Research Article

Polysomnography: A Study of Sleep Pattern and Disorders in Suspected Cases of OSA

Kriti Diwevedi, Swapnil Jain, Anil Badal, Shradhansh Agrawal, Arti Julka, J.C. Agrawat*

Introduction: A refreshing sleep plays one of the most essential part in ensuring a healthy lifespan. Identification of abnormal sleep pattern is crucial for remedial measures. The obstructive sleep apnea (OSA) is the most common prevailing sleep disorder involving near 15% of the population leading to frequent awakening due to drop in body oxygen saturation and a fragmented non refreshing sleep.

Material and Method: This study is prospective observational and Epworth sleepiness scale, STOP-BANG test etc were used to detect suspected candidates of OSA for evaluation along with polysomnography test (PSG) to understand the sleep architecture and underlying defects.

Result: Our study observed male (>40 years), with an increased waist and neck circumference and higher BMI (over weight were 11.4% + obese were 74.3%) were more prone to suffer from OSA. Among the scoring systems the STOP-BANG was found to be much superior for the OSA. The snoring was seen in 93%, non-refreshing sleep in 89%, day time sleepiness in 86% remained the common presenting symptoms while the hypertension in 51% and DM in 23% were the frequently associated co-morbidities found with the OSA. PSG report revealed deprived N3 (deep sleep) and REM sleep in >60% of the selected cases of OSA.

Discussion: The present study observed a strong co-relation of OSA and obesity (BMI >30) in >74% of cases; which further increased with the advance in age. The OSA and higher BMI (obesity) have bidirectional relation to each other. The OSA cases are prone to develop systemic hypertension but all hypertensive cases may not have that affinity for OSA, however a reverse relationship may be present with COPD cases with more affinity for OSA.

Conclusion: An increased AHI with repeated significant desaturation of blood oxygenation are likely to invite physical and mental ailments. An early identification of OSA with detailed patient's history, scoring system and multidisciplinary approach with PSG test is increasingly accepted modality for diagnosis. A community based awareness campaign is emphasized for promoting good sleep hygiene with importance of deep sleep.

Access this article online

Website: www.cijmr.com

DOI: 10.58999/cijmr.v5i02.399

Keywords: Mallampati grade, Parasomnias, REM/ NERM sleep, Sleep architect.

Introduction

Sleep is a biologically complex process that facilitates both mental and physical restoration. Humans devote approximately one-third of their lives to sleeping, making it as vital as nutrition or hydration.[1] The individual remains inactive and unaware of the happenings during sleep due to the suppression of the brain itself till he or she awakens. The ordinary auditory and other sensory stimuli are also diminished during sleep; however, one may recapitulate about the dreams or sudden untoward somatic activities (parasomnias) during sleep.[2] The sleep study, also called polysomnography (PSG), is a test that measures brain activity with autonomic activity of the heart and respiration as well as somatic muscle functions during a sleep study that is carried out in the home of the patient or preferably at a sleep laboratory.

The suppressed brain activities of an individual are assessed by electroencephalogram (EEG), and these waves change according to the depth of sleep with rapid eye movement (REM sleep) or without eye movement (Non-REM sleep, i. N1 to N3 stages). The sleep starts with drowsiness and closing of the eyes, then about 50% of the beta waves (wake stage) start to convert in low amplitude alpha waves (N1 relax but awake), which may last for 10 to 15 minutes on EEG, comprising 5% of the total sleep period. These EEG waves further convert to theta waves,

R. D. Gardi Medical College, Ujjain, Madhya Pradesh, India

Correspondence to: Swapnil Jain, R. D. Gardi Medical College, Ujjain, Madhya Pradesh, India. E-mail: drswapniljain89@gmail.com

Submitted: 24/04/2026 Revision: 27/04/2026
Accepted: 17/06/2026 Published: 15/08/2026

How to cite this article: Diwevedi K, Jain S, Badal A, Agrawal S, Julka A, Agrawat JC. Polysomnography: A Study of Sleep Pattern and Disorders in Suspected Cases of OSA. Central India Journal of Medical Research. 2026;5(2):104-110.

Table 1: A profile of suspected cases of obstructive sleep apnea (OSA)

S N	*Indicators*	*Analyzed data*	*Interpretation/Inference*
1	Total cases = 35 Male Female	No./Percent 24 (69%) 11 (31%)	Male predominance
2	Age in years Up to 40 41–60 61 & above	No./Percent 11 (31.4%) 13 (37.2%) 11 (31.4%)	The majority of severe cases being found in aged more than 40 yrs
3	BMI Under wt. <18.5 Normal 18.5–24.9 Overweight 25–29.9 Obese ≥30	No./Percent 00 (0.0%) 05 (14.3%) 04 (11.4%) 26 (74.3%)	A strong relation of obesity and OSA was observed in snorer (74%), that suggest Wt. reduction with life style modifications.
4	Neck circumference Male: cutoff: 43cm Female:cutoff: 41cm	No./Percent 10 (42%) 06 (54%)	54% (6/11) Female vs 42% (10/24) Male had higher neck circumference are at risk factor for OSA however poorer pridector than BMI
5	Mallampati grade I Grade II Grade III Grade IV Grade	No./Percent 01 (03%) 05 (15%) 11 (31%) 18 (51%)	A combined III+IV grade (82%) were with higher Mallampati grade is challenging to visualization airways and become more vulnerable to OSA. They may even be a candidate for some short of corrective interventions.
6	ENT findings Normal DNS Hypertrophy turbinates Tympanic membrane	No./Percent 31 (88%) 02 (06%) 01 (03%) 01 (03%)	ENT checkup is integral part of study but no gross anatomical abnormalities detected, however minimal obstructive finding could create a suspicion or contributing factor to OSA. Dental checkup was essentially normal.
7	Epworth (ESS) score Mild (05–10) Moderate (11–15) Severe (16–24)	No./Percent 18 (52%) 06 (17%) 11 (31%)	Sleepiness score is subjective questionnaire help in predicting suspected case of OSA among the community or study group.
8	Stop bang score Low risk 0–2 Intermediate 3–4 high risk:score ≥5	No./Percent 00 (0.0%) 05 (14%) 30 (86%)	It facilitate to detect and estimate the severity of OSA so that PSG should strongly be recommended to these patient with a high STOP-Bang score. (A total score out of 8)
9	Symptoms Snoring Non refreshing sleep Day time sleepiness Breathlessness Other	No./Percent 34 (97%) 31 (89%) 30 (86%) 28 (80%) 09 (26%)	A history of snoring apart from the non refreshing sleep and day time sleepiness strongly suggested for the OSA evaluation.
10	Co-morbidity (30) HTN DM Hypothyroidism COPD Nasal Br. Allergy	No./Percent 18 (51%) 08 (23%) 05 (14%) 02 (06%) 02 (06%)	Hypertension (HTN) was present in 51% cases, while 60% (15/25) among severe OSA cases that showed a significant association of HTN with severity of OSA (*p-value* of 0.011).
11	2D ECHO EF 40–50 EF 50–60 EF >60	No./Percent 04 (11%) 01 (03%) 30 (86%)	Considered as a protocol to exclude any underlying cardiac disease.

denoting the entry of the longest N2 stage is usually comprised 45% of the total sleep. This is followed by N3 (deep sleep) delta stage and REM stage.[3] The N2 stage is easily identifiable by the presence of K complexes and sleep spindles (helps in memory consolidation). The N3 stage is called the most slow-wave, i.e., lower frequencies and higher amplitudes (delta waves) are the deepest of all sleep stages, and it becomes most difficult to interrupt/awake and comprises 25% of the total sleep period. The N3 stage is concerned mainly with strengthening the immune system, body regrowth and undergoing tissue repair. The night terror, sleepwalking (Somnambulism), nostalgia (sentiments) and bed wetting, etc may happen in stage N3.[2] Each phase and stages of sleep normally have variations as: 1) Brain wave patterns (Beta, Alpha, Theta, Delta). 2) Change in eye movements (NREM and REM). 3) Muscle tone (submental, chest and abdominal wall and leg movement) and/or atonia, especially during REM sleep. 4) Change of heart rate, respiratory rhythm, SpO_2 oxygen saturation and snoring sound, etc., are also recorded in a sleep study. An architectural imbalance and abnormal changes in duration or disruption in various stages of sleep activities are monitored and recorded. The obtained data is then analyzed, incorporating the detailed history of the individual to enable proper management of sleep disorders.[4]

Broadly 7 type of sleep disorders are identified that includes: sleep apnea (obstructive/central), narcolepsy (excessive day time sleepiness), insomnia, periodic limb movement disorder (restless leg syndrome), seizure/epilepsy, sleep parasomnias (walk/talk/bed-wetting etc) and hypersomnea are also explained by Gupta R, *et al.* in the clinical practice guidelines for sleep disorders from India.[5] The present study remained confined to obstructive sleep apnea (OSA) and the commonest cause is the relax tongue dropping on the larynx during sleep. These individuals usually present with a history of snoring, early morning headache and daytime sleepiness that could be assessed to confirm with higher Epworth sleeping scale (ESS) 0–24 score,[6] Mallampati[7] and Stop-Bang 0–8 score[8] etc.

A partial or complete occlusion of the airway leads to hypopnea or even apnea with a significant fall in blood oxygen saturation, which in turn resulted with frequent awakening and fragmented or disturbed sleep. These pathognomonic events (identified by PSG test) with apnea-hypopnea index (AHI/hour) could have an untoward systemic effect on body systems due to a change/disruption in the sleep pattern. So this study is undertaken to efficiently identify the predictors of OSA, and plan for a PSG test to understand the sleep pattern and severity of OSA to enable to apply remedial measures.

Material and Method

This study is a prospective and observational study to perform polysomnography (PSG) test among the clinically suspects having a history of unusual breath, awakening, or snorer during sleep. All such willing patients attending out patient department of respiratory medicine during one year of study were evaluated for OSA. Patients on sedatives or with alcohol dependence were excluded from the study.

Results

A total of 35 cases suspected of OSA who attended the respiratory medicine OPD were selected for the polysomnographic test (PSG), on the basis of the case history and with applying the Epworth, Mallampati and STOP-BANG scoring system as a protocol to identify OSA suspects. The male were (69%), advanced aged above 40 yrs (>68%), higher BMI (overweight 11.4% + obese 74.3%), with an increased waist and neck circumference were observed as dominant risk factors for OSA suspects. Similarly, higher encouraging values of the Epworth, Mallampati and Stop Bang score were also remained useful to identify OSA suspects. The patient's profile is briefed in Table 1**,** and an interpretation of compiled salient features of the PSG report is summarized in Table 2. The snoring (97%), non-refreshing sleep (89%), daytime sleepiness/narcolepsy (86%), etc were the dominant presenting symptoms, while early morning headache and disturbances like bruxism or sleep talking, walking, etc were sporadically observed in a few cases. The HTN (51%), DM (23%), and hypothyroidism (14%) were major comorbidities among these suspect cases of OSA.

Discussion

A definite and trusted history given by the patient and his/her spouse or family member pertaining to the sleep should always be incorporated with the PSG report. The prevalence of OSA in India has been concluded after a meta-analysis by T. M. Suri *et al.* is around 14 and 6% in males and females, respectively; is not any different from the developed countries.[9] All the patient in the present study (N=35) had snoring followed by apnea and awakening (OSA), except 1 (3%) case who in on some occasions had apnea (cessation of breath) without snore

Table 2: Brief polysomnography (PSG) data of OSA cases

1	Sleep Efficiency % Good > 80 Moderate 50–79 Poor < 50	No./Percent 01 (03%) 19 (54%) 15 (43%)	% of total time in bed vs actually spent in sleep. 97% had moderate to poor sleep deficit due to fragmented sleep and may lead to psychosomatic and cardio-vascular disorders .
2	Disruption of N1 Early <10 minutes Normal 10–15 minutes Prolong > 15 minutes	No./Percent 16 (46%) 08 (23%) 11 (31%)	N1 Sleep Latency is 10-15 minutes. However OSA cases usually has short sleep latency (quickly sleep)
3	Disruption of N2 Early <45 minutes Normal 45–55 minutes Prolong > 55 minutes	No./Percent 09 (26%) 05 (14%) 21 (60%)	N2 is light sleep (Theta waves) identify with K complexes and sleep spindles remained for about 45% of the total sleep. However in this study it exceed and prolonged in 60% of the cases
4	Disruption of N3 shortened <15 minutes Normal 15–20 minutes Prolong > 20 minutes	No./Percent 22 (63%) 02 (06%) 11 (31%)	N3 is deepest (Delta wave) and essential part of sleep comprises 25% period but in present study majority it shortened in 63% of cases.
5	Disruption of REM Early <20 minutes Normal 20-25 minutes Prolong > 25 minutes	No./Percent 22 (63%) 02 (06%) 11 (31%)	Normally it comprises 25% of total sleep period. The deprived REM may effect memory, emotional process and absence of usual muscle paralysis (atonia) causes parasomnias
6	Wake/Arousal index <5 / hour .....(Normal) 5-15 / hour.....(Mild) 16-30/ hour..... (Moderate) >30/ hour..... (Severe)	No./Percent 08 (22.9%) 20 (57.1%) 04 (11.4%) 03 (8.6%)	Number of time a person briefly wake up per hour of sleep. These can be identified with abrupt change in EEG frequency and may last for 3second or more. The cause could be increased age. OSA, PLM or spontaneous awakening, resulted non-restorative sleep.
7	Sleep Position	Supine > Rt	Maximum apnea were observed in supine and then to right lateral position.
8	Leg movements(PLM) < 5/ hr Normal 05–20/ hr Mild 21 40/ hr Moderate > 40 / hr Maximum	REM *vs* NREM 66 *vs* 46% 20 *vs* 14% 09 *vs* 03% 06 *vs* 37%	Abnormal moderate to severe PLM were observed in 15% of REM sleep. REM vs NREM PLM are inversely proportional and minimal during REM sleep even in severe OSA due to temporary atonia or muscle paresis.
9	Desaturation index <5/hour is Normal 5–15 15–<30 >30	No./Percent 05 (14%) 02 (06%) 05 (14%) 23 (66%)	Desaturation was not observed in 14% of cases while in rest of the cases it remained proportionate to the severity of AHI and sleep fragment or awakening.
10	OSA severity(AHI) Normal .....<5/ Hour Mild 5–15 Moderate 16–30 Severe > 30	No./Percent 00 (0%) 05 (14%) 05 (14%) 25 (72%)	All the suspected cases for OSA were sufferer with variable severity and confirm on PSG test. However among them 1 (3%) case was diagnosed as mixed central apnea due occasional cessation of breath without snore and respiratory effort observed on PSG

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and respiratory effort, with decline in SpO_2 followed by awakening and that was confirmed by PSG tracings and was finally recognized as a case of mixed central apnea as per also mentioned by Zheng Y *et al.*[10]

A quite significant AHI (Table 2) was observed among all the cases, though with variable severity of 14, 14 and 72%, respectively for mild, moderate, and severe with or without oxygen desaturation and repeated awakening that lead to fragmented sleep (Table 2). The N3 (deep sleep) and REM sleep, each with 25% of the total sleep study, observed a gross reduction in 63% of cases of OSA (Figure 1). A proportionate increase of AHI with desaturation was also observed, which coincides with severity. Repeated desaturation and awakening may promote cardiovascular and cognitive ailments likely to adversely affect socioeconomic and quality of life.

The present study noted history of snoring (97%), Non refreshing sleep (89%) and day time sleepiness

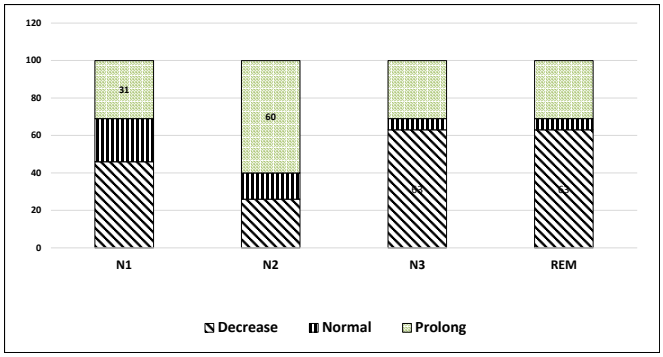

Figure 1: Only 6–23% suspected cases of OSA could sleep normally in different stages. The N3 and REM sleep grossly deprived in 63% cases with undue prolonged N2 stage in 60%

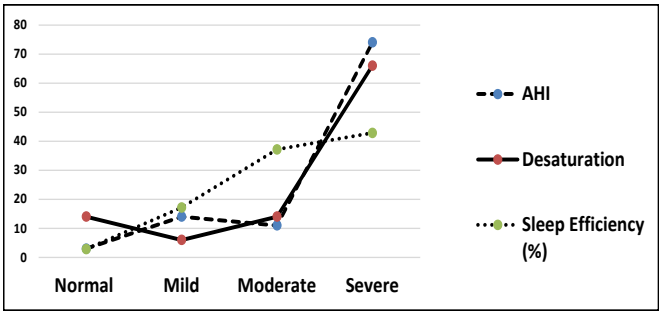

Figure 2: Sleep efficacy % smoothly deteriorate with severity while O2 desaturation and AHI proportionately and steeply raised from moderate towards severity of OSA status

(86%) as the main complaints (Table 1) and almost similar data reported by other studies except a variability in parasomnia events.[11] The effect of beverages like coffee, alcohol, and certain medications (i.e., opiate, barbiturates, etc) and addiction is not unlikely to alter/disrupt normal sleep, and should always be considered in conjunction with the presenting history. The systemic HTN remained the major comorbidity (51%) among our total 35 cases; however, its proportion increased to 60% in the severe OSA category (15 out of 25), which showed a strong incremental effect with the severity of OSA (*p-value* 0.011). Govind Narayan Srivastava *et al.* reported HT (65%), obesity (61%), left ventricular hypertrophy (23%) (50%) and diabetes mellitus (46%), etc.[12] Similarly, Papachatzakis *et al.* found that about 50% of their patients with overlap syndrome (COPD & OSA) had systemic hypertension (HT).[13] Piyush P Gupta and Anmol B Fuladi reported 46% cases (23/50) of OSA, among the COPD cases.[14] had strengthened the COPD-OSA overlap syndrome as a phenotype. However, our study found only 2 (6%) cases of COPD among OSA, which could be due to differences in study groups (Figure 2).

The present study observed obesity in >74%, Mallampati (combined grade III to IV) in >82%, with broader neck circumference in 50% as a dominant predisposing factor in support of suspect OSA. We had applied ESS and STOP-Bang test for predicting and identifying cases at higher risk to recommend and prioritize for PSG test and found that STOP-Bang remained more practicable. A similar opinion was also expressed by other authors.[15,16] However, a multicentric study funded by the Indian Chest Society had enrolled 1841 cases (1443 with OSA and 398 without OSA). It concluded that STOP-BANG is less discriminatory than neck circumference, especially while evaluating low BMI Asian patients with central obesity.[17,18] The present study

Figure 3: Multiple sensors applied on the body and connected with the PSG Machine

observed a strong correlation of OSA and obesity (BMI >30) in >74% of cases. Obesity is a well-established risk factor for obstructive sleep apnea (OSA); nevertheless, a reversible risk factor (most adults with OSA do not have obesity) had been reported by Neda Esmaeili *et al.*, with a meta-analysis of 12,860 adults showing OSA and Obesity in 56.2 and 25.7%, respectively.[19] Munje R P *et al.* had studied 50 cases of metabolic syndrome and reported 72% with AHI of >5 and among them 42, 22, and 8%, were respectively classified as mild, moderate and severe sleep apnoea.[20] In context, our study had >74% obese (Metabolic syndrome), and almost all had a higher AHI index of moderate to severe. We mentioned obesity among OSA while Munje R P observed OSA among the metabolic syndrome; however, OSA and BMI have a bidirectional relation to each other. Our study observed high BMI in 74% of cases and relied more predictive factor for OSA than the neck circumference observed in around 50% (Figure 3).

An OSA patient suffered from partial or complete obstruction of the upper airways transiently and repeatedly, which could be due to underlying morphology, comorbidities, or tongue drop due to decreased motor and relax brain activity during sleep. A compounded effect

resulted in significant hypoxia with a recorded drop of >3 or 4% of SpO_2, discomfort, and leg movements with repeated wakening/sleep interruption or fragmented sleep. These OSA patients may not feel refreshed or satisfied after a whole night's sleep due to fragmented and poor/deficient N3 deep sleep. Our study observed non-refreshing sleep in 89% and narcolepsy (daytime sleepiness) in 86% of the OSA cases, which may often require psychiatric counselling to resolve mood swings, altered psychology and cognitive illnesses. More than 80% of our cases had moderate to severe AHI and presented with frequent awakening, which in turn deprived deep sleep (N3) and REM sleep (Figure 1) along with undue prolongation of light (N1 & or N2) NERM sleep. A reduction of N3 (Deepest sleep) and REM sleep in 63% cases with a reciprocal increase of N2 sleep showed gross distortion of sleep architecture, which is worth interpreting in clinical interest. A deprived N3 and REM related sleep is due to higher AHI with frequent blood oxygen (PaO_2) desaturations, which are the genesis of systemic effects including HT and Obesity etc.[21] Similarly, a person with a high BMI and neck circumference is more prone to suffer from OSA; hence, a management strategy should be directed to break this vicious cycle. The mouth implant or the CPAP/BiPAP devise may fulfill the promise to keep the upper airways open. A sleep study with CPAP titration for the whole night may require to calibrate CPAP machine according to the individual's needs.

OSA patients may often have narcolepsy (excessive daytime nap); hence, they may further be studied for the multiple sleep latency test (MSLT) and they also have a tendency to directly enter N1 to REM sleep and remain deprived of deep N3 sleep, which is mainly related to repair, regrowth, the immune system and emotional sensitivity of individuals. The REM sleep (normally dreaming without actions) is characterized by temporary atonia means temporary paralysis of muscles, so have least to no limb movements. However, Aakash K. Patel *et al.* in their article "Physiology, Sleep Stages" had mentioned that in disorders of REM sleep, one could physically act out in the form of sudden jerking and unplanned limb movement or vocalizations.[22] He further mentioned that it could be due to neurological degenerative changes in the brain (e.g. Parkinson) or the effect of certain antidepressant drugs; however, it's all beyond the purview of the present study but helpful in identification and clinical interpretation.

Conclusion

Sleep is an integral part of life span, deeply concerned with the mental, physical and social health. The OSA is one of the most common sleep disorder encounter in the general population. The STOP-Bang scoring test is most reliable and feasible to identify OSA sufferers at community based studies. An untreated case of OSA is vulnerable to systemic hypertension, obesity, metabolic syndrome, cardiovascular, and psychosomatic issues. and cognitive ailments, etc relate to a multidisciplinary approach. So, an awareness needs to be created and a sleep laboratory is required at least at the tertiary care institutions. The OSA is an easily identifiable and manageable disorder with available tools like the PSG test, mouth implant, or continuous positive airway pressure (CPAP) devices.

Declaration by the Author

The author received no potential conflict of interest concerning the research, authorship, and/or publication of this article. The author received no financial support for the research, authorship, and/or publication of this article. The approval of the institutional ethics committee (Dated 02.08.2023) and patient consent were also obtained.

Conflict of Intrest

None.

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