ORIGINAL ARTICLE

# Difference in Sleep Apnea Pattern According to Body Mass Index (BMI): A Cohort Study in a Tertiary Care Center-Rawalpindi

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## ABSTRACT

**Objective:** To evaluate the prevalence of Obstructive Sleep Apnea (OSA) using polysomnography (PSG) in symptomatic Pakistani patients and assess its association with demographic factors (age, sex, BMI) and obesity.

**Study Design**: Retrospective cohort study.

**Place and Duration of Study**: This study was conducted at the Department of Pulmonology and Sleep Studies, Pak Emirates Military Hospital (PEMH), Rawalpindi, Pakistan from April 2021 to April 2023.

**Methods**: A total of 577 clinically suspected Obstructive Sleep Apnea patients underwent sleep studies in our sleep study departments using Convenience Sampling. Polysomnography (PSG) was carried out with the Philips Respironics Alice Night One device using 1 RIP effort belt and a pressure-based flow sensor. Heart rate, oxygen saturation, apnea (Mixed, Central, Obstructive), hypopnea episodes, and Apnea/hypopnea index (AHI) were recorded in all individuals. AHI > 5 was cut off for diagnosis of OSA, as all symptomatic patients were included in this study. The patients with AHI>5 were further divided into three groups: Mild Apnea/hypopnea index (AHI 5-15), Moderate Apnea/hypopnea index (AHI 15-30), and Severe (AHI >30). Chi-square tests were used for the analysis of data.

**Results**: 577 clinically suspected OSA patients were included in this study, among whom 379 (65.7%) were males and 198 (34.3%) were females. The Mean age of patients was 50.23 (SD- 12.56), and the mean BMI was 33.06 (SD -6.52). There was no significant relationship between gender and obesity seen in our study. Patients with higher BMI exhibited a significant positive correlation (*P*-value <0.001).

**Conclusion**: Higher BMI showed a direct relationship with the severity of obstructive sleep apnea, manifested by a higher apnea hypopnea index and increased duration and severity of desaturation.


**Keywords**: *Apnea, Body Mass Index (BMI), Obesity, Obstructive Sleep Apnea (OSA), Polysomnography (PSG).*

***How to cite this:*** *Ali K, Arshad AA, Imran M, Khaliq A, Rashid A, Raza H. Difference in Sleep Apnea Pattern According to Body Mass Index (BMI): A Cohort Study in a Tertiary Care Center-Rawalpindi. Life and Science. 2025; 6(2): 261-265. doi: http://doi.org/10.37185/LnS.1.1.414*



## Introduction

In developing countries, data regarding sleeping disorders is not readily available. A very small number of studies have been conducted to date, and scant literature is available. One reason could be the expensive medical management, and resource scarcity can contribute to the figures, educational level, and limited understanding or knowledge of the general population. Sleep disorders, including Obstructive Sleep Apnea (OSA), are one of the common problems in our society, which is under-reported due to a lack of awareness in the general public and a lack of medical facilities in major health centers in the country. The OSA should be picked up early because it can lead to many secondary health problems, including hypertension, ischemic heart disease, obesity, diabetes mellitus, insomnia, mental health disorders, and road traffic accidents.[1] OSA is important sleep disorder. The pathophysiology of obstructive sleep apnea is complex and important to understand as misdiagnosis or late diagnosis can lead to serious medical condition.[2]

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*Received: Jun 01, 2024; 1st Revision Received: Nov 22, 2024*
*2nd Revision Received: Mar 10, 2025; Accepted: Mar 18, 2025*

OSA is defined as a disorder of repetitive blockage of the upper airway during the sleep cycle due to collapse of the soft tissues of the upper airway tract during sleep. The recurrent episodes of breathing cessation during sleep leads to more awakening episodes, snoring, sleep disturbance of patient as well as his or her partner, episodes of apnea and hypopnea at night leading to excessive day time sleeping, morning headache, adversely affecting daily activities of life, less productivity at day time and secondary health related issues as already discussed due to lack of good oxygenation due to repeated episodes of apnea and hypopnea increases stress hormones release.[3] This disorder of sleep is more common in males as compared to female gender. Its prevalence is more in older individuals and increasing with increasing age.[4]

According to international literature approximately 936 million populations is suffering with OSA around the globe among which 425 million belongs to age group of 30 to 69 years of age.[5] Its prevalence is increasing day by day, according to study the prevalence of OSA is increased from 11 to 14 % in last two decades in male population and 4 to 5 % in female population. The prevalence in American and Asian population is equal despite having low BMI in Asian population. So some other factors also play role in pathophysiology of OSA along with BMI.[6] According to a local study of Karachi Pakistan, the prevalence in Pakistani population was 10 to 12.4%, calculated on the basis of Berlin questionnaire.[7]

Sleep studies (PSG) is gold standard test to diagnose OSA. In this diagnostic test different parameters are checked during the period of sleep with the help of different probes attached to the patient and record the activity of patient during sleep including oxygen saturation, heart rate, number of apnea, hypopnea and snoring episodes.[8] Different additional tools including careful history taking, ENT evaluation (upper airway anatomy), mallampati score, Epworth sleepiness scale, and Berlin questionnaire, also help in diagnosis of OSA.[9]

This study aims to assess the Pakistani population presenting with clinical signs and symptoms of Obstructive Sleep Apnea (OSA) and to confirm the diagnosis using polysomnography (PSG). Additionally, it examines demographic factors such as age, sex, BMI, and the association between obesity and OSA through sleep studies in patients reporting relevant complaints at the hospital.

## Methods

This study was conducted at the Department of Pulmonology and Sleep Studies, Pak Emirates Military Hospital (PEMH), Rawalpindi, Pakistan after taking ethical approval from the Ethical Review Committee of hospital vide letter no: A/28/EC/528/21, held on 23rd March 2021. A total of 577 clinically suspected OSA patients underwent sleep studies in our sleep laboratory using convenience sampling. As this was a retrospective cohort study which is an observational study where researchers look back in time to investigate whether an exposure is associated with an outcome. The sample size was determined by the feasibility approach, encompassing all eligible patients who completed polysomnography (PSG) during the study period from April 2021 to April 2023 (24 months). The patients included in this study were 18 years and older. The data was collected based on the

Inclusion Criteria: Symptomatic patients referred for PSG (all with AHI >5).

Exclusion Criteria: Patients with incomplete PSG data or AHI ≤5 (if asymptomatic). The study was recorded on a Philips Respironics Alice Night One device using 1 RIP effort belt and a pressure-based flow sensor. The heart rate is derived from the pulse oximeter sensor, and the snoring signal is derived from the pressure sensor. The device also records body position and uses it to determine the monitoring time (sleep/wake periods). AHI > 5 was cut off for the diagnosis of OSA. The patients with AHI>5 were further divided into three groups Mild (AHI 5-15), Moderate (AHI 15-30) and Severe (AHI >30). Patients were grouped as per WHO BMI criteria into underweight (BMI< 18.5), normal weight (BMI 18-25), overweight (BMI 25-29.9), and obese groups (BMI >30). Different variables were analyzed using SPSS version 23, including sex, age, BMI, heart rate, saturation, and sleep study parameters. Different descriptive statistics were applied, including mean, frequencies; chi-square tests were also used to analyze data. *A P-value* of < 0.05 was considered statistically significant.

## Results

In our study, we took 577 patients, among whom 379

(65.7%) were males and 198 (34.3%) were females. The mean age of patients was 50.23 years (SD-12.56), and the mean BMI was 33.06 (SD -6.52). Out of these patients, 2 (0.3%) were underweight, 54 (9.4%) had normal weight, 139 (24.1%) were overweight, and 382 (66.2%) were obese. Out of total patients 479 (83.0%) were with AHI>5 and the remaining 98 (17.0%) were with Apnea/hypopnea index AHI<5. As per the value of AHI, 163 (28.2%) patients were mild, 113 (19.5%) moderate, and 203 (35.2%) had a severe problem. It was also seen that BMI directly correlated with different types of apneas. With increasing BMI, central apnea, obstructive apnea, mixed, and hypopnea also increases (*P* value <0.001) as shown in figure.1. The mean recording time was 257.93 (SD-85.22) minutes and the total snoring episodes in this time were 102.57 (SD- 142.8) with a duration of snoring was 22.34 (SD- 37.95) minutes. The mean of the lower limit of saturation (Desaturation during sleep studies) was 76.99 % (SD- 13.23) and the mean of the lowest heart rate was 57.33 (SD - 11.5) (range:19-97/ minute) and the highest heart rate was 106.53 (SD-27.4) (range:61-255/ minute).

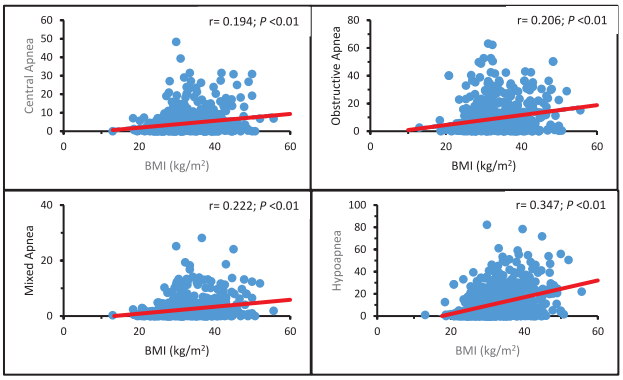


**Fig.1: Relationship of BMI with Apnea and Hypoapnea**

## Discussion

Obstructive Sleep Apnea (OSA) is characterized by recurrent episodes of obstruction in the upper airway during sleeping hours, resulting in poor oxygenation of blood and lack of gas exchange, leading to multiple episodes of awakening during the sleep cycle, causing morning headache, excessive sleep during the day, and fatigue.[10] OSA is a common sleep disorder which is under-reported as well as underdiagnosed in our society due to a lack of awareness, education, economic conditions, and lack of medical facilities. Undiagnosed cases can lead to deleterious effects on the body. Timely diagnosis has favorable outcomes and is easy to treat with fewer complications.[11]

As per guidelines, apnea is defined as complete or near-complete blockage (>90%) of the flow of air in the upper respiratory tract during sleeping, and it is further classified into Central, Obstructive, or Mixed apnea depending upon the underlying cause.[12] Hypopnea is defined as a reduction of airflow during sleep, leading to awakening episodes during sleep cycles or a drop in oxygen saturation during sleep. The reduction of around 30% in flow of air is seen in hypopnea.

As with advancement in the health sector and general public awareness regarding OSA, many questionnaires have been formulated which are easy to use and patients can self-report. Standardized questionnaires such as the Epworth Sleepiness Scale (ESS), Berlin Questionnaire (BQ), and STOP-BANG are valuable tools for assessing daytime sleepiness and sleep quality. In resource-limited settings like Pakistan, these screening instruments can help identify high-risk patients for obstructive sleep apnea (OSA), thereby optimizing polysomnography (PSG). Given that PSG is a costly test with limited availability across healthcare centers, targeted utilization in patients with high clinical suspicion of OSA based on these questionnaires would ensure more efficient diagnostic stratification.[13]

Our study showed that most of the patients presented to our sleep study department with clinical obstructive sleep apnea had an AHI> 5, the majority of them were male, and there was no significant association between gender and OSA seen in our study. Patients with higher BMI had a direct relationship with OSA. Disease severity was also higher with increasing BMI. Obese patients showed a direct relationship with different types of apneas (Central, Obstructive, Mixed, and hypopnea). Snoring episodes and duration were higher in obese patients. Sleep study findings were seen more in the elderly population.

The American College of Physicians formulated guidelines in 2014. And recommend sleep studies in patients with complaints of day time sleepiness.[14] The Gold standard investigation to diagnose patients with OSA is sleep studies (Polysomnography), and as

per guidelines, it should be offered to all patients with suspected OSA or patients with clinical signs and symptoms of OSA.[15] As per the literature, the prevalence of OSA is higher in obese patients than in patients with a normal BMI score or overweight individuals.[16]

According to JH Park et al.'s study published in the Korean Journal of Family Practice, no positive relationship between age and sex was noticed. The severe AHI and higher number of desaturation episodes were seen in obese patients as compared to the non-obese population. Our study also showed similar results. JH Park et al. also included other parameters like ESS and otorhinolaryngological findings of patients in their research, which differs from our study as no such parameters were studied in our population.[17]

Sultan et al. from a private sector hospital concluded in their study that OSA was more severe in patients with higher BMI. The average age was 50.84 years, and the mean BMI was 34.7. Age of patients was statistically significant (P<0.000) for OSA, as increasing age showed more severity as compared to the younger population. The gender was not significant statistically the results of our study are also similar to this study.[18]

Samson et al. studied the relationship between different comorbidities, including metabolic syndrome, heart failure, diabetes mellitus, and hypertension, with OSA. None of these parameters and the relationship among these co-morbidities with OSA were studied by us.[19]

MR Bonsignore et al. studied sleep apnea based on gender. According to his study on the clinical presentation, pathophysiology, the presence of co morbidities and response to treatment is markedly different in both genders and marked difference noticed in males and females. The prevalence of OSA was two times in post-menopause females as compared to the younger age group. The episodes of snoring in pregnant females increase with increasing gestational age. Males showed more episodes of snoring, whereas females showed more daytime sleep and fatigue. The compliance and adherence to treatment for OSA was similar in both genders.[20]

Taj et al. conducted a study in the Pakistani population based on the Berlin Questionnaire and identified the patients who were at higher risk of developing OSA in the future. According to this study, the prevalence of OSA is increasing in the Pakistani population, and we need more public awareness, and our physicians should pick up the condition early to minimize the deleterious long-term effects of this disorder.[21]

This study is single-centered and has limited patients due to a lack of awareness, education, and affordability regarding procedural diagnostic investigations.

As it was a retrospective study, patients' data regarding co-morbidities, otorhinolaryngological parameters, and the Epworth sleepiness scale were missing.

## Conclusion

Higher BMI showed direct relationship with severity of obstructive sleep apnea, manifested by higher apnea hypopnea index, increase duration and severity of desaturation.

**Acknowledgement:** We recognize and appreciate the vital contribution of our sleep studies lab technician, Mr. Javed, to collecting data for this research work.

**Conflict of Interest**: The authors declare no conflict of interest

**Grant Support and Financial Disclosure**: None

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**Author Contributions**

**KA:** Conception and design of the work, data acquisition, curation, and statistical analysis
**ARA**: Revising, editing, and supervising for intellectual content
**MI**: Validation of data, interpretation, and write-up of results
**AK**: Writing original draft (methodology, investigation), validation of data, interpretation, and write-up of results, revising, editing, and supervising for intellectual content
**AR**: Conception and design of the work, writing original draft (methodology, investigation)
**HR**: Data acquisition, curation, and statistical analysis