

Original Research Article

ARE SNORERS AT RISK OF HIGH BLOOD PRESSURE?

Abstract

Background: Snoring is a sign of partial upper airway obstruction 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 snoring.

Method: 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, and 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. Their neck circumference and blood pressure were measured. The body mass indices (BMI) were determined. Statistical analysis was performed with IBM- SPSS version 20 and level of significance was 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 $23.79 \text{ kg/m}^2 \pm 3.93$ and $24.86 \text{ kg/m}^2 \pm 4.9$ 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: The prevalence of hypertension was high among adult snorers in the rural community and has relationship with neck circumference, and Mallampati score.

Key words: Blood pressure, Oropharyngeal crowdedness, habitual Snoring, Mallampati Score and black Africans.

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 age¹. 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 activation². This may induce blood vessels constriction with resultant **pulmonary** or systemic hypertension. Obstructive sleep apnea (OSA) is an independent risk factor in the development of essential hypertension and cardiovascular disorders^{3,4}. Systemic elevated blood pressure is a risk factor for stroke, heart failure and chronic kidney failure⁵. Some individuals do not manifest these disturbances because their ventilation during wakeful periods is sufficient to prevent these complications of **chronic** 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 pressure⁶.

Hypertension has no identifiable cause, but there are associated genetic and environmental risk factors.^{7,8} It is a common disease with significant burden in developing countries like Nigeria^{9,10}.

There is dearth of information on the relationship between hypertension and snoring in Nigeria.

Therefore, this study was carried out to determine the possible association between hypertension and indices of snoring among adults in Oyo rural community of South-west Nigeria.

Methodology

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 leader. 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.

Data Collection Procedure

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)¹¹, which has eight questions about the person's level of subjective daytime sleepiness in given daily activities. The

68 scale is from 0 – 24 and individual with a score higher than 10 is considered to have excessive
69 daytime sleepiness.

70 **Anthropometric measurement:** The neck circumference (cm), weight (kilogram) and height
71 (meter) and neck circumference (cm) which was taken at the lower border of thyroid cartilage of
72 the participants were measured. The Body Mass Index (BMI) was calculated as weight in
73 kilograms divided by height in squared meter (Kg/m^2). BMI value of $< 25 \text{ Kg/m}^2$ is normal
74 healthy weight, $26 - 29 \text{ Kg/m}^2$ is overweight and $\geq 30 \text{ Kg/m}^2$ is obese¹².

75 **Blood pressure measurement:** This was done using a standard mercury sphygmomanometer
76 with an appropriate size cuff encircling the arm (covering two-thirds of the entire length of the
77 arm). Standard procedure for measuring blood pressure (BP) was followed after the participant
78 had sat and rested for five minutes and arm supported at heart level. On each participant, the
79 blood pressure measurement was done twice at interval of 3 – 5 minutes. If the obtained readings
80 varied by more than 5 mmHg, it was repeated the third time and the average obtained. At the
81 initial assessment, blood pressure was measured in both arms, and if pressure differed, the
82 subsequent readings were taken from the arm with higher blood pressure. During the
83 measurements, the BP cuff was inflated to a pressure 20 mmHg above the systolic, as recognised
84 by disappearance of the radial pulse. Then, the cuff was deflated 3 mmHg every second.
85 Korotkoff phase I was taken as the systolic blood pressure and Korotkoff phase V
86 (disappearance) was taken as the diastolic blood pressure. The blood pressure was define as
87 normal if systolic pressure is less than 120mmHg and diastolic is less than 80 mmHg,
88 Prehypertension was define as systolic blood pressure of 120 – 139 mmHg or diastolic blood
89 pressure of 80 – 89 mmHg, and Hypertension was define as systolic blood pressure that is above
90 139mmHg or diastolic pressure that is above 89 mmHg^{13,14}. 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.

Determination of Oropharyngeal crowdedness: Mallampati score and tonsillar size were used to determined Oropharyngeal crowdedness^{15, 16,17}. 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 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 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 obstructive¹⁵.**



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).

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 have hypertension ($p = 0.37$). Table 1 shows the socio-demographic characteristics of the hypertensive participants. There was a significant difference in the occupation and educational

status of hypertensive snorers and hypertensive non-snorers. Table 2 shows that there was no difference in their daytime sleepiness.

Table 3 shows the comparison of indices of snoring 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.

191(46.8%) snore consisting 101(24.75%) habitual snorers and 90(22.06%) non-habitual 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).

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
Gender			
Male	12	10	p = 0.337
Female	15	14	
Occupation			
None	6	5	p = 0.002
Student	-	3	
Farmer	7	2	
Trading	14	14	
Educational status			
None	13	13	p = 0.002
Primary	6	9	
Secondary	4	1	
Tertiary	4	1	
Socioeconomic class			
Low	20	19	p = 0.085
Middle	7	4	
High	0	1	
Religion			
Islam	18	16	p = 0.172
Christianity	7	7	
Paganism	2	0	
Others	0	1	
Alcohol consumption			
Yes	4	0	p = 0.432
No	23	24	
Cigarette /Tobacco smoking			
Yes	0	0	p = 0.26
No	27	24	



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142 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
Excessive daytime sleepiness	14	1	p = 0.908
Yes	13	23	
No			
Mean duration of overnight sleep (Hours)	8.41 ± 1.32hrs	8.03 ± 1.58hrs	
Mean systolic blood pressure	145 ± 5.5mmHg	143 ± 3.2 mmHg	
Mean diastolic blood pressure	93 ± 2.2 mmHg	90 ± 4.5 mmHg	

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

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Variables		Snorers (n=191)		P-value	Non-snorers (n=217)		P-value
		Hypertension (n=27)	Non-hypertensive (n=164)		Hypertension (24)	Non-hypertensive (193)	
Body Mass Index (Kg/m ²)	Underweight	1(0.2%)	0(0%)	0.140	1(0.2%)	1(0.2%)	 0.382
	Normal weight	14(3.4%)	85(20.8%)		15(3.6%)	150(36.8%)	
	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 = 0.000							
Brodsky tonsillar grade							
	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%)	0.051	0(0%)	1(0.2%)	0.693
	+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

DISCUSSION

Hypertension and its complications are significant health problems in Africa¹⁸. There is a gradual paradigm shift towards non-communicable diseases with increase economic and health burden on the society. The relationship between hypertension and snoring 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 snoring. The prevalence of hypertension in this study is 12.5%, this is within the reported prevalence in developing countries,^{19,20} and similar to prevalence of 12.4% reported in Nigeria²¹. This is lower than 15.9% that was observed in the general population of Africans in Eritrea²², and higher than 8.7% observed among the rural dwellers in sub-Saharan Africa²³. These differences might be due to factors such as sampling methods, study settings, the study population, definition of hypertension as well as duration of the study.

162 There was significant association between hypertension and increasing age of the studied
 163 population, the diastolic and systolic blood pressures got higher with the increase in age and this
 164 was similar to other studies^{19,24,25}. There was no significant difference between male and female
 165 snorers in this study, although there were slightly more hypertensive female snorers than males
 166 in this study, previous studies have shown that male gender is a risk factor for OSA, and women
 167 tend to have less severe OSA than males²⁶. OSA in the supine position occurred almost
 168 exclusively in men, indicating that positional OSA is not really an issue for women.²⁷
 169 Snoring, a cardinal sign of obstructive sleep apnoea was encountered among 46.8% participants
 170 and this is similar to the reported prevalence of snoring among adults in Brazil²⁸ and in China²⁹.
 171 The high proportion of hypertension among the snorers in this study is similar to the findings in
 172 other similar studies^{30,31}. The high prevalence of hypertension among the snorers may be due to
 173 intermittent systemic hypoxia experienced by the snorers, which initiates the catecholamine
 174 release (adrenergic and renin–angiotensin system activation), with sustained sympathetic
 175 activation,² thus the development of sustained increase in blood pressure (BP) seen in OSA
 176 patients. Blood pressure varies in relation to autonomic nervous system activity, chronic
 177 hypoxia from upper airway obstruction during sleep and unrestful sleep result in increased
 178 sympathetic nervous system activity, leading to increased blood pressure^{32,33}. Regardless of
 179 higher prevalence of hypertension among habitual snorers there was no association between
 180 snoring and hypertension in this study **this** was similar to previous studies^{34,35}. Silverberg et al 
 181 observed that only one half of patients with obstructive sleep apnoea have hypertension⁴. Some
 182 snorers had no hypertension, probably due to variation in the degree of upper airway obstruction
 183 during sleep.

184 There was no association between hypertension and BMI in this study, though previous study in
 185 Africa had shown that Obesity is a risk factor for hypertension³⁶, and higher BMI indicates a
 186 greater severity of OSA³⁷. The pharyngeal fat distribution is significant in OSA and is related to
 187 gender³⁸, there are less pharyngeal fat and lower soft tissue volume in the neck of obese women
 188 compare to obese men³⁹. Progesterone is a known respiratory stimulant, which increases
 189 chemoreceptor responses to hypercapnia and hypoxia, and has been shown to increase upper
 190 airway muscle tone⁴⁰

191 Sleep restriction and sleep disorders are synergistically associated with increased prevalence and
 192 incidence of hypertension⁴¹. Overnight sleeping time has decreased in the general population
 193 over the years,⁴² with sleeping time less than 6 hours in 16% of population, reflecting voluntary
 194 sleep restriction⁴². However in this study 91.4% participants slept for more than 6 hours. Though
 195 the prevalence of hypertension is higher among those who had sleeping duration of 4-6 hours,
 196 there was no association between hypertension and overnight sleeping duration in this study ($p =$
 197 0.06). Gottlieb et al ⁴³ have demonstrated that short and long habitual sleeping times are both
 198 associated with higher prevalence of hypertension when compared with subjects sleeping
 199 between 7 and 8 hours per night that was similarly observed in this study.

200 Though short sleep duration has been found to be associated with hypertension in previous
 201 studies^{44,45}. Prolonged reduction of overnight sleeping time in healthy subjects increase blood
 202 pressure and sympathetic nervous system activity,^{46,47} due to activation of the hypothalamic-
 203 pituitary-adrenal axis and elevated sympathetic nervous system activity^{46,48}. Sleep deprivation
 204 has also been reported to be associated with systemic inflammation⁴⁹, oxidative stress, and
 205 endothelial dysfunction, all these conditions supports the development of hypertension by
 206 making the cardiovascular system to operate at elevated pressure equilibrium⁵⁰.

207 The non-association of overnight sleeping time and hypertension in this study, may be due to the
 208 fact that other factors might be responsible for hypertension in black Africans other than short
 209 overnight sleeping time, also the participants might have had refreshing sleep despite the short
 210 sleeping time. Studies had shown that there is age-related changes in sleep due to a weaker
 211 circadian regulation of sleep and wakefulness, and older people require less overnight sleeping
 212 time^{51,52}. Healthy older individuals experience twice as much time awake during night sleep
 213 episodes than young adults, in spite of marked changes in sleep physiology with aging, the
 214 healthy aging population are not symptomatic⁵³.

215 The Mallampati score is practically valuable since it can be easily determined through a simple
 216 oral/oropharyngeal examination. High Mallampati score was significantly associated with
 217 hypertension in this study which was similar to previous study¹⁹. Previous studies had shown that
 218 high Mallampati score is an important risk factor for the worsening of the apnea, with negative
 219 effects on the cardiovascular system like heart rate and blood pressure.^{54,55, 56} Hypoxia arising
 220 from upper airway obstruction increase the sympathetic neural activity through the carotid body
 221 and causes vasoconstriction in the peripheral blood vessels, and resulting hypercapnia
 222 furthermore increases sympathetic neuronal activity.^{57,58}

223 There was no association between hypertension and tonsillar enlargement ($p = 0.23$), in this
 224 study probably due to the fact that in adults the tonsils are atrophic and contribute less to the
 225 oropharyngeal crowdedness.

226 Limitations of this study include undiagnosed and sub-clinical medical conditions that
 227 predisposes to hypertension like renal insufficiency and diabetics among the participants which
 228 was beyond our control in this study.

In conclusion, hypertension is common in the apparently healthy adult in Nigeria and the risk factors included increased age and high Mallampati. There is a need for Health education to enlighten the populace on the risk factors for hypertension and OSA. 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 relieve 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.

REFERENCES

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- 1 Kaufman JS, Durazo-Arvizu RA, Rotimi CN, McGee DL, Cooper RS. Obesity and hypertension prevalence in populations of African origin. The Investigators of the International Collaborative Study on Hypertension in Blacks. *Epidemiology*. 1996 Jul;7(4):398-405.
 - 2 Hedner J, Ejnell H, Sellgren J, Hedner T, Wallin G. Is high and fluctuating muscle nerve sympathetic activity in the sleep apnoea syndrome of pathogenetic importance for the development of hypertension? *J Hypertens Suppl*. 1988;6:SS29-S31

- 3 Kario K. Obstructive sleep apnea syndrome and hypertension: ambulatory blood pressure. *Hypertens Res.* 2009;32 (6):428-32.
- 4 Silverberg DS, Iaina A, Oksenberg A Treating obstructive sleep apnea improves essential hypertension and quality of life. *Am Fam Physician.* 2002 Jan 15;65(2):229-36
- 5 Carretero OA, Oparil S. Essential hypertension. Part I: definition and etiology”.*Circulation* 2000;101(3):329-35
- 6 Gangwisch JE A review of evidence for the link between sleep duration and hypertension. *Am J Hypertens.* 2014;27(10):1235-42
- 7 Luft FC. Molecular genetics of human hypertension. *J Hypertens.* 1998;16:1871-1878. ;
INTERSALT Co-operative Research Group. Sodium, potassium, body mass, alcohol and blood pressure: the INTERSALT study. *J Hypertens.* 1988;6(Suppl. 4):S584-S586.
- 8 Sever PS, Poulter NR. A hypothesis for the pathogenesis of essential hypertension: the initiating factors. *J Hypertens.* 1989;7(Suppl 1):S9 – S12.
- 9 Ibekwe RU Modifiable Risk factors of Hypertension and Socio-demographic Profile in Oghara, Delta State; Prevalence and Correlates *Annals of Medical and Health Sciences Research* 2015 ; 5(1) :71-77
- 10 CA Alikor, PC Emem-Chioma, OJ Odia Hypertension in a Rural Community in Rivers State, Niger Delta Region of Nigeria: Prevalence and Risk Factors. *Nigerian Health Journal.* 2013;13(1):18-25
- 11 Murray W. Johns - A New Method For Measuring Daytime Sleepiness: The Epworth Sleepiness Scale - *Sleep* 1991; 14: 540-545
- 12 World Health Organization .BMI classification. http://apps.who.int/bmi/index.js?intro_3.html.

- 13 Braunwald, Zipes and Libby. Heart Disease: A Textbook of Cardiovascular Medicine, 6th ed. Philadelphia: W.B. Saunders Company; 2001.p.944.
- 14 WHO. Prevention of Cardiovascular Disease. Pocket Guidelines for Assessment and Management of Cardiovascular Risk. Geneva: World Health Organization, 2007
- 15 Brodsky L. Modern assessment of tonsils and adenoids. *Pediatr Clin North Am.* 1989;36(6):1551-1569
- 16 Mallampati SR, Gatt SP, Gugino LD. A clinical sign to predict difficulty intubation ; A prospective study. *Can Anaesth Soc J.* 1985; 32:429-463.
- 17 Samsoon GLT, Young JRB. Difficult tracheal intubation : a retrospective study. *Anaesthesia* 1987; 42: 487-490.
- 18 Nissinen A, Bothig S, Granroth H, Lopez AD. Hypertension in developing countries. *World Health Stat Q.* 1988;41(3-4):141-54
- 19 Güçlü Kaan Beriat, Aycan Fahri Erkan, Berkay Ekici, Aslıhan Alhan, Hasan Fehmi Töre, Sinan Kocatürk Is High Modified Mallampati Score A Risk Factor for Arterial Hypertension? *J Clin Anal Med* 2012;3(3): 263-7
- 20 Kearney PM, Whelton M, Reynolds K, Whelton PK, He J. Worldwide prevalence of hypertension: a systematic review. *J. Hypertens* 2004;22(1):11-9
- 21 Ekwunife O I , Aguwa C N. A meta-analysis of prevalence rate of hypertension in Nigeria population *JPHE.* 2011; 3(13):604-607
- 22 Mufunda J, Mebrahtu G, Usman A, Nyarango P, Kosia A, Ghebrat Y, Ogbamariam A, Masjuan M, Gebremichael A The prevalence of hypertension and its relationship with obesity: results from a national blood pressure survey in Eritrea. *J Hum Hypertens.* 2006 Jan;20(1):59-65

- 23 David Guwatudde,Joan Nankya-Mutyoba, Robert Kalyesubula, Carien Laurence, Clement Adebamowo, IkeOluwapo Ajayi,et al. The burden of hypertension in sub-Saharan Africa: a four-country cross sectional study BMC Public Health2015; 15:1211
- 24 Rodriguez-Roca GC, Llisterri-Caro JL, Barrios-Alonso V, Alonso-Moreno FJ, LouArnal S., Prieto-Diaz MA, Sanchez Ruiz T, Dura-Belinchon R, Santos-Rodriguez JA, Divison-Garrote JA, Gonzalez-Segura D, Banegas-Banegas JR. Working Group of Arterial Hypertension of the Spanish Society of Primary Care Physicians PRESCAP 2006 Investigators. Cardiovascular risk and blood pressure control in a Spanish hypertensive population attended in a Primary Care setting. Data from the PRESCAP 2006 study. Blood Press 2009;18(3):117-25.
- 25 E. Lindberg, C. Janson, T. Gislason, K K. Svärdsudd , J. Hetta, G. Boman Snoring and hypertension: a 10 year follow-up Eur Respir J 1998; 11: 884–889
- 26 AJ Wimms, S Ketheeswaran, BBiomedSc; JP Armitstead, Obstructive Sleep Apnea in Women: Specific Issues and Interventions. ResMed Science 2014 ;1-9
- 27 O'Connor, C., K.S. Thornley, and P.J. Hanly, Gender differences in the polysomnographic features of obstructive sleep apnea. Am J Respir Crit Care Med, 2000. 161(5): p. 1465-72
- 28 Renato S, Sergio T, Maria C, Mattos S, Fernarda L, Martinhu H, et al. Systematic evaluation of the upper airway in adult population of Sao Paulo, Brazil. Otolaryngology-Head and Neck Surgery. 2012 ;147: 757
29. Shih-An L, Chia-Yee L. Prevalence of snoring in Taichung area: An epidemiological study. J Chin Med Assoc. 2004; 67:32-36
30. Gislason T, Aberg H, Taube A. Snoring and systemic hypertension: an epidemiological study. Acta Med Scand 197;22:415-421

31. Koskenvuo M, Kaprio J, Partinen M, Langinvainio H, Saran S, Heikkilä K. Snoring as a risk factor for hypertension and angina pectoris. *Lancet* 1985; 1:893 - 896
32. Tochikubo O, Ikeda A, Miyajima E, Ishii M Effects of insufficient sleep on blood pressure monitored by a new multibiomedical recorder. *Hypertension*. 1996;27(6):1318-24.
33. Palagini L, Bruno RM, Gemignani A, Baglioni C, Ghiadoni L, Riemann D. Sleep loss and hypertension: a systematic review *Curr Pharm Des*. 2013;19(13):2409-19
34. Stradling J.R, Crosby J.H. Relation between systemic hypertension and sleep hypoxaemia or snoring: analysis in 748 men from general practice. *Br Med J* 1990; 300:75-8
35. Jennum P, Sjørl A. snoring ,sleep apnoea and cardiovascular risk factors: MONICAL II study . *Int J Epidemiol* 1993;22:439-444
- 36 Hendriks ME, Wit FW, Roos MT, Brewster LM, Akande TM, de Beer IH, et al. Hypertension in sub-Saharan Africa: cross-sectional surveys in four rural and urban communities. *PLoS One*. 2012;7(3):e32638.
- 37 Young T, Shahar E, Nieto FJ, Redline S, Newman AB, Gottlieb DJ, Walsleben JA. Predictors of sleep-disordered breathing in community-dwelling adults: the Sleep Heart Health Study. *Arch Intern Med*. 2002 Apr 22;162(8):893-900.
38. Lin, C.M., T.M. Davidson, and S. Ancoli-Israel, Gender differences in obstructive sleep apnea and treatment implications. *Sleep Med Rev*, 2008. **12**(6): p. 481-96.
- 39 Mohsenin, V., Effects of gender on upper airway collapsibility and severity of obstructive sleep apnea. *Sleep Med*, 2003. 4(6): p. 523-9.
- 40 Krishnan, V. and N. Collop. Gender differences in obstructive sleep apnea, in *Obstructive sleep apnea: diagnosis and treatment*, C. Kushida, Editor., Informa Healthcare: New York. 2007: Chap.14 p. 247-260.

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- 41 Jean-Louis Pépin, Anne-Laure Borel, Jean-Phillipe Baguet, Renaud Tamisier, Patrick Lévy, Jean-Michel Mallion, HYPERTENSION AND SLEEP European Society of Hypertension Scientific Newsletter: Update on Hypertension Management 2010; 11: No. 46
 - 42 Kronholm E, Partonen T, Laatikainen T, et al. Trends in self-reported sleep duration and insomnia-related symptoms in Finland from 1972 to 2005: a comparative review and reanalysis of Finnish population samples. *J Sleep Res* 2008; 17: 54–62.
 - 43 Gottlieb DJ, Redline S, Nieto FJ, et al. Association of usual sleep duration with hypertension: the Sleep Heart Health Study. *Sleep* 2006; 29: 1009–1014.
 44. Lusardi P, Zoppi A, Preti P, Pesce RM, Piazza E, Fogari R. Effects of insufficient sleep on blood pressure in hypertensive patients: a 24-h study *Am J Hypertens*. 1999 Jan;12(1Pt 1):63-8
 45. Gangwisch JE A review of evidence for the link between sleep duration and hypertension. *Am J Hypertens*. 2014;27(10):1235-42
 - 46 . Tochikubo O, Ikeda A, Miyajima E, Ishii M. Effects of insufficient sleep on blood pressure monitored by a new multibiomedical recorder. *Hypertension* 1996; 27: 1318-1324.
 - 47 Lusardi P, Mugellini A, Preti P, Zoppi A, Derosa G, Fogari R. Effects of a restricted sleep regimen on ambulatory blood pressure monitoring in normotensive subjects. *Am J Hypertens* 1996; 9: 503–505. .
 - 48 Spiegel K, Leproult R, Van Cauter E. Impact of sleep debt on metabolic and endocrine function. *Lancet* 1999; 354: 1435–1439
 49. Irwin MR, Wang M, Campomayor CO, Collado-Hidalgo A, Cole S. Sleep deprivation and activation of morning levels of cellular and genomic markers of inflammation. *Arch Intern Med* 2006; 166: 1756–1762

50. James E. Gangwisch, Steven B. Heymsfield, Bernadette Boden-Albala, Ruud M. Buijs, Felix Kreier, Thomas G. Pickering, et al. Short Sleep Duration as a Risk Factor for Hypertension Analyses of the First National Health and Nutrition Examination Survey Hypertension. 2006; 47: 833-839
51. Klerman, E. B., and Dijk, D. J. Age-related reduction in the maximal capacity for sleep – implications for insomnia. Curr. Biol. 2008;18:118–1123
52. Duffy, J. F., Willson, H. J., Wang, W., and Czeisler, C. A. Healthy older adults better tolerate sleep deprivation than young adults. J. Am. Geriatr. Soc. 2009;57:1245–1251
53. Christina Schmidt, Philippe Peigneux and Christian Cajochen. Age-related changes in sleep and circadian rhythms: impact on cognitive performance and underlying neuroanatomical networks. *frontiers neurology* 2012 ;3:8-11
- 54 Rodrigues MM, Dibbern RS, Goulart CW. Nasal obstruction and high Mallampati score as risk factors for Obstructive Sleep Apnea. *Braz J Otorhinolaryngol* 2010;76(5): 596-9
- 55 Roux F, D'Ambrosio C, Mohsenin V. Sleep-related Breathing disorders and cardiovascular disease. *Am J Med* 2000;108:396-402.
- 56 Liistro G, Rombaux, Belge C, Dury M, Aubert G, Rodenstein DO. High Mallampati score and Nasal obstruction are associated risk factors for obstructive sleep apnoea. *Eur Respir J* 2003; 21: 248-52.
- 57 Schneider H, Schaub CD, Chen CA, Andreoni KA, Schwartz AR, Smith PL, Robotham JL, O'Donnell CP. Neural and local effects of hypoxia on cardiovascular responses to obstructive apnea. *J Appl Physiol* 2000; 88:1093-102.

58 O'Donnell CP, Schwartz AR, Smith PL, Robotham JL, Fitzgerald RS, Shirahata M. Reflex stimulation of renal sympathetic nerve activity and blood pressure in response to apnea. Am J Respir Crit Care Med 1996; 154: 1763-70