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ANTHROPOMETRICAL CORRELATES OF SLEEP AND METABOLIC PARAMETERS: A TERTIARY CENTER SLEEP LAB BASED STUDY

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ABSTRACT

Obstructive Sleep Apnoea Syndrome (OSAS) is a disorder characterized by repetitive complete or partial upper airway collapse occurring during sleep. OSAS leads to adverse medical conditions, including hypertension, cardiovascular disease, stroke, and insulin resistance . OSAS is estimated to be 7.5 per cent in males between 35-65 yr of age in the urban Indian population. Obesity is the most important risk factor for OSAS. This hospital based study was designed to study, sleep and metabolic correlates of anthropometric variables in north Indian population. Study was performed with one hundred and ninety subjects as per inclusion and exclusion criteria. Anthropometrical, overnight polysomnography, vital and biochemical data were collected and analyzed. Significant differences were found in mean values of anthropometrical, AHI, Obstructive events and Hypopnea events between OSAS and Non OSAS subjects. BMI, Neck Circumference, waist circumference and Waist Hip Ratio of subjects were observed significantly correlated with metabolic and sleep related variables.

KEYWORDS: Obstructive Sleep Apnea Syndrome, BMI, Neck Circumference, waist circumference, Waist Hip Ratio

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INTRODUCTION

Obstructive Sleep Apnoea Syndrome (OSAS) is a disorder characterized by repetitive complete or partial upper airway collapse occurring during sleep, accompanied by intermittent hypoxia, ventilatory overshoot hyperoxia, sympathetic nervous system surges, enhanced state of inflammation, oxidative stress and endothelial dysfunction. These potential mechanistic pathways lead to adverse medical conditions, including hypertension, nocturnal cardiac arrhythmias, cardiovascular disease, stroke, insulin resistance and increased mortality. Quality of life may also be affected in those with OSAS with increased likelihood of drowsy driving/accidents, mood disorders and neurocognitive deficits [1]. The prevalence of OSAS worldwide in middle-aged women and men is 2–3% and 4–5%, respectively[2]. In Indian scenario, OSAS is estimated to be 7.5 per cent in males between 35-65 yr of age in the urban population. [3]Obesity is probably the most important risk factor for the development of OSAS. The prevalence of OSAS among obese patients exceeds 30%, reaching as high as 50–98% in the morbidly obese population. In another study, OSAS was found present in 40% of obese subjects[4].This study was done to evaluate sleep and metabolic correlates of anthropometric variables in north Indian population.

MATERIALS AND METHODS

Subjects

One hundred and ninety subjects were enrolled after taking written/informed consent from the pool of 320 randomly screened subjects from OPD of King George's Medical University, Lucknow, India. All the subjects fitted with inclusion criteria (body mass index>25 Kg/m^2 and age 18-65 years). Study was conducted between November 2008 to May 2012 after approval from IEC. Subjects with history of sleep disorders other than SDB, Liver disease, COPD, uncontrolled asthma, cancer, End Stage Renal Disease, heart failure and any other endocrine disorder (except type 2 diabetes mellitus) like Cushing syndrome and thyroid abnormalities were excluded from the study.

Anthropometric Measurements

Waist to hip ratio was measured to the nearest cm using a measuring tape. Waist Circumference (WC) was measured midway between the margin of the lowest ribs and the iliac crest, at the point of minimal inspiration. Hip Circumference (HC) was measured at the maximum circumference of the buttocks.WHR =Waist circumference/Hip circumference Body mass Index was defined as weight in kilograms divided by the height in meter square. Body mass was measured to the nearest 0.5 kg using a standard physician's weight scale, with the participants in light clothing (shoes removed), and height was measured using a stadiometer to the nearest cm.Neck circumference (NC) was measured at the level of cricothyroid membrane using measuring tape.

Polysomnography

All subjects underwent full night polysomnography (S-7000, Cogent technologies, EMBLA System Inc). The parameters studied were Electroencephalograms (EEG), (C3-A2,C4-A1,O2-A1,O3-A2), Bilateral Electro-oculogram (ROC,LOC), Chin and Leg Electromyogram, Nasal airflow, thoracic and abdominal movements, ECG, O_2 Saturation measurement by finger Pulse oximeter and body position recorders. Apnea Hypopnea Index (AHI) was calculated with the help of Somnologica Studio software.The apnea episodes were defined as complete cessation of airflow for ≥10 s, and hypopnea was defined as a ≥50% reduction in oronasal airflow accompanied by a reduction of at least 4% oxygen saturation calculated by pulse oximetry. Apnea events were classified as obstructive, mixed, or central, according to the presence or absence of breathing efforts with thoraco-abdominal paradox. AHI was determined by the frequency of these events per hour during sleep time based on the results of the overnight polysomnography. Recorded polysomnographic data was cross checked

manually for scoring of sleep stages, apneas and Hypopnea events regarding each subject. OSAS Cases and NON OSAS Controls were defined as per the criteria of Epstein LJ et al (2009) [5]

Cases: Overweight and obese subjects (BMI>25) of 18 to 65 years of age with Apnea Hypopnea Index (AHI) of > 5 and ESS ≥10 or AHI>15.

Controls: Overweight and obese non apnic subjects (BMI>25) of 18 to 65 years of age with AHI <15 and ESS ≤9.

Blood Pressure

Blood Pressure (BP) was measured after 10 minutes rest at the of time of screening of subjects with syphinomanometer device. Three Blood Pressure readings were obtained, with traditional oscillometric technique.

Biochemical analysis

Fasting venous blood samples were taken in plain (2ml) and in fluoride vial (1ml) just after completion of the overnight polysomnography study (within 30 minutes). Serum lipid profile (Total Cholesterol, Triglyceride and HDL-C) and Fasting Plasma glucose estimation was done by enzymatic method (Merck) using Microlab Semi-autoanalyzer (Merck, Germany). LDL and VLDL calculated by Friedweld formula.

Statistical analysis was performed using SPSS 20(SPSS Inc, USA).

RESULTS

PSG study was accomplished in 190 subjects. These subjects include 134 OSAS subjects and 56 NON-OSAS subjects (Table 1). There were 150 males and 40 females in the studied population. In OSAS cases there were 110 males and 24 females. In NON-OSAS subjects there were 40 males and 16 females. Anthropometric variables were compared and found significant differences in mean values of age, Body Mass Index, Neck Circumferences, Waist Circumferences, Hip Circumferences and Waist Hip Ratio in OSAS and Non OSAS subjects (Table 2). Significant difference was observed in (%) distribution of degree of severity of disease (p=0.04) in different BMI group (Table 3). Respiratory event related data of Polysomnographic Variables AHI, Obstructive events, Central events, Mixed events and Hypopnea events was compared. Significant differences were observed between OSAS and NON-OSAS subjects in mean AHI, Obstructive events and Hypopnea events (Table 4). We compared and analyzed the BMI, Neck Circumference, waist circumference and Waist Hip Ratio with metabolic and sleep related variables. Table 5, 6, 7 and 8 represents the variables with significant correlation in the subjects.

DISCUSSION

In our study, anthropometrical parameters were strongly correlated with metabolic and sleep related variables in the studied population. In this study BMI was not only associated with occurrence of the OSAS, it was significantly correlated with systolic BP, diastolic BP, AHI, ESS , Obstructive events, Hypopnea, Desaturation fall>5%, Sp O_2 <90%, Average Desaturation , OD (per hr), Lowest O_2 Saturation and average saturation of the studied subjects. We purposely included only overweight and obese subjects (BMI>25) to avoid possible confounding effect.In previous studies obesity was particularly present in OSAS and it was the strongest risk factor for OSAS [6]. Morbid obesity, defined as a body mass index (BMI) of (30>kg.m-$^{2)}$, was present in 60–90% of patients with OSAS. The severity of OSAS has also been shown to vary with weight loss and gain, reported in a longitudinal study of the Wisconsin Sleep Cohort Study [7]. Increase in neck circumference and fat deposition around the upper airway in overweight and obese subjects causes narrowing of upper airway [8]. Central obesity and increased neck circumference were found strongly correlated with OSAS. In our study, neck circumference was found significantly correlated with AHI, Obstructive events, Hypopnea, Desaturation Fall >5%, Lowest O2 Saturation and OD(Per hour) while waist circumference was correlated

with Systolic, Diastolic BP, AHI, TG, disease occurrence, Hypopnea events, Desaturation Fall>5%, fasting plasma Glucose, Average Desaturation, Lowest Oxygen Saturation, Sp O2 <90% and OD per hour. Our anthropometrical parameters are in accordance with previous Indian studies [9-13.] This data emphasizes the importance of assessment of obesity parameters for risk assessment as well as their predictive value in reviewing associated disease conditions, i.e. hypertension and dyslipidemia.There are several mechanisms responsible for the increased risk of OSAS with obesity. These include reduced pharyngeal lumen size due to fatty tissue within the airway or in its lateral walls, decreased upper airway muscle protective force due to fat deposits in the muscle, and reduced upper airway size secondary to mass effect of the large abdomen on the chest wall and tracheal traction. These mechanisms emphasize the great importance of fat accumulated in the abdomen and neck regions compared with the peripheral one [14]. It is the abdomen, much more than the thighs that affect the upper airway size and function. Hence, obesity is associated with increased upper airway collapsibility (even in nonapneic subjects), with dramatic improvement after weight reduction. Conversely, OSAS may itself predispose individuals to worsening obesity because of sleep deprivation, daytime somnolence, and disrupted metabolism. OSAS is associated with increased sympathetic activation, sleep fragmentation, ineffective sleep, and insulin resistance, potentially leading to diabetes and increased obesity. Furthermore, OSAS may be associated with changes in leptin, ghrelin, and orexin levels; leading to increased appetite and calorie intake; thus increasing obesity and worsening obesity releted grievances. Thus, it appears that obesity and OSAS form a vicious cycle where each results in worsening of the other[15].Obesity also affects lung function.[16]In previous studies, 1% increase in weight was associated with a 3% increase in AHI, eg 10% decrease in weight associated with a 26% decrease in AHI whereas 10% increase in weight associated with a 32% increase in AHI .[17]

Table 1
Distribution of the Subjects

Total (n=190,100%)	OSAS (n=134, 100%)	NON-OSAS (n=56, 100%)
Male (150, 70.5%)	110 (82.1%)	40 (71.4%)
Female (40, 29.5%)	24 (17.9%)	16 (28.6%)

Table 2
Comparison of anthropometric parameters

Variable	OSAS	NON-OSAS	P-Value
AGE (Years)	49.5± 8.9	46.0±10.7	.019
BMI (kg/m^2)	32.4± 4.6	29.7 ± 3.5	<.001
NC (inches)	16.4 ±1.5	15.2±1.0	<.001
WC (cm)	112.3±11.5	103.7 ±10.2	<.001
HC (cm)	105.6±8.9	100.0±6.4	<.001
WHR	1.06± .06	1.03± .07	.012

BMI – Body mass index, NC – Neck circumference, WC –Waist Circumference, HC – Hip Circumference, WHR – Waist Hip Ratio

Table 3
Distribution of the subjects on the basis of AHI and BMI

BMI(kg/m^2)	AHI(per hour)				p-value
	<5	5-15	15.1-30	>30	
<30	17.6%	25.7%	12.2%	44.6%	0.04
30-35	25.0%	12.5%	8.3%	54.2%	
>35	5.3%	15.8%	7.9%	71.1%	

Table 4
Comparison of Apnea-Hypopnea Index (AHI) and other respiratory events (per hour)

Variable	OSAS	NON-OSAS	P-Value
AHI	50.9±26.0	4.3±3.8	<.001
Obstructive events	37±27.1	2.2±2.1	<.001
Central events	0.2±1.2	0.0±0.0	.214
Mixed events	1.1±3.3	0.0±0.1	.010
Hypopnea events	10.4±10.2	2.3±2.8	<.001

Table 5
Correlation of BMI with metabolic and Sleep related variables

Correlation	Correlation coefficient (r)	p-value
Neck circumference	.333**	.000
Waist circumference	.778**	.000
Hip circumference	.759**	.000
WHR	.173*	.018
Systolic BP	.251**	.001
Diastolic BP	.153*	.036
AHI	.322**	.000
Diagnosis	.276**	.000
ESS	.254**	.000
Obstructive events	.218**	003
Hypopnea	.167*	.025
Desaturation Fall<5%	.343**	.000
Sp O2 <90%	.367**	.000
Average Desaturation	.226**	.002
OD (per hr)	.319**	.000
Lowest O_2 Saturation	-.355**	.000
Average Saturation	-.394**	.000

Table 6
Correlation of Neck Circumference with metabolic and Sleep related variables

Correlation	Correlation coefficient (r)	p-value
BMI	.498**	.000
WC	.366**	.000
HC	.526**	.000
AHI	.197**	.007
TC	-.168*	.024
VLDL	-.216**	.004
TG	-.216**	.004
Obstructive events	.177*	.017
Hypopnea	.174*	.019
Desaturation Fall <5%	.203**	.006
Lowest O_2 Saturation	-.566**	.000
OD(Per hour)	.179*	.016
Sleep Efficiency	-.147*	.050

Table 7
Correlation of waist circumference with metabolic and Sleep related variables

Correlation	Correlation coefficient (r)	p-value
BMI	.778**	.000
NC	.549**	.000
HC	.802**	.000
WHR	.643**	.000
SYS	.182*	.013
AHI	.371**	.000
Diagnosis	.332**	.000
fasting plasma Glucose	.194**	.009
ESS	.264**	.000
Obstructive events	.242**	.001
Hypopnea	.321**	.000
Desaturation Fall<5%	.381**	.000
Average Oxygen Saturation	-.427**	.000
Lowest Oxygen Saturation	-.346**	.000
Sp O2 <90%	.369**	.000
OD per hour	.383**	.000
Average Desaturation	.275**	.000

Table 8
Correlation of Waist Hip Ratio circumference with metabolic and Sleep related variables

Correlation	Correlation coefficient (r)	p-value
BMI	.330**	.000
NC	.497**	.000
HC	.643**	.000
SYS	.177*	.016
TG	.237**	.001
Diagnosis	.184*	.012
Hypopnea	.190*	.010
Desaturation Fall<5%	.163*	.029
Average Desaturation	.197**	.009
Lowest Oxygen Saturation	-.199**	.007
Sp O2 <90%	.225**	.003
OD per hour	.178*	.017

CONCLUSION

Although there are controversies regarding the most significant predictive anthropometric parameters yet generally the exclusive association between obesity and OSAS is well recognized.. Our study on these north Indian subjects showed that the AHI correlates with increased BMI, NC and HC. These anthropometric variables were also strongly correlated with metabolic parameters and excessive day time sleepiness.

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