stage 2. This high prevalence of hypertension among OSA patients is consistent with previous research, such as the Sleep Heart Health Study, which found a strong association between OSA and increased risk of hypertension. The distribution underscores the importance of monitoring blood pressure in individuals with OSA to prevent cardiovascular complications.

The positive correlations observed between the Apnoea-Hypopnea Index (AHI) and both systolic ( $r = 0.45$ ) and diastolic blood pressure ( $r = 0.41$ ) indicate a moderate relationship. These findings align with previous studies, such as those by Nieto et al. (2000), which also found significant correlations between OSA severity and elevated blood pressure. The statistical significance of these correlations ( $p < 0.001$ ) emphasizes the robustness of the association and supports the hypothesis that more severe OSA contributes to higher blood pressure levels.<sup>11</sup>

The multiple linear regression analysis further corroborates the significant impact of OSA severity on blood pressure. The coefficient for AHI ( $\beta = 0.52$ ,  $p < 0.0001$ ) suggests that higher AHI values are strongly associated with increased blood pressure, even after adjusting for confounding variables. This finding is consistent with the study by Bixler et al.<sup>12</sup> which demonstrated a similar independent effect of OSA on hypertension. The regression analysis also identified other significant predictors of hypertension, including age ( $\beta = 0.18$ ,  $p = 0.00032$ ), BMI ( $\beta = 0.32$ ,  $p < 0.00006$ ), smoking ( $\beta = 0.15$ ,  $p = 0.0124$ ), and alcohol consumption ( $\beta = 0.12$ ,  $p = 0.0872$ ). These factors are well-documented contributors to hypertension and are consistent with findings in broader epidemiological studies, such as those reported by Kannel et al.<sup>13</sup> and Stamler et al. (1993).<sup>14</sup>

Comparing these results with other studies reinforces the significant relationship between OSA and systemic hypertension. The Sleep Heart Health Study found that individuals with severe OSA had a markedly higher risk of developing hypertension compared to those without OSA. Additionally, the Wisconsin Sleep Cohort Study by Peppard et al.<sup>7</sup> reported a dose-response relationship between OSA severity and the risk of developing hypertension.

#### **Limitation(s) of the study**

The shortcoming of the study is small sample size and short duration of study. Hence the resulting statistics might not accurately represent the population. Future studies incorporating larger sample sizes and multicentre collaborations could further validate and extend our results.

#### **Conclusion**

We concluded that the significant correlation between the severity of obstructive sleep apnoea and systemic hypertension. The positive correlations and significant regression coefficients suggest that as the severity of OSA increases, so do the levels of both systolic and diastolic blood pressure. Additionally, age, BMI, smoking, and alcohol consumption were also significant predictors of blood pressure levels. These findings highlight the importance of managing OSA not only to improve sleep quality but also to potentially mitigate the risk of developing or exacerbating systemic hypertension.

#### **Acknowledgement**

I am immensely grateful to all faculties and co-workers of the Department of Cardiology, Indira Gandhi Institute of Medical Sciences, Patna, Bihar, India, for their support and valuable suggestions. I am especially thankful to Dr. (Prof.) B. P. Singh, Head of Department, Department of Cardiology, Indira Gandhi Institute of Medical Sciences, Patna, Bihar, India, for their support and valuable suggestions.

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