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Is Oropharyngeal Crowdedness a Risk Factor for High Blood Pressure?

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Authors' contributions

This work was carried out in collaboration between all authors. Authors SAO and OAL did the study design and wrote the protocol. Authors SAO and KOA did the statistical analysis and literature searches while analyses of study was by authors SAO, AJF and OSA. Authors SAO, AJF, OSA, KOA and OAL wrote the first draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Background: Snoring is a sign of partial upper airway obstruction from oropharyngeal crowdedness during sleep but little is known about its association with essential hypertension in black Africans.
Aim: To determine prevalence of hypertension among adult snorers and its relationship with selected indices of oropharyngeal crowdedness.
Methods: It is a cross-sectional study of adults in Oyo Rural Community. Questionnaire was administered to obtain data on socio-demography, daytime sleepiness, snoring, duration of overnight sleep. Those with chronic medical conditions and past surgical procedures in the nose or throat were excluded. Oropharyngeal crowdedness was assessed using Mallampati scoring and Brodsky tonsillar grading methods. Participants' neck circumference and blood pressure were

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measured. The body mass indices (BMI) were determined. Statistical analysis was performed with IBM- SPSS version 20 and level of significance was at set at p value < 0.05.

Results: There were 408 participants consisting 191(46.8%) snorers and 217 (53.2%) non-snorers. Fifty-one (12.5%) participants have hypertension comprising of 27 (52.9%) snorers and 24 (47.1%) non-snorers. Mean BMI for male and female were 23.79 kg/m^2 ±3.93 and 24.86 kg/m^2 ± 4.9 respectively. Mean neck circumference was 34.08±2.7 cm and duration of overnight sleep was 8.2±1.4 hours. Mallampati score I, II, III and IV were in 94 (23.0%), 148 (36.3%), 121 (29.7%) and 45 (11.0%) participants respectively, and Brodsky tonsillar grade 0, 1, 2, and 3 were observed in 293 (71.8%), 70 (17.2%), 33 (8.1%) and 12 (2.9%) participants respectively. There was a significant association between hypertension and neck circumference ($p < 0.047$), and Mallampati ($p < 0.001$), but no association with enlarged tonsil ($p = 0.203$), gender ($p = 0.407$), BMI ($p < 0.68$), overnight sleep duration ($p = 0.37$) and daytime sleepiness ($p = 0.908$).

Conclusion: There was no significant correlation between snoring and hypertension, but the risk factors for the hypertension were increased age, increased neck circumference and high Mallampati score.

Keywords: Blood pressure; oropharyngeal crowdedness; snoring; Mallampati score; black Africans.

1. INTRODUCTION

Snoring is a raspy noise produced during sleep from turbulent airflow in the narrowed nasal and pharyngeal airway. This may result from obstructive nasal airways, muscular hypotonia in the throat and tongue, bulky throat tissue and long soft palate and uvula. It occurs more frequently in overweight individuals, men and worsens with age [1]. Although sometimes, it could be barely audible causing no risk but when it is very loud, it interferes with sleep pattern or activities of their neighbors. Habitual snoring is a sign of obstructive sleep apnea that has associated health problems including poor night sleep as a result of frequent waking, excessive daytime sleepiness and fatigue, chronic headache and hypoxaemia. Hypoxia from frequent and prolonged obstructive sleep apnea can trigger the release of catecholamine with sustained sympathetic activation [2]. This may induce blood vessels constriction with resultant systemic hypertension. Obstructive sleep apnea (OSA) is an independent risk factor in the development of essential hypertension and cardiovascular disorders [3]. Severity of OSA increase with increase in Mallampati score or tonsillar size, with likelihood of OSA increasing for every point increase in Mallampati score and tonsillar grading score [4]. Neck circumference is an index of the upper body fat distribution and a useful predictor of obstructive sleep apnoea than general obesity [5]. High Neck circumference is associated with an increased risk of high blood pressure [6], due to fat compression of the pharynx with consequent upper airway obstruction during sleep [7]. Systemic elevated blood pressure is a risk factor for stroke, heart failure and chronic kidney failure [8]. Some individuals do not manifest these disturbances because their ventilation during wakeful periods is sufficient to prevent these complications of intermittent hypoxia. Disruptions in the timing and duration of sleep could disrupt circadian rhythmicity, increase autonomic nervous stimulation, and disrupt diurnal rhythm of cardiac output leading to increase in blood pressure [9]. Hypertension has no identifiable cause, but there are associated genetic and environmental risk factors. [10], It is a common disease with significant burden in developing countries like Nigeria [11]. There is dearth of information on the relationship between hypertension and indices of oropharyngeal crowdedness in Nigeria. Therefore, this study was carried out to determine the possible association between hypertension and indices of oropharyngeal crowdedness among adult snorers in Oyo rural community of South-west Nigeria.

2. METHODOLOGY

2.1 Study Design

The study was a cross-sectional community based survey of adults in Oyo town, Nigeria. Ethical approval was obtained for the conduct of the study from Oyo-State Ministry of Health ethical review board. Permission to conduct the study was also obtained from Oyo community leaders. All healthy adults (age ≥18 years) from selected households gave informed consent to participate in the study. Adults with craniofacial abnormality, unilateral tonsillar enlargement, past

throat or nasal surgeries, and chronic medical diseases were excluded.

2.2 Data Collection Procedure

2.2.1 Questionnaire

This was used to collect data on demography, occupation, medical illness, cigarettes, alcohol and medication usage (sedatives), daytime-sleepiness, sleep duration per night, number of arousal episodes during overnight sleep, history of snoring and sleep apnoea. The partner or roommates answered questions relating to snoring and sleep apnoea. Degree of daytime sleepiness was assessed on Epworth Sleepiness Scores (ESS) [12], which has eight questions about the person's level of subjective daytime sleepiness in given daily activities. The scale is from 0 – 24 and subjects with scores higher than 10 are considered to have excessive daytime sleepiness.

2.2.2 Anthropometric measurement

The weight (kilogram), height (meter) and neck circumference (cm) which was taken at the lower border of thyroid cartilage of the participants were measured. The Body Mass Index (BMI) was calculated as weight in kilograms divided by height in squared meter (Kg/m^2). BMI value of < 25 Kg/m^2 is classified as normal healthy weight, 26 - 29 Kg/m^2 is classified as overweight and ≥ 30 Kg/m^2 is classified as obese [13].

2.2.3 Blood pressure

A standard mercury sphygmomanometer with an appropriate size cuff for the arm (encircling two-thirds of the entire length of the arm) of the subject was used to measure the blood pressure. Standard procedure for measuring blood pressure (BP) was followed after the participant had sat and rested for five minutes and arm supported at heart level. On each participant, the blood pressure measurement was done twice at interval of 3 – 5 minutes. If the obtained readings varied by more than 5 mmHg, it was repeated the third time and the average obtained. At the initial assessment, blood pressure was measured in both arms, and if pressure differed, the subsequent readings were taken from the arm with higher blood pressure. During the measurements, the BP cuff was inflated to a pressure 20 mmHg above the systolic, as recognised by disappearance of the radial pulse. Then, the cuff was deflated 3 mmHg every second. Korotkoff phase I was taken as the systolic blood pressure and Korotkoff phase V (disappearance) was taken as the diastolic blood pressure. The blood pressure was defined as normal if systolic pressure is less than 120 mmHg and diastolic is less than 80 mmHg, Prehypertension was define as systolic blood pressure of 120 – 139 mmHg or diastolic blood pressure of 80 – 89 mmHg, and Hypertension was define as systolic blood pressure that is above 139mmHg or diastolic pressure that is above 89 mmHg [14]. In this study normal blood pressure and pre-hypertension were define as no hypertension. For the diagnosis of hypertension, three sets of readings were obtained a week apart.

2.2.4 Determination of oropharyngeal crowdedness

Mallampati score and tonsillar size were used to determined Oropharyngeal crowdedness [15,16]. Mallampati score was performed with the patient in the sitting position, head in a neutral position, the mouth widely opened and the tongue protruding to its maximum. Classification is assigned according to the extent to which the base of tongue is able to mask the visibility of pharyngeal structures. In this study, Mallampati score of I and II were considered normal while Mallampati score III and IV were abnormal. Tonsils were graded during oropharyngeal examination using Brodsky grading methods. Brodsky tonsillar grade 3 and 4 were considered enlarged and obstructive [15].

2.3 Statistical Analysis

The statistical analysis was performed using IBM-Statistical Package for Social Sciences Version 20. The continuous variables were presented as the mean (Standard deviation) for all participants. Proportions were compared using Chi-square with Yates' correction or Fisher's exact tests. Level of significance was determined at $p < 0.05$, at 95% Confidence Interval (CI).

3. RESULTS

A total of 408 healthy adults participated in the study consisting 202 (49.5%) males and 206 (50.5%) females with male to female ratio of 1:1. The age of the participants ranged from 18 to 82 years with mean age of 37.0±15.23 years. There were 191 (46.8%) snorers and 217 (53.2%) non-

snorers. Fifty-one (12.5%) participants comprising 27 (52.9%) snorers and 24 (47.1%) non-snorers had hypertension, and the prevalence of hypertension among the snores was 14.1% (27 vs. 191) and 11.1% (24 vs.217) among non-snorers (p = 0.37). Table 1 shows the socio-demographic characteristics of the hypertensive participants. There was a significant difference in the age of hypertensive snorers and hypertensive non-snorers, but after excluding the confounding factors for age, there was no association between hypertension and snoring, but with the age. Table 2 shows that there was no difference in their daytime sleepiness. Table 3 shows the comparison of indices of oropharyngeal crowdedness among the hypertensive and non-hypertensive participants. There was a significant difference in Mallampati scores between the hypertensive and non-hypertensive snorers (p= 0.04) as well as between the hypertensive and non-hypertensive non-snorers (p= 0.026). The proportion of participants with hypertension increases with increased Mallampati score among the snorers and non-snorers.

There was no significant association between hypertension and BMI (0.68), EDS (p = 0.77), tonsillar enlargement (p = 0.23), and overnight sleeping time (p = 0.06) as shown in Table 3.

There was no association between hypertension and overnight sleeping duration in this study (p = 0.06) (see Table 4).

4. DISCUSSION

Hypertension and its complications are significant health problems in Africa [17]. There is a gradual paradigm shift towards non-communicable diseases with increase economic and health burden on the society. The relationship between hypertension and oropharyngeal crowdedness among the black Africans has not been well investigated. To the best of our knowledge, this is the first study in South West Nigeria that investigated association between hypertension and indices of oropharyngeal crowdedness. The prevalence of hypertension was 14.1% (27 vs. 191) among the snorers, this is within the reported prevalence in developing countries, [18,19] and similar to prevalence of 12.4% reported in Nigeria [20]. This is lower than 15.9% that was observed in the general population of Africans in Eritrea [21], and higher than 8.7% observed among the rural dwellers in sub-Saharan Africa [22]. These differences might be due to factors such as definition of hypertension, sampling methods, study settings, the study population, duration of the study as well as age of the study population.

Table 1. Socio-demographic parameters of hypertensive snorers with hypertensive non-snorers

Variables	Hypertensive		P value
	Snorers (n=27)	Non-snores (n=24)	
Mean age	58.92±15.64	54.70 ± 13.23	p = 0.001 * age is associated with hypertension
Gender			p = 0.337
Male	12	10	*no association between gender and
Female	15	14	hypertension
Occupation			
None	6	5	
Student	-	3	p = 0.002**
Farmer	7	2	
Trading	14	14	
Educational status			
None	13	13	
Primary	6	9	
Secondary	4	1	p = 0.002**
Tertiary	4	1	
Socioeconomic class			
Low	20	19	p = 0.085
Middle	7	4	*no association between socioeconomic
High	0	1	status and hypertension

***Hypertension is multifactorial in origin and some associations may not be significant*

Table 2. Comparing the clinical parameters of hypertensive participants

Variables	Hypertensive patients		p-value
	Snorers (n = 27)	Non-snorers (n = 24)	
Mean neck circumference	34.46±2.17cm	34.27±2.77cm	p = 0.047 *increase in neck circumference was associated with hypertension
Excessive daytime sleepiness			
Yes	14	1	p = 0.908
No	13	23	*no association between daytime sleepiness and hypertension
Mean duration of overnight sleep (Hours)	8.41±1.32 hrs	8.03±1.58 hrs	p = 0.06 *no association between overnight sleeping time and hypertension
Mean systolic blood pressure	145±5.5 mmHg	143±3.2 mmHg	
Mean diastolic blood pressure	93±2.2 mmHg	90±4.5 mmHg	

Table 3. Comparison of indices of snoring among hypertensive and non-hypertensive participants

Variables		Snorers (n=191)		P-value	Non-snorers (n=217)		P-value
		Hypertension (n=27)	Non-hypertensive (n=164)		Hypertension (n = 24)	Non-hypertensive (n=193)	
Body Mass Index (Kg/m^2)	Underweight	1(0.2%)	0(0%)	0.140	1(0.2%)	1(0.2%)	
	Normal weight	14(3.4%)	85(20.8%)		15(3.6%)	150(36.8%)	0.382
	Over weight	10(2.5%)	45(11.0%)		5(1.2%)	32(7.8%)	
	Obesity	2(0.5%)	34(8.3%)		3(0.7%)	10(2.5%)	
P = 0.682							
Mallampati score				0.040			0.026
	I	2(0.5%)	16(3.9%)		8(2.0%)	68(16.6%)	
	II	2(0.5%)	57(14.0%)		5(1.2%)	84(20.6%)	
	III	12(2.9%)	61(15.0%)		8(2.0%)	40(9.8%)	
	IV	11(2.7%)	30(7.4%)		3(0.7%)	1(0.2%)	
P < 0.001							
Brodsky tonsillar grade				0.051			0.693
	0	21(5.1%)	110(26.9%)		19(4.7%)	68(16.6%)	
	+1	6(1.5%)	22(5.4%)		1(0.3%)	84(20.6%)	
	+2	0(0%)0	23(5.6%)		4(1.0%)	40(9.8%)	
	+3	0(0%)	9(2.2%)		0(0%)	1(0.2%)	
	+4	0(0%)	-		0(0%)	0(0%)	
P = 0.203							

Table 4. Hypertension and overnight sleeping duration

Overnight sleeping period	Blood pressure		Total
	No hypertension	Hypertension	
4-6 hours	29(7.1%)	6 (1.5%)	35(8.6%)
7-9 hours	268(65.7%)	30(7.4%)	298(73.0%)
10-12 hours	60(14.7%)	15(3.7%)	75(18.4%)
Total	357(87.5%)	51(12.5%)	408(100.0%)

*p = 0.06; *no association between overnight sleeping time and hypertension*

Table 5. Hypertension and the age distribution of the participants

Age	Hypertension		Total
	No	Yes	
≤ 20	19 (4.7%)	0(0%)	19 (4.7%)
21- 30	139(34.0%)	3(0.7%)	142(34.8%)
31-40	91(22.3%)	4(1.0%)	95(23.3%)
41-50	54(13.2%)	9(2.2%)	63(15.4%)
51-60	32(7.8%)	4(1.0%)	36(8.8%)
61-70	16(3.9%)	22(5.4%)	38(9.3%)
71-80	3(0.7%)	3(0.7%)	6(1.5%)
81 -89	3(0.7%)	6(1.5%)	9(2.2%)
Total	357(87.5%)	51(12.5%)	408(100.0%)

X^2= 96.1; d = 6; p < 0. 001

There was significant association between hypertension and increasing age of the studied population, the diastolic and systolic blood pressures got higher with the increase in age and this was similar to other study [14]. The participant's age cut-across the young adults, middle age and the elderly; hypertension was found in all the age groups, but more prevalent among in the 6th decade of life (Table 5). Though after excluding the confounding factors for age, there was no association between hypertension and snoring, but with the age. Hypertension has significantly increased among children and adolescents in recent years, and this track to adulthood [23]. Environmental and genetic factors as well as their interactions are known to affect high Blood Pressure [24]. There was no significant difference between male and female snorers in this study, although there were slightly more hypertensive female snorers than males in this study, previous studies have shown that male gender is a risk factor for OSA, and women tend to have less severe OSA than males [25]. OSA in the supine position occurred almost exclusively in men, indicating that positional OSA is not really an issue for women [26].

Snoring, a cardinal sign of obstructive sleep apnoea was encountered among 46.8% participants, similar to the reported prevalence of snoring among adults in Brazil [27] and in China [28]. The proportion of hypertension among the snorers in this study is similar to the findings in other studies [29,30]. The occurrence of hypertension among the snorers may be due to intermittent systemic hypoxia experienced by the snorers, which initiates the catecholamine release (adrenergic and renin–angiotensin system activation), with sustained sympathetic activation, [2] thus the development of sustained increase in blood pressure (BP) seen in OSA patients. Blood pressure varies in relation to autonomic nervous system activity, chronic hypoxia from upper airway obstruction during sleep and unrestful sleep result in increased sympathetic nervous system activity, leading to increased blood pressure [31]. Regardless of higher prevalence of hypertension among snorers there was no association between snoring and hypertension in this study, similar to previous studies [32]. Silverberg et al observed that only one half of patients with obstructive sleep apnoea have hypertension [3]. Some snorers had no hypertension, probably due to variation in the degree of upper airway obstruction during sleep, and the snorers without hypertensions may not experience OSA, because the oropharyngeal crowdedness may not be severe enough to cause significant obstruction during sleep, and this might be responsible for no hypertension among them. Though this study did not assessed the OSA among the snorers, there is a need for further study to compare the prevalence of hypertension between snorers with OSA and snorers without OSA so that the association between snoring and hypertension can be assessed after excluding the confounding effect of OSA.

There was no association between hypertension and BMI in this study, though previous study in Africa had shown that Obesity is a risk factor for hypertension [33], and higher BMI indicates a greater severity of OSA [34]. The pharyngeal fat distribution is significant in OSA and is related to gender [35], there are less pharyngeal fat and lower soft tissue volume in the neck of obese women compare to obese men [36]. Progesterone is a known respiratory stimulant,

which increases chemoreceptor responses to hypercapnia and hypoxia, and has been shown to increase upper airway muscle tone [37].

Sleep restriction and sleep disorders are synergistically associated with increased prevalence and incidence of hypertension [38]. Overnight sleeping time has decreased in the general population over the years, with sleeping time less than 6 hours in 16% of population, reflecting voluntary sleep restriction [39]. However in this study 91.4% participants slept for more than 6 hours at night. Though the prevalence of hypertension is higher among those who had sleeping duration of 4-6 hours, there was no association between hypertension and overnight sleeping duration in this study ($p = 0.06$). Gottlieb et al. [40] have demonstrated that short and long habitual sleeping times are both associated with higher prevalence of hypertension when compared with subjects sleeping between 7 and 8 hours per night, this was similarly observed in this study.

Short sleep duration is associated with hypertension [41]. Prolonged reduction of overnight sleeping time in healthy subjects increase blood pressure and sympathetic nervous system activity, [42] due to activation of the hypothalamic-pituitary-adrenal axis and elevated sympathetic nervous system activity [36]. Sleep deprivation has also been reported to be associated with systemic inflammation [43], oxidative stress, and endothelial dysfunction, all these conditions supports the development of hypertension by making the cardiovascular system to operate at elevated pressure equilibrium [44].

The non-association of overnight sleeping time and hypertension in this study, may be due to the fact that other factors might be responsible for hypertension in black Africans other than short overnight sleeping time, also the participants might have had refreshing sleep despite the short sleeping time. Studies had shown that there are age-related changes in sleep due to a weaker circadian regulation of sleep and wakefulness, and older people require less overnight sleeping time [45]. Healthy older individuals experience twice as much time awake during night sleep episodes than young adults, in spite of marked changes in sleep physiology with aging, the healthy aging population are not symptomatic [46].

The Mallampati score is practically valuable since it can be easily determined through a simple oral/oropharyngeal examination. High Mallampati score was significantly associated with hypertension in this study which was similar to previous study [18]. Mallampati score was significantly associated with hypertension in both snorers and non-snorers in this study, thus oropharyngeal crowdedness from high Mallampati is associated with hypertension. Previous studies had shown that high Mallampati score is an important risk factor for the worsening of the apnea, with negative effects on the cardiovascular system like heart rate and blood pressure [47]. Hypoxia arising from upper airway obstruction increases the sympathetic neural activity through the carotid body and causes vasoconstriction in the peripheral blood vessels, and resulting hypercapnia furthermore increases sympathetic neuronal activity [48].

There was no association between hypertension and tonsillar enlargement ($p = 0.23$), in this study probably due to the fact that in adults the tonsils are atrophic and contribute less to the oropharyngeal crowdedness. Hypertension is a multifactorial disease and this may be the reason why some factors were not significantly associated with hypertension or why some associations may be insignificant.

Limitations of this study include undiagnosed and sub-clinical medical conditions that predisposes to hypertension like renal insufficiency and diabetics among the participants which was beyond our control in this study. The occurrence of OSA among the snorers was not assessed to determine the relationship between snoring, OSA and hypertension.

5. CONCLUSION

In conclusion, there is no significant correlation between snoring and hypertension, but the risk factors for the hypertension included increased age, increased neck circumference and high Mallampati score. The need for awareness, prevention, and treatment of hypertension should be regarded as a high priority. The physicians can easily determine the oropharyngeal crowdedness with oral examination and patients at risk of OSA can be identified and other adjunct medical care can be initiated to relief the oropharyngeal crowdedness or refer to ENT surgeons for appropriate care. There is a need to determine if surgical reduction of oropharyngeal crowdedness will improve the blood pressure status of hypertensive patients.

CONSENT

The participants gave consent before participating in the study.

ETHICAL APPROVAL

It was obtained before the commencement of the study from Oyo State Ministry of Health, Oyo State, Nigeria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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