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Obstructive Sleep Apnea Risk and The Relationship with Periodontal Disease in A Nigerian Population

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Abstract

Introduction: Obstructive sleep apnea (OSA) and periodontal disease have both been widely studied, both have been associated with several systemic conditions. Studies have recently focused on the bidirectional interrelationship of both entities.

Objective: This is to determine the risk of OSA and assess its relationship with periodontal disease in a Nigerian population.

Methodology: This was a cross-sectional study conducted at the Oral diagnosis clinic of the Lagos State University Teaching Hospital Lagos Nigeria. A total of 133 subjects participated in this study. Data was collected using a self-administered questionnaire to obtain the socio-demographics. Intraoral parameters were recorded and the Berlin OSA risk assessment tool assessed the OSA risk level. Data analysis was carried out using SPSS version 23. The prevalence of periodontal disease and the risk of OSA in the subjects was determined using Pearson's chi-square. Logistic regression was used to assess the effect of covariates and to adjust for confounders. Statistical significance was inferred at $p \leq 0.05$.

Results: The mean age was 40.7±15.7. Forty-nine (34.6%) of the subjects reported snoring. The mean OHI was 1.61±0.8 while the mean pocket depth was 3.6±1.9. Twenty-eight (21%) have a high risk of OSA. Fifty-four (40.6%) have gingivitis, 24(18%) and 12(9%) have periodontitis and advanced periodontal disease respectively. Pearson's chi-square assessment of the

variables and the OSA risk showed a significant difference in the age groups (p=0.03) with 51 years old and above having the most subjects with high risk of OSA. The periodontal status of the subjects is statistically significant (p=0.001), the subjects with periodontitis 14(10.5%) and advanced periodontal disease 8(6%) formed the majority of the subjects with a high risk of OSA. Binary logistic regression showed that age groups and periodontal status were significantly related to a high risk of OSA with (p=0.03) and (p=0.01) respectively.

Conclusion: The relationship of age, periodontal disease and high risk of OSA is further strengthened in this study, however the cause/effect relationship between periodontal disease and risk of OSA needs further study. Health education directed especially at the elderly as regards OSA and periodontal disease is recommended.

Keywords: Obstructive, Sleep, Apnea, Periodontitis, Periodontal disease, OSA, Berlin

Introduction

Obstructive sleep apnea (OSA) is a condition of intermittent bouts of collapse of the pharyngeal space leading to partial or complete restriction of airflow during sleep, which may result in cardiopulmonary metabolic and neurological disturbance [1,2,3]. This nocturnal hypoxemia/hypercapnia eventually gives rise to excessive daytime sleepiness (EDS) and disruptive loud snoring, apnea, dry mouth, sleeplessness, oversleeping, and attention deficits [2,3,4]. OSA is commoner amongst elderly males with a male-to-female ratio of 3:1. Globally, when 5 or more episodes per hour were considered, more than 900 million individuals have mild to severe OSA [1]. Independent of body weight, OSA is more prevalent amongst African Americans below 35 years old than in Caucasians of a similar age range [4]. Family history and genetics have also been implicated in risk factors [2,3]. The prevalence of OSA in Asia is similar to that in the United States though they have a lower obesity rate. In a Nigerian study, the prevalence of high risk for OSA was 18%, using the Berlin questionnaire [5]. Individuals with OSA are more predisposed to overweight/obesity, diabetes, and cardiovascular and cerebrovascular complications [4,6].

Predisposing factors to OSA include facial malformations, micrognathia, macroglossia, lateral pharyngeal walls thickening, nasal congestion, abnormally large uvula, hypertrophy of the tonsils, and obesity which narrows the airway as a result of fatty infiltration of areas surrounding the airway including the tongue and soft palate [1,6]. The resulting hypoxemia also reduces nitrous oxide production, causing vasoconstriction and the release of proinflammatory mediators that damage the endothelium and potentiate the formation of atherosclerotic plaques. OSA is reported to have an independent relationship with stroke, and cancer, amongst other diseases kidney disease, hypertension, and gastroesophageal reflux [2,7,8].

Periodontal disease is a commonly reported inflammatory condition affecting the periodontal tissues [8,9]. In a hospital-based study, the prevalence of periodontitis in Ile-Ife, Nigeria was 68.7% [10], similar to other reports in Mexico (62.7%) [11], and Brazil (67.8%) [12]. It frequently presents as gingivitis which occurs when the pathology is limited to the gingival tissues, it is characterised clinically by pain, swelling, redness, and bleeding without periodontal pocket formation and alveolar bone loss [9,13,14]. Periodontal disease also presents as periodontitis when there is pathologic pocket formation and bone loss, this may eventually lead to tooth migration, mobility, and loss [9]. Periodontitis is classified based on severity into stages I-IV and based on the rate of progression is classified into grades A-C

[15]. Periodontal diseases are initiated by oral microorganisms that colonise the tooth surface and dental sulcus/ periodontal pockets via dental biofilms, invading the tissues and indirectly instigating a host immunoinflammatory response [9,12,13].

The host immunoinflammatory responses release several pro-inflammatory mediators like tumour necrosis factor-alpha and interleukins-6, 1B, and 33, which damage the periodontal structure, and eventually loss of the tooth [12,13]. Entry of these mediators into the blood and systemic circulation potentiates several systemic pathologies. Recent studies have reported a relationship between periodontal disease and systemic diseases, such as rheumatoid arthritis, type 2 diabetes mellitus, cardiovascular disease, gastrointestinal and colorectal cancer, Alzheimer's disease, pulmonary tract infections, adverse pregnancy outcomes, and recently obstructive sleep apnea [9,12,13,14].

The similarity of periodontitis and OSA in eliciting systemic inflammation invariably elucidates the relationship between these two morbidities. Quite a few studies have reported an association between obstructive sleep apnea OSA and periodontal disease. In a systematic review and meta-analysis, an assessment of 10 studies revealed a direct relationship between periodontitis and OSA (OR=2.17) even when sex and age were adjusted for [15]. There is a relationship between periodontitis and mild to moderate severity of OSA [16]. The explanation for the association is that episodic hypoxemia in OSA can result in oxidative stress and systemic inflammation response which injures the periodontal tissues as it does to other body systems [15,16,17]. Dry mouth which results from prolonged mouth breathing also limits the ability for self-cleansing and enhances the progression of periodontal disease [16,17]. A study suggested that OSA can enhance the growth of Prevotella melaninogenica and Candida albicans, thereby enhancing the severity of periodontal disease [18].

The assessment of OSA and periodontal disease has received limited research attention hence this study aims to determine the relationship between the risk for OSA and periodontal disease among patients attending a dental clinic in an urban center in Nigeria.

Methodology

This study was conducted at the Oral diagnosis clinic of the Lagos State University Teaching Hospital (LASUTH) Ikeja Lagos Nigeria. LASUTH provides tertiary health service to Lagos state and its environs including nearby Ogun state. LASUTH is a tertiary hospital/referral hospital that serves inhabitants of Lagos state a former federal capital of Nigeria and a metropolitan city. The Oral diagnosis clinic of the Dental Centre receives an inflow of more than 500 new patients monthly with more than 50% of them referred for varying forms of periodontal assessment and treatment.

The study was cross-sectional with the subjects drawn via convenient sampling. Patients included in this study were those attending for the clinic first time who gave their consent and were between 18 and 60 years old, African descent with at least 10 teeth in the mouth; and patients who are non-smokers and not on antibiotics or steroids. Patients who are not pregnant and not currently on periodontal treatment were also included. Patients who had scaling and polishing done in the last 6 months or were diagnosed with upper or lower respiratory tract infections and lesions, diabetes mellitus, and any immune-compromising disease were excluded.

Data was collected using a self-administered questionnaire consisting of both open and closed-ended questions to obtain information on age, sex, occupation, medical history, and dental history after informed

consent was obtained from the participants. The questionnaire also contained the Berlin OSA risk assessment questionnaire which consists of 3 categories related to the risk of having sleep apnea [19]. Patients can be classified into high-risk or low-risk based on their responses to the individual items and their overall scores in the symptom categories. A high-risk score is when 2 or more categories are positive while a low-risk score is when only 1 or no category is positive [19]. The subject parameters i.e., indices for extent and severity of periodontal disease using William's periodontal probe to determine the probing depths at sites around each tooth, simplified oral hygiene index, Basic periodontal examination, and periodontal treatment need were also estimated.

Data analysis was carried out using SPSS version 23 (IBM Texas). Descriptive statistics was carried out for socio-demographic variables such as age and sex, and educational status. For descriptive variables that are continuous, the mean and measures of variability were determined. For descriptive variables that are categorical, simple frequency and percentages was determined. The prevalence of periodontal disease and the risk of OSA in the subjects were determined statistically using the Pearson's chi-square.

Multivariate logistic regression method for repeated data was used to determine the effect of covariates in the prevalence of periodontitis and to adjust for confounders. Statistical significance was inferred at $p \leq 0.05$.

Results

A total of 133 subjects participated in this study, the mean age was 40.7±15.7 (Table 1). The male-female ratio was 1:1.4 while the majority of the subjects were in the 21-30 years age group (26.3%) followed by the 31-40 years age group (21.8%) the least was the 11-20 years age group (5.3%) (Figure 1). The professionals and the retirees topped when the occupation of the subjects was considered with 34(26.6%) of the subjects each, this was followed by the unskilled 30(22.6%) while the least was the unemployed 3(2.25%) (Table 2). In terms of the educational status of the subjects, the highest was the tertiary 113(85%). Forty-nine (34.6%) of the subjects reported snoring while 8(6%) were unsure. The mean OHI was 1.61±0.8. Most subjects 67(50.4%) scored 1.3-3.0 (fair).

Table 1: Description of the continuous variables

		Age	Oral hygiene score	Pocket depth
N	Valid	133	133	133
	Missing	0	0	0
Mean		40.7293	1.6125	3.5624
Median		37.0000	1.5000	3.0000
Std. Deviation		15.69942	.77631	1.89827
Skewness		.544	.689	1.557
Std. Error of Skewness		.210	.210	.210

Figure 1: Description of the subjects by age groups

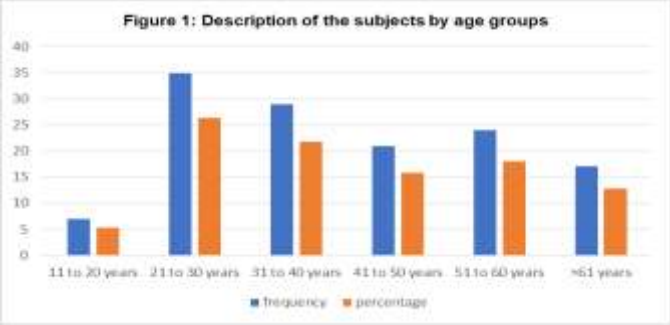
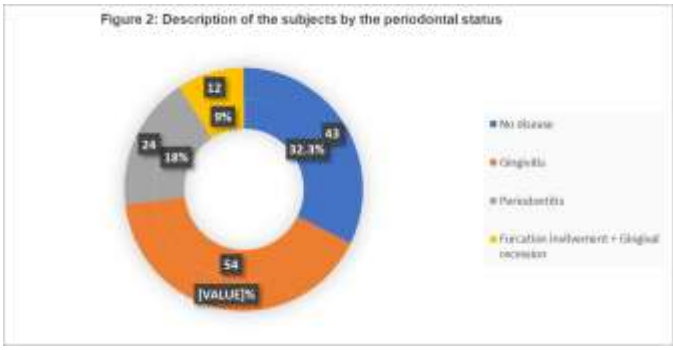


Figure 2: Description of the subjects by the periodontal status



The OSA risk assessment of the subjects showed 28(21%) have a high risk of OSA while 105(79%) have a low risk. Figure 2 expressed the periodontal status of the subjects, 54(40.6%) have gingivitis while those with periodontitis 24(18%), and those with advanced periodontal disease (furcation involvement and gingival recession 12(9%). The mean pocket depth was 3.6±1.9.

Table 2: Description of the variables

Variable		Frequency (%)	Total
Sex	Male	56(42.1)	133
	Female	77(57.9)	
Occupation	Unemployed	3(2.25)	133
	Unskilled	30(22.6)	
	Skilled	22(16.5)	
	Professional	34(25.6)	
	Retired	34(25.6)	
	Student	10(7.5)	
Highest educational status	Primary	2(1.5)	133
	Secondary	18(13.5)	
	Tertiary	113(85)	
Snoring	Yes	46(34.6)	133
	No	79(59.4)	
	I don’t know	8(6)	
Oral hygiene	Good (0.1-1.2)	54(40.6)	133
	Fair (1.3-3.0)	67(50.4)	
	Poor (3.1-6.0)	12(9)	
OSA risk	High	28(21)	133
	Low	105(79)	

Bivariate assessment of the variables and the OSA risk using Pearson's chi-square (Table 3) showed a significant difference in the age groups (p=0.03) with the 51-60 years and the >60 years having the most subjects with high risk of OSA. The subjects with a high risk of OSA increased with age. The sex of the subjects did not show any significant difference with males 13(9.8%) and females 15(11.3%) with high risk of OSA. Socioeconomic factors such as occupation (p=0.58) and educational status (p=0.22) have no significant difference, this is also true of the oral hygiene status of the subjects (p=0.35). The periodontal status of the subjects has an appreciable significant difference (p=0.001), the subjects with periodontitis 14(10.5%) and advanced periodontal disease 8(6%) formed the majority of the subjects with a high risk of OSA compared to those with gingivitis 4(3%) and healthy gingiva 2(1.5%). The Phi correlation coefficient for periodontal pocket depth and the risk of OSA was 0.62 with p=0.001.

Table 3: Chi square assessment of the variables and OSA risk

Variable		High risk frequency(%)	Low risk frequency(%)	P- value
Age group (years)	11-20	0(0)	7(5.3)	0.04*
	21-30	4(3)	31(23.3)	
	31-40	5(3.8)	24(18)	
	41-50	5(3.8)	16(12)	
	51-60	7(5.3)	17(12.8)	
	>60	7(5.3)	10(7.5)	
Sex	Male	13(9.8)	43(32.3)	0.6
	Female	15(11.3)	62(46.6)	
Occupation	Unemployed	0(0)	3(2.3)	0.58
	Unskilled	9(6.8)	21(15.8)	
	Skilled	6(4.5)	16(12)	
	Professional	6(4.5)	28(21.1)	
	Retired	5(3.8)	29(21.8)	
	Student	2(1.5)	8(6)	
Highest educational status	Primary	1(0.8)	1(0.8)	0.22
	Secondary	6(4.5)	12(9)	
	Tertiary	21(15.8)	92(69.2)	
Snoring	Yes	13(9.8)	33(24.8)	0.11
	No	12(9)	67(50.4)	
	I don't know	3(2.3)	5(3.8)	
Oral hygiene	Good (0.1-1.2)	8(6)	46(34.6)	0.35
	Fair (1.3-3.0)	17(12.8)	50(37.6)	
	Poor (3.1-6.0)	3(2.3)	9(6.8)	
Periodontal status	No disease	2(1.5)	41(30.8)	0.001*
	Gingivitis	4(3)	50(37.6)	
	Periodontitis	14(10.5)	10(7.5)	
	Advanced disease (furcation+gingival recession)	8(6)	4(3)	

*significant (p-value < 0.05)

Multivariate analysis using binary logistic regression (Table 4) showed that age groups and periodontal status were significantly related to the risk of OSA with (p=0.03) and (p=0.01) respectively.

Table 4: Binary logistic regression to assess the relationship between the variables and the risk of OSA

Variables	Odd	S.E.	Wald	df	Sig.	Exp(B)
Age group	.392	.265	2.187	1	.003	.675
Sex	-.675	.627	1.159	1	.282	.509
Marital status	.336	.610	.303	1	.582	1.399
Occupation	.184	.241	.582	1	.445	1.202
Average income per month	-.246	.285	.749	1	.387	.782
Highest educational status	1.155	.658	3.083	1	.079	3.175
Do you snore	.369	.475	.605	1	.437	1.447
oral hygiene grade	-.181	.443	.166	1	.684	.835
Periodontal status	1.694	.352	23.130	1	.001	.184
Constant	2.807	3.086	.827	1	.363	16.561

Discussion

Most of the subjects in this study were in the middle age group between 21 and 40 years old (figure 1). A lot of them were in one profession or the other, this is not unexpected considering the age group of the subjects and the fact that they form a substantial proportion of Nigeria's population. About a third of the subjects reported snoring, this is similar to a previous study in Nigeria by Adewole and coworkers [20] another study reported 44% [21]. The oral hygiene status of most of the

subjects was fair, reflecting the socioeconomic status of the study population, because these relatively professional middle-aged subjects are reported to have better access to oral health facilities [22,23,24]. The high risk of OSA (28%) is within the range of previous studies in Nigeria that reported 17-40% in several hospital-based studies [25,26]. This study further exemplifies the pyramidal structure of the progression of periodontal disease from gingivitis which is more prevalent and more than double the value of periodontitis and advanced periodontitis (gingival recessions and furcation involvements which is almost a quarter of it [27,28].

Age difference was a significant factor related to periodontal disease among the subjects studied, it also has a direct proportionality with a high risk of OSA, which may be associated with ageing itself and other accompanying comorbidities [29]. The high risk of OSA is higher among those aged 50 and above, this is consistent with other studies but it is reported to be less severe as the individual ages [30,31]. This study revealed that the high risk of OSA has no preference for sex, socioeconomic status, and oral hygiene status, this is at variance to previous studies that reported 30% of males and 19% of females were at high risk of OSA [32,33], a systematic review showed that a lower socioeconomic status is associated with an increased risk of OSA, this disagrees with the outcome of this study [34].

This study revealed a marked relationship between periodontal disease and the risk of OSA among the subjects in this study, with the prevalence of periodontitis and advanced periodontal disease being higher in patients with a high risk of OSA similar to other studies [18,35]. In the reverse a South Korean study by Kim et al [36] examined the risk of chronic periodontitis in subjects with OSA and found a strong association, suggesting a possible bidirectional relationship. The majority of the subjects with a high risk of OSA were the subjects with periodontitis and advanced periodontal disease 22(16.5%) while those with gingivitis 4((3%) a previous study reported a much higher prevalence of periodontitis in patients with OSA (94.6%) [37]. The low prevalence in this study may be because the risk for OSA was being assessed. Arango et al [38] reported 33.4% in a study in North Carolina in the United States of America. The ability of both periodontitis and OSA to cause systemic inflammation may explain the association between the two entities. The intermittent hypoxemia in OSA may give rise to oxidative stress and systemic inflammatory response, affecting the periodontal tissues like other body systems [15,16,17]. Prolonged mouth breathing as a result of OSA causes dry mouth which limits intraoral self-cleansing and furthers the progression of periodontal diseases [16,17,39].

Conclusion

This study further strengthens the relationship between age, periodontal disease, and a high risk of OSA; however, the cause/effect relationship between periodontal disease and the risk of OSA needs further study. Health education and promotion of the populace, particularly concerning OSA, attendant complications, periodontal diseases, and the associated systemic sequela, should be emphasized and directed, especially at the elderly.

Ethical approval for the study was obtained from the Research and Ethical Committee of the Lagos State University Teaching Hospital Ikeja.

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