# Acute Effect of Apnea and Hypopnea Attacks on Blood Pressure During Sleep

## Uyku Esnasındaki Apne ve Hipopne Ataklarının Kan Basıncına Akut Etkisi

Özgür KEMAL,[a]
Salih BİLGİN,[b]
Mustafa YAZICI,[c]
Adem AKKURT[d]

[a]Department of Otolaryngology,
Ondokuz Mayıs University
Faculty of Medicine,
Clinics of
[b]Chest Diseases,
[c]Cardiology,
[d]Neurology,
Samsun International Medicana Hospital,
Samsun

Geliş Tarihi/*Received:* 25.02.2015
Kabul Tarihi/*Accepted:* 08.06.2015

*This study was presented as a poster at the 2nd Breathless Symphony Congress, 12-13 March 2015, İstanbul, Turkey.*

Yazışma Adresi/*Correspondence:*
Özgür KEMAL
Ondokuz Mayıs University
Faculty of Medicine,
Department of Otolaryngology, Samsun,
TÜRKİYE/TURKEY
drozgurkemal@gmail.com

**ABSTRACT Objective:** The present study aimed to investigate whether or not apneic and hypopneic attacks can cause acute blood pressure changes. **Material and Methods:** 82 patients with symptoms of obstructive sleep apnea were included in the study. A full overnight polysomnography was performed in the sleep laboratory. At the same time, 24-hour ambulatory blood pressure was monitored in all patients. Total apnea and hypopnea attacks between 23.00 and 07.00 hours were counted for each hour. All blood pressure levels were recorded and then compared for each sleep hour. Assessment was made as to whether or not immediate changes in apnea and hypopnea attacks affected the blood pressure. **Results:** The mean systolic blood pressure was 128.90±3.293 of the patients. The mean diastolic blood pressure was 77.29±0.98 mmHg. The mean heart rate was 72.68±0.77. The mean apnea hypopnea index (AHI) was 31.4±3.78. Systolic blood pressure, diastolic blood pressure, heart rate and AHI were recorded each hour independently and the mean values during the hours of sleep were compared statistically. The hourly changes of mean AHI (increase or decrease) did not correlate with the hourly changes of mean systolic blood pressure, mean diastolic blood pressure or mean heart rates (p=0.012). **Conclusion:** No acute changes between AHI and blood pressure were observed during the study.

**Key Words:** Sleep apnea, obstructive; hypertension; blood pressure monitoring, ambulatory

**ÖZET Amaç:** Bu çalışmada uyku esnasında oluşan apne ve hipopne ataklarının akut kan basıncı değişikliklerine yol açıp açmadığının tespiti amaçlanmıştır. **Gereç ve Yöntemler:** Çalışmaya tıkayıcı uyku apnesi semptomları ile Medicana Samsun Hastanesine başvuran 82 hasta dâhil edilmiştir. Tüm hastalara anamnez ve fizik muayeneyi takiben uyku laboratuvarında tüm gece polisomografik uyku testi ve 24 saatlik ambulatuar kan basıncı ölçümü yapılmıştır. Gece 23.00 ile sabah 07.00 saatleri arasındaki total apne ve hipopne atakları saatlik olarak ölçülmüştür. Eş zamanlı saatlik kan basınçları da kaydedilmiş ve her saat için kıyaslanmıştır. Böylelikle saatlik apne ve hipopne sayılarının değişiminin kan basıncı değişimine yol açıp açmadığı araştırılmıştır. **Bulgular:** Çalışmaya katılan hastaların ortalama sistolik kan basıncı 128,90±3,293, ortalama diastolik kan basıncı ise 77,29±0,98 mmHg idi. Ortalama kalp hızı 72,68±0.77, ortalama apne hipopne indeksi ise (AHI) 31,4±3,78 olarak tespit edildi. Sistolik kan basıncı, diastolik kan basıncı, kalp hızı ve AHI, her saat için bağımsız olarak ölçüldü. Ölçülen bu değerlerde saatlik sistolik ve diastolik tansiyon ortalamaları, saatlik AHI ile kıyaslanmıştır. Çalışmada saatlik apne ve hipopne ataklarının değişiminin (artış veya azalış) kan basıncı değişimleri ile ilişkili olmadığı saptanmıştır (p=0,012). Aynı zamanda apne ve hipopneye bağlı kan basınçlarında değişim saptanmamıştır. **Sonuç:** Çalışmada AHI değişimi neticesinde oluşan akut kan basıncı değişimi saptanmamıştır.

**Anahtar Kelimeler:** Uyku apnesi, tıkayıcı; hipertansiyon; kan basıncı izlemi, ambulatuar

**Turkiye Klinikleri J Intern Med 2016;1(1):1-5**

doi: 10.5336/intermed.2015-44471



Obstructive sleep apnea syndrome (OSAS) is determined as recurrent episodes of partial or complete upper airway obstruction during sleep. It is one of the leading causes of poor quality of life and

affects 15-24% of middle-aged males and 9-26% of middle-aged females.[1,2] The disease can cause daytime sleepiness or fatigue, dry mouth, sore throat, headaches in the morning, trouble concentrating, forgetfulness, depression, irritability, restlessness during sleep, sexual dysfunction, snoring, sudden awakenings with a sensation of gasping or choking and difficulty getting up in the mornings. It is also known to have interactions with many diseases such as cardiovascular diseases, respiratory diseases and OSAS.[3]

In healthy individuals, sleep is associated with a reduction of systolic and diastolic blood pressure of approximately 10-15%. Especially in non-REM sleep, blood pressure is lower than in REM sleep. Sleep-related low blood pressure levels are important for cardiovascular health. It has been shown that night-time overall blood pressure is the best predictor of cardiovascular mortality.[4] OSAS is also known to be a major risk factor for hypertension (HT), cardiovascular events, atherosclerosis. There have been many studies which have proved the relationship between OSAS and HT. OSAS triggers a cascade of adverse effects, including sympathetic activity, systemic inflammation, and metabolic dysregulation, which raise blood pressure.[5-7] According to the Seventh Joint National Committee, OSAS is the secondary cause of HT.[8] Hypertension affects 25-30 % of the adult population. Of patients with hypertension, 30% have OSA, and 45-68% of OSA patients have hypertension.[9-11] The impact of OSAS on hypertension is higher for diastolic hypertension in younger individuals, than for systolic hypertension in the elderly.[12] Continuous positive airway pressure (CPAP) has been used to treat OSAS and CPAP masks are able to decrease blood pressure by 1.5-10 mmHg.[13]

The present study aimed to investigate whether or not apnea and hypopnea attacks can cause acute (hourly) blood pressure changes.

## MATERIAL AND METHODS

Approval for the study was granted by Ondokuz Mayıs University Ethics Committee. This retrospective study comprised 150 patients with symptoms of OSAS who were referred to Samsun Medicana Hospital for OSA between January 2013 and September 2013 years. The patients all underwent a detailed otolaryngology and pulmonary disease examination and were questioned about daytime sleepiness using the Epworth Sleepiness Scale (ESS). Patients with basic hypertension, diabetes mellitus or any other systemic disease were excluded from the study.

A full overnight polysomnography was performed in the sleep laboratory with a 50-channel Grass Technologies Comet PSG unit (Warwick, USA). At the same time, 24-hour ambulatory blood pressure was monitored in all patients using a Schiller BR-102 Plus Ambulatory Blood Pressure Holter System (Baar, Switzerland).

While sleeping, oxyhemoglobin saturation, thoraco-abdominal movements (respiratory effort), electroencephalograms, electrocardiographic status, position of the patient and loudness of snoring were monitored. 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 by at least 50% for a minimum of 10 seconds followed either by a decrease in oxygen saturation of 4% or signs of physiological arousal.

Blood pressure measurements were made every 15 minutes over 24 hours. The following clinical parameters were assessed: systolic blood pressure, diastolic blood pressure, mean blood pressure and heart rate.

The criteria of OSAS (apnea hypopnea index (AHI) <%5) were not met by 50 of the 150 patients, so they were not included in the study. A further 18 patients were excluded as they were unable to sleep long enough to provide sufficient data. Therefore, final evaluation was made of 82 patients with apnea hypopnea index AHI >15 or AHI >5 with any of the following; unintentional sleep episodes during wakefulness; daytime sleepiness; unrefreshing sleep; fatigue; insomnia; waking up breath holding; gasping or choking; or the bed partner describing loud snoring, or breathing interruptions.[14] Total apnea and hypopnea attacks were counted for

each hour while sleeping. Blood pressure levels were recorded (systolic and diastolic) and hourly mean blood pressure levels were calculated. To rule out personal blood pressure differences a calculation method was used. The mean systolic and diastolic blood pressure levels were calculated for 24 hours.

The method that has been used to eradicate the differences which would occur between the blood pressure values of individuals is as follows. The mean systolic and diastolic blood pressures were calculated for all patients over a 24-hour period. Then each 1 mmHg increase or decrease in the hourly mean pressures was added to or subtracted from these values. For example, if the mean 24-hour blood pressure was 126/67, this was accepted as 100/100. If there was a value of 120/70 during sleep, this value would be taken as 94/103 during calculation. To eradicate inter-personal differences due to apnea hypopnea, a special method was used. The apnea hypopnea index value during night-time sleep was determined for the patients. Then the total hourly apnea hypopnea values (total number of hourly attacks) were calculated. The percentage of the hourly value compared to the mean value was used. For example, for a patient with a night AHI value of 25 with a total apnea and hypopnea value of 20 during 1 hour of sleep, a value of 80 was used in the statistical calculation. Then the apnea hypopnea values were compared separately with the systolic and diastolic blood pressure values.

The primary goal of the study was to determine any immediate association between blood pressure and hourly apnea and hypopnea. SPSS 15.0 for Windows was used for statistical analysis. Non-parametric correlations (Spearman's rho test) were made to determine any correlation between apnea and hypopnea attacks and blood pressure levels. A value of $p<0.05$ was accepted as statistically significant.

## RESULTS

A total of 82 OSAS patients were included the study, comprising 60 (73%) males and 22 (27%) females with a mean age of 51.95±1.89 years. The mean height of the patients was measured as 168±1.426 cm, the mean weight was 89.22±2.468 kg and the mean Body Mass Index was calculated as 31.61±0.898.

The mean systolic blood pressure was 128.90±3.293 mmHg. The mean diastolic blood pressure was 77.29±.98 mmHg. The mean heart rate was 72.68±.77. The mean AHI was 31.4±3.78 (Table 1).

According to the analysis, the hourly numbers of apnea and hypopnea attacks (increase or decrease) did not correlate with the hourly changes of mean systolic blood pressure ($p=0.012$), mean diastolic blood pressure or mean heart rates (Figures 1 and 2).

**TABLE 1:** The mean and median values of parameters.

| Variable | Mean±SD | Median (Min-Max) |
|---|---|---|
| Age (year) | 51.95±1.89 | 52.50 (26-75) |
| Height (cm) | 168±1.426 | 168 (150-192) |
| Weight (kg) | 89.22±2.468 | 90 (52-120) |
| Body Mass Index (kg/m$^2$) | 31.61±0.898 | 30.51 (22.38-48.88) |
| The mean systolic blood pressure (mmHg) | 128.90±3.293 | 127 (83-183) |
| The mean diastolic blood pressure (mmHg) | 77.29±.98 | 77 (50-121) |
| The mean heart rate | 72.68±.77 | 74 (58-102) |
| Mean AHI | 31.4±3.78 | 25.3 (5.2-91.9) |

AHI: Apnea hypopnea index.

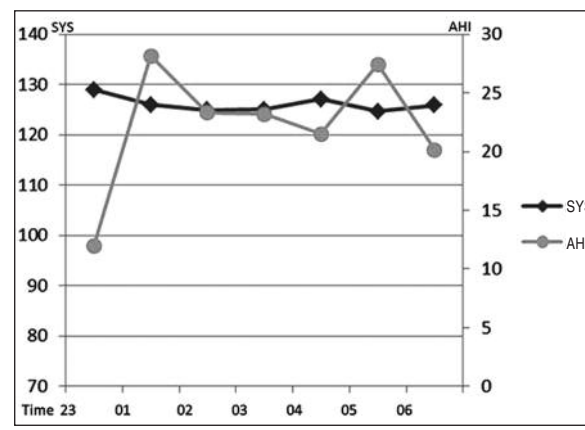


**FIGURE 1:** Mean apnea hypopnea index (AHI) and mean systolic blood pressure (SYS) changes during sleep.

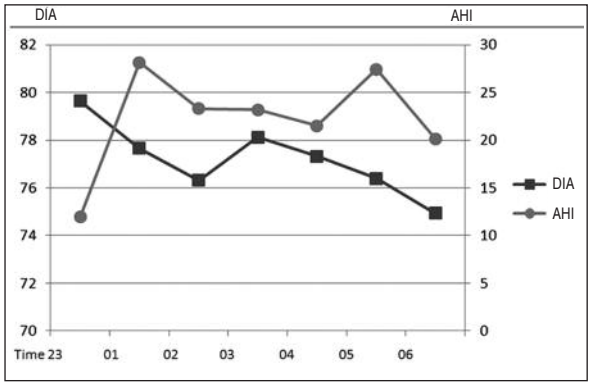


**FIGURE 2:** Mean apnea hypopnea index (AHI) and mean diastolic blood pressure (DIA) changes during sleep.

In addition, all patients were examined individually. Each patient's hourly AHI values were separately compared with the hourly systolic and diastolic blood pressure values. Of the 82 patients, the changes in 10 were found to be statistically significant and no statistical significance was determined in the results of the other 72 patients.

In addition, the mean AHI values (for all night) were compared with the mean blood pressure values of the total 24-hour blood pressure results. In patients with high blood pressure values, the AHI values were also determined to be higher than normal ($p<0.01$).

## DISCUSSION

Several studies have shown that OSAS is common in both males and females.[1,15,16] At least 60% of patients with OSAS have hypertension.[15] There are also many studies showing the relationship between hypertension and OSAS. Hypertension due to OSAS is usually resistant to antihypertensive therapy. There are several meta-analyses that show the relationship between OSAS and hypertension, and there are studies which have shown a decrease in blood pressure after CPAP treatment.[17-21]

The mechanisms of hypertension due to OSAS have not yet been completely established. There are several theories to define the relationship. First, chemoreflex activation and increased sympathetic activity response to hypoxemia and hypercapnia which may result in increased peripheral vascular tone. Second, hypoxemia may increase production of various circulating vasoconstrictors that increase blood pressure. Third, endothelin-1 (a potent and long-acting vasoconstrictor) hypersecretion due to vasculopathy. Fourth, weight gain, which is a result of OSAS.[15] All these mechanisms may cause chronic changes and hypertension, but their effect on acute attacks is still debatable. There are several different theories of acute pressure changes of OSAS; these theories are upper airway conclusion and subsequent hypoxia, hypercapnia, large negative intrathoracic pressure swings and arousal from sleep, which may increase peripheral sympathetic activity and may result in acute blood pressure increases.[4]

All the patients included in the study had OSAS. It has previously been established in several multiple studies that OSAS patients have more severe hypertension compared with healthy subjects.[16,17] However, the current study showed that blood pressure levels have a correlation with AHI even in OSAS patients. In other words, a strong correlation with mean systolic and diastolic pressure with AHI in OSAS patients was observed. This data demonstrates that if AHI rises, blood pressure also rises.

The other question concerned acute rises of blood pressures during sleep. In other words, whether or not acute rises of apneic periods could cause acute rises of blood pressure. There are few studies that show acute blood pressure increases following obstructive sleep apnea periods.[22,23] According to the data of the current study, hourly changes in AHI (increase or decrease) during sleep did not result in immediate changes of blood pressure. In other words, acute changes of AHI while sleeping do not cause immediate blood pressure changes. This data shows that blood pressure changes in OSAS is a chronic process, which has been proven with both systolic and diastolic blood pressures.

## CONCLUSION

OSAS is a major risk factor of hypertension and is one of the leading causes of hypertension. Increased AHI in OSAS patients correlates with in-

creases in blood pressure. However, acute changes of apnea and hypopnea attacks do not result in acute changes of blood pressure.

*Acknowledgement*

*The authors thank Caroline Walker for English language assistance.*

## REFERENCES

1. Young T, Palta M, Dempsey J, Skatrud J, Weber S, Badr S. The occurrence of sleep-disordered breathing among middle-aged adults. N Engl J Med 1993;328(17):1230-5.
2. Cano-Pumarega I, Durán-Cantolla J, Aizpuru F, Miranda-Serrano E, Rubio R, Martínez-Null C, et al. Obstructive sleep apnea and systemic hypertension: longitudinal study in the general population: the Vitoria Sleep Cohort. Am J Respir Crit Care Med 2011;184(11):1299-304.
3. Tomori Z, Szaboova E, Donic V. Interaction of sleep apnea syndrome with various diseases. Bratisl Lek Listy 1999;100(2):80-4.
4. Phillips CL, O'Driscoll DM. Hypertension and obstructive sleep apnea. Nat Sci Sleep 2013;5:43-52.
5. Pedrosa RP, Drager LF, Gonzaga CC, Sousa MG, de Paula LK, Amaro AC, et al. Obstructive sleep apnea: the most common secondary cause of hypertension associated with resistant hypertension. Hypertension 2011; 58(5):811-7.
6. Parati G, Lombardi C, Hedner J, Bonsignore MR, Grote L, Tkacova R, et al; European Respiratory Society; EU COST ACTION B26 members. Position paper on the management of patients with obstructive sleep apnea and hypertension: joint recommendations by the European Society of Hypertension, by the European Respiratory Society and by the members of European COST (COoperation in Scientific and Technological research) ACTION B26 on obstructive sleep apnea. J Hypertens 2012;30(4):633-46.
7. Okcay A, Somers VK, Caples SM. Obstructive sleep apnea and hypertension. J Clin Hypertens (Greenwich) 2008;10(7):549-55.
8. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, et al; Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. National Heart, Lung, and Blood Institute; National High Blood Pressure Education Program Coordinating Committee. Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Hypertension 2003;42(6):1206-52.
9. Kearney PM, Whelton M, Reynolds K, Muntner P, Whelton PK, He J. Global burden of hypertension: analysis of worldwide data. Lancet 2005;365(9455):217-23.
10. Worsnop CJ, Naughton MT, Barter CE, Morgan TO, Anderson AI, Pierce RJ. The prevalence of obstructive sleep apnea in hypertensives. Am J Respir Crit Care Med 1998;157(1):111-5.
11. Hedner J, Bengtsson-Boström K, Peker Y, Grote L, Råstam L, Lindblad U. Hypertension prevalence in obstructive sleep apnea and sex: a population-based case-control study. Eur Respir J 2006;27(3):564-70.
12. Haas DC, Foster GL, Nieto FJ, Redline S, Resnick HE, Robbins JA, et al. Age-dependent associations between sleep-disordered breathing and hypertension: importance of discriminating between systolic/diastolic hypertension and isolated systolic hypertension in the Sleep Heart Health Study. Circulation 2005;111(5):614-21.
13. Baguet JP, Lévy P, Barone-Rochette G, Tamisier R, Pierre H, Peeters M, et al. Masked hypertension in obstructive sleep apnea syndrome. J Hypertens 2008;26(5):885-92.
14. Epstein LJ, Kristo D, Strollo PJ Jr, Friedman N, Malhotra A, Patil SP, et al; Adult Obstructive Sleep Apnea Task Force of the American Academy of Sleep Medicine. Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults. J Clin Sleep Med 2009:5(3):263-76.
15. Phillips BG, Somers VK. Hypertension and obstructive sleep apnea. Curr Hypertens Rep 2003;5(5):380-5.
16. Sharabi Y, Dagan Y, Grossman E. Sleep apnea as a risk factor for hypertension. Curr Opin Nephrol Hypertens 2004;13(3):359-64.
17. Peppard PE, Young T, Palta M, Skatrud J. Prospective study of the association between sleep-disordered breathing and hypertension. N Engl J Med 2000;342(19):1378-84.
18. Nieto FJ, Young TB, Lind BK, Shahar E, Samet JM, Redline S, et al. Association of sleep-disordered breathing, sleep apnea, and hypertension in a large community-based study. Sleep Heart Health Study. JAMA 2000;283(14):1829-36.
19. Alajmi M, Mulgrew AT, Fox J, Davidson W, Schulzer M, Mak E, et al. Impact of continuous positive airway pressure therapy on blood pressure in patients with obstructive sleep apnea hypopnea: a meta-analysis of randomized controlled trials. Lung 2007;185(2):67-72.
20. Bazzano LA, Khan Z, Reynolds K, He J. Effect of nocturnal nasal continuous positive airway pressure on blood pressure in obstructive sleep apnea. Hypertension 2007;50(2):417-23.
21. Haentjens P, Van Meerhaeghe A, Moscariello A, De Weerdt S, Poppe K, Dupont A, et al. The impact of continuous positive airway pressure on blood pressure in patients with obstructive sleep apnea syndrome: evidence from a meta-analysis of placebo-controlled randomized trials. Arch Intern Med 2007; 167(8):757-64.
22. Okabe S, Hida W, Kikuchi Y, Taguchi O, Ogawa H, Mizusawa A, et al. Role of hypoxia on increased blood pressure in patients with obstructive sleep apnea. Thorax 1995; 50(1):28-34.
23. Ali NJ, Davies RJ, Fleetham JA, Stradling JR. The acute effects of continuous positive airway pressure and oxygen administration on blood pressure during obstructive sleep apnea. Chest 1992;101(6):1526-32.