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Modified Mallampati Score as a Predictor for the Presence and the Severity of Obstructive Sleep Apnea in Snoring Patients

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Abstract

Aim of the study: To assess if the modified Mallampati score (MMS) can predict the presence and the severity of obstructive sleep apnea syndrome (OSA) in a group of patients who had snoring and witnessed apnea from Al-Azhar university hospitals, Cairo, Egypt and Almoosa Hospital, Alhasa, Saudi Arabia.

Methods: A retrospective study was done for patients who had snoring and witnessed apnea referred to a sleep lab for the diagnosis of OSA by overnight full polysomnogram from January 2017 to November 2020. Apnea-hypopnea index (AHI) was used to categorize the severity of sleep apnea. Age, sex, MMS, body mass index (BMI), comorbidities, sleep and laboratory parameters were recorded. Also, full Otorhinolaryngological, Neurological and Internal medicine examinations were recorded.

Results: The study was carried out on 350 patients fulfilling the inclusion criteria with a mean age 51.3 ± 14.3 years ranging from 14 to 81 years. More than half of them (58.6%) were males, the mean BMI was 35.1 ± 8.8 kg/m^2 and the mean MMS was 4.7 ± 1.6 with about 65% of patients grouped in classes III and IV. OSA (AHI>5) was diagnosed in 278 (79.4%) patients. Significantly, OSA was more detected among males, those with increased age, BMI, MMS, and those with type 2 diabetes mellitus (T2DM). Further evaluation showed a significant positive correlation between both BMI and MMS with the severity of OSA (ρ =0.23, P<0.001 and ρ =0.36, P<0.001) respectively.

Conclusion: MMS is a useful tool to predict the presence as well as the severity of OSA in snoring patients. BMI and male gender are independent predictors.

Keywords: Snoring; Modified Mallampati Score; Body Mass Index; Obstructive Sleep Apnea

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Introduction

Sleep-disordered breathing (SDB) is the upper-airway obstruction occurring during sleep that was first demonstrated within the 1960s. SDB represents a gaggle of physiopathologic conditions characterized by an abnormal respiratory pattern during sleep which can be isolated or can coexist with other respiratory, nervous, cardiovascular, or endocrine diseases. SDB is widely prevalent within the general population [1,2]. SDB includes obstructive sleep apnea (OSA), which consists of breathing cessations of a minimum of 10 seconds occurring within the presence of inspiratory efforts during sleep. Central sleep apnea (CSA) consists of comparable apneas, but these instead happen within the absence of inspiratory efforts [3]. Complex (mixed) sleep apnea defined as a mixture of OSA with CSA or Cheyne-Stokes breathing pattern [4]. Upper-airway resistance syndrome (UARS) is characterized by snoring with increased resistance within the upper airway, leading to arousals during sleep [5]. OSA is the commonest sort of SDB and results in recurrent episodes of upper airway collapse during sleep which results in repetitive episodes of respiratory efforts associated with arousal, the symptoms of OSA are snoring, gasping and choking, witnessed apneas, insomnia, nocturia, restless sleep, excessive daytime sleepiness, morning headache, decreased concentration, and daytime fatigue [6].

Patients have OSA at an increased risk for hypertension, stroke, type 2 diabetes mellitus (T2DM), impaired cognitive function, motor car accidents, and occupational or social problems. To enhance the standard of life and to avoid morbidity and mortality associated with OSA, early diagnosis and treatment are important. The gold standard diagnostic tool is polysomnography (PSG) and it's necessary for

accurate diagnosis of OSA and to assess the treatment plan [7].

The predictors for OSA include obesity, increased neck circumference, craniofacial abnormalities, hypothyroidism, acromegaly, enlarged tonsil size, and a high Mallampati score [8]. Other risk factors for OSA are male gender, advanced age, and hypertension [9]. Several screening tools exist to assist in the identification of patients for apnea. There are four screening tools widely known as being fairly easy to administer: Stop, STOP-BANG (SB), Epworth Sleepiness Scale (ESS), and 4-Variable screening tool (4-V) [10].

The modified Mallampati score (MMS) helps to predict the convenience of endotracheal intubation. A high MMS (class 3 or 4) is related to harder intubation also as a better incidence of apnea [11,12]. A 2006 study showed that for every 1-unit increase within the MMS, the chances ratio of getting OSA (defined by an apnea-hypopnea index [AHI] >5) increased by 2.5. Additionally, the AHI increased by 5 events per hour [12]. The MMS is non-invasive and simply conducted in 15 seconds by trained healthcare providers. Hiremath et al. reported that the MMS is often a useful gizmo for subjects at high risk for OSA thanks to anatomical crowding of the oropharynx [13].

The aim of this study was to assess the value of the MMS to predict OSA among a gaggle of patients who had snoring and witnessed apnea.

Subjects & Methods

A retrospective study was performed at Al-Azhar university hospitals, Cairo, Egypt and Almoosa Hospital, Alhasa, Saudi Arabia, during the period from January 2017 to November 2020. Patients who had to snore and witnessed apnea with possible OSA were tracked across the outpatient hospitals settings. Ethical approval obtained from the Institutional Review Board at Almoosa hospital in KSA (IRB Log No ARC -21.02.3) and research ethics committee approval, from faculty of medicine Al-Azhar university, registration number; ENT. Med. Research. _snoring, neck circumference, body mass index, obstructive sleep apnea. _0000060.

The study population included all patients who visited our hospitals during the study period with a chief complaint of snoring and witnessed apnea and completed overnight PSG.

The exclusion criteria included patients younger than 14 years, those diagnosed before as OSA, those who had central apnea, and those who underwent tonsillectomy or uvuplataophyrngoplasty for treatment of apnea.

Demographic data were obtained from the YASASSI program that's a singular program utilized in outpatient and inpatient hospital settings. YASASSI may be a comprehensive healthcare data system designed for all kinds of healthcare facilities. This technique is straightforward, easy to use, reduces clinical errors, and improves workflow, so can save lives, improve the standard of healthcare, and reduce prices.

Age, sex, height, weight, BMI, co-morbidities (like T2DM, hypertension, ischemic heart condition, asthma, chronic obstructive pulmonary disease, cerebrovascular stroke, and renal disease), and MMS were determined from the patients' files.

Procedures

Overnight PSG was performed on all or any patients within the sleep laboratory room, the following were monitored: central and occipital electroencephalogram, electrooculogram, submentalis electromyogram to assess sleep stages (non-rapid-eye movement stages N1, N2, N3, and rapid eye movement stage R), nasal and oral airflow meter measured by thermocouples, thoracic and wall motions, anterior tibialis electromyogram, body position, and electrocardiogram. A pulse oximeter was used to measure arterial oxygen saturation. The tracing was scored using 30 seconds epochs. Hypopneas were scored per American academy of sleep medicine (AASM) definition VII4.B (3% desaturation) [14]. Snoring noise was captured by a microphone. Finally, the polysomnographic recordings were analyzed.

Sleep was summarized into total recording time, total sleep time, sleep efficiency, R latency from onset of sleep, and wake after sleep onset. Apnea, hypopnea, arousal, AHI, and respiratory disturbance index were recorded.

Apnea is that the cessation of airflow for a minimum of 10 seconds, hypopnea may be a ≥50% decrease in airflow that persisted for a minimum of 10 seconds with oxygen desaturation of ≥ 3% or arousal, and respiratory effort–related arousal is increasing respiratory effort for a minimum of 10 seconds resulting to an arousal from sleep but one that doesn't fulfill the standards for a hypopnea or apnea [15]. AHI equals the entire number of respiratory events (apnea plus hypopnea) per hour of sleep. Maximal and minimum oxygen saturations were recorded. Total limb movement (number/H), and periodic limb movement (number/H) were recorded. Pulse average, lowest, and arrhythmias were recorded.

A split night procedure was used. The split-night study involves diagnostic PSG within the half of the night followed, if there's an abnormal frequency of apneas and hypopneas, by CPAP/Bi-PAP titration for the rest of the night sleep to succeed rock bottom pressure can decrease the events of AHI to 5 events/H and maintain oxygen saturation quite 92%. OSA diagnosis was made if AHI ≥ 5 with witnessed snoring or apnea [15,16]. The severity of apnea was classified into 3 groups: mild if AHI ≥5 to ≤15, moderate if AHI ≥15 to ≤30, and severe if AHI ≥30.

The MMS, which is predicated on the inspection of the upper airway, may be a sensitive predictor of OSA [17]. The patient is instructed to open the mouth as wide as possible. For all patients, the assessment of scores was done or directly supervised by the physician. The patient was instructed not to emit sounds during the assessment.

There are four classes of MMS:

Class I: the taste bud and full uvula are visible,

Class II: the taste bud, surface, and upper portion of the uvula are visible,

Class III: the taste bud, surface, and base of the uvula are visible, and

Class IV: only the surface is visible.

For every 1-point increase within the score, the chances of getting OSA increases quite twofold. Although this procedure could also be useful for non-sleep specialists, during a sleep clinic (Figure 1).

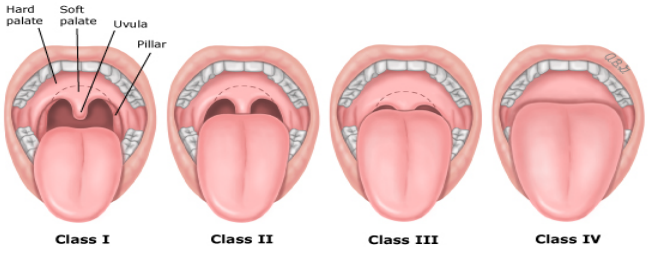

Figure 1: Modified Mallampati score [18].

Statistical Analysis of Data

It was carried out using the SPSS computer package (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp., USA). For descriptive statistics: the mean ± SD was used for quantitative variables while frequency and percentage was used for qualitative variables. Chi-square test or Fisher's exact test were used to assess the differences in frequency of qualitative variables, while Mann-Whitney test or Kruskal-Wallis test were used to assess the differences in means of quantitative nonparametric variables. Spearman correlation coefficient was used to measure the strength and direction of association between OSA severity (indicated by AHI) and both BMI and MMS. ROC curve analysis was used to assess the diagnostic ability of different cut-offs of MMS for the prediction of OSA that maximizes both sensitivity and specificity. The statistical methods were verified, assuming a significant level of $p< 0.05$ and a highly significant level of $p< 0.001$.

Results

The study was carried out on 350 patients fulfilling the inclusion criteria with a mean age 51.3 ± 14.3 years ranging from 14 to 81 years. More than half of them (58.6%) were males, the mean BMI was 35.1 ± 8.8 kg/m^2 and the mean MMS was 4.7 ± 1.6 with about 65% of patients grouped in classes III and IV. OSA (AHI > 5) was diagnosed in 278 (79.4%) patients. Significantly, OSA was more detected among males, those with increased age, BMI, MMS and those with T2DM (Table 1).

The mean sleep efficiency was 72.4 ± 16.7 with about 28.6% of cases had poor sleep quality. The means of ESS, arousal index, and AHI were significantly higher among patients with OSA (Table 2).

Regarding laboratory findings, CRP and $PaCO_2$ were significantly higher while minimum and maximum O_2 saturations were significantly lower among patients with OSA than non-OSA (Table 3).

Variables that showed significant differences in the previous tables were further evaluated according to the degree of severity of OSA. Male gender, increasing age, BMI, MMS, ESS, arousal index, AHI, CRP, $PaCO_2$, and presence of T2DM were found to be significantly associated with increased severity of OSA. Decreasing maximum and minimum O2 saturations were found to be significantly associated with increased severity of OSA (Table 4).

Further evaluation showed a significant positive correlation between both BMI and MMS with the severity of OSA (ρ =0.23, P<0.001 and ρ =0.36, P<0.001) respectively (Figure 2).

Table 1: General and clinical characteristics of the studied sample.

Variables		All cases	Without OSA	With OSA	P-value
		n=350 (%)	n= 72 (%)	n= 278 (%)	
Age (years)	Mean ± SD	51.3 ± 14.3	37.6 ± 11.4	54.9 ± 12.7	<0.001*
	Min – Max	14 – 81			
Gender	Male	205 (58.6)	27 (37.5)	178 (64.0)	<0.001*
	Female	145 (41.4)	45 (62.5)	100 (36.0)	
BMI (kg/m^2)	Mean ± SD	35.1 ± 8.8	32.6 ± 9.3	35.7 ± 8.6	0.008*
	Min – Max	20.6 – 52.1			
MMS	Mean ± SD	4.7 ± 1.6	3.4 ± 1.5	5.0 ± 1.5	<0.001*
	Min – Max	1 – 8			
	Class I	20 (5.7)	16 (22.2)	4 (1.4)	<0.001*
	Class II	101 (28.9)	31 (43.1)	70 (25.2)	
	Class III	158 (45.1)	24 (33.3)	134 (48.2)	
	Class IV	71 (20.3)	1 (1.4)	70 (25.2)	
HTN		207 (59.1)	41 (56.9)	166 (59.7)	0.688
T2DM		125 (35.7)	18 (25.0)	107 (38.5)	0.038*
IHD		42 (12.0)	11 (15.3)	31 (11.2)	0.317
Other diseases[1]		210 (60.0)	39 (54.2)	171 (61.5)	0.281

BMI: Body mass index, MMS: Modified Mallampati score, T2DM: Type 2 diabetes mellitus, IHD: Ischemic heart disease HTN: Hypertension.

[1]: Some cases had more than one condition.

Values present as number & % were analyzed by chi-square or Fisher's exact tests.

Values present as mean ± SD were analyzed by Mann-Whitney *U* test. *: Significant.

Table 2: Sleep parameters among the studied samples.

Variables		All cases	Without OSA	With OSA	P-value
		n=350 (%)	n= 72 (%)	n= 278 (%)	
Sleep efficiency	Mean ± SD	72.4 ± 16.7	75.3 ± 13.5	71.6 ± 17.4	0.188
	Min – Max	10.0 – 98.2			
Sleep quality	Good (>90)	78 (22.3)	21 (29.2)	57 (20.5)	0.289
	Fair (70-90)	172 (49.1)	32 (44.4)	140 (50.4)	
	Poor (<70)	100 (28.6)	19 (26.4)	81 (29.1)	
ESS	Mean ± SD	11.0 ± 5.4	8.3 ± 4.4	11.6 ± 5.4	<0.001*
	Min – Max	2 – 24			
AI (event/H)	Mean ± SD	17.7 ± 14.0	12.7 ± 4.5	19.0 ± 15.3	<0.001*
	Min – Max	2 – 83.2			
AHI (event/H)	Mean ± SD	28.3 ± 25.2	4.6 ± 2.3	34.5 ± 24.8	<0.001*
	Min – Max	0 – 106			

AI: Arousal index, AHI: apnea hypopnea index, ESS: Epworth sleepiness score.

Values present as number & % were analyzed by chi-square test.

Values present as mean ± SD were analyzed by Mann-Whitney *U* test. *: Significant.

Table 3: Laboratory findings of the studied samples.

Variables		All cases	Without OSA	With OSA	P-value
		n=350 (%)	n= 72 (%)	n= 278 (%)	
CRP	Mean ± SD	3.74 ± 3.54	1.62 ± 1.67	4.29 ± 3.7	<0.001*
	Min – Max	0 – 18			
Max O_2 sat %	Mean ± SD	91.3 ± 2.8	92.4 ± 2.2	91.0 ± 2.9	<0.001*
	Min – Max	84 – 98			
Min O_2 sat%	Mean ± SD	84.4 ± 10.1	91.9 ± 2.6	82.5 ± 10.4	<0.001*
	Min – Max	24 – 96			
$PaCO_{2\ (mmHg)}$	Mean ± SD	40.6 ± 3.0	37.7 ± 3.0	41.4 ± 2.4	<0.001*
	Min – Max	32 – 45			

CRP: C reactive protein.

Values present as mean ± SD were analyzed by Mann-Whitney U test. *: Significant.

Table 4: Relation between severity of obstructive sleep apnea and different study variables.

Variables		Normal	Mild	Moderate	Severe	P-value
		n=72 (%)	n=54 (%)	n=101 (%)	n=123 (%)	
Age (years)		37.6 ± 11.4	50.0 ± 9.4	53.8 ± 12.6	57.9 ± 13.3	<0.001*
Gender	Male	27 (37.5)	23 (42.6)	50 (49.5)	105 (85.4)	<0.001*
	Female	45 (62.5)	31 (57.4)	51 (50.5)	18 (14.6)	
BMI		32.6 ± 9.3	27.9 ± 7.8	36.3 ± 8.7	38.7 ± 6.5	<0.001*
MMS		3.4 ± 1.5	4.4 ± 1.1	5.1 ± 1.7	5.2 ± 1.4	<0.001*
T2DM		18 (25.0)	16 (29.6)	36 (35.6)	55 (44.7)	0.032*
ESS		8.3 ± 4.4	8.7 ± 3.4	10.7 ± 5.3	13.6 ± 5.4	<0.001*
AI (event/H)		12.7 ± 4.5	14.6 ± 16.5	16.8 ± 13.8	22.7 ± 15.1	<0.001*
AHI (event/H)		4.6 ± 2.3	12.9 ± 5.6	25.2 ± 11.5	51.6 ± 26.4	<0.001*
CRP		1.62 ± 1.67	1.41 ± 1.16	4.37 ± 3.32	5.48 ± 4.04	<0.001*
Max O2 sat %		92.4 ± 2.2	91.5 ± 3.0	91.4 ± 3.0	90.3 ± 2.7	<0.001*
Min O2 sat %		91.9 ± 2.6	84.4 ± 7.5	82.8 ± 11.3	81.4 ± 10.7	<0.001*
$PaCO_{2\ (mmHg)}$		37.7 ± 3.0	38.4 ± 2.5	41.1 ± 1.7	42.8 ± 1.6	<0.001*

BMI: Body mass index, MMS: Modified Mallampati score, T2DM: Type 2 diabetes mellitus, ESS: Epworth sleepiness score, AI: Arousal index AHI: apnea hypopnea Index, CRP: C reactive protein.

Values present as number & % were analyzed by chi-square test.

Values present as mean ± SD were analyzed by Kruskal-Wallis test. *: Significant.

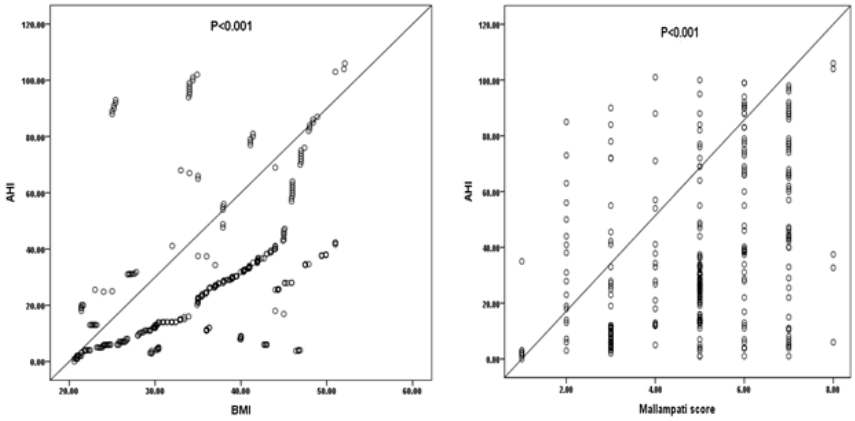

Figure 2: Correlation between BMI and modified Mallampati score with the severity of OSA.

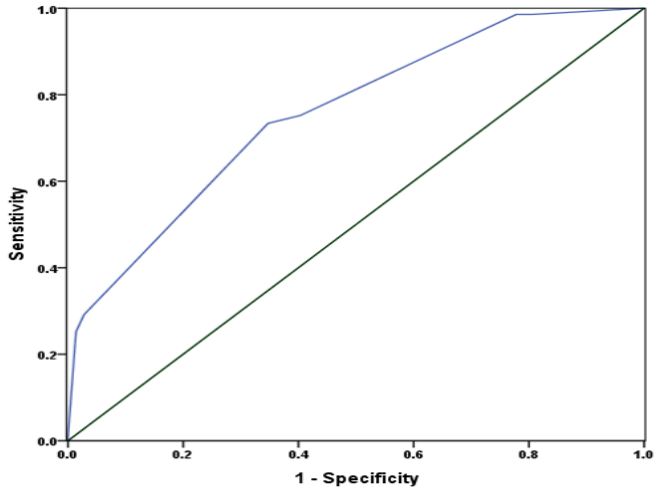

Figure 3: ROC curve analysis of modified Mallampati score.

We assessed the diagnostic ability of different cut-offs of MMS for the prediction of OSA using ROC curve that maximizes both sensitivity and specificity. AUC=0.77 (95% CI 0.70 – 0.82, P<0.001) with optimal cut-off was 4.5, sensitivity=74%, specificity=66% (Figure 3).

Discussion

Obesity is increasing globally and therefore, the associated diseases, OSA, hypertension, and T2DM prevalence are additionally increasing globally [19]. OSA is one of the main leading factors causing hypertension, T2DM, metabolic syndrome, and cardiovascular diseases [20]. The main purpose of this study was to assess the value of the MMS to predict the presence and severity of OSA. Patients were sent for PSG testing supported a mixture of symptoms and risk factors indicative of OSA, including daytime snoring, sleepiness, and obesity.

All patients in our study had been referred for evaluation for OSA. Thus, clinicians presumably had some suspicion of getting OSA or SDB before referral. OSA (AHI > 5) was diagnosed in 278 (79.4%) of our patients with a significant positive correlation between both BMI and MMS with the severity of OSA (ρ =0.23, P<0.001 and ρ =0.36, P<0.001) respectively. This is in agreement with Zonato AI, et al. (2003) [21], and Rahaghi F, et al. (1999) [22], reported the proportions of patients with OSA that were similar to those with MMS of class III or IV. However, the typical AHI was higher in patients with MMS of class IV.

Our results may challenge the results provided by Nuckton TJ, et al. (2006) [12], who showed the MSS to be an independent predictor of the presence and therefore the severity of OSA [12]. Nuckton TJ, et al. (2006) [12], found that for each 1-point increase within the Mallampati score, the chances of getting OSA increased quite twofold with a predicted increase of the AHI by quite 5 events per hour [12].

Also, Friedman M, et al. (1999) [28], reported a significant correlation (r=0.340, p<0.001) between the MMS and the respiratory disturbance index (RDI; the sum of apneas and hypopneas per hour of sleep) in a group of 172 patients selected based on a sleep questionnaire [23]. Tham EJ, et al. (1992) [24], reported that BMI and collar size were independent predictors of AHI whereas Mallampati score was associated with AHI only when the nasal obstruction is present.

Liistro G, et al. (2003) [25], reported that high Mallampati score and nasal obstruction were associated risk factors for OSA. Yu JL, et al. (2020) [26], did a systemic review to assess the utility of the MMS grade and Friedman tongue position (FTP) in the assessment of OSA and found that MMS and FTP were difficult subjective assessments with little significance correlating the risk of OSA.

However, there is also evidence that MMS and FTP can be useful tools in the assessment of risk for OSA and potential severity. In the high-risk group for OSA, MMS still has the potential to play a role in screening for OSA [26]. Dahlqvist J, et al. (2007) [27], Friedman M, et al. (2017) [28], Ramachandran SK, et al. (2010) [29], and Schwab RJ, et al. (2017) [30], reported that MMS grade 3 or above was an independent risk factor for an AHI > 15 events/h, which was statistically significant in men, but not significant in women. Avincsal MO, et al. (2017) [31], found that MMS grades 3 and 4 in combination with the STOP-BANG score increased the specificity of detecting an AHI > 15 events/h from 10.6% to 26% [31]. Hukins C (2010) [32], found a statistically significant but weak correlation between MMS and AHI (r = 0.13, P < 0.001) in their study (a retrospective study for 953 patients who were evaluated for OSA by PSG). In contrary to our results, den Herder C, et al. (2005) [33], found no positive correlation exists between a large tongue and obstruction at the tongue base level.

Also, Bins S, et al. (2011) [34], did a systemic review and reported that MMS provides no practical value in predicting OSA. Mallampati scoring might not be as useful among patients with a lower probability of getting OSA. However, given the good simplicity of Mallampati scoring, and therefore the independent nature of the connection between the Mallampati score and OSA, this score has potential value for facilitating and standardizing communication among clinicians

who look after patients with OSA. Mallampati scoring could even be wont to prioritize patients for PSG, a crucial consideration given the massive backlog of patients awaiting assessment for OSA [22,23].

In summary, our results indicate that the MMS, while having limitations as a diagnostic assay, may be a useful part of the physical examination of patients before PSG. The independent association between MMS and therefore, the presence and severity of OSA suggests that this rating system will have practical value in clinical settings, and in prospective studies of SDB.

Conclusion

MMS is useful tool to predict the presence as well as the severity of OSA in snoring patients. BMI, and male gender are independent predictors.

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