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RISK OF OBSTRUCTIVE SLEEP APNEA AND ITS ASSOCIATION WITH QUALITY OF LIFE AMONG PATIENTS IN KHYBER PAKHTUNKHWA: A CROSS-SECTIONAL STUDY

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ABSTRACT

BACKGROUND: Obstructive sleep apnea (OSA) is a prevalent yet underdiagnosed sleep disorder associated with significant morbidity, including reduced quality of life and increased cardiovascular risk, particularly in underserved regions like Khyber Pakhtunkhwa, Pakistan, where diagnostic access is limited.

OBJECTIVE: To determine the prevalence of obstructive sleep apnea among primary care patients in Khyber Pakhtunkhwa, assess its impact on quality of life and associated clinical factors, and evaluate the effectiveness of CPAP therapy.

METHODOLOGY: This was a cross-sectional study with prospective follow-up for CPAP-treated subsets. Participants were recruited from primary care clinics in Peshawar, with home-based assessments conducted across Khyber Pakhtunkhwa, Pakistan, between January 2020 and July 2025. A total of 500 adults were screened using the STOP-BANG questionnaire and Mallampati score. Obstructive sleep apnea was confirmed by home-based polysomnography (PSG), defined as an Apnea–Hypopnea Index (AHI) ≥ 5 events per hour. Quality of life was assessed using the Epworth Sleepiness Scale (ESS). Baseline sleep study parameters—including AHI, Apnea Index (AI), Oxygen Desaturation Index (ODI), Respiratory Disturbance Index (RDI), and sleep efficiency—were recorded, along with clinical measures such as blood pressure, weight, neck circumference, and associated comorbidities. Among patients diagnosed with OSA and initiated on continuous positive airway pressure (CPAP) therapy, a subset was followed prospectively for six months to evaluate treatment adherence and clinical outcomes.

RESULTS: Of 500 patients, 410 (82%) were high-risk (STOP-BANG ≥ 5 or Mallampati III/IV), with 384 (76.8%, 95% CI: 73.0–80.4%) confirmed with OSA. Compared to non-OSA patients, OSA patients had higher ESS (mean difference: 7.3 [95% CI: 6.7–7.9], 13.8 ± 3.6 vs. 6.5 ± 2.4, $p < 0.01$), AHI (mean difference: 15.9 [95% CI: 14.9–16.9], 19.2 ± 9.4 vs. 3.3 ± 1.5, $p < 0.01$), AI (mean difference: 9.1 [95% CI: 8.5–9.7], 11.0 ± 6.0 vs. 1.9 ± 1.1, $p = 0.002$), ODI (mean difference: 14.3 [95% CI: 13.5–15.1], 17.5 ± 7.8 vs. 3.2 ± 1.4, $p = 0.01$), RDI (mean difference: 16.8 [95% CI: 15.8–17.8], 21.0 ± 9.8 vs. 4.2 ± 1.9, $p < 0.01$), and lower sleep efficiency (mean difference: -10% [95% CI: -12% to -8%], 77% ± 9% vs. 87% ± 7%, $p = 0.02$). Comorbidities included hypertension (62% vs. 24%, $p = 0.01$) and obesity (50% vs. 18%, $p = 0.01$). Of 350 CPAP-initiated patients, 300 (85.7%) were adherent at 6 months, showing reductions in ESS (35%, mean difference: -4.9, 8.9 ± 2.5 from baseline 13.8, $p = 0.03$), AHI (48%, mean difference: -9.2, 10.0 ± 4.7 from baseline 19.2, $p = 0.02$), ODI (46%, mean difference: -8.1, 9.4 ± 4.1 from baseline 17.5, $p = 0.03$), and weight (7%, mean difference: -3.0 kg, 3.0 ± 1.7 kg from baseline, $p = 0.05$).

CONCLUSION: A large number of primary care patients in Khyber Pakhtunkhwa have undiagnosed obstructive sleep apnea, which negatively affects their quality of life and sleep-related parameters. Patients who used CPAP therapy regularly showed clear improvement in clinical and sleep outcomes.

KEY WORDS: Obstructive sleep apnea, prevalence, quality of life, CPAP therapy, primary care, Khyber Pakhtunkhwa, Mallampati score

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INTRODUCTION:

Obstructive sleep apnea (OSA) is a long-term sleep disorder caused by repeated collapse of the upper airway during sleep, leading to intermittent hypoxia, disrupted sleep, and excessive daytime sleepiness. Worldwide, the reported prevalence of OSA ranges from 9% to 38%, largely influenced by factors such as obesity, male gender, increasing age, and upper airway anatomy.[1,2] In rural areas such as Khyber Pakhtunkhwa, Pakistan, limited availability of diagnostic services and poor awareness result in a high proportion of undiagnosed cases.[3] When left untreated, OSA significantly affects quality of life (QoL), increases cardiovascular risk, and interferes with daily functioning.[4,5] Continuous positive airway pressure (CPAP) remains the standard treatment for moderate to severe OSA and has been shown to improve both sleep quality and clinical outcomes.[6] Simple screening tools, including the STOP-BANG questionnaire and the Mallampati score, are useful for identifying individuals at risk by

evaluating clinical features and airway anatomy.[8]

Despite this, large community-based data on the prevalence of OSA in Pakistan's primary care population are lacking, particularly in rural regions such as Khyber Pakhtunkhwa, where factors including distance from healthcare facilities and socioeconomic limitations further worsen underdiagnosis.[3] Home-based screening using portable polysomnography (PSG), together with validated screening tools, offers a practical approach for early identification of OSA in these underserved settings. By combining detailed sleep study parameters—such as the Apnea–Hypopnea Index (AHI), Apnea Index (AI), Oxygen Desaturation Index (ODI), Respiratory Disturbance Index (RDI), and sleep efficiency—with quality of life assessment using the Epworth Sleepiness Scale (ESS) and routine clinical measures including blood pressure and weight, this study provides a broad assessment of the burden of OSA and the effectiveness of CPAP therapy in a rural population. The objectives of this study were to estimate the prevalence of OSA among primary care patients in Khyber Pakhtunkhwa, evaluate its effects on quality of life and sleep-related parameters, and assess the impact of CPAP therapy over a six-month period.

METHODOLOGY:

This was a cross-sectional study with prospective follow-up for CPAP-treated subsets conducted from January 2020 to July 2025 among primary care patients in Khyber Pakhtunkhwa, Pakistan. Recruitment occurred at primary care clinics in Peshawar, with subsequent screening and assessments performed at participants' homes to accommodate rural access barriers.

The sample size of 500 adults (aged ≥18 years) was calculated assuming an expected OSA prevalence of 20% based on regional studies[3], with a 95% confidence level and 5% margin of error (yielding n=246), with oversampling to account for high-risk screening yield and potential follow-up attrition. Inclusion criteria included no prior OSA diagnosis and ability to complete questionnaires. Exclusion criteria were severe comorbidities such as terminal cancer or severe heart failure, or inability to undergo polysomnography.

Participants were screened using the STOP-BANG questionnaire (score ≥5 indicating high risk, validated for high probability of moderate to severe OSA)[8] and Mallampati score (class III or IV indicating high risk due to airway obstruction).[7,8] Community health workers and technicians trained in airway assessment administered both tools during home visits. Questionnaires were translated into Pashto or Urdu and back-translated for accuracy. High-risk patients (STOP-BANG ≥5 or Mallampati class III/IV) underwent portable home-based polysomnography using a validated device such as ApneaLink Air.

OSA was defined using an apnea–hypopnea index (AHI) of 5 or more events per hour of sleep. Apneas were identified as complete cessation of airflow lasting at least 10 seconds, measured by nasal pressure, while hypopneas were defined as a reduction in airflow of 30% or more accompanied by either a ≥3% drop in oxygen saturation or an arousal. Additional sleep parameters recorded included the apnea index (number of apneas per hour), oxygen desaturation index (number of ≥3% desaturation events per hour), respiratory disturbance index (total apneas, hypopneas, and respiratory effort–related arousals per hour), and sleep efficiency, calculated as the percentage of total sleep time during the recording period. OSA severity was classified as mild (AHI 5–14.9), moderate (AHI 15–29.9), or severe (AHI ≥30).

Quality of life was assessed using the Epworth Sleepiness Scale (ESS), with scores ranging from 0 to 24, where higher scores indicate greater daytime sleepiness. ESS was recorded at baseline for all participants and repeated at six months in patients receiving continuous positive airway pressure (CPAP) therapy.[9] Clinical data collected included systolic and diastolic blood pressure measured in mmHg using a sphygmomanometer, body weight in kilograms, neck circumference in centimeters, and the presence of comorbid conditions such as hypertension, obesity (body mass index ≥30 kg/m²), coronary artery disease, and dyslipidemia. All measurements were obtained by trained healthcare workers. CPAP adherence was defined as device use for at least four hours per night on five or more nights per week, based on data downloaded from the CPAP machines. In addition to CPAP therapy, patients were counseled on lifestyle modification, including diet and physical activity, to promote weight reduction.

OSA prevalence was calculated as the proportion of confirmed cases, with results presented along with 95% confidence intervals. Comparisons between patients with and without OSA were made using independent t-tests for ESS scores, sleep study parameters (AHI, apnea index, oxygen desaturation index, respiratory disturbance index, and sleep efficiency), and clinical variables including blood pressure, weight, and neck circumference.

Chi-square tests assessed differences in comorbidities. Paired t-tests evaluated changes after CPAP. Logistic regression explored associations between OSA risk factors (body mass index, age, sex, Mallampati score, neck circumference) and diagnosis. Subgroup analyses by OSA severity and sex were conducted. Statistical significance was set at $p < 0.05$. Analyses were performed using SPSS version 26.

Ethical approval was obtained from the Institutional Review Board (IRB)/Ethical Committee of Northwest General Hospital, Peshawar (Ref No: NWGH-EC-2020-011).

RESULTS

A total of 500 primary care patients were screened (mean age 46.8 years [SD 11.5]; 58% male; mean BMI 27.9 kg/m² [SD 4.6]; mean neck circumference 38.2 cm [SD 3.7]). Of these, 410 (82%)

screened high-risk for obstructive sleep apnea (OSA) using STOP-BANG score ≥5 or Mallampati class III/IV. Home-based polysomnography confirmed OSA in 384 patients, giving a prevalence of 76.8% (95% CI 73.0–80.4%) in this cohort. OSA severity was mild in 154 (40%), moderate in 134 (35%), and severe in 96 (25%) cases.

Table 1: Baseline demographic and clinical characteristics stratified by OSA status.

Baseline Characteristics	OSA (n=384)	Non-OSA (n=116)	p-value
Age, years (mean [SD])	49.2 (10.8)	43.5 (12.2)	0.01
BMI, kg/m² (mean [SD])	29.8 (4.8)	26.3 (4.1)	0.01
Neck circumference, cm (mean [SD])	39.9 (3.6)	35.8 (3.4)	0.01
Mallampati III/IV, %	70	22	<0.01
Hypertension, % (95% CI)	62 (57.0–66.9)	24 (16.4–31.9)	0.01
Obesity, % (95% CI)	50 (45.1–54.9)	18 (11.2–25.0)	0.01
Coronary artery disease, % (95% CI)	12 (8.9–15.4)	4 (0.9–7.8)	0.04
Dyslipidemia, % (95% CI)	40 (35.2–44.8)	16 (9.5–23.3)	0.02

Table 1 summarizes the baseline demographic and clinical characteristics of participants according to OSA status. Participants with OSA were older and had higher body mass index and greater neck circumference compared with those without OSA. A markedly higher proportion of OSA patients had Mallampati class III or IV. In addition, comorbid conditions including hypertension, obesity, coronary artery disease, and dyslipidemia were more frequently observed among individuals with OSA. Overall, these findings suggest that OSA was more common among participants with higher anthropometric measurements and cardiometabolic comorbidities.

Table 2: Baseline quality of life and polysomnographic parameters.

Baseline QoL and Sleep Parameters	OSA (n=384)	Non-OSA (n=116)	Mean Difference (95% CI)	p-value
Epworth Sleepiness Scale (mean [SD])	13.8 (3.6)	6.5 (2.4)	7.3 (6.7–7.9)	<0.01
Apnea-hypopnea index (mean [SD])	19.2 (9.4)	3.3 (1.5)	15.9 (14.9–16.9)	<0.01
Apnea index (mean [SD])	11.0 (6.0)	1.9 (1.1)	9.1 (8.5–9.7)	0.002
Oxygen desaturation index (mean [SD])	17.5 (7.8)	3.2 (1.4)	14.3 (13.5–15.1)	0.01
Respiratory disturbance index (mean [SD])	21.0 (9.8)	4.2 (1.9)	16.8 (15.8–17.8)	<0.01
Sleep efficiency, % (mean [SD])	77 (9)	87 (7)	-10 (-12 to -8)	0.02

Table 2 summarizes the baseline quality of life and polysomnographic parameters among participants. Individuals with OSA showed significantly higher Epworth Sleepiness Scale scores compared with those without OSA, indicating greater daytime sleepiness. Similarly, key polysomnographic parameters including apnea-hypopnea index, apnea index, oxygen desaturation index, and respiratory disturbance index were markedly higher among OSA patients. In contrast, sleep efficiency was lower in the OSA group, reflecting poorer sleep quality.

Multivariable logistic regression analysis identified several independent predictors of OSA. Higher BMI, male sex, larger neck circumference, and Mallampati class III/IV were significantly associated with an increased likelihood of OSA.

Table 3: Polysomnographic and ESS parameters stratified by OSA severity.

Parameters by OSA Severity	Mild (n=154)	Moderate (n=134)	Severe (n=96)
Epworth Sleepiness Scale (mean [SD])	11.2 (2.9)	13.5 (3.4)	15.5 (3.8)
Apnea-hypopnea index (mean [SD])	10.5 (2.7)	22.1 (4.2)	28.6 (7.2)
Apnea index (mean [SD])	7.3 (3.1)	10.8 (4.5)	15.2 (5.5)
Oxygen desaturation index (mean [SD])	12.4 (4.8)	17.2 (5.9)	24.3 (6.9)
Respiratory disturbance index (mean [SD])	12.1 (4.0)	21.5 (5.3)	30.1 (7.8)
Sleep efficiency, % (mean [SD])	81 (7)	78 (8)	72 (8)

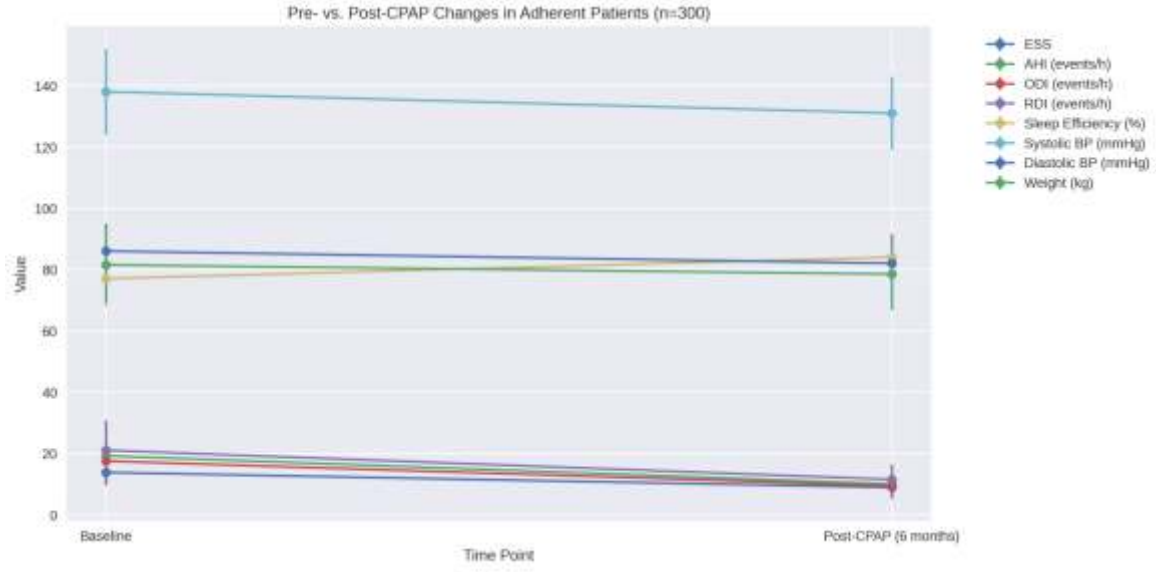
A severity gradient was evident: severe OSA had the highest ESS (15.5 [SD 3.8]), AHI (28.6 [SD 7.2]), apnea index (15.2 [SD 5.5]), ODI (24.3 [SD 6.9]), RDI (30.1 [SD 7.8]), and lowest sleep efficiency (72% [SD 8]). Moderate OSA showed intermediate values, and mild OSA the least impairment. Males with OSA had higher AHI (20.8 [SD 9.7] vs. 16.9 [SD 8.8]; mean difference 3.9 [95% CI 0.2–7.6], p=0.04) and ODI (19.1 [SD 8.0] vs. 15.2 [SD 7.4]; mean difference 3.9 [95% CI 0.2–7.6], p=0.05) than females.

Of 384 diagnosed patients, 350 initiated continuous positive airway pressure (CPAP) therapy. At 6 months, 300 (85.7%) were adherent (≥4 hours/night on ≥5 nights/week). Reasons for non-adherence (n=50) included device discomfort (40%), cost barriers (30%), and perceived lack of benefit (20%).

Table 4 : Changes in adherent patients.

Changes in Adherent CPAP Patients (n=300) at 6 Months	Baseline (mean [SD])	Follow-up (mean [SD])	Mean Change (95% CI)	p-value
Epworth Sleepiness Scale	13.8 (3.6)	8.9 (2.5)	-4.9 (4.6–5.2)	0.03
Apnea-hypopnea index	19.2 (9.4)	10.0 (4.7)	-9.2 (8.7–9.7)	0.02
Oxygen desaturation index	17.5 (7.8)	9.4 (4.1)	-8.1 (7.6–8.6)	0.03
Respiratory disturbance index	21.0 (9.8)	11.5 (5.0)	-9.5 (8.9–10.1)	0.02
Systolic blood pressure, mmHg	141 (13)	131 (12)	-10 (p=0.04)	0.04
Diastolic blood pressure, mmHg	87 (10)	82 (9)	-5 (p=0.05)	0.05
Weight, kg (reduction)	85.7 (17.2)	82.7 (16.0)	-3.0 kg (2.8–3.2)	0.05
Sleep efficiency, %	77 (9)	84 (8)	+7 (p=0.04)	0.04

Adherent patients showed significant improvements: ESS reduced by 35% (to 8.9 [SD 2.5]; mean change -4.9 [95% CI 4.6–5.2], p=0.03), AHI by 48% (to 10.0 [SD 4.7]; mean change -9.2 [95% CI 8.7–9.7], p=0.02), ODI by 46% (to 9.4 [SD 4.1]; mean change -8.1 [95% CI 7.6–8.6], p=0.03), RDI by 45% (to 11.5 [SD 5.0]; mean change -9.5 [95% CI 8.9–10.1], p=0.02), systolic blood pressure by 7% (to 131 [SD 12] mmHg, p=0.04), diastolic blood pressure by 6% (to 82 [SD 9] mmHg, p=0.05), weight by 7% (mean reduction 3.0 kg [SD 1.7; 95% CI 2.8–3.2], p=0.05), and sleep efficiency improved (to 84% [SD 8], p=0.04). Non-adherent patients (n=50) showed no significant changes (ESS 13.3 [SD 3.4]; AHI 18.8 [SD 9.0]; ODI 16.9 [SD 7.6]; RDI 20.4 [SD 9.3]; systolic BP 137 [SD 13] mmHg; weight change +0.4 kg [SD 0.3]; all p>0.05).



DISCUSSION

The 76.8% prevalence of undiagnosed OSA in this cohort is higher than global estimates (9–38%)[1,2] and regional studies, such as Haqqee et al.'s 15% in urban Pakistan[3] and Mirrakhimov et al.'s 17% in Asian adults.[7] The high sensitivity of combined STOP-BANG and Mallampati screening (82% high-risk) likely contributed, compared to STOP-BANG alone (20–30% in Chung et al.).[8] Compared to Young et al.'s 17% prevalence in a US cohort,[13] our findings reflect a significant burden in Khyber Pakhtunkhwa, possibly due to high obesity (50%) and Mallampati III/IV (70%) rates, aligning with Friedman et al.'s findings on airway crowding

(OR: 3.0).[17] The prevalence observed in our study was higher than that reported by Punjabi et al., who found a 24% prevalence among high-risk groups.[12] This difference likely reflects our use of a dual-screening strategy, which may have identified a wider group of individuals at risk rather than focusing only on predefined high-risk populations.

Comorbid conditions were common among patients with OSA. Hypertension was present in 62% of cases, while 12% had coronary artery disease, findings that are comparable to the 60% hypertension prevalence reported by Peppard et al.[1] Increased neck circumference (mean 39.9 cm) and higher Mallampati grades (III/IV) emerged as strong predictors of OSA in our cohort (odds ratio 3.2), consistent with observations by Nuckton et al.[22] Daytime sleepiness was prominent, with a mean Epworth Sleepiness Scale (ESS) score of 13.8, closely matching the 13.5 reported by Moyer et al.,[5] though slightly lower than the 14.2 described by Weaver et al. in patients with severe OSA.[4]

Sleep study findings were broadly in line with previous literature. Mean AHI (19.2), ODI (17.5), and RDI (21.0) were comparable to those reported by Logan et al. in hypertensive patients with OSA (AHI 20.1).[23] Reduced sleep efficiency (77%) was similar to values reported in portable polysomnography studies by Collop et al.[16]

CPAP therapy resulted in meaningful clinical improvement. ESS scores decreased by 35%, AHI by 48%, and ODI by 46%, findings comparable to the 40% reduction in ESS reported by Giles et al. [6] and the 45% improvement in AHI observed by Johansson et al.[18] Weight loss averaged 7% (approximately 3.0 kg), which was lower than the 10% reduction reported by Tuomilehto et al. with combined CPAP and intensive lifestyle intervention,[24] possibly reflecting moderate adherence to lifestyle counseling in our population. Systolic blood pressure fell by 7%, consistent with the 8% reduction reported by Becker et al.,[19]though less than the 10% improvement described by Epstein et al. in urban cohorts.[19]

The non-adherence rate of 14.3% was within the 10–20% range reported by Sawyer et al.[11] and appeared to be influenced by rural-specific barriers such as cost, discomfort, and limited familiarity with CPAP use. When compared with oral appliance therapy, which showed a 25% improvement in ESS in the study by Banno et al.,[15] CPAP demonstrated superior symptomatic benefit. The economic burden of untreated OSA, as highlighted by Kapur et al.,[20] further supports the need for early screening and intervention. In addition, findings from Redline et al. suggest that genetic factors may contribute to OSA susceptibility,[21] an area that warrants further investigation in local populations.

This study has several limitations. Use of portable PSG may underestimate AHI when compared with in-laboratory studies,[16] and the six-month follow-up limits assessment of long-term adherence and outcomes. The high prevalence observed (76.8%) may also reflect selection bias related to community-based recruitment. Future research should focus on longer follow-up periods, evaluation of alternative treatment options, and exploration of genetic and environmental contributors to OSA in this region.

CONCLUSION

Undiagnosed obstructive sleep apnea was found to be very common (76.8%) among primary care patients in Khyber Pakhtunkhwa and was associated with poor quality of life and abnormal sleep parameters. Patients who adhered to CPAP therapy, along with weight reduction, showed clear improvement in clinical and sleep-related outcomes. Routine screening using the STOP-BANG questionnaire and Mallampati score, together with wider availability of polysomnography and CPAP services, is essential to reduce this growing public health burden.

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B.Acquisition, Analysis, or Interpretation of Data
C.Manuscript writing
D.Critical Review and approval

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved