Influence of neck circumference and body mass index on obstructive sleep apnea based on age groups

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The aim of this study is to demonstrate the significances of neck circumference (NC) and Body Mass Index (BMI) in obstructive sleep apnea (OSA) based on age groups. The influence of OSA diagnosed according to age groups was discussed. The study was done in Misurata city for 243 (135 males and 108 females aged 13-80yrs) patients referred to the Misurata city sleep clinic with suspected OSA. Polysomnography (PSG) was done for all. The main finding in this study was that the mean of BMI in age group (45-55yrs) was higher in females and the mean of NC was higher in males for all age groups. Simple linear regression analysis showed that there was significant positive correlation between BMI and respiratory disturbance index (RDI) in addition there was also positive significant correlation between NC and RDI specifically in middle and elder age groups (35-45yrs), (55-65yrs) respectively. Furthermore, using multiple linear regression analysis for both BMI and NC it was found that the NC was the only significant associated with RDI in middle and elder age groups. In addition, it was demonstrated that NC could be more associated with OSA than BMI in middle and elder Misurata patients.

Keywords: sleep apnea; body mass index; age group; neck circumference

I. INTRODUCTION

Obstructive sleep apnea (OSA) is being increasingly recognized as an important cause of medical morbidity and mortality. It is a relatively common sleep disorder that is characterized by recurrent episodes of partial or complete collapse of the upper airway during sleep. Prevalence is estimated at 2% of women and 4% of men in the general population [1].

The patients with OSA were shown to have an increased risk of cardiovascular disease, stroke, hypertension, diabetes mellitus, depression, and impaired cognitive function [2]. Several risk factors, including obesity, male sex and age have been associated with an increased prevalence of OSA in the general population [3]. Among these, obesity is one of the strongest sleep apnea risk factors [4]. Davies et al and Katz et al indicated that neck circumference (NC) is more predictive for OSA severity than body mass index (BMI) [4, 5]. NC is correlated with central obesity rather than general obesity. Because polysomnography (PSG) is expensive and has limited availability it is useful to know the predictive risk factor for OSA to define which patient should have priority to perform PSG. The study of Bixler et al shows that the prevalence of sleep apnea tends to increase with age in males [6]. Further, these studies have not addressed the clinically relevant question of whether age groups combining NC with BMI may allow the clinical diagnosis or exclusion of sleep apnea to be made with reasonable confidence [6]. This study evaluates these issues. Thus, the goal of this study is to demonstrate the significance of NC and BMI in OSA based on age groups.

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Patient and methods

Study sample

243 patients were prospectively examined (135 males and 108 females aged 13-80 years) referred to the Misurata city sleep clinic with suspected sleep apnea. All were both non-selected and consecutively referred for diagnostic sleep recordings over one-year period.

Protocol

Nocturnal PSG was performed in hospital. This included monitoring of both respirations, with inductance plethysmography and oronasal temperature as substitute measurements of respiratory effort and flow, and oxygen saturation. From these measures we obtained the apnea-hypopnea index (total number of apneic events plus hypopneic events divided by hours of sleep) and the lowest and mean nocturnal oxygen saturation; we also recorded the percentage of time spent asleep with oxygen saturation below 90%. Apnea was defined as a cessation in airflow of at least 10 seconds, and hypopnea was defined as a decrease in the amplitude of the respiratory signal of at least 50% for a minimum of 10 seconds followed by either a decrease in oxygen saturation of 4% or signs of physiological arousal[7]. The apnea index was calculated by dividing the total number of apneas by the total number of hours of sleep, and the manual detection of respiratory events was performed for every 30

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seconds interval according to standard Americana academe of sleep Medicine (AASM) criterion. The respiratory disturbance index (RDI) was calculated by dividing the total number of apneas, hypopneas and respiratory effort related arousals (RERA) observed during the recording by the total time of sleep in hours. Each patient had to have at least 30 apneas and an apnea index of 5 or greater to be included in this analysis.

Anthropometric measurements: We measured the patients' height, weight, neck circumference, and we calculated their body mass index.

Statistical analysis and results

We used SPSS version 21 to analyze the study data. Comparisons between measures (Mean ± SE). In addition, multiple regression analysis was used in this study. Also, the probability value (p-value) was considered significant when it is equaled to or less than 0.05. The description analysis showed firstly the number of patients in this study was 243 (135 of them were male and 108 were female). The mean age in males was 41.11yrs ± 1.003 and in females was 51.75yrs ± 1.42. The mean of BMI in males was 34.78 Kg/m^2 ± 0.56 and in females was 39.68 Kg/m^2 ± 0.87. In addition, the mean of NC in males was 43.01 cm ± 0.35 and in females was 40.82 cm ± 0.44. Furthermore, the age groups for males and female were shown in figure (1).

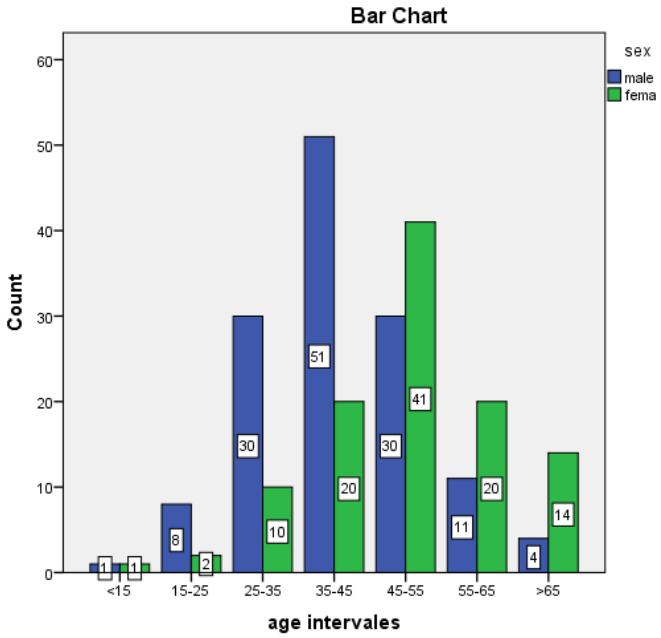

Figure (1) showed age group number in males and females.

Sample description

According to the age groups as shown in (Figure 1) the highest age group was in middle age group (35-45yrs, 45-55yrs) were the number of individuals was 71 for each and the male more in age group (35-45yrs). The lowest age group is seen in young age group (15-25yrs) was 10 persons and 18 persons in old age group. In age group (55-65yrs) was 31 persons females are more.

In the following table showed the mean of BMI based on age groups in gender

Table (1) means of BMI in age groups:

Age group \ sex	Male	Female
<15	25.8±0	39.4±0
15-25	34.41±3.40	24.2±7.40
25-35	35.62±1.05	38.8±2.72
35-45	33.29±0.75	41.05±2.04
45-55	36.19±1.14	40.96±1.12
55-65	37.78±2.09	41.34±1.38
>65	34.67±3.22	38.03±1.67

The highest means of BMI was 37.7 kg/m^2 ± 2.09 in age group (55-65yrs) in males and 41.3 kg/m^2 ± 1.4 in females while 36.2 kg/m^2 ± 1.1 in age group (45-55yrs) in males and 40.96 kg/m^2 ± 1.12 in females and 41.1 kg/m^2 ± 2.04 in age group (35-45yrs) in females and 33.3 kg/m^2 in males. The following table showed the means of NC based on age group in sex.

Table (2) the means of NC in age groups:

Sex / Age group	Male	Female
<15	34.0±0 cm	39.5±0 cm
15-25	39.42±1.81 cm	32.50±2.50 cm
25-35	42.72±0.61 cm	40.45±1.71 cm
35-45	43.06±0.60 cm	42.26±0.85 cm
45-55	43.55±0.67 cm	41.12±0.60 cm
55-65	44.36±1.75 cm	40.45±0.81 cm
>65	40.37±0.37 cm	40.60±0.98 cm

The NC was increased gradually with the age group in males where the highest mean of NC was 44.4 ± 1.8 centimeters in age group (55-65yrs) but the lowest NC was in the age groups (<15yrs and >65yrs). While, in females the means of NC was relatively ranged from 42.3 ± 0.9 centimeters in age group (35-45yrs) and 41.1 ± 0.6 centimeters in age group (45-55yrs). The furthermore, the following table showed the mean of RDI based on age groups in gender.

Table (3) the means of RDI in age groups:

Sex / Age group	Male	Female
<15	108.60±0	47.70±0
15-25	20.26±8.57	39.10±34.60
25-35	24.36±4.77	28.74±9.87
35-45	39.71±4.23	19.84±3.14
45-55	36.41±4.71	35.60±4.64
55-65	42.29±8.41	32.68±5.59
>65	29.52±12.79	46.06±7.16

In males the RDI in age groups ranged from 15-45yrs was gradually increased while in females was gradually decreased. In the age group (45-55yrs) was almost the same in males and females. In addition, the elder age group the RDI was higher in females than males but in younger age group was higher in males than females.

The effects of predisposing factors (BMI and NC) on RDI according to age groups

By using linear regression analysis as shown in table (4), it was revealed positive significant correlation between BMI and RDI (R^2= 0.06, r = 0.245 p-value = 0.039) in age group (45-55yrs), but there was no significant correlation between BMI and RDI on the other age groups.

Table (4) the Effect of BMI on RDI according to age groups:

Table (4) the Effect of BMI on RDI according to age groups:

Age intervals	R	R^2	B	Std.Error	p-value
15-25	0.008	0.000	-0.023	0.977	0.982
25-35	0.265	0.070	1.09	0.643	0.089
35-45	0.026	0.001	-.098	0.453	0.829
45-55	0.245	0.060	0.955	0.455	0.039
55-65	0.336	0.113	1.32	0.690	0.065
>65	0.064	0.004	-0.271	1.06	0.802

The results found in regression analysis between NC and RDI in age groups were shown in table (5).

Table (5) the Effect of NC on RDI according to age groups:

Age intervals	R	R2	B	Std.Error	p-value
15-25	0.122	0.015	0.620	1.788	0.738
25-35	0.174	0.030	1.210	1.111	0.283
35-45	0.393	0.155	2.686	0.762	0.001
45-55	0.122	0.015	0.835	0.827	0.316
55-65	0.642	0.412	3.457	0.766	0.000
>65	0.124	0.015	1.042	2.06	0.625

It was found highly positive significant correlation between NC and RDI in age group (35-45yrs) (R^2= 0.155, r = 0.393 and p-value = 0.001) and in age group (55-65yrs) (R^2= 0.412, r = 0.642 and p-value = 0.000), but in the other age groups was not significant correlation.

Table (6) shows results for multiple regression analysis, it was revealed highly positive significant correlation between NC and RDI in age group (35-45yrs) (R^2= 0.177, r = 0.420 and p-value=0.000) but there is no significant correlation between BMI and RDI at the same age group where the p-value=0.185. Furthermore, there was highly positive significant correlation between NC and RDI in age group (55-65yrs) (R^2= 0.425, r = 0.652 and p-value=0.001) while there was no significant correlation between BMI and RDI at the same age group where the p-value=0.442.

Table (6) the Effect of both BMI and NC on RDI based on age groups

Age intervals		R	R^2	B	Std.Error	p-value
15-25	BMI	0.145	0.021	-0.256	1.267	0.840
	NECK			-0.910	2.357	0.711
25-35	BMI	0.269	0.072	0.938	0.759	0.203
	NECK			0.353	1.285	0.785
35-45	BMI	0.420	0.177	-0.582	0.435	0.185
	NECK			2.973	0.787	0.000
45-55	BMI	0.230	0.053	0.791	0.481	0.105
	NECK			0.317	0.876	0.719
55-65	BMI	0.652	0.425	0.472	0.606	0.442
	NECK			3.225	0.827	0.001
>65	BMI	0.196	0.038	-0.761	1.270	0.558
	NECK			1.808	2.473	0.476

Discussion

The influence of OSA diagnosed according to age groups was discussed in this study. The age group of (55-65yrs) of 11 males and 20 females with OSA, the highest means of BMI were 37.7 kg/m^2 ±2.09, 31.3 kg/m^2 ± 1.38 respectively. The mean RDI in this age group was higher in males than females. In addition, the direct relation between RDI and BMI was not significant (p-value= 0.065). Furthermore, the mean of BMI in the age group

(45-55yrs) was higher in females than males, with a significant positive correlation with RDI (p-value= 0.039). The increase in BMI in middle age group could be a predictive factor for the increased the incidence of OSA. Our results are supported by the findings of Pływaczewski et al with strongest correlation between BMI and OSA in females in spite of age groups [8].

The means of NC was higher in males than in females in all age groups was higher in middle and elder age group (35-45yrs), (55-65yrs) in males 43.06 cm ± 0.6, 44.36 cm ± 1.75 and in females 42.26 cm ± 0.85, 40.45 cm ± 0.81 respectively. Furthermore, there was also positive significant correlation between NC and RDI in these age groups (p-value= 0.001, p-value= 0.000) respectively. In addition positive significant correlation was higher in the age group (55-65yrs) than in the age group (35-45yrs). It is clear that the elder age group (55-65yrs) supported the NC as more of a risk factor than in the youngest age group.

Using the multiple linear regression for both BMI and NC, it was found that the NC had a more significant risk factor for OSA, specifically in age groups (35-45yrrs) and (55-65yrs) with p-value= 0.000, p-value= 0.001 respectively. Thus the conclusion that NC is better clinical predictor for OSA than the BMI for the middle and elder age groups, which had been demonstrated by Davies et al and recently reconfirmed [9]. Furthermore, the main finding of our study confirmed in general that the prevalence of OSA tends to increase with age which reconfirmed the findings of Bixler et al and Kim et al [6, 10]. Kawaguchi et al demonstrated that NC was associated with OSA and serves as a surrogate marker for of visceral obesity in obese individual and in patient with sever OSA [11]. Recently in 2019 Tażbirek et al confirmed that increase in NC in patient with metabolic syndrome could be considered as a risk factor for the development of OSA [12].

In conclusion we demonstrated that the BMI and NC could be used to predict the presence of OSA in Misurata patients based on age groups. In addition, our findings on the relationship between the NC and RDI clearly support the hypothesis that OSA in the middle and elder age patients (55-65yrs) was more severe than the youngest age group. A plausible explanation for our finding is that localized adipose tissue distribution around the neck could be more associated with OSA than BMI, and OSA may be more vulnerable to the change in neck circumference of Misurata patients.

For future work we recommended that such this study could be extended to the influence of NC and BMI on OSA severity in gender based on age groups.

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