

Risk Assessment of Obstructive Sleep Apnoea Symptoms and Its Correlation with Oral Manifestations: A Cross-sectional Study

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ABSTRACT

Introduction: Obstructive Sleep Apnoea (OSA) is the most common sleep-related breathing disorder seen in all age groups. The aetiology is multifactorial, including factors such as obesity, aging, stress, and a sedentary lifestyle. Poor knowledge about diagnostic options, management, and consequences of improper treatment may contribute to morbidity and mortality. Berlin Questionnaires (BQ) are simple, low-cost, non-invasive tools that can be used to assess the risk of OSA. Screening subjects using questionnaires and oral examinations for a multi-disciplinary approach to treat OSA is essential.

Aim: To assess the risk of OSA symptoms and their association with oral manifestations among students.

Materials and Methods: This cross-sectional study was conducted among medical students aged between 18 and 24 years. Three hundred medical students (171 males, 129 females) willing to participate in the study were included. Responses to the Berlin and oral health questionnaires were

collected, and oral examinations were performed. Statistical analysis was conducted using Epi Info software. Kruskal-Wallis H test and one-way Analysis Of Variance (ANOVA) were carried out to evaluate significance in different groups and to examine associations between OSA, oral health, and other variables.

Results: The collected data were statistically analysed. In the present study, 35 subjects (11.67%) were classified as high-risk and 265 subjects (88.33%) as low-risk by the BQ. The prevalence of OSA in the present study was 12.87% in males and 10.08% in females. High-risk subjects were educated, motivated, and referred for confirmatory diagnostic tests and early treatment.

Conclusion: The prevalence of OSA in the present study was 12.87% in males and 10.08% in females. Emphasis should be placed on highlighting the clinical aspects related to OSA and its relation to oral health. There is a great need to educate and motivate dental and medical students and professionals about OSA by conducting health education programs.

Keywords: Berlin questionnaires, Medical students, Oral health, Snoring

INTRODUCTION

Sleep disorders are very common and are seen in all age groups. They present with various pathophysiological features and clinical manifestations. Disturbed sleep has adverse consequences on physical, psychological, social, marital, and economic quality of life. OSA is the most common chronic sleep-related breathing disorder, characterised by a repetitive partial or total obstruction of the upper airways resulting in recurrent arousals, intermittent hypoxemia, and sleep fragmentation. This leads to lower oxygen saturation and sleep disruption [1]. The aetiology is multifactorial, including obesity, aging, stress, a sedentary lifestyle, adenotonsillar hypertrophy, neuro-muscular disorders, cranio-facial dental anomalies, hormonal changes (e.g., pregnancy, menopause), smoking, alcohol, sedatives, or tranquilisers, which may cause collapsibility of the upper airway [1-3].

OSA has been found to be a risk factor for metabolic syndrome, diabetes mellitus, hypertension, coronary artery disease, cerebrovascular disorders, cognitive dysfunction, and an increased risk of automobile and occupational accidents [3,4]. Symptoms of OSA include snoring during sleep, excessive daytime sleepiness, lack of concentration, morning nausea and headaches, fatigue, memory impairment, personality changes, and automatic behaviour manifestations such as irritability, impatience, and depression [5]. OSA also presents with oral manifestations like gingivitis, periodontitis, dry mouth, halitosis, frequent throat infections, attrition, sleep-related bruxism, orofacial pain, dental caries, mobility of teeth, etc., [5-10]. Prevalence rates of OSA vary widely in males, females, urban, and rural populations [4,11].

Interestingly, the treatment of OSA has been found to improve the overall general health of the patient. Dentists can identify patients

with OSA during their regular dental check-ups through proper medical history and oral examination. Dental Sleep Medicine is a rapidly growing blend of medicine and dentistry [12,13]. Unawareness and misconceptions/misinterpretations regarding early diagnostic options, management, and consequences of improper treatment may be the cause of morbidity and mortality due to OSA [11,14]. Therefore, a multi-disciplinary approach to treat OSA is very important. Sleep specialists, pulmonologists, otolaryngologists, neurologists, psychiatrists, and dental professionals play an important role in detecting and treating OSA patients [7,15]. Treatment includes a controlled diet, regular exercise, behaviour modification like sleep position, medication, continuous positive airway pressure, oral appliance therapy, surgical therapy, etc., [1,5,8].

Polysomnography (PSG) is a gold standard non-invasive technique for the diagnosis of OSA that measures overnight physiological variables such as eye movements, muscle tone, respiratory effort, airflow, electro-encephalography, and oxygen saturation. However, it is expensive, time-consuming, and requires well-trained personnel. Screening questionnaires are simple, low-cost, non-invasive tools that can be used to prioritise patients eligible for PSG [3,6,8,10,13]. Screening questionnaires like the BQ, Snoring, Tiredness, Observed apnea, and high blood Pressure (STOP) questionnaire, and Body Mass Index (BMI), Age, Neck circumference, Gender (BANG) questionnaires, as well as the Epworth Sleepiness Scale (ESS) and Wisconsin questionnaire, are most widely used [3,6,8,13].

The validity of the BQ was confirmed in earlier studies on the general aged population [2-4,14,16]. A limited number of studies [8,9] were conducted in young adults (medical students) regarding knowledge, screening, diagnosis, and treatment modalities of OSA. Therefore, the present study aims to screen subjects with OSA

using validated questionnaires, oral examinations, and further refer them to specialists for a final diagnosis, thus promoting a multi-disciplinary approach and early treatment at a young age. Therefore, the present study aimed to assess the risk of OSA symptoms and their association with oral manifestations among students.

MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of Physiology at Hassan Institute of Medical Sciences, Hassan, Karnataka, India, from September 2023 to November 2023. The study was conducted after approval from the Institutional Ethics Committee (IEC/HIMS/RR 458/05-09-2023). Informed consent was obtained from all participants.

Inclusion criteria: Medical students between the ages of 18-24 years who were willing to participate in the study were included.

Exclusion criteria: Students unwilling to participate, as well as those with chronic diseases such as diabetes mellitus, respiratory and cardiac diseases, and students taking sleep medications, were excluded from the study.

Sample size estimation: was done based on a prevalence rate of 8%, considering that most studies mentioned prevalences ranging from 3.7% to 14% [4,11] using the Daniel formula ($N=Z^2pq/d^2$). The estimated sample size was 113; A total of 300 students were included in the study with 171 male participants and 129 females.

Procedure

A general physical examination was conducted, including measurements of height, weight, neck circumference, and blood pressure. The BMI was calculated for all participants. Study questions were developed based on previous research and were adjusted to suit the needs of the present study [1,2,4,8-11,13]. Students were briefed on OSA and its symptoms.

Questionnaire: a pre-tested, validated 10-item BQ [2,3,11] and a peer-reviewed 14-item self-structured oral health questionnaire [13], were distributed to participants for completion. The BQ comprises three categories related to the risk of sleep apnea. A positive score in two or more categories categorised participants as high-risk, while

a positive score in one or no categories indicated low-risk. High-risk individuals were educated, motivated, and referred for confirmatory diagnostic tests, with early treatment recommended to prevent further complications. Completed questionnaires were coded to maintain participant anonymity and ensure anonymous reporting of results. The questionnaire required approximately 20-30 minutes to complete.

Oral examinations were conducted, and findings were recorded as detailed in responses as shown in [Table/Fig-4] were summarised in a binomial form by tallying agree and disagree responses separately. A 'yes' or 'no' response pattern was employed for statistical convenience. Data was collected and statistically analysed to classify individuals as high or low-risk based on their BQ scores.

STATISTICAL ANALYSIS

A master chart was created from the collected data and appropriately organised into tables for analysis and discussion. Analysis was conducted using Epi Info software and Statistical Package for Social Sciences (SPSS) version 26.0. Qualitative data were presented as percentages, and quantitative continuous variables were shown as mean±standard deviation. The Kruskal-Wallis H test, equivalent to the Chi-square test, and One-way analysis of variance (ANOVA) test were performed to assess significance among different groups and to explore associations between OSA, oral health, and other variables. A p-value <0.05 was considered statistically significant.

RESULTS

Participants returned completed questionnaires, resulting in a response rate of 100%. The study included 171 males and 129 females [Table/Fig-1]. In the present study, 35 (11.67%) subjects were classified as high-risk and 265 (88.33%) as low-risk for OSA based on their responses to individual items and overall scores in the symptom categories of the BQ. The prevalence of OSA was found to be 12.87% in males and 10.08% in females [Table/Fig-2]. The gender-wise categorisation of participants into high-risk and low risk is mentioned in [Table/Fig-2].

The responses of participants and their associations with symptoms of OSA and other factors are presented in the oral

| Parameters | Number (n) | Age (Years) | Height (centimeters) | Weight (Kilograms) | BMI (kg/m ²) | Neck circumference (cm) |
|------------------|------------|-------------|----------------------|--------------------|--------------------------|-------------------------|
| Total | 300 (100%) | 19.13±0.99 | 167.78±9.82 | 59.83±11.5 | 21.22±3.28 | 33.01±2.70 |
| Males | 171 (57%) | 19.12±1.01 | 173.52±6.57 | 64.2±10.78 | 21.29±3.09 | 34.44±2.15 |
| Females | 129 (43%) | 19.15±0.97 | 160.18±8.13 | 54.05±9.82 | 21.12±3.53 | 31.09±2.12 |
| Kruskal Wallis H | | 0.045 | 142.13 | 62.52 | 0.802 | 119.23 |
| p-value | | 0.8312 | 0.00001 | 0.00001 | 0.3705 | 0.00001 |

[Table/Fig-1]: Descriptive characteristics of study participants.

| Parameters | OSA | | Total |
|------------|-------------|--------------|-------|
| | High-risk | Low-risk | |
| Males | 22 (12.87%) | 149 (87.13%) | 171 |
| Females | 13 (10.08%) | 116 (89.92%) | 129 |
| Total | 35 (11.67%) | 265 (88.33%) | 300 |

[Table/Fig-2]: Risk categorisation based on Berlin Questionnaire (BQ) results. (N=300)

health questionnaire, as shown in [Table/Fig-3]. Many students exhibited one or more symptoms of OSA. Symptoms such as mouth breathing, dry mouth, sore throat, Temporomandibular Joint (TMJ) pain, morning headache, nausea, insomnia, and lack of concentration were statistically significant ($p<0.05$) in males. In females, dry mouth, sore throat, TMJ pain, morning headache, and nausea were also found to be statistically significant ($p<0.05$) [Table/Fig-3].

| S. No. | Questions | Males (Total:171) | | | Females (Total:129) | | |
|--------|--|-------------------|------------|---------------|---------------------|------------|---------------|
| | | High-risk | Low-risk | p-value | High-risk | Low-risk | p-value |
| 1 | Are you a mouth breather? | 7 (4.1%) | 14 (8.2%) | 0.0029 | 4 (3.1%) | 16 (12.4%) | 0.1102 |
| 2 | Do you have dry mouth when you wake up? | 11 (6.4%) | 28 (16.4%) | 0.0012 | 6 (4.5%) | 26 (20.2%) | 0.0612 |
| 3 | Are you frequently suffering from sore throat? | 6 (3.5%) | 14 (8.2%) | 0.0152 | 5 (3.9%) | 12 (9.3%) | 0.0046 |
| 4 | Do you have Bad breath? | 4 (2.3%) | 11 (6.4%) | 0.0956 | 2 (1.6%) | 12 (9.3%) | 0.5811 |
| 5 | Do you have jaw pain, TMJ pain? | 3 (1.8%) | 5 (2.9%) | 0.0336 | 3 (2.3%) | 6 (4.7%) | 0.0167 |
| 6 | Do you have morning headache and nausea? | 3 (1.8%) | 2 (1.2%) | 0.0014 | 3 (2.3%) | 6 (4.7%) | 0.0167 |
| 7 | Do you have insomnia (lack of sleep)? | 6 (3.5%) | 10 (5.8%) | 0.0021 | 1 (0.8%) | 14 (10.9%) | 0.6419 |

| | | | | | | | |
|----|--|-----------|------------|---------------|----------|------------|---------------|
| 8 | Do you have frequent arousals during sleep? | 3 (1.8%) | 14 (8.2%) | 0.5361 | 2 (1.6%) | 17 (13.2%) | 0.9441 |
| 9 | Do you walk during sleep (nocturnal walking)? | 0 | 2 (1.2%) | 0.5857 | 0 | 2 (1.6%) | 0.6346 |
| 10 | Do you have sleep talking? | 3 (1.8%) | 14 (8.2%) | 0.5361 | 5 (3.9%) | 24 (18.6%) | 0.1471 |
| 11 | Do you have lack of concentration or memory impairment? | 12 (7.0%) | 25 (14.6%) | 0.0001 | 4 (3.1%) | 20 (15.5%) | 0.2364 |
| 12 | Do you know all the above are symptoms of Obstructive Sleep Apnea (OSA)? | 6 (3.5%) | 47 (27.5%) | 0.6868 | 0 | 39 (30.2%) | 0.0127 |
| 13 | Do you know that OSA increases with age? | 6 (3.5%) | 46 (26.9%) | 0.7326 | 2 (1.6%) | 47 (36.4%) | 0.0778 |
| 14 | Do you know Dentist play a role in diagnosis and treatment of OSA? | 3 (1.8%) | 38 (22.2%) | 0.2250 | 0 | 30 (23.3%) | 0.0371 |

[Table/Fig-3]: Responses of participants and their association with symptoms of OSA.

Clinically, it was observed that malocclusion in males and Class-III and Class-IV types of soft palate and uvula (based on Mallampati scores) in females were statistically significant ($p < 0.05$) and associated with OSA. All participants had a normal tongue, and none showed tooth mobility. Other oral findings were not statistically significant since the participants were young adults. These factors collectively increase the risk of developing OSA [Table/Fig-4].

to females. They reported that 10-17% of men and 3-9% of women have moderate or severe OSA [4].

Similarly, Devaraj U et al., conducted a study revealing that the risk of OSA after screening was 36 (6.7%) among urban participants and 28 (8.7%) among rural participants. The prevalence of OSA was 18 (4.6%) in urban subjects and 12 (3.7%) in rural subjects [11]. These findings align with those of other studies.

| S. No. | Findings | Males | | | Females | | |
|--------|---|-----------|------------|---------------|-----------|------------|---------------|
| | | High-risk | Low-risk | p-value | High-risk | Low-risk | p-value |
| 1 | Facial asymmetry | 5 (2.9%) | 37 (21.6%) | 0.831 | 1 (0.8%) | 24 (18.6%) | 0.2628 |
| 2 | Lip incompetency | 1 (0.6%) | 9 (5.3%) | 0.7809 | 1 (0.8%) | 8 (6.2%) | 0.9153 |
| 3 | Temporo-mandibular Joint(TMJ) disorders | 4 (2.3%) | 24 (14.0%) | 0.8067 | 3 (2.3%) | 14 (10.9%) | 0.2677 |
| 4 | Missing teeth | 0 | 5 (2.9%) | 0.3846 | 0 | 5 (3.9%) | 0.4469 |
| 5 | Decayed teeth | 7 (4.1%) | 30 (17.5%) | 0.2155 | 4 (3.1%) | 32 (24.8%) | 0.8090 |
| 6 | Malocclusion | 4 (2.3%) | 5 (2.9%) | 0.0037 | 0 | 4 (3.1%) | 0.4981 |
| 7 | Attrition | 1(0.6%) | 7 (4.1%) | 0.9748 | 0 | 4 (3.1%) | 0.4981 |
| 8 | Mobility of teeth | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | Hard palate (V-Shape) | 3 (1.8%) | 20 (11.7%) | 0.9782 | 1 (0.8%) | 21 (16.3%) | 0.3458 |
| 10 | Soft palate Class-III, IV | 7 (4.1%) | 35 (20.5%) | 0.3983 | 8 (6.2%) | 35 (27.1%) | 0.0234 |
| 11 | Tongue | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | Gingivitis | 0 | 5 (2.9%) | 0.3846 | 0 | 0 | 0 |

[Table/Fig-4]: Oral examination results.

DISCUSSION

Regardless of the aetiology, OSA results in poor health, reduced quality of life, and decreased work productivity. Being a multifactorial disease, OSA is underdiagnosed and undertreated in India, which may be attributed to the poor healthcare system, limited epidemiological data, and a lack of awareness among the general population, as well as the medical and dental communities [1,7,11]. Many population-based studies have indicated an increasing prevalence of OSA [2]. There is limited data on the prevalence of OSA among young adult medical students. High stress levels, lack of awareness, sedentary lifestyles, and behavioural habits among medical students may be contributing factors to the earlier development of OSA, hence prompting the conduct of this study.

The BQ was developed in 1996 in Germany by a group of respiratory and primary care physicians. The questionnaire has been recognised for its utility as a screening tool in the general population due to its sensitivity, reliability, and validity [2,4,7,8]. Therefore, the Berlin Screening questionnaire was utilised for the risk assessment of OSA in the present study.

In this study, 35 subjects (11.67%) were classified as high-risk and 265 subjects (88.33%) as low-risk according to the BQ. The prevalence of OSA was 12.87% in males and 10.08% in females, with an overall prevalence of 11.67%. This difference could be attributed to variations in fat distribution, sex hormones, pharyngeal anatomy, and function [4,13]. Pattanaik S et al., demonstrated a higher prevalence of OSA with age, particularly among males compared

Obesity is a significant predisposing factor for OSA [4,5,8,13]. In the present study, 22 males (12.87%) and 18 females (13.9%) exhibited high BMI values. Additionally, 16 (9.4%) males and 10 (7.8%) females had increased neck circumference, which is also a contributing factor to OSA. It is worth noting that the blood pressure of all participants was within normal limits.

Many authors have reviewed articles to discuss in detail the oral manifestations, diagnosis, treatment approaches, and the role of a dentist in managing OSA [3,5,6]. Berggren K et al., stated that dental professionals are not consistently able to recognise patients who have or are at high-risk for OSA [12].

A thorough oral clinical evaluation, in conjunction with an oral health questionnaire, helps us correlate and diagnose OSA at an early stage to successfully manage patients. The results and [Table/Fig-3] demonstrate a statistically significant association between OSA and symptoms such as mouth breathing, dry mouth, sore throat, TMJ pain, morning headache, nausea, insomnia, frequent arousal during sleep, lack of concentration, and memory impairment ($p < 0.05$). Factors such as facial asymmetry, incompetent lips, enlarged tongue, malocclusion, retrognathic mandible/maxilla, V-shaped palate, narrow arches, bruxism, attrition, and enlarged tonsils were identified as contributing factors for OSA and should be examined [5,7,12,13]. Signs of mouth breathing may manifest as dry mouth, gingivitis, periodontal disease, dental caries, and missing teeth.

The oral examination results presented in [Table/Fig-4] revealed a statistically significant association between OSA and

malocclusion in males and Class-III and Class-IV soft palate in females ($p < 0.05$), consistent with previous studies [14]. Given that all participants were young medical students, most intraoral clinical manifestations were not clinically significant, and their oral hygiene was well maintained. Previous research has indicated that OSA patients often exhibit enlarged tongues, narrow palatal vaults, and Class-III (soft palate and base of uvula visible) and Class-IV (only hard palate visible) Mallampati scores of the soft palate and uvula [5,10,12]. Saluja IP et al., using lateral cephalograms, found that the majority of participants had type 2 (rat tail type) soft palates (26.0%) and observed a highly significant association between BQ responses (positive and negative) and soft palate morphology types [14]. Advanced diagnostic technologies like radiographs and cone-beam tomography in airway imaging, as well as computational fluid dynamics, aid in the accurate diagnosis of airway obstruction [1]. Zafna A highlighted the need for health education programs to promote oral health awareness and increase knowledge of sleep-disordered breathing [13].

Numerous studies have evaluated the knowledge, attitudes, and opinions of participants regarding OSA, revealing a significant lack of awareness among medical students, interns, and general dentists [8-10]. Therefore, screening individuals for OSA using validated questionnaires and oral examinations, and subsequently referring them to specialists for final diagnosis, is crucial in promoting a multi-disciplinary approach and early treatment.

Limitation(s)

Some students were reluctant to honestly declare their health status, possibly due to being medical students. Our survey group only represents young adults, and many other age groups are not included. Further detailed oral examination is required for confirmation.

CONCLUSION(S)

Based on the Berlin and oral health questionnaire, it can be concluded that 11.67% of medical students were at a higher risk of OSA, but only a few exhibited oral manifestations upon examination due to their young adult age group. Emphasis should be placed on highlighting the clinical aspects related to OSA and its relationship to oral health. There is a significant need to educate and motivate dental and medical students and professionals about OSA through the implementation of health education programs.

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