Tracing the Complete Journey of Patient Compliance in Obstructive Sleep Apnea Management: A 12-Year Retrospective Study at Rashid Hospital on Diagnosis, Device Adherence, and Treatment Outcomes

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Abstract

Background: The incidence of obstructive sleep apnea (OSA) is rising globally, with significant health repercussions. Current research falls short in chronicling the complete trajectory of OSA management—specifically, the intricacies of patient adherence to device therapy post-diagnosis. This study aims to bridge this gap by providing a detailed analysis of the journey from diagnosis to consistent therapeutic device use, identifying potential delays and patterns of adherence.

Methodology: A retrospective observational study was conducted at Rashid Hospital's sleep study lab, Dubai, UAE, spanning from 2010 to 2022 and encompassing 1,949 patients. Data were extracted from the hospital's Healthcare Information System, focusing on demographics, sleep study results, and device usage patterns. Analysis utilized Python's Pandas library to evaluate compliance and treatment efficacy.

Results: The study revealed that 83.4% of patients visiting the sleep lab were diagnosed with OSA. Of these, 33.0% purchased a therapeutic device, but only 19.7% of the total population adhered to the recommended device usage. Treatment led to a decrease in AHI to below 5 in 26.5% of the total patient cohort. The results also demonstrated an increasing trend in OSA diagnosis over the years and identified delays in treatment initiation and varied adherence levels.

Conclusion: The study addresses a significant gap by detailing the patient journey from OSA diagnosis to treatment, highlighting delays in device acquisition and challenges in adherence. It underscores the need for integrated care models that consider socioeconomic factors and patient education to improve outcomes for OSA.

Keywords: Obstructive sleep apnea(OSA), CPAP, BiPAP, patient compliance, device usage, sleep study, Rashid Hospital

Introduction

Obstructive sleep apnea (OSA) is a prevalent sleep-related breathing disorder characterized by repeated episodes of partial or complete obstruction of the upper airway during sleep, leading to significant reductions in blood oxygen saturation and disruptions

in sleep architecture [1]. OSA is associated with a multitude of cardiovascular, metabolic, and neuropsychiatric risks, including hypertension, coronary artery disease, diabetes, and depression [2].

Globally, the prevalence of OSA has shown an alarming increase, with estimates suggesting that nearly 936 million adults worldwide suffer from mild to severe OSA, affecting approximately 3-7% of men and 2-5% of women [3]. OSA is commonly linked with obesity, metabolic syndrome, and hypertension conditions that not only contribute to cardiovascular disease but also exacerbate the activation of the sympathetic nervous system, oxidative stress, endothelial dysfunction, and metabolic disturbances [3].

The journey of an OSA patient extends far beyond the initial sleep study. Current literature often neglects the full continuum of care, which includes diagnosis, the acquisition of Continuous Positive Airway Pressure (CPAP) or Bilevel Positive Airway Pressure (BiPAP) machines, adherence to recommended usage of these devices for more than four hours daily, and long-term follow-up to evaluate treatment efficacy and make necessary adjustments [6]. This retrospective observational analytical study aims to delve into these aspects by detailing the complete cycle of care from initial diagnosis through long-term management, thereby filling significant gaps in our understanding of patient-device interaction and overall treatment adherence [7].

Our research utilizes comprehensive data from Rashid Hospital, one of the largest sleep labs in the UAE and the Gulf region. This data spans a twelve-year period from 2010 to 2022, capturing all patient data and interactions with the sleep lab during this time. This research is not limited to diagnostic metrics but includes extensive information on CPAP and BiPAP usage and patient compliance, providing a unique insight into the longitudinal management of OSA [8]. By examining these aspects, we aim to offer new perspectives that can assist pulmonologists and healthcare strategists in improving outcomes for individuals with OSA.

Methodology

This retrospective observational study was conducted at Rashid Hospital's sleep study lab located in Dubai, UAE. The study spanned a twelve-year period, from 2010 to 2022, and included all patients who visited the sleep lab during this time frame. Ethical approval for the study was granted by the ethical committee at Rashid Hospital, ensuring adherence to the ethical standards of medical research.

Data Collection

Data were systematically extracted from the hospital's Healthcare Information System. The extraction process was divided into three main parts: demographic information of the patients, data from the initial sleep studies conducted upon their first visit, and data extracted from devices that were returned by the patients for analysis. These devices, which were used in the treatment of diagnosed sleep disorders, primarily involved CPAP and BiPAP machines.

A total of 1,949 patients were followed up over the twelve-year study period. This comprehensive follow-up enabled the collection of longitudinal data concerning the effectiveness of treatment modalities and patient compliance with prescribed therapies.

Data Analysis

The data were analyzed using the Python programming language, employing the Pandas library—a powerful tool for data manipulation and analysis. This approach allowed for sophisticated statistical analyses, including the tracking of patient compliance over time and the correlation of demographic factors with treatment outcomes.

Results

This study meticulously traced the obstructive sleep apnea (OSA) treatment journey for 1,949 patients over a twelve-year period, encapsulating intricate details from the initial sleep study to long-term device utilization.

General Demographics at the Time of Sleep Study

The average age of patients undergoing sleep studies was 47.5 years with a standard deviation of 14.6, indicating a broad age range among the study participants (Table 1). Among them, 1074 (55.1%) were male and 875 (44.9%) were female.

Body Mass Index (BMI) classifications showcased a notable inclination towards higher obesity categories, with only 0.8% of patients categorized as underweight and a substantial 30.9% falling into the Obesity Class III category. The distribution across other BMI categories was as follows: 6.3% in the normal range, 19.2% overweight, 24.5% in Obesity Class I, and 18.2% in Obesity Class II.

The assessment of the Apnea-Hypopnea Index (AHI) revealed that 15.3% of patients had a normal range, while the rest were distributed across mild (26.4%), moderate (26.2%), and severe (32.1%) OSA categories, emphasizing the severity of OSA within the patient population at our sleep lab.

Table 1 General Demographics of patients at sleep study time

Category	**Statistics, N = 1949**
Age (Patients doing sleep study), mean (SD)	47.5 (14.6)
Gender, count (%)	
Male	1074 (55.1%)
Female	875 (44.9%)
BMI, count (%)	
Underweight	15 (0.8%)
Normal	115 (6.3%)
Overweight	349 (19.2%)
Obesity Class I	444 (24.5%)
Obesity Class II	331 (18.2%)
Obesity Class III	560 (30.9%)
AHI, count (%)	
Normal	292 (15.3%)
Mild	506 (26.4%)
Moderate	502 (26.2%)
Severe	614 (32.1%)

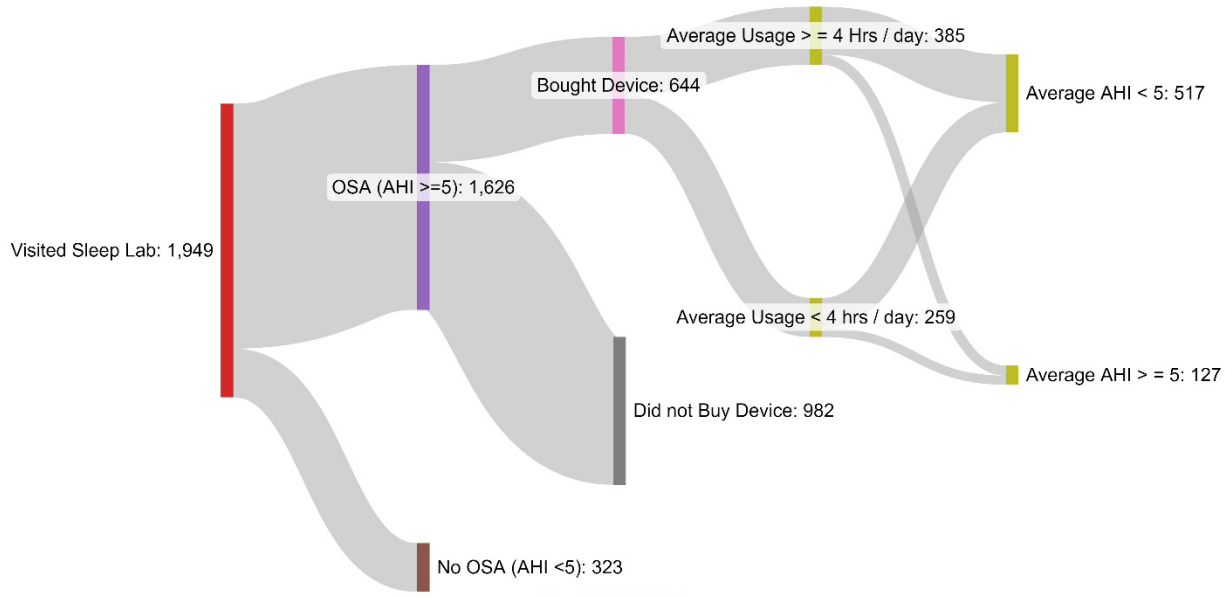
Patient Journey and Time Series Analysis

The Sankey plot (Figure 1) meticulously maps the trajectory of patients from their initial visit to the sleep lab through the various stages of OSA management. Initially, out of the 1,949 patients assessed at the sleep lab, a significant proportion, 1,626 patients (83.4%), were diagnosed with OSA (AHI ≥ 5). Among these diagnosed patients, 644 (39.6% of those diagnosed with OSA and 33.0% of the total population) took the step to purchase a therapeutic device.

It's notable that out of the patients who bought a device, 385 (59.8% of those who purchased a device and 19.7% of the total population) demonstrated compliance with average usage of 4 or more hours per day. On the other hand, 259 patients (40.2% of those who purchased a device and 13.3% of the total population) fell below the optimal usage threshold.

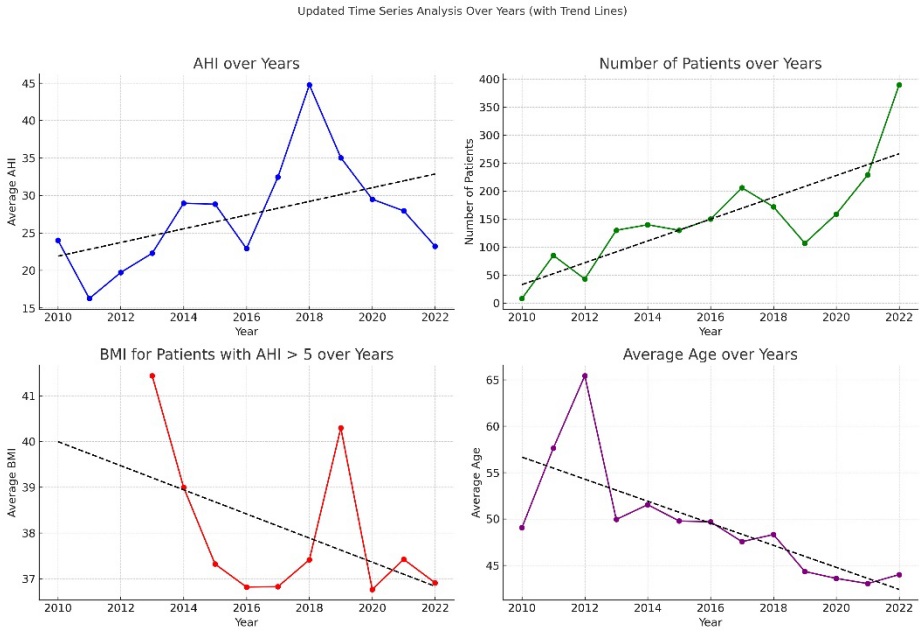
In the context of treatment outcomes, 517 patients achieved an average AHI < 5 post-treatment, accounting for 31.8% of those diagnosed with OSA and 26.5% of the overall population. This is a key indicator of successful treatment in the cohort. Conversely, among the patients who adhered to device usage, 127 individuals (33.0% of adherent patients and 6.5% of the total population) continued to have an average AHI ≥ 5, reflecting ongoing challenges in managing their condition effectively.

Figure 1 Sanky Plot for Patient Journey over 12 years



The temporal trend analysis exhibited an escalation in both the number of patients and the severity of OSA over the years (Figure 2). The average AHI fluctuated, spiking at certain intervals, whereas the average BMI for patients with AHI > 5 showed an overall downward trend over the years. Correspondingly, the average age of patients decreased progressively, indicating an expanding younger demographic grappling with OSA. Notably, in 2018, there was an increase in BMI due to a heightened preoperative evaluation for bariatric surgery as part of a gastric bypass program. In 2019, the number of working sleep labs in the hospital increased from one to two, which caused a higher capacity for patient intake.

Figure 2 Change in AHI, No. of Patients, BMI , Age over years in sleep lab



Device Usage Results

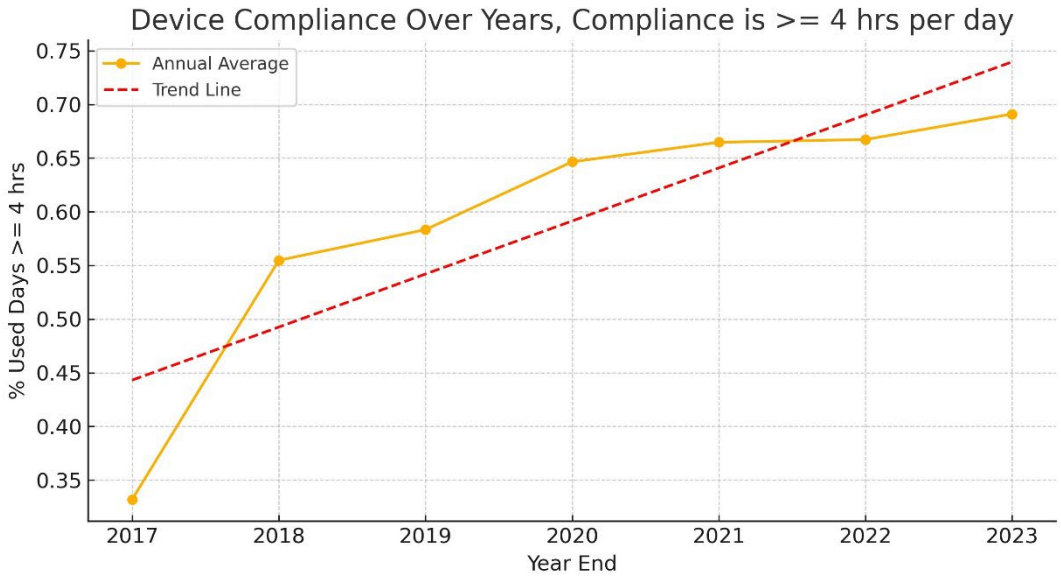
Patients took an average of 1.3 years to decide to purchase a CPAP or BiPAP device after their sleep study and initial diagnosis. The cycle time for providing the prescription for the device to patients after the sleep study is less than or equal to 2 weeks. The devices, when bought, were used for an average duration of 7.5 months before data extraction. Notably, the average daily usage was 4.6 hours, suggesting a reasonable level of adherence among those who opted to utilize the device. However, as seen in the Sankey plot, the adherence varied, with 40.2% using the device for less than the recommended 4 hours daily and a more compliant 59.8% exceeding the 4-hour threshold (Table 2).

Furthermore, the time series plot (Figure 3) illustrates a trend in device compliance over the years, focusing on usage of 4 or more hours per day. From 2017 onwards, there has been a gradual increase in the average percentage of days where devices were used for at least four hours, indicating an improving trend in patient compliance.

Table 2 Device Usage Results

Details	**Duration/Percentage**
Waiting time to decide to buy the device	1.3 years
Duration device was used before data extraction	Average 7.5 months (SD = 6 months)
Average daily usage of the device	4.6 hours

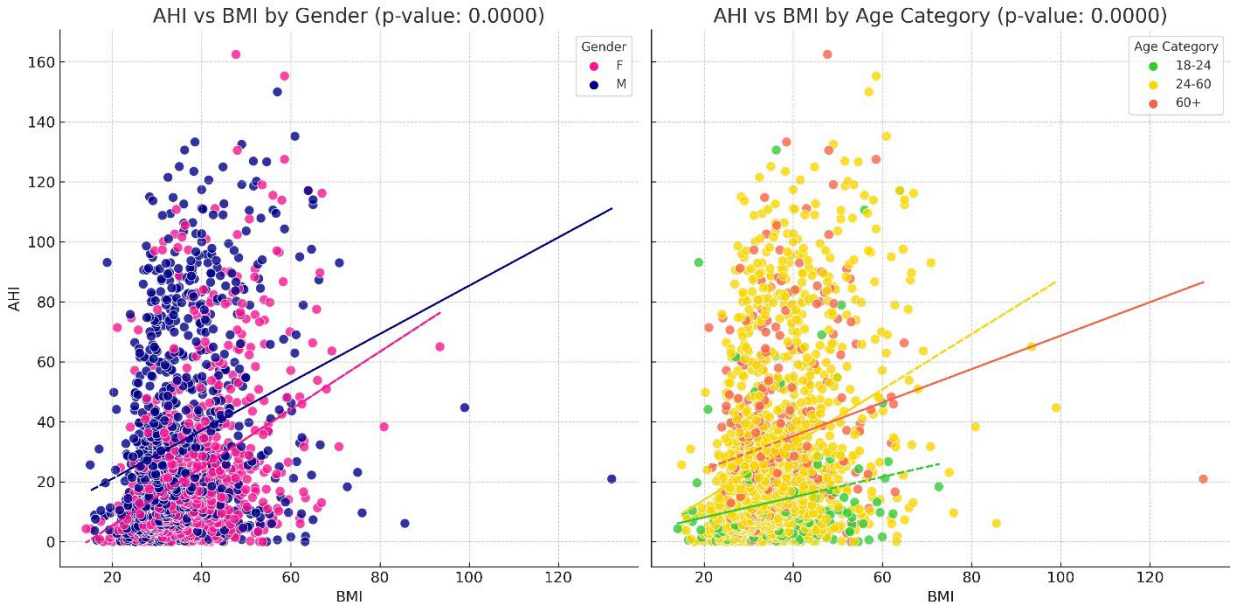
Figure 3: Device Compliance over years



Regression Analysis and Device Usage Patterns

The regression analysis of AHI versus BMI by gender and age category (Figure 4) underscored significant correlations, with p-values reaching statistical significance. The plots revealed that higher BMI values are associated with higher AHI scores, and this trend is consistent across different age categories.

Figure 4 Regression Model for AHI vs BMI and Age category



The boxplots depicting device usage patterns (Figure 5) delineated the age distribution across various categories of device usage. While the median age remained relatively stable, the interquartile range suggested a broader age spectrum among those with lower device usage, a pattern worth noting for future compliance interventions.

Figure 5 Device Usage Patterns

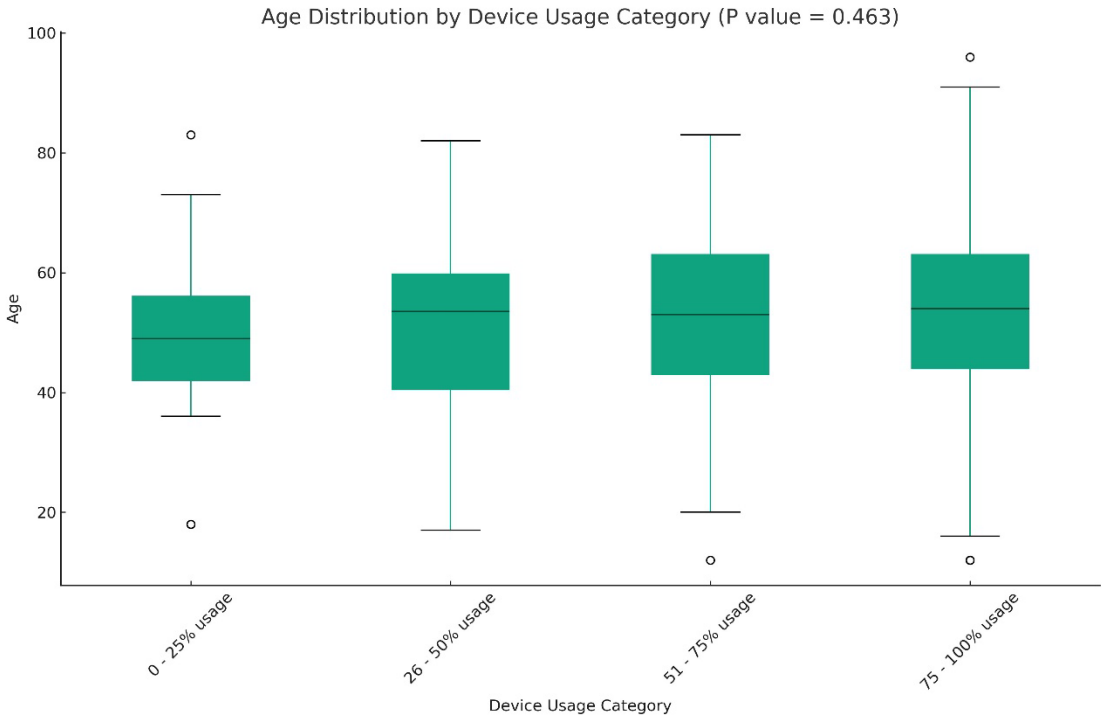


Figure 6: Bubble Plot to show variation in AHI within same BMI, Gender and Age

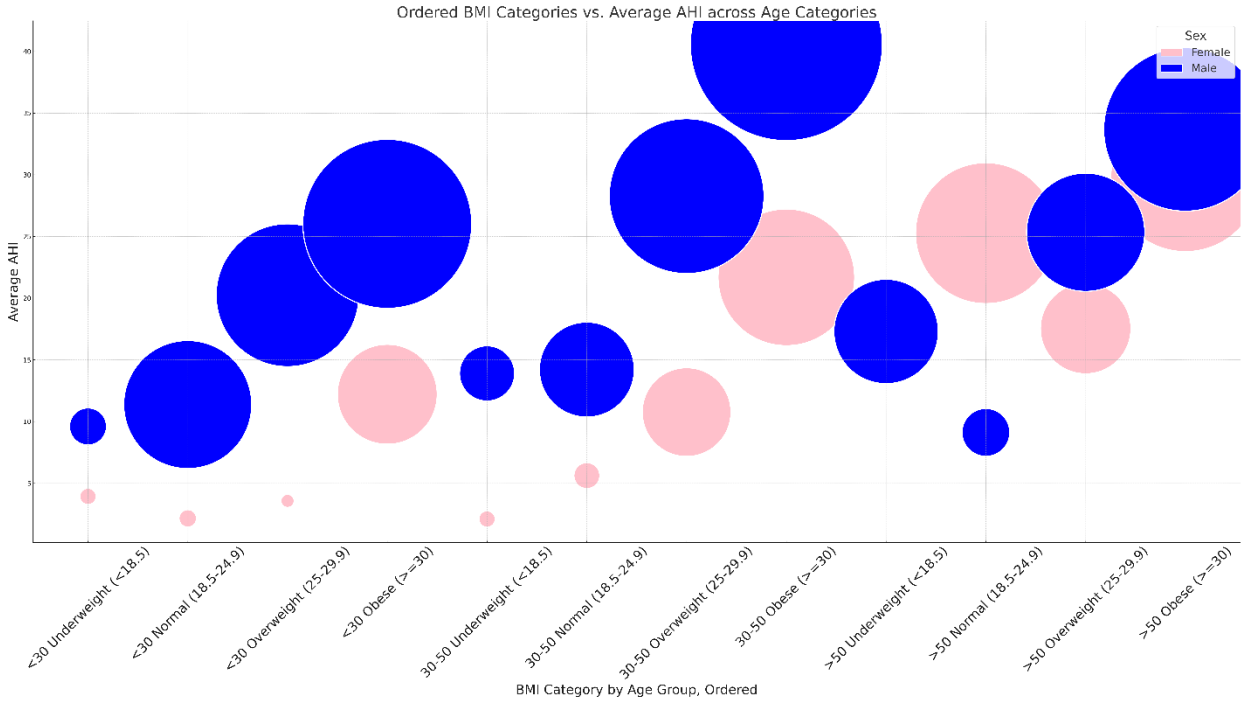


Figure 6 provides a detailed analysis of the variation in the Apnea-Hypopnea Index (AHI) among different cohorts categorized by age, BMI, and gender. Each bubble's position on

the x-axis represents the BMI category within specific age groups (<30, 30-50, and >50), ordered from underweight to obese. The y-axis indicates the average AHI for each cohort. The pink bubbles represent females, while the blue bubbles represent males. The size of each bubble corresponds to the standard deviation within that group, indicating the variability of AHI around the mean.

The data shows a clear trend of increasing AHI with higher BMI categories across all age groups and genders, reflecting the well-known correlation between obesity and sleep apnea severity. Males generally have a higher average AHI compared to females within the same BMI and age categories, suggesting gender-specific physiological differences in the manifestation of sleep apnea. Notably, the largest bubbles, indicating the highest variability, are seen in the obese category across all age groups, particularly among males. This suggests that while obesity is a significant modifiable risk factor, there are also substantial individual differences within this group, possibly due to other modifiable factors such as lifestyle, or non-modifiable factors such as genetic predisposition and anatomical differences.

The presence of large standard deviations within certain groups, particularly in the obese category, points to the influence of unknown or less understood factors that could be affecting AHI variability. These could include differences in fat distribution, muscle tone, upper airway structure, and the presence of comorbid conditions like diabetes or hypertension. The data indicates that as BMI increases, the impact of these various factors becomes more pronounced, highlighting the complexity of managing sleep apnea in obese patients. Furthermore, the trends observed in the younger age group (<30) suggest that early intervention and lifestyle modifications could play a critical role in preventing the progression of sleep apnea severity. Overall, the graph underscores the multifaceted nature of sleep apnea, where both modifiable (BMI, lifestyle) and non-modifiable (age, gender) factors contribute to its variability, necessitating a comprehensive and personalized approach to treatment.

Discussion

This study's findings cast a spotlight on the complexities inherent in the management of obstructive sleep apnea (OSA), a multifaceted condition that demands comprehensive

care strategies. The data indicate that despite a high diagnostic rate within our population, there is a palpable disconnect in translating diagnoses into timely and effective treatment actions.

Detailed Analysis of Results

Our study observed an average delay of 1.3 years before patients acquired a CPAP or BiPAP device post-diagnosis. This delay could be attributed to a multitude of factors, including financial constraints, perceived inconvenience [15]. The economic impact, including the cost of devices and insurance coverage issues, represents significant barriers to device acquisition and has been documented in several health economic studies [16].

The growing incidence of OSA, as highlighted by the increasing number of patients presenting with the condition, is likely reflective of broader epidemiological trends. This includes the rise in obesity rates globally—a known risk factor for OSA [17]. Additionally, age and gender have emerged as significant determinants in our study, aligning with previous research indicating that the prevalence of OSA increases with age and is more common in males, which may be influenced by hormonal variations, fat distribution, and airway anatomy [18].

Compliance Challenges

Adherence to device use remains a substantial challenge. Among device owners, only 59.8% met the recommended threshold for usage, which may stem from factors such as discomfort, inconvenience, and psychosocial issues such as stigma [19]. Age appeared to have a non-significant correlation with device usage patterns, suggesting that age-related factors alone do not predict adherence levels. This finding diverges from certain studies that report better compliance among older patients, potentially due to greater health awareness or more severe symptoms [20].

Addressing Compliance and Time to Device Acquisition

Solutions to improve compliance have been explored in other research, including the use of telemedicine for regular follow-ups and patient education to enhance device familiarity and comfort [21]. Interventions targeting health literacy and social support can profoundly impact patient attitudes and behaviors regarding treatment acceptance [22].

Reducing the time to device acquisition is crucial. Beyond financial considerations, psychological factors such as denial of disease severity and fear of treatment dependency are pervasive [23]. Healthcare organizations can bridge this gap through initiatives that promote early diagnosis and patient education. Programs such as the American Sleep Apnea Association's CPAP Assistance Program have made strides in improving access to treatment by subsidizing costs and providing educational resources [24].

Enhancing Proactivity in Sleep Centers

Sleep centers can implement routine OSA screenings for high-risk individuals and integrate these screenings into regular health check-ups. Partnering with community health programs to conduct awareness campaigns about OSA's risks and symptoms can facilitate early diagnosis. Additionally, sleep centers can develop targeted educational programs for healthcare providers, enhancing their ability to identify potential OSA cases during routine consultations and use system-based prompts to refer these patients directly to specialized sleep labs.

Enhancing Patient Compliance and Engagement

To improve patient compliance, sleep centers can adopt personalized care models that account for individual lifestyle and barriers to adherence. This includes flexible follow-up schedules, remote monitoring of therapy adherence, and establishing support groups for sharing coping strategies. Sleep centers should also advocate for better insurance coverage for OSA treatments to reduce financial barriers, thus increasing treatment continuation and effectiveness.

Future Directions

For future strategies, organizations must leverage multifactorial approaches that incorporate economic, educational, and psychosocial support systems. Efforts to streamline the pathway from diagnosis to treatment, coupled with targeted awareness campaigns, can be instrumental in mitigating the treatment initiation lag [25].

Limitations

Despite the insights gained, our study is not without limitations. The retrospective nature imposes inherent constraints, including potential biases in data recording and the unavailability of certain longitudinal data that could affect the outcomes. Moreover, the study's focus on a single center may limit the generalizability of the findings across different demographics and healthcare systems. We recommend future multicentric studies in UAE to validate these findings and an exploration into the psychological and socio-economic barriers that could influence device purchase and adherence.

Conclusion

This study sheds light on the essential yet often overlooked aspects of obstructive sleep apnea (OSA) management, emphasizing the importance of timely and effective interventions following diagnosis. The observed delay in patients' procurement of CPAP or BiPAP devices and the challenge of maintaining consistent use reflect a broader narrative of patient engagement and the multifaceted nature of adherence. The journey from diagnosis to management is revealed to be fraught with hurdles, both medical and socioeconomical, which are critical to consider in the pursuit of improved patient outcomes.

In response, our findings advocate for an integrative model of care that prioritizes personalized patient education, robust support systems, and strategies that streamline and simplify the pathway to treatment. As the healthcare community continues to advance its understanding of OSA, the emphasis must be on creating a treatment landscape that not only addresses the clinical dimensions of OSA but also actively dismantles the barriers to efficient and effective care. This approach promises to optimize therapeutic outcomes and enhance the quality of life for individuals living with this complex condition.

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