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ORIGINAL STUDY

Correlations between daytime sleepiness, arterial hypertension and the degree of apnea in patients with obstructive sleep apnea syndrome

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ABSTRACT

BACKGROUND. Sleep-breathing disorders are increasingly common in the general population, affecting the quality of life from many points of view. Patients with sleep-disordered breathing have a series of comorbidities, including arterial hypertension, which affects the quality of life also through the collateral manifestations of daytime sleepiness.

MATERIAL AND METHODS. A descriptive study was conducted on a group of 134 patients who underwent investigations to determine the degree of obstructive sleep apnea syndrome (OSAS) by respiratory polygraphic and polysomnographic investigations. This group was also investigated from the point of view of blood pressure values as well as the degree of daytime sleepiness, an important element for the quality of life.

RESULTS. The average age of the evaluated patients was 42.18±12.70 years, and the body mass index was 31.20±5.74 kg/m^2. The assessment of systemic blood pressure indicated an increased value above its standard normal value in most subjects: 58 patients (43.9%) were included in stage I hypertension, 9.8% in stage II, 1.5% of the subjects were diagnosed with stage III hypertension. To describe the relationship between OSAS and quality of life assessed by the degree of daytime sleepiness, we performed the regression and correlation analysis. The dependence between the values of the apnea-hypopnea index (AHI) and the ESS (the degree of daytime sleepiness) was positive; an increase in the AHI implies an increase in the ESS, thus a decrease in the quality of life.

CONCLUSION. We can conclude that the severity of OSAS is directly involved in establishing the degree of arterial hypertension. Moreover, early detection is essential in order to decrease the degree of daytime sleepiness and implicitly increase the quality of life.

KEYWORDS: sleep apnea, arterial hypertension, quality of life, daytime sleepiness.

INTRODUCTION

Sleep-breathing disorders are increasingly common in the general population, affecting the quality of life from many points of view.

Obstructive sleep apnea (OSA) is the most frequent and common sleep respiratory pathology encountered in medical practice, being characterized by marked snoring and apnea caused by repeated, partial or total obstruction of the upper airways during sleep. The period of cessation of airflow is 10 seconds or more and its frequency occurs at least 5 times per hour, being accompanied by respiratory effort.

These repeated episodes of obstruction lead to nocturnal hypoxia, hypoxemia and hypercapnia. Because of this, patients with obstructive sleep apnea syndrome (OSAS) pre-

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sent short, repeated awakenings (microarousals) during the night, with sleep fragmentation, producing excessive daytime sleepiness with a decrease in daily skills, cognitive disorders, decreased vigilance, reduced intellectual capacity and memory and probably depression, with long-term personality changes. Measurements using quality of life scales in sleep apnea show a significant reduction in vital parameters, mental function, general condition, and alteration of social relationships.

Daytime sleepiness and snoring are cardinal symptoms of major importance for the diagnosis and assessment of the severity of sleep apnea and should therefore be accurately identified and measured.

The apnea-hypopnea index (AHI), characterized by the number of episodes of apnea and hypopnea per hour during sleep, is used as an indicator of the presence and severity of sleep apnea. The normal value of the AHI index is considered to be below 5 apneas/hypopneas per hour of sleep, its calculation being performed by respiratory polygraphic or polysomnographic examination.

The risk factors of obstructive sleep apnea syndrome are: genetic factors, obesity, nasopharyngeal anatomical abnormalities, neuromuscular diseases, endocrine pathology, position during sleep, medication, alcohol.

The objective diagnostic criteria are obtained by evaluating the result of the polysomnography or respiratory polygraphy and are represented by:

- The apnea-hypopnea index AHI (AHI>5/hour of recording)
- Respiratory effort during apnea (over 70% of the events)
- Decreases in oxygen saturation (SpO2) of more than 3-4% compared to the base value
- Microarousals at the end of apnea.

Recurrent episodes of upper airway obstruction during sleep cause changes in autonomic control, with increased sympathetic activity leading to increased heart rate and blood pressure, all of which have long-term consequences for cardiovascular morbidity. Obstructive sleep apnea syndrome is described as an independent factor for high blood pressure (HBP). Possible mechanisms include oxidative stress, endothelial inflammation, sympathetic stimulation, activation of the renin-angiotensin system. Clinical studies have shown that there is a correlation between OSA and primary aldosteronism in patients with hypertension, in which it was highlighted that excess aldosterone can exacerbate OSA by increasing fluid flow during the night and affecting muscle mass activity during sleep[1,2]. Combining CPAP treatment with weight loss significantly reduces cardiovascular risk in patients with OSA[3]. The incidence of resistant hypertension, obesity and obstructive sleep apnea syndrome shows that one in three adults have hypertension and a large percentage of them have insulin resistance[3]**.** The risk of hypertension is reduced once OSA is treated, as well as with the improvement of sleep quality[4]. Reducing the quality of sleep as well as its duration can cause high blood pressure. Obstructive sleep apnea is associated in current practice with increasing the effects of sleep breathing disorders, with the possibility of progression and development of arterial hypertension[5].

As a consequence of fragmented sleep, daytime sleepiness is the most important symptom, which implicitly leads to a decrease in the quality of life. Daytime sleepiness can be assessed using self-report scales, including questionnaires such as the Stanford Sleepiness Scale and the Epworth Sleepiness Scale, the latter being often used in the clinic due to the fact that it is a simple and much more practical questionnaire.

The Epworth Sleepiness Scale (ESS) is a questionnaire that was created with the intention of describing the probability of falling asleep in 8 specific situations, evaluating the degree of daytime sleepiness with implications on the patient's quality of life. The patient is asked to write down with points from 0 to 3 (never, often, frequently, or rarely) the answer to simple questions about the occurrence of drowsiness. However, this questionnaire is subjective and introspective, depending on the accuracy with which the patient perceives sleepiness and his ability to record it accurately[5,6]. The values of the ESS score vary between 0 and 24 points, the average of patients with OSA being 10±5 points. However, these questionnaires have mediocre predictive values with a sensitivity of 63% and a specificity of 80%.

The fundamental objective of this study was to show how the sleep apnea syndrome influences the degree of essential hypertension, as well as how the quality of life is influenced by evaluating some daytime sleepiness parameters.

MATERIAL AND METHODS

A descriptive study was conducted on a group of 134 patients who underwent investigations to determine the degree of obstructive sleep apnea syndrome (OSAS). Of the 134 patients, 2 patients were excluded due to missing information on blood pressure values.

The study population was subjected to polysomnographic and respiratory polygraphic records associated with an ENT examination focusing on nasal endoscopy and filling in an examination form, as well as self-assessment of daytime sleepiness by filling in the ESS questionnaire.

All patients who were investigated complained of daytime sleepiness, decreased ability to concentrate, irritability, self-reported or reported snoring and periods of sleep apnea.

The ESS questionnaire measures the patient's risk of falling asleep in ordinary situations. The score is on a scale from 0 to 24, and the normal value is up to 10. Patients who have ESS values ≥12 are considered susceptible for OSAS.

Sleep recording was performed for a duration of 6 hours during physiological, non-drug-induced sleep. During sleep, cardiac activity parameters, the number of periods of apnea and hypopnea per time unit, as well as the respiratory flow and degree of saturation were recorded, all parameters appearing on the sleep investigation by respiratory polygraphy or polysomnography (Figure 1). Following the evaluation of the apnea-hypopnea index, 45 of the 132 patients (34.1%)

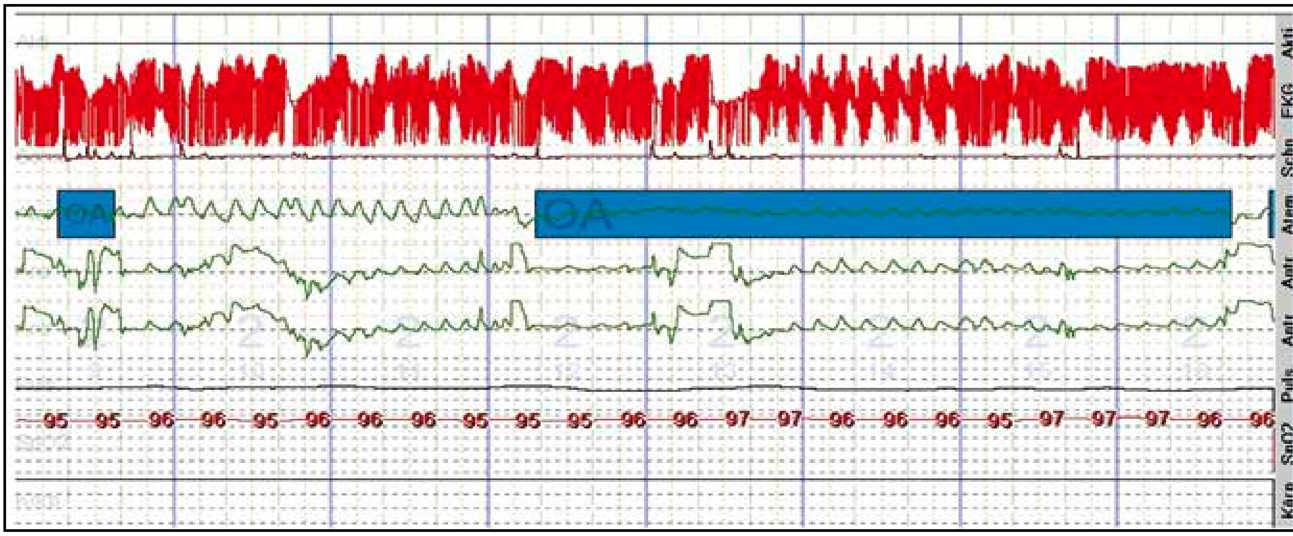

Figure 1. Image illustrating changes during sleep – oxygen saturation, nasal flow, cardiac activity – periods of obstructive sleep apnea are depicted in blue.

presented snoring during sleep, having an AHI value < 10/h.

The study population (N=132) was divided into 4 groups, depending on the values of the apnea-hypopnea index (AHI), and the results obtained (especially the AHI) were correlated with the values of the ESS scale and the blood pressure.

The data processing was done in the Excel 2007 program, and the statistical analysis was performed using the MedCalc program, which is intended for statistics in biomedical research. Frequency tables were used to obtain numerical data and percentages. For the univariate data analysis, we used the $\chi 2$ test (dichotomous variables). Differences were considered to be statistically significant at a *p* value of less than 0.05.

We analyzed the correlation between two quantitative variables and the strength of linkage using the Pearson correlation coefficient (r). This is a number between -1 and 1; the closer r is to 1 in absolute value, the greater the strength of the linear correlation between the two variables, so the stronger the link.

RESULTS

A total of 134 patients were involved in this study, of which 110 were male (82.1%), and the remaining 24 were female (17.9%) (Figure 2). The mean age of the evaluated patients was 42.18±12.70 years, and the BMI (body mass index) was 31.20±5.74 kg/m2.

The assessment of systemic blood pressure indicated an increased value above its standard normal value in most subjects: 58 patients (43.9%) were included in stage I hypertension, 13 patients (9.8%) in stage II and only 2 (1.5%) of the subjects were detected with stage III hypertension. The presence of stage I hypertension can be found in most patients (Figure 3). 2 patients were excluded for lack of information on blood pressure values.

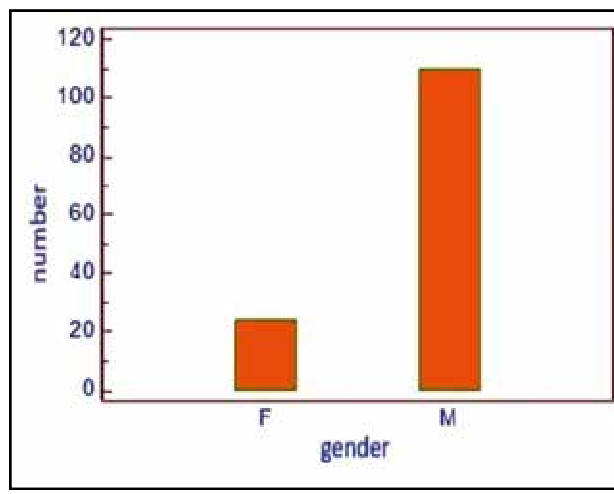

Figure 2. Gender distribution of patients with suspected sleep apnea syndrome.

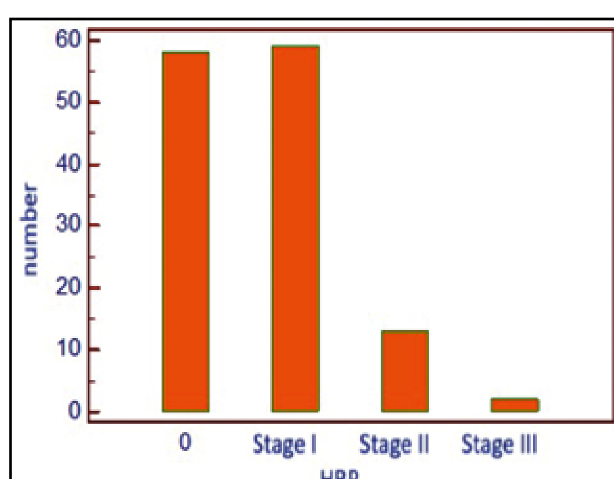

Figure 3. Incidence of hypertension (HBP) in patients from the studied group.

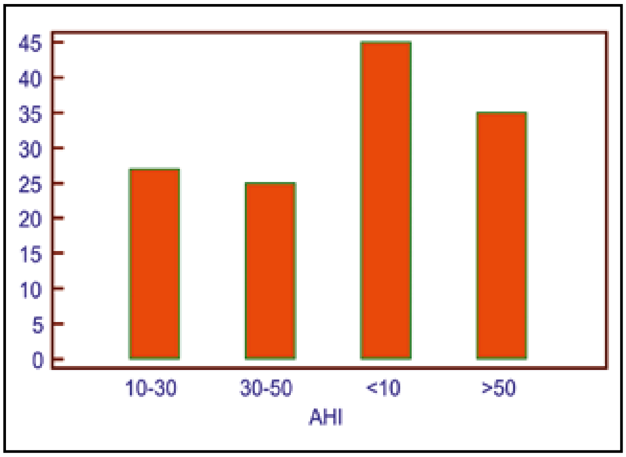

Figure 4. Distribution of patients according to the value of the degree of apnea expressed by the apnea-hypopnea index.

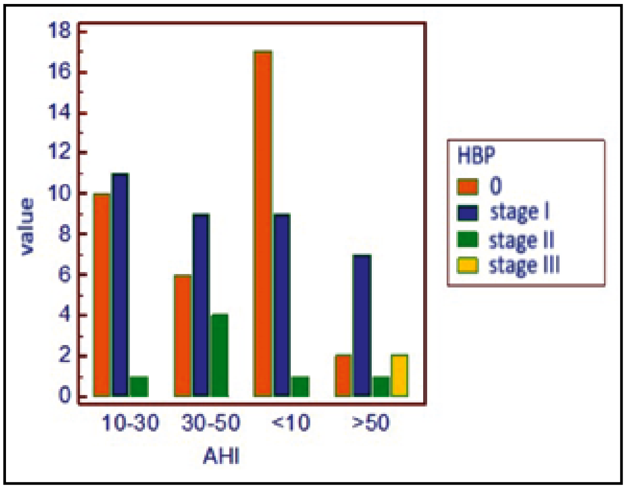

Figure 5. Correlation between the degree of apnea and the degree of arterial hypertension in patients examined by respiratory polygraphy.

Following the evaluation of the apnea-hypopnea index, of the 132 patients, 45 (34.1%) presented snoring during sleep, having an AHI value < 10/h, 27 (20.5%) had an AHI value between 10 - 30/h, 25 (18.9%) with an AHI index between 30 - 50/h, and 35 of the subjects (26.5%) presented AHI values >50/h (Figure 4).

To establish the relationship between blood pressure values and obstructive sleep apnea, we assessed the AHI index in all subjects and correlated HBP stages with AHI groups. The mean AHI value was 32.16±27.95, the CI95% correlation index being 26.35 - 35.97. Since we had 2 methods of sleep investigation, through respiratory polygraphy and polysomnography, the evaluation was performed on the 2 groups. Analyzing the results, a statistically significant difference can be observed between the AHI groups according to the HBP stages (p=0.008 for respiratory polygraphy and p=0.001 for polysomnography) (Figure 5).

In the category of patients who were evaluated by polysomnography, it was found that: among the patients with normal blood pressure values, 17 had AHI < 10/h and only 2 had AHI>50/h, 11 of those with stage I HBP had AHI between 10 - 30/h, and 7 of those with stage I HBP had AHI>50/h. Among those with stage II HBP, there were 4 patients with an AHI between 30 - 50/h; only 2 patients had an AHI > 50/h and stage III HBP (Figure 6).

The evaluation of the degree of daytime sleepiness was performed using the Epworth scale. The patients whose degree of daytime sleepiness was evaluated presented an ESS value between 0 and 19, with a mean value of 8.66±4.70 and the 95% confidence interval between 7.85 - 9.47 (Figure 7). It should be noted that the higher the ESS value, the higher the degree of daytime sleepiness with a lower quality of life.

To describe the relationship between obstructive sleep apnea syndrome and the quality of life assessed by the degree of daytime sleepiness, we performed the regression and correlation analysis, considering as the dependent variable

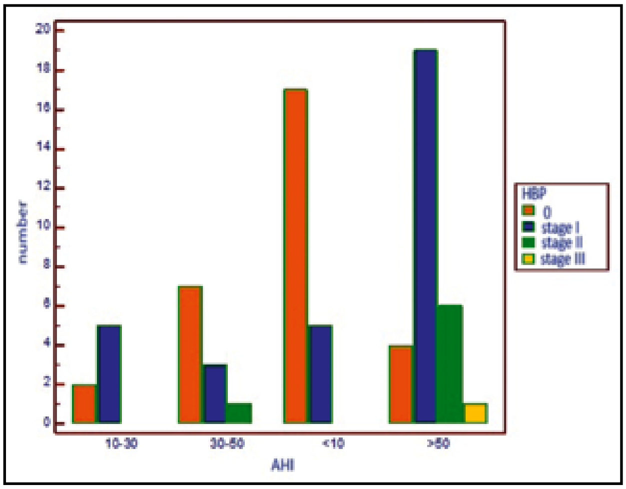

Figure 6. Correlation between the degree of apnea and the degree of hypertension in patients who underwent polysomnography.

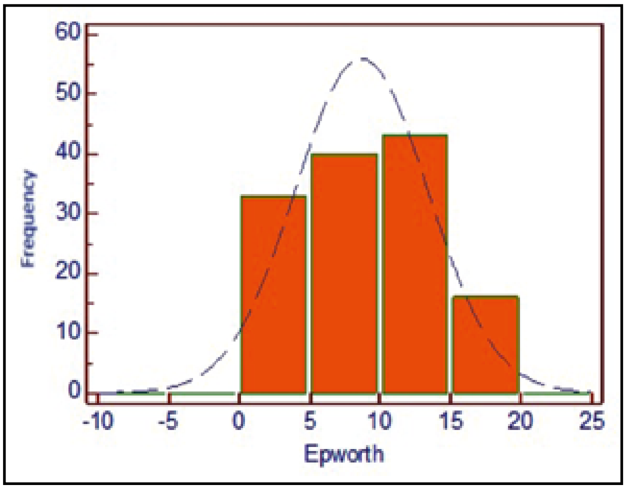

Figure 7. The mean value of the degree of daytime sleepiness values evaluated by the Epworth scale.

OSAS, quantitatively represented by AHI, and as the independent variable the degree of daytime sleepiness. The scatterplot has an increasing trend, the dispersion clouds making the appearance of an imaginary line representing linear regression. The dependence between the values of the apnea-hypopnea index, that is the severity of OSAS, and the ESS, namely the degree of daytime sleepiness, respectively the quality of life, is positive, in the sense that an increase in the AHI implies an increase in the ESS, therefore a decrease in the quality of life (Figure 8).

DISCUSSIONS

The purpose of this study was to establish how the variation of arterial hypertension is dependent on the values of the apnea-hypopnea index, its degree being correlated with the values of the apnea-hypopnea index. We also analyzed how these parameters relate to the degree of daytime sleepiness and implicitly the quality of life. There are numerous studies in the literature that support the association between OSAS severity and cardiovascular disease, especially arterial hypertension[6].

A sympathetic hyperreactivity during the day and during sleep, as well as the release of a greater amount of noradrenaline to control hypoxia, is thought to explain the association of sleep apnea syndrome with systemic arterial hypertension. Mild, moderate or severe apnea syndrome is associated with arterial hypertension, this association being more frequent in men[7].

The results of this study show that OSAS is associated with a higher frequency of HBP, especially stage I HBP, with a statistically significant difference between AHI groups according to HBP stages. It has also been proven that HBP is frequently present in patients with AHI > 50/h.

Regarding the demographic characteristics of the subjects participating in the study, a statistically significant difference between women/men was reported (p=0.0001). Comparing the results with data from the literature, which claims that obstructive sleep apnea is estimated to affect approximately 4% of men and 2% of women in middle age[7], our study demonstrates the same aspect, the frequency of OSAS being higher in men and the mean age of the study sample being 42.18±12.70. Blood pressure control is a promising approach in the treatment of obstructive sleep apnea syndrome[8].

Knowing that obesity is the main risk factor for OSAS, approximately 70% of patients with OSAS being obese, we considered it necessary to determine the body mass index (BMI) in all patients, the mean value being 31.20±5.74, which means that most of the subjects belong to the obesity class I. This result can be compared with some studies that reported that the severity of OSAS in patients with a BMI of 30 or more is due to obesity. Alveolar hypoventilation occurs in obese patients and can be associated with the degree of obesity. Hypercapnia in the hypoventilation syndrome is related to the sleep apnea syndrome but not to its severity[9,10].

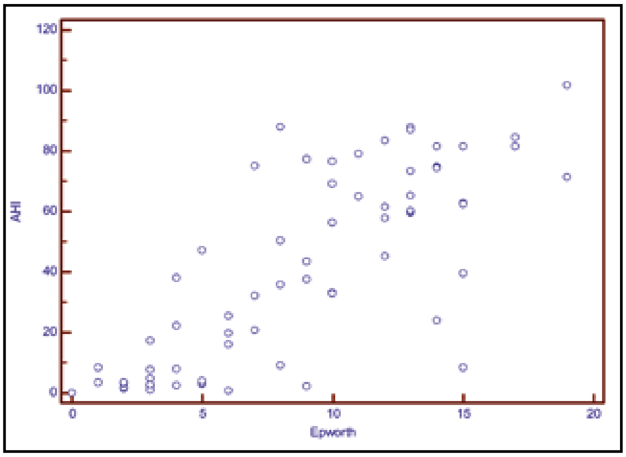

Figure 8. Scatterplot between AHI and ESS.

The ESS score varies considerably for each patient, but the classification between “normal” and “daytime sleepiness” changes substantially in relation to other parameters such as polysomnography, with the evaluation of the apnea-hypopnea index[11]. Excessive daytime sleepiness is the most evocative symptom of OSAS, associated with fatigue, attention and memory disorders, headache and dizziness, especially in the morning, all of which have implications on the quality of life. In our study, the mean value of the ESS score was 8.66±4.70; the correlation between the ESS values and the severity of OSAS, that is the AHI index, demonstrates that the higher the AHI value, the higher the ESS score, so the quality of life is more affected. In patients who suffer from daytime sleepiness, the quality of life is affected, including physical activity, pain in different parts of the body, as well as their state of health[12].

Thus, ESS with values between 0 - 10, representing values within normal limits, was more frequent for the group with mild OSAS or in patients who snore. ESS between 10 - 18, corresponding to a decrease in the quality of life by increasing the degree of daytime sleepiness, was specific to an average OSAS, while ESS with values between 18 - 24 predominated in the group with AHI > 50/h, so severe OSAS, corresponding to a marked decrease in the quality of life. Similar data were obtained in other studies that tried to evaluate the severity of daytime sleepiness, therefore the quality of life depending on the AHI, using self-report scales such as the Epworth Sleepiness Scale[12]. Daytime sleepiness, evaluated by the Epworth scale, represents an essential parameter in case of OSAS patients due to its multiple negative effects upon health status and quality of life[13].

CONCLUSIONS

In the conducted study, it was demonstrated that the severity of the degree of sleep apnea, implicitly the severity of the obstructive sleep apnea syndrome, is directly involved in establishing the degree of arterial hypertension, and early detection is essential in order to decrease the degree of daytime sleepiness and increase the quality life.

Another aspect emphasizes the fact that wakefulness and everyday activity, respectively quality of life, are influenced by the severity of obstructive sleep apnea. In this context, the reduction of morbidity and mortality due to arterial hypertension can be influenced by early diagnosis and effective treatment of obstructive sleep apnea syndrome and the collateral factors that cause the appearance of this disease.

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REFERENCES

1. Wang Y, Li CX, Lin YN, Zhang LY, Li SQ, Zhang L , et al. The role of aldosterone in OSA and OSA-related hypertension. Front Endocrinol (Lausanne). 2022;12:801689. DOI: 10.3389/fendo.2021.801689.
2. Dudenbostel T, Calhoun DA. Resistant hypertension, obstructive sleep apnoea and aldosterone. J Hum Hypertens. 2012;26(5):281-7. DOI: 10.1038/jhh.2011.47.
3. Salman LA, Shulman R, Cohen JB. Obstructive Sleep apnea, hypertension, and cardiovascular risk: epidemiology, pathophysiology, and management. Curr Cardiol Rep. 2020;22(2):6. DOI: 10.1007/s11886-020-1257-y.
4. Marcus JA, Pothineni A, Marcus CZ, Bisognano JD. The role of obesity and obstructive sleep apnea in the pathogenesis and treatment of resistant hypertension. Curr Hypertens Rep. 2014;16(1):411. DOI: 10.1007/s11906-013-0411-y.
5. Han B, Chen WZ, Li YC, Chen J, Zeng ZQ. Sleep and hypertension. Sleep Breath. 2020;24(1):351-6. DOI: 10.1007/s11325-019-01907-2.
6. Li H, Ren Y, Wu Y, Zhao X. Correlation between sleep duration and hypertension: a dose-response meta-analysis. J Hum Hypertens. 2019;33(3):218-228. DOI: 10.1038/s41371-018-0135-1.
7. Hou H, Zhao Y, Yu W, Dong H, Xue X, Ding J, et al. Association of obstructive sleep apnea with hypertension: A systematic review and meta-analysis. J Glob Health. 2018;8(1):010405. DOI: 10.7189/jogh.08.010405.
8. Jhamb M, Unruh M. Bidirectional relationship of hypertension with obstructive sleep apnea. Curr Opin Pulm Med. 2014;20(6):558-64. DOI: 10.1097/MCP.0000000000000102.
9. El Gharbi LD, Ismail I, Dhahri B, Ammar JB, Baccar MA, Azzabi S, et al. Obesity hypoventilation syndrome and obstructive sleep apnea syndrome: is there an association? Tunis Med. 2011;89(8-9):668-71.
10. Weitzenblum E, Kessler R, Chaouat A. Alveolar hypoventilation in the obese: the obesity-hypoventilation syndrome. Rev Pneumol Clin. 2002;58(2):83-90.
11. Walker NA, Sunderram J, Zhang P, Lu SE, Scharf MT. Clinical utility of the Epworth sleepiness scale. Sleep Breath. 2020;24(4):1759-65. DOI: 10.1007/s11325-020-02015-2.
12. Alami YZ, Ghanim BT, Zyoud AH. Epworth sleepiness scale in medical residents: quality of sleep and its relationship to quality of life. J Occup Med Toxicol. 2018;13:21. DOI: 10.1186/s12995-018-0203-z.
13. Wu S, Wang R, Ma X, Zhao Z, Yan X, He J. Excessive daytime sleepiness assessed by the Epworth Sleepiness Scale and its association with health related quality of life: a population-based study in China. BMC Public Health. 2012;12:849. DOI: 10.1186/1471-2458-12-849.