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A Study of Obesity and Sleep Disordered Breathing

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Introduction: Obstructive sleep apnea (OSA) is associated with increased cardiovascular morbidity and mortality and various Cardiovascular risk factors. Obesity is strongly linked with respiratory symptoms and diseases like dyspnea on exertion, obstructive sleep apnea syndrome (OSAS). This study has been undertaken to analyze the severity of hypertension in obese patients, sleep-disordered breathing (SDB) in obese patients, to analyze whether SDB is a risk factor for hypertension in obese individuals and to correlate how many obese hypertensives have correctable SDB. **Methods:** A total of 200 obese patients were randomly selected from the outpatient department. Berlin's questionnaire and the Epworth sleepiness scale score (ESSS) were used to assess sleep-disordered breathing (SDB). Asian classification of obesity suggested by the World Health Organization was used for the assessment of BMI. All statistical analysis was carried out using the SPSS version20, and Appropriate Statistical tools were applied wherever required, like a test of proportion, Chi-square test etc. **Results:** Out of 200 subjects, 116 were male, and 84 were female. The majority of the study population (70.0%) had suffered from obstructive sleep apnea, while the rest (30.0%) had mixed sleep apnea. The mean spread of age for total selected subjects (N=200) was 45.64±12.75 years. The body mass index (BMI) between 40 and 50 kg/m^2 in 49.0% obese patient. Systemic hypertension prevailed more in male (81.0%) obese subjects than female (77.4%) obese subjects. The most significant risk factor for predicting hypertension was moderate type sleep apnea ($p<0.005$) followed by the age of the ($p<0.007$) obese patients that were confirmed strongly significant on the statistical ground. **Conclusion:** Obesity has a very high and proportionate correlation between sleeping disordered breathing. Obstructive sleep apnea is the predominant sleep-disordered breathing in our study population. Sleep-disordered breathing is very much correctable in the obese hypertensive population by weight reduction and risk factor control.

Keywords: Obstructive sleep apnea, Obesity, Sleep-disordered breathing, Hypertension, Respiratory distress index

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Introduction

Obstructive sleep apnea (OSA) is characterized by frequent episodes of upper airway closure during sleep. It is associated with a constellation of symptoms and objective findings, including motor restlessness, loud snoring, unrefreshing sleep, and excessive daytime sleepiness (EDS).[1].

The association of OSA with increased cardiovascular morbidity and mortality [2] and various Cardiovascular risk factors [3] has been known for a long time. Various metabolic and morphological risk factors for cardiovascular disease such as obesity, hypertension, and dyslipidemia, and insulin resistance are coexistent in patients.[4].

The diagnostic test for OSA is overnight polysomnography (PSG) [5]. & Respiratory distress index (RDI). [6,7]. However, these diagnostic tools are time-consuming, costly, and of limited availability, particularly in developing countries. OSA has been diagnosed using a sleep questionnaire to assess the specific symptoms associated with sleep-related breathing disorders with higher predictive ability, with additional data on body mass index (BMI).[8]. This is particularly relevant to our country, where the initial diagnosis of OSA can be made using a questionnaire. Then, the patients can be subjected to PSG for confirmation and assessment of severity. The Epworth sleepiness scale (ESS) score is a simple tool to determine the degree of EDS in patients with OSA. [9].

Obesity is strongly linked with respiratory symptoms and diseases like dyspnea on exertion, obstructive sleep apnea syndrome (OSAS), obesity hypoventilation syndrome (OHS), chronic obstructive pulmonary disease (COPD), asthma, pulmonary embolism, and aspiration pneumonia. [10]. A higher BMI is a risk of developing OSA. In a morbidly obese (BMI>40 kg/m2) individual, the risk of developing OSA lies between 55% and 90%. [11].

The important association of excess body weight, a modifiable risk factor, with SDB raises many questions relevant to clinical practice and public health. There are many types of sleep-disordered breathing, out of which most are undiagnosed yet correctable by timely intervention and management. Effectively managing risk factors related to sleep-disordered breathing (SDB) includes hypertension & cardiovascular system morbidity and mortality. Identification of risk factors and their quantification is of great importance to determine the avoidable burden of SDB. Therefore it is essential to assess the SDB in obese and hypertensive patients.

Numerous studies have been conducted all over the world, including India, for estimation of the burden of SBD & risk factors for SBD. No such research has been shown in our area. However, such data are necessary to formulate a plan for the preventive & curative strategy. Therefore the present study has been undertaken with the following objectives: To analyze the severity of hypertension in obese patients, To analyze SDB in obese patients, To analyze whether SDB is a risk factor for hypertension in obese individuals, To correlate how many obese hypertensive have correctable SDB.

Methods

It was a hospital-based cross-sectional study conducted in the Department of Pulmonary Medicine, PCMS, Bhopal. A simple random sampling technique is used to select desired samples according to the inclusion-exclusion criterion. The study population consisted of all adults aged 17-80 Years admitted to the study centre. We included those who were willing to participate in the study. We excluded the participants who were unwilling to participate in the survey, did not tolerate sleep study & had other co-morbid conditions like bronchial asthma, coronary artery disease, and chronic obstructive airway disease.

Patients with pure central sleep apnea were also excluded from the study. Two hundred obese patients were randomly chosen from the outpatient department of People's College of Medical Science and Research Centre selected as subjects for the study. Berlin's questionnaire and the Epworth sleepiness scale score (ESSS) were used to assess sleep-disordered breathing (SDB).

The questionnaire was handed to the patient at the time of history recording and collected when the analysis was performed. Polysomnograph analysis, body mass index (BMI), neck circumference, pulmonary function test, and clinical history were carried out with the assistance of nursing staff and sleep study technicians. Asian classification of obesity suggested by the World Health Organization was used for the assessment of BMI. The biochemical parameters of subjects were identified.

Data analysis: All statistical analysis was carried out using the SPSS version 20, and Appropriate Statistical tools were applied wherever required, like a test of proportion, Chi-square test etc. Binary logistic regression was used to predict hypertension and the risk factors. Karl Pearson's correlation coefficient was used to identify the degree and direction of the relationship of obesity, hypertension, sleep apnea and diabetic status of obese patients with blood pressure, biochemical and other parameters.

Ethical consideration: Research permission and Ethical approval was obtained from the RAC and institutional ethics committee of PCMS and R.C. Bhopal, respectively.

Results

A total of 200 subjects were randomly selected for the study. Out of the 116 subjects were male and 84 were female. The mean spread of age for total selected subjects (N=200) was 45.64±12.75 years. The following tables show the analyzed results with interpretations.

Table 1: Demographic Characteristic

Age (years)	Male (N=116)		Female (N=84)	
	N	%	N	%
15-35	25	21.6	19	22.6
35-55	59	50.9	38	45.2
55-75	31	26.7	26	31.0
≥75	1	0.9	1	1.2

Table 2 projected the body mass index (BMI) between 40 and 50 kg/m2 in 49.0% of the obese patient. Approximately all (99.5%) obese patients were measured in grade II, while only one patient was identified in grade I.

Table 2: Distribution of Body Mass Index with Grading of Obesity

Body Mass Index (N=200)			Obesity Grading (N=200)		
BMI (kg/m2)	Frequency	%	Grading	Frequency	%
<40	37	18.5	Grade I	1	0.5
40-50	98	49.0			
50-60	51	25.5	Grade II	199	99.5
≥60	14	7.0			

Appro ximately half (46.0%) of subjects had neck circumference (N.C.) in the range of 16-18 inches, followed by 14-16 inches measured in 31.0%, which can be seen easily in table 3. About 20.5% of subjects had N.C. in the ranges of 18-20 inches. N.C. of ≥20 inches was observed in a few (2.5%) subjects. Most of the subjects (62.5%) were found with addiction. 54.0% used alcohol, but tobacco was used by 51.5% while both the material used by 43.0%.

Table 3: Polysomnograph Analysis for Sleep Apnea And Type Of Sleep Apnea

Severity of apnea (N=200)			Predominant Apnea (N=200)		
Category	Frequency	%	Type	Frequency	%
Normal	1	0.5	Obstructive	140	70.0
Mild	13	6.5			
Moderate	51	25.5	Mix	60	30.0
Severe	135	67.5			

It was easily seen in table 3 that sleep-disordered breathing (SDB) was present in most of the cases. The majority of the study population (70.0%) had suffered from obstructive sleep apnea, while the rest (30.0%) had mixed sleep apnea.

Table 4: Co-morbid Status of Subjects

Parameter		Male		Female	
Disease status	Variable	N	%	N	%
Hypertension	Yes	94	81.0	65	77.4
	No	22	19.0	19	22.6
Thyroidism	Hyperthyroid	0	0.0	1	1.2
	Euthyroid	93	80.2	57	67.9
	Hypothyroid	23	19.8	26	31.0
Diabetes	Diabetic	73	62.9	37	44.0
	Non-Diabetic	43	37.1	47	56.0

Table 5: Descriptive Statistics For Male And Female Obese Patients

Variable		Min.	Max.	Mean	Std. Error	Std. Dev.
MALE OBESE PATIENTS (N=116)	Age (year)	17	80	44.90	1.22	13.14
	Weight (kg)	84.00	201.00	136.96	2.10	22.67
	Height (meter)	1.51	1.87	1.69	0.01	0.07
	BMI (kg/m2)	32.81	77.04	47.76	0.73	7.84
	NC (inch)	15	22	17.10	0.12	1.31
	SBP (mmHg)	110	200	138.71	1.19	12.82
	DBP (mmHg)	70	110	89.40	0.72	7.72

	FEV1/FVC	1	2	1.04	0.02	0.20
	TSH	0.67	10.89	3.13	0.17	1.88
	Hb1AC	4.89	17.24	7.06	0.18	1.99
	AHI	5.70	90.00	42.84	1.67	17.95
FEMALE OBESE PATIENTS (N=84)	Age (year)	21	76	46.67	1.33	12.18
	Weight (kg)	69.00	175.00	110.27	2.19	20.09
	Height (meter)	1.25	1.77	1.54	0.01	0.07
	BMI (kg/m2)	28.35	80.00	46.35	0.96	8.79
	NC (inch)	14	19	15.48	0.12	1.07
	SBP (mmHg)	110	170	136.90	1.27	11.61
	DBP (mmHg)	70	110	88.38	0.83	7.63
	FEV1/FVC	1	1	1.00	0.00	0.00
	TSH	0.23	52.78	5.54	0.81	0.23
	Hb1AC	1.46	13.62	6.55	0.21	1.46
	AHI	4.80	82.50	33.54	1.78	16.27

Table 6: Association of Age with Various Co-Morbidities

Risk Factor		Age category (Year)				Total N=200	χ2	P-value
		15-35 n=44	36-55 n=97	55-75 (n=57	>75 n=02			
		N (%)	N (%)	N (%)	N (%)			
OBESITY GRADING	Grade I	1 100%	0 0.0%	0 0.0%	0 0.0%	01	df=3 3.56	p>0.05 (Insignificant)
	Grade II	43 21.6%	97 48.7%	57 28.6%	2 1.0%	199		
Blood Pressure Grading	Normal	10 47.6%	7 33.3%	3 14.3%	1 4.8%	21	df=9 23.73	p<0.005 (Highly significant)
	Pre hypertensive	9 45.0%	7 35.0%	4 20.0%	0 0.0%	20		
	Stage I	17 13.7%	65 52.4%	41 33.1%	1 0.8%	124		
	Stage II	8 22.9%	18 51.4%	9 25.7%	0 0.0%	35		
Severity Of Sleep Apnea	Normal	1 100.0%	0 0.0%	0 0.0%	0 0.0%	01	df=9 9.09	p>0.05 (Insignificant)
	Mild	5 38.5%	6 46.2%	2 15.4%	0 0.0%	13		
	Moderate	14 27.5%	23 45.1%	14 27.5%	0 0.0%	51		
	Severe	24 17.8%	68 50.4%	41 30.4%	2 1.5%	135		
Predominant Apnea	Obstructive	33 23.6%	67 47.9%	38 27.1%	2 1.0%	140	df=3 1.72	p>0.05 (Insignificant)
	Mixed	11 18.3%	30 50.0%	19 31.7%	0 0.0%	60		
Reversibility	No	26 20.5%	69 54.3%	30 23.6%	2 1.6%	127	df=3 6.86	p<0.08 (Poorly significant)
	Yes	18 24.7%	28 38.4%	27 37.0%	0 0.0%	73		
Diabetic Status	Non-Diabetic	31 34.4%	34 37.8%	25 27.8%	0 0.0%	90	df=3 17.6	p<0.001 (Highly significant)
	Diabetic	13 11.8%	63 57.3%	32 29.1%	2 1.8%	110		

Thyroid Stimulating Hormone	Hyperthyroid	1 100.0%	0 0.0%	0 0.0%	0 0.0%	01	df=6 5.41	p>0.05 (Insignificant)
	Euthyroid	30 20.0%	74 49.3%	45 30.0%	1 0.7%	150		
	Hypothyroid	13 26.5%	23 46.9%	12 24.5%	1 2.0%	49		

Table 6 shows that the age of obese patients had a very strong association (p<0.005) with blood pressure grading.

It was also concreted statistically that age of the obese patient is the most critical and significant solid factor that highly impacted the diabetic status of the obese patient.

Table 7: Association of Sex with Various Co-Morbidities

Risk Factor		Gender		Total N=200	χ2	P value
		Male (n=)	Female (n=)			
		N (%)	N (%)			
OBESITY GRADING	Grade I	0 (0.0%)	1 (100.0%)	01	df=1 1.39	p>0.05 (Insignificant)
	Grade II	116 (58.3%)	83 (41.7%)	199		
Blood Pressure Grading	Normal	12 57.1%	9 42.9%	21	df=3 1.42	p>0.05 (Insignificant)
	Pre hypertensive	10 50.0%	10 50.0%	20		
	Stage I	71 57.3%	53 42.7%	124		
	Stage II	23 65.7%	12 34.3%	35		
Severity Of Sleep Apnea	Normal	0 0.0%	1 100.0%	01	df=3 10.71	p<0.02 (significant)
	Mild	4 30.8%	9 69.2%	13		
	Moderate	24 47.1%	27 52.9%	51		
	Severe	88 65.2%	47 34.8%	135		
Diabetic Status	Non-Diabetic	43 (47.8%)	47 (52.2%)	90	df=1 7.02	p<0.008 (Highly significant)
	Diabetic	73 (66.4%)	37 (33.6%)	110		
Thyroid Stimulating Hormone	Hyperthyroid	0 0.0%	1 100.0%	01	df=6 4.83	p<0.09 (Poorly significant)
	Euthyroid	93 62.0%	57 38.0%	150		
	Hypothyroid	23 46.9%	26 53.1%	49		

It is presented in table 7 that blood pressure grading was not associated significantly (p>0.05) with the sex of obese patients. However, the sex of obese patients was associated significantly (p<0.02) with the severity of sleep apnea. The sex of obese patients was poorly associated (p<0.08) at a 91.0% confidence interval with thyroid-stimulating hormone.

It was rooted that sex statistically is the most important and strong significant factor that highly impacted the diabetic status of the obese patient.

It was concreted statistically when sex was considered that neck circumference, thyroid-stimulating hormone and apnea-hypopnea index were the significant risk factors in obese patients concerning sleeping disorder breathing. (Table-8)

Neck circumference was deviated positively about the apnea-hypopnea index in both male and female obese patients but very poorly correlated with the apnea-hypopnea index that was measured insignificant ($p>0.05$) on the statistical ground. Diabetic male and female whose Hb1AC was not related with AHI, but the direction of the relationship was in negative direction observed for both male and female diabetic obese patients that were conformed statistically insignificant ($p>0.05$).

Systolic blood pressure and diastolic blood pressure of subjects with and without hypertension were absent concerning apnea-hypopnea index in obese patients except for diastolic blood pressure of subjects without hypertension were deviated in the negative direction, and the strength of correlation was very poor confirmed statistically not significant ($p>0.05$).

In, non-diabetic subjects the systolic blood pressure was found poorly correlated with apnea-hypopnea index deviated in a positive direction was confirmed significant ($p<0.02$) on the statistical ground. The diastolic blood pressure was associated very poorly with the apnea-hypopnea index but deviated positively, which proved statistically not significant ($p>0.05$). In diabetic obese subjects, the systolic and diastolic blood pressure were found with an absence of correlation with the apnea-hypopnea index.

Discussion

Obesity is strongly linked with sleep disorder breathing in previous studies. Earlier studies have been conducted in the developed world where demography and lifestyles are different from that of an Indian population. Hence, this observational study was conducted from Oct 2013 to April 2015 to understand the pattern of a sleep-related breathing disorder in an obese individual concerning the Indian population, chiefly in Central India.

From 200 randomly selected subjects in our study, sleep-disordered breathing (SDB) was present in approximately all the obese subjects (99.5%). Maximum subjects (67.5%) had a severe form of sleep apnea, while 25.5% of obese subjects had moderate sleep apnea. Mild sleep apnea was found in 6.5% of obese patients, while only 0.5% of obese patients had a normal sleep study. The most common type of sleep apnea was an obstructive type, which was present in 70% of the obese subjects.

A mixed variety of sleep apnea was found in 30% of obese patients. In a study done by Lopez et al. of 290 obese subject population {comprising of 22% males and 278% females}, the prevalence of sleep-disordered breathing was found to be 78% [12].

Our result supported the study done by Paul .E. Peppard et al. (2000) on moderate weight change and OSA. It concluded that even modest weight control are likely to be effective in managing SDB and reducing the new occurrence of SDB [13].

Similarly, Peter.P.Lopez et al. (2003) conducted a study where the incidence of OSA is more than 70% in the study population and incidence of OSA increases as BMI increases.

Issack Biyong et al (2012) [14] also found a significant relation between respiratory disorders during sleep and BMI. They showed a strong correlation between BMI, AHI and partial airway obstruction.

However, G. Namyslowski et al. (2002) [15] found a lack of statistical correlation between BMI and all sleep parameters in overweight patients but got positive correlation between BMI and SDB in obesity class I and obesity class II patients and concluded that BMI determination may be considered as a simple yet important predictor of the OSAS in the group of obese patients.

In our study, moderate apnea is more in female patients (52.9%) as compared to male patients (47.1%), while severe apnea (AHI) is more in male patients (65.2%) as compared to females (34.8%). But these differences are not statistically significant ($p>.05$).

Our result supports study done by Kumiko Yukawa et al (2009) [16]. They studied gender differences among Japanese patients with Obstructive Sleep Apnea Syndrome. Their results suggest that the OSAS severity is less in Japanese female patients than in male patients.

In our study, as age increases, the severity of apnea increases and then decreases. However, this association is not statistically significant.

Edward.O. Bixler et al. (1998) [17] also studied the effects of age on sleep apnea in men; they found that the prevalence of any type of sleep apnea increased monotonically with age and central sleep apnea appeared to account for this monotonic relationship with age.

In our study, neck circumference was deviated positively concerning apnea-hypopnea index in both male and female obese patients but very poorly correlated with an apnea-hypopnea index that was measured insignificant ($p>0.05$) on the statistical ground. However, a polish study done by Plywaczewskir et al. (2008) [18] analysis revealed a significant correlation between neck circumference and AHI. Still, they found that BMI with AHI was more substantial than with neck circumference.

Also, Robert.J.O.Devis et al. (1990) [19] concluded in their study that neck circumference corrected for height is more valuable as a predictor of OSA than general obesity.

Previous work estimated that around 40% of patients with OSAHS are hypertensive, and 40% of patients with refractory hypertension have OSAHS.

Pepperall JCT et al. (2002) [20] concluded from their study that improvement in B.P. correlated as strongly with improvement in sleepiness as with OSA severity.

In a study by Dennis.A et al (2005) [21]. the result supports the use of AHI as a marker of blood pressure risk.

In our study in non-diabetic subjects, the systolic blood pressure was poorly correlated with an apnea-hypopnea index ($p<0.02$). The diastolic blood pressure was also associated very poorly with apnea-hypopnea index confirmed statistically not significant ($p>0.05$).

In a study done by Hoffstein et al (1994) [22]. On 1415 subjects, revealed AHI to be an independent determinant of systemic hypertension.

Similarly, in a study done by Grunstein et al. (1995) [23]. On 3035 subjects, using multivariate analysis, revealed that OSA is independently associated with blood pressure in men and women.

Lavie P et al (2000) [24]. and Nieto. F.J et al (2000) [25]. also concluded from their study that OSAHS is an independent risk factor for hypertension.

Robinson G V et al (2004) [26]. found that there is stronger evidence that OSAHS is an independent risk factor for hypertension than any other cardiovascular disease state, and treatment with CPAP can reduce blood pressure.

In our study, the correlation between diastolic blood pressure and AHI is more than systolic blood pressure.

Our study supports the result of a study done by Qimin Wang et al. (2014) [27], who studied an association between excessive daytime sleepiness and blood pressure in patients with Obstructive Sleep Apnea-Hypopnea Syndrome. They studied 508 adults with suspected OSAHS and found that ESS was positively correlated with morning diastolic blood pressure, mean arterial pressure and bedtime DBP.

Similarly, Tomas Konecny et al., in 2014 [28], conducted a study on obstructive sleep apnea and hypertension, and they concluded OSA as one of the modifiable and highly prevalent factors in the development of HTN. They also found that patients with OSA have decreased exercise tolerance and higher diastolic B.P. during exercise testing.

In our study probability of developing hypertension increase with an increase in age, but this relation is not statistically significant. Our study supports a study done by Margaret Brennan et al. (1986) [29], which showed that in hypertensives of different age variability of blood pressure is not consistently related to age and concluded that clinical decision and assessment of blood pressure behaviour could be made with similar confidence in old and young hypertensives.

In our study, the overall severity of sleep apnea was found to be the most important significant risk factor ($p<0.05$) for predicting systemic hypertension among obese patients, with the moderate type of sleep apnea ($p<0.005$) being the most significant risk factor for predicting systemic hypertension.

In a study done by Hoffstein et al [29]. of 1415 subject population {comprising of 72.5% males and 27.5% females}, revealed AHI to be an independent determinant of systemic hypertension

In a study done by Grunstein et al. [30] of 3035 subject population {comprising 43.6% males and 56.4% females}, using multivariate analysis, it revealed that OSA was independently associated with blood pressure in men and women.

Conclusion

Obesity has a very high and proportionate correlation between sleeping disordered breathing. Obstructive sleep apnea is the predominant sleep-disordered breathing in our study population. Moderate obstructive sleep apnea correlates very highly for predicting hypertension and may be considered as a risk factor for the same.

Sleep-disordered breathing is very much correctable in the obese hypertensive population by weight reduction and risk factor control.

Limitations: The number of study subjects and study duration is very small for application to the general population.

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