



The Effect of Obstructive Sleep Apnea on Violent and Non-violent Behavior*

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ABSTRACT

Aim: Obstructive sleep apnea (OSA) characterized by repetitive collapse of the upper airway during sleep and this condition leading to oxygen desaturation, sympathetic activation, and recurrent arousals. Patients who experience sleep problems consider themselves, less able to control impulsive, aggressive tendencies. The aim of this study was to investigate the effect of OSA and daytime sleepiness on violent and non-violent behaviors.

Material and Methods: Hundred fifty individuals who were admitted to the Chest Disease Polyclinic for Sleep Disorders of Duzce University, School of Medicine Hospital were included in the study. All patients underwent polysomnography (PSG). All tests [Beck Depression Inventory (BDI), Beck Anxiety Inventory (BAI), Epworth Sleepiness Scale (ESS) and Nonviolent and Violent Offending Behavior Scale (NVOBS)] were applied to all participants by face to face interview.

Results: In this study, no significant relationship was found between NVOBS and AHI in OSA patients. Patients with OSA; There was a significant relationship between total score of NVOBS and ESS ($r=0.267$ $p=0.003$). There was a significant relationship between the ESS score and the BDI score ($r=0.314$ $p < 0.001$) and BDI scale ($r=0.319$ $p < 0.001$) scores.

Conclusions: There was no significant relationship between violent and non-violent behaviors and AHI. However, there was a significant relationship between ESS and BDI, BAI and NVOBS. There may be common neurophysiological activation mechanisms of sleep and violence action. Today, violent behavior and sleep problems increase and further research is needed to investigate the relationship between sleep problems and violent behavior.

Keywords: Daytime sleepiness; obstructive sleep apnea; violent behavior.

Obstrüktif Uyku Apnesi'nin Şiddet İçeren ve İçermeyen Davranışlar Üzerine Etkisi

ÖZ

Amaç: Obstrüktif uyku apne (OUA) üst hava yollarının uyku sırasında daralması ile karakterizedir ve bu durum oksijen desaturasyonu, sempatik aktivasyon, tekrarlayan arousallara neden olur. Uyku problemi yaşayan insanların kendilerini agresif eğilimleri olan ve dürtüselliklerini daha az kontrol edebilen kişiler olarak düşünürler. Bu çalışmanın amacı OUA ve gündüz uykululuk halinin, şiddet içeren ya da içermeyen davranışlar üzerine etkilerini araştırmaktır.

Gereç ve Yöntemler: Düzce Üniversitesi Tıp Fakültesi Hastanesi Göğüs Hastalıkları Polikliniğine uyku bozuklukları nedeniyle başvuran 150 kişi çalışmaya dâhil edildi. Tüm hastalara polisomnografi (PSG) yapıldı. Tüm diğer testler [Beck depresyon ölçeği (BDÖ), Beck anksiyete ölçeği (BAÖ), Epworth uykululuk skalası (EUS) ve Şiddet içeren ve içermeyen suç davranışları ölçeği (ŞİSDÖ)] katılımcılarla yüz yüze görüşme ile yapıldı.

Bulgular: Bu çalışmada OUA hastalarında ŞİSDÖ ile apne-hipopne indeksi (AHI) arasında anlamlı bir ilişki saptanmadı. OUA'lı hastalarda toplam ŞİSDÖ skoru ile EUS arasında anlamlı bir ilişki bulundu ($r=0,267$ $p=0,003$). EUS ile BDÖ skoru ($r=0,314$ $p < 0,001$) ve BAÖ skalası skoru ($r=0,319$ $p < 0,001$) arasında anlamlı bir ilişki vardı.

Sonuç: AHI ile şiddet içeren ve şiddet içermeyen davranışlar arasında bir ilişki yoktu. Bununla birlikte ESS ile BDÖ, BAÖ, ŞİSDÖ arasında anlamlı bir ilişki vardı. Uyku ve şiddet davranışlarının ortak nörofizyolojik bir mekanizması olabilir. Çalışmamız gündüz uykululuk halinin artmasıyla şiddet eğiliminin arttığını göstermiştir.

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Uyku problemleri ile şiddet davranışlarının arasındaki ilişkiyi araştırmak için ileri çalışmalara ihtiyaç vardır.

Anahtar Kelimeler: Gündüz uyukluluk hali; obstrüktif uyku apne; şiddet davranışı.

INTRODUCTION

Obstructive sleep apnea (OSA) characterized by repetitive collapse of the upper airway during sleep and this condition leading to oxygen desaturation, sympathetic activation, and recurrent arousals. Previous studies point out that OSA is associated with high morbidity and mortality and indicate a causal relationship between OSA and many diseases including cardiovascular disease, diabetes mellitus, and neurocognitive dysfunction (1,2). OSA is common among general population (1). It was considered that OSA affects about 13% of the male and 7-9% of the female population (3).

Violence is defined as the intentional use of physical force or power, threatened or actual, against oneself, another person, or against a group or community, that either results in or has a high likelihood of resulting in injury, death, psychological harm, maldevelopment, or deprivation by the World Health Organization. Violence can comprises of murder, torture, coup, strike and effective action, war, terror, oppression, intimidation, threat, blackmail etc. all behaviors. Violence can easily be distinguished as a physical attack. Almost everything can be perceived as violence when the rules are violated (4).

The concept of crime includes violent and non-violent crime behaviors. Offenses including violence are crimes aimed at damaging a person's physical integrity. Offenses that do not include threats and attacks against any victim, such as theft, robbery, fraud, forgery, stolen property, rape, arson, prostitution, possession or sale of illegal drugs, damage to public order (crimes against property or community order); defined as non-violent crimes (5-8).

The aim of this study was to investigate the effect of OSA and daytime sleepiness on violent and non-violent behaviors. In the literature, there are few studies investigating the relationship between sleep problems and violent behavior. Today, violent behavior and sleep problems increase and further research is needed to investigate the relationship between sleep problems and violent behavior.

MATERIAL AND METHODS

Study group

Hundred fifty individuals who were admitted to the Chest Disease Polyclinic for Sleep Disorders of Duzce University, School of Medicine Hospital were included in the study. All patients underwent polysomnography (PSG). All tests (Beck Depression Inventory, Beck Anxiety Inventory, Epworth Sleepiness Scale and Nonviolent and Violent Offending Behavior Scale) were applied to all participants by face to face interview. Informed consent was obtained from all study participants. The permission was obtained from our institutional ethics committee for the use of patient data for publication purposes (Date of Approval: 07.01.2019; Reference number/Protocol No: 2018/258).

Exclusion criteria

Individuals under 18 years of age, pregnant women and patients diagnosed with psychiatric illness were excluded from the study.

Polysomnography

PSG was performed on all patients for a minimum of 6 hours. A PSG digital system was used (Alice 5 Sleep System, Philips, Respironics, Pennsylvania, United States). At the same time electroencephalography, electro-oculography, chin electromyography, oral and nasal airflow (nasal-oral 'thermistor' and nasal cannula), thorax movements, abdominal movements, arterial oxygen saturation (pulse oximetry instrument), electrocardiography and snoring recordings (>6 hours) were obtained from all patients. The same device was used for all of these parameters. All records were scored manually in computer environment. Apnea-Hypopnea Index (AHI) is represented by the number of apnea and hypopnea events per hour of sleep. Patients with AHI of ≥ 5 were diagnosed with obstructive sleep apnea syndrome (OSA). The severity of OSA was considered as follows: normal (AHI of <5); mild sleep apnea (AHI of 5-15); moderate sleep apnea (AHI of 16-30); and severe sleep apnea (AHI of >30) (9).

Non-Violent and Violent Offending Behavior Scale (NVOBS)

It is a 7-point Likert-type scale developed by Thornton et al. (2013) under the name "Non-Violent and Violent Offending Behavior Scale". It consists of totally 33 items and 3 sub-titles. As a result of exploratory factor analysis, a three-factor structure, "Violence in Close Relationship", "General Violence" and "Non-Violent Crimes" was obtained (10). Turkish validity and reliability were obtained by Merve Koçak et al. (8). All items rated between '0' to '6'. 0 (never done), 1 (I did 1 time in the last year), 2 (I did 2 times in the last year), 3 (I did 3-5 times in the last year), 4 (6-10 times in the last year) I have done), 5 (I have done 11-20 times in the last year) and 6 (I have done more than 20 times in the last year). The scores of each sub-factor are collected within itself and the total score of that sub-factor is obtained. The total score of the crime type can be obtained by summing the sub-factors including violent and non-violent crime behaviors. Individuals are expected to respond by considering the last year of their life. Increased scores indicate that the frequency of criminal behavior increases (10).

Beck Depression Inventory (BDI)

It measures physical, emotional, cognitive and motivational symptoms which seem in depression. The aim of the scale is not to diagnose depression, but to determine the level and severity of depression symptoms. BDI is a scale consisting of 21 self-assessment sentences and each item consists of 4 options. Each item is scored between 0-3 and the total score varies between 0-63 (11). A validity and reliability study was performed in Turkey. The cut-off point of the Turkish form was determined as 17 (12).

Beck Anxiety Inventory (BAI)

This test measures the prevalence of anxiety symptoms experienced by an individual. BAI, which is based on self-report, consists of 21 items, each item is scored between 0 and 3 and the total score varies between 0 and

63. The severe of anxiety increases when the score increases (13). The validity and reliability study of Turkey was performed by Ulusoy et al. (14).

The Epworth Sleepiness Scale (ESS)

ESS is a validated test includes 8 items and measures daytime sleepiness. It is a 24-point scale, and higher scores representing greater levels of sleepiness. This scale can distinguish the sleepiness level of OSA patients from normal (15). Agargün et al. (16) made this scale's reliability and validity of the Turkish version. Forty patients with primary hypersomnia and 41 healthy control subjects were included in their study. Internal homogeneity of separate items was assessed using Cronbach's a statistic and Pearson correlation analysis. Test-retest reliability was assessed with paired t tests and Pearson correlation analysis. Validity was assessed using Student's t test. The questionnaire had a high level of internal consistency (Cronbach's $\alpha=0.80$). Paired t tests showed no significant differences between two different occasions. Total and item scores differed significantly between patient and control groups. They concluded that the ESS is a simple and reliable method for measuring persistent daytime sleepiness and may be used in sleep researches in Turkish population (17).

Definitions of various terms are shown in the Box (11,13,15,18-20).

Box: Definitions of various terms used in this study.

Apnea: Complete lack of airflow through the mouth and nose for ≥ 10 seconds.

Hypopnea: 30% Reduction of airflow for ≥ 10 seconds, along with 3% decrease in oxygen saturation or leading to arousal.

Apnea-hypopnea index (AHI): The ratio of the total duration of apnea and hypopnea observed during sleep to total length of sleep.

Severity of obstructive sleep apnea syndrome: When evaluated based on apnea-hypopnea index (AHI):

Normal: AHI <5 /hour

Mild sleep apnea: AHI 5-15/hour

Moderate sleep apnea: AHI 6-30/hour

Severe sleep apnea: AHI >30 /hour

OSA: Obstructive sleep apnea

NVOBS: Non-Violent and Violent Offending Behavior Scale

BDI: Beck Depression Inventory:

BAI: Beck Anxiety Inventory

ESS: The Epworth Sleepiness Scale

EDS: Excessive Daytime Sleepiness

Statistical analysis

SPSS 22 was used for statistical evaluation. Appropriate descriptive statistics (mean, standard deviation, median, interquartile range, minimum, maximum, percentage) of all data included in the study were calculated. Kolmogorov Smirnov and Shapiro Wilk tests were used for normality hypothesis control of continuous quantitative variables and Levene test was used for hypothesis control of homogeneity of variances. One-Way ANOVA (post hoc Fisher LSD test) was used for the comparison of the variables that provided parametric test assumptions, and Kruskal-Wallis analysis (post hoc Dunn test) was used for the comparison of the variables

that did not provide parametric test assumptions. Spearman Correlation and Nonparametric Partial Correlation analyzes were used to determine the relationship between quantitative variables. Pearson Chi-square and Fisher-Freeman-Halton (post hoc Bonferroni test) tests were used to compare categorical variables. Chi-square test (post hoc z ratio test with Bonferroni correction) was used for ratio comparison. $p<0.05$ was considered statistically significant.

RESULTS

Of the 150 individuals included in the study, 65.3% were male and the mean age was 47.3 ± 11.5 (18-76). It was found that 58.7% of these individuals had additional disease and from those diseases heart disease (18.7%) were the most common and neurological disease (6%) were the least common additional diseases. Dermographical and clinical characteristics of individuals according to OSA severity and comparison results are given in Table 1.

According to the severity of OSA, there was no significant difference between the ratio distributions of presence of additional disease, presence of lung disease, presence of heart disease, presence of neurological disease, presence of thyroid disease ($p> 0.05$ for each Table 1).

The rate distribution of ESS according to OSA severity was significantly different ($p=0.003$). In patients with severe OSA, the rate of ESS (67.2%) was significantly higher than in normal (29.2%) and moderate (35.5%) OSA patients ($p<0.05$).

There was no significant difference in terms of beck depression scale scores, beck anxiety scale scores, epworth scale score, NVOBS total and NVOBS close violence, general violence and non-violent crimes subscale scores according to OSA severity ($p> 0.05$ Table 2 for each).

Patients with severe OSA; There was no significant relationship between AHI and the NVOBS total ($r=0.062$ $p=0.642$), NVOBS close violence ($r=0.054$ $p=0.684$), general violence ($r=0.092$ $p=0.488$) and non-violent crimes ($r=-0.077$ $p=0.562$) scale scores.

Patients with OSA; There was a significant relationship between total score of NVOBS and ESS ($r=0.267$ $p=0.003$) while there was not a significant relationship between BDI scale ($r = 0.107$ $p=0.235$) and BAI scale ($r=0.096$ $p=0.287$) scores. There was a significant relationship between NVOBS close violence subscale score and ESS ($r=0.225$ $p=0.011$) while there was not a significant relationship between BDI scale ($r=0.075$ $p=0.407$) and BAI ($r=0.079$ $p=0.378$) scores. There was a significant relationship between NVOBS general violence subscale score and ESS ($r=0.243$ $p=0.006$), while there was not a significant relationship between BDI scale ($r=0.142$ $p=0.112$) and BAI scale ($r=0.140$ $p=0.109$) scores.

In addition, there was a significant relationship between the ESS score and the BDI score ($r=0.314$ $p<0.001$) and BDI scale ($r=0.319$ $p<0.001$) scores.

Table 1. Dermographical and clinical characteristics of individuals according to OSA severity and comparison results

	OSA SEVERITY										p
	NONE		Mild		Moderate		Severe		Total		
	n	%	n	%	n	%	n	%	n	%	
Gender											0.030 [#]
Male	11	45.8	16	44.4	13	41.9	12	20.3	52	34.7	
Female	13	54.2	20	55.6	18	58.1	47	79.7	98	65.3	
Total	24	100.0	36	100.0	31	100.0	59	100.0	150	100.0	
Comorbidities											0.179 [#]
No	14	58.3	11	30.6	14	45.2	23	39.0	62	41.3	
Yes	10	41.7	25	69.4	17	54.8	36	61.0	88	58.7	
Total	24	100.0	36	100.0	31	100.0	59	100.0	150	100.0	
Lung Diseases											0.169 [‡]
No	20	83.3	26	72.2	28	90.3	52	88.1	126	84.0	
Yes	4	16.7	10	27.8	3	9.7	7	11.9	24	16.0	
Total	24	100.0	36	100.0	31	100.0	59	100.0	150	100.0	
Heart Diseases											0.084 [#]
No	23	95.8	31	86.1	25	80.6	43	72.9	122	81.3	
Yes	1	4.2	5	13.9	6	19.4	16	27.1	28	18.7	
Total	24	100.0	36	100.0	31	100.0	59	100.0	150	100.0	
Neurological Disease											0.384 [‡]
No	22	91.7	34	94.4	31	100.0	54	91.5	141	94.0	
Yes	2	8.3	2	5.6	0	0.0	5	8.5	9	6.0	
Total	24	100.0	36	100.0	31	100.0	59	100.0	150	100.0	
Thyroid disease											0.088 [‡]
No	19	79.2	35	97.2	26	83.9	54	91.5	134	89.3	
Yes	5	20.8	1	2.8	5	16.1	5	8.5	16	10.7	
Total	24	100.0	36	100.0	31	100.0	59	100.0	150	100.0	
Age*	38.8±13.2 [18-65]		48.2±10.4 [27-72]		47.8±10.2 [28-65]		49.9±10.8 [27-76]		47.3±11.5 [18-76]		0.001 ^{&}
BMI**	26 (4.9) [21-35.4]		31.1 (7.1) [24-49]		30 (8) [19-49.6]		32 (7) [24-52]		31 (7) [19-52]		<0.001 ^Ω

*mean±standard deviation [minimum-maximum]. ** median (Interquartile Range) [minimum-maximum]. [#] Pearson Chi-square test, [‡] Fisher-Freeman-Halton test, [&] One Way ANOVA, ^Ω Kruskal-Wallis analysis, OSA: Obstructive sleep apnea BMI: Body Mass Index

Table 2. Descriptive statistics and comparison results of scale scores used in the study according to OSA severity

		OSA SEVERITY					p
		None (n=24)	Mild (n=36)	Moderate (n=31)	Severe (n=59)	Total (n=150)	
NVOBS close violence subscale	Mean±SD	0.21±0.66	0.39±1.29	0.29±0.46	0.44±0.82	0.36±0.88	0.098
	Median (IQR)	0 (0)	0 (0)	0 (1)	0 (1)	0 (0)	
	Min-Max	[0-3]	[0-6]	[0-1]	[0-5]	[0-6]	
NVOBS general violence subscale	Mean±SD	0.46±1.47	0.97±4.07	0.94±3.57	0.39±0.89	0.65±2.68	0.460
	Median (IQR)	0 (0)	0 (0)	0 (1)	0 (1)	0 (0)	
	Min-Max	[0-7]	[0-24]	[0-20]	[0-6]	[0-24]	
NVOBS non-violent crimes subscale	Mean±SD	0	0.08±0.28	0	0.02±0.13	0.03±0.16	0.105
	Median (IQR)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
	Min-Max	0	[0-1]	0	[0-1]	[0-1]	
NVOBS Total score	Mean±SD	0.67±1.66	1.44±4.67	1.23±3.59	0.85±1.39	1.04±3	0.415
	Median (IQR)	0 (0)	0 (0)	0 (2)	0 (2)	0 (1)	
	Min-Max	[0-7]	[0-26]	[0-20]	[0-7]	[0-26]	
Beck Depression Inventory score	Mean±SD	12.5±8.35	15.78±11.9	13.71±8.77	14.54±8.09	14.34±9.28	0.686
	Median (IQR)	11 (8.5)	13 (15)	12 (13)	14 (11)	13 (13)	
	Min-Max	[1-29]	[0-54]	[0-33]	[0-44]	[0-54]	
Beck Anxiety Inventory score	Mean±SD	14.79±8.69	19.08±14.79	18.45±10.74	19.41±11.77	18.39±11.95	0.500
	Median (IQR)	14.5 (12)	15 (22.5)	18 (16)	18 (18)	17 (16)	
	Min-Max	[1-34]	[0-53]	[0-42]	[1-248]	[0-53]	
Epworth Sleepiness Scale scores	Mean±SD	8.33±5.52	9.08±5.79	7.61±5.58	10.68±5.42	9.29±5.64	0.051
	Median (IQR)	7 (7)	8 (8.5)	6 (10)	10 (10)	9 (9)	
	Min-Max	[2-24]	[0-20]	[0-18]	[1-21]	[0-24]	

OSA: Obstructive sleep apnea NVOBS: Non-Violent and Violent Offending Behavior Scale, SD: Standard Deviation, IQR: Interquartile Range, Min-Max: Minimum-Maximum

DISCUSSION

In this study, no significant relationship was found between NVOBS and AHI in OSA patients. There was a significant relationship between NVOBS and ESS. There was a significant relationship between ESS and BDI and BAI. It was founded a significant relationship between NVOBS subgroups close and general violence and ESS but no significant relationship between NVOBS subgroups close and general violence and BDI, BAI was founded.

Sleep-wake cycle; occurs depending on the biological rhythm. Circadian rhythm is decisive in this cycles occurrence by the repetition of the 24-hour stages. Circadian rhythm is regulated by the suprachiasmatic nucleus in the anterior hypothalamus. The most powerful stimulus involved in the formation of this rhythm is sunlight. The effect of light stimuli on the suprachiasmatic nucleus is achieved by retinal photoreceptors. Another function that occurs due to these stimuli is melatonin synthesis. Melatonin is secreted due to the rhythmic activity of the suprachiasmatic nucleus and reaches its highest level in the dark, regulating the activity of this nucleus with feedback mechanism. The absence of light changes the neuroendocrine regulation in the hypothalamus and the suppression and secretion of some hormones including especially melatonin, contributes to the initiation of sleep (21-23). Hypothalamic-Pituitary-Adrenocortical (HPA) changes are also associated with aggressive behavior (24).

It has been suggested that prefrontal cortex, temporal cortex, insula, amygdala, hippocampus / parahippocampus, anterior-posterior cingulate gyrus have structural and functional abnormalities in individuals who are antisocial and criminal. The brain region that associates mostly with violence and antisocial behavior is prefrontal cortex (25).

There are many studies about relationship between sleep and criminal behavior. Meijers et al. (26) conducted a study in 19 male prisoners with psychotic illness and showed that nocturnal restlessness was a significant predictor of aggression/agitation. Positive relationship between nocturnal restlessness and aggressive behaviour might be causal, as sleep deprivation results in reduced functioning of the prefrontal cortex, that is crucial to the inhibition of aggression.

Researchers think that sleep loss seems to reduce affective stability and increase emotional reactivity. Patients who experience sleep problems consider themselves, less able to control impulsive, aggressive tendencies. Kamphuis et al. (27) examined the relationship between poor sleep, impulsivity and aggression in forensic psychiatric patients. They showed that worse sleep quality and higher insomnia scores were significantly associated with aggression and impulsivity, clinicians rated hostility and involvement in aggressive incidents within the facility. There are also studies suggest that the relationship between sleep and aggression (28). Stress results in impaired sleep and daytime sleepiness (29).

Raine et al. (30) assessed whether daytime subjective sleepiness is a risk factor for crime. Adolescents who reported being more sleepy during day time were more

antisocial and were 4.5 times more likely to go on to become convicted criminals in adult.

There are studies investigating the relationship between depression and ESD (31-35). David T. Plante et al. (36) demonstrate a significant longitudinal association between increased subjective EDS and depression. Julio Fernandez-Mendoza et al. (37) investigated the relationship between EDS and obesity, weight loss and depression and founded a relationship between EDS and depression. In this study, we also found a significant relationship between ESS and BDS scores.

Question 'Do the sleep affects the delinquency' was assessed in a study. 516 maltreated children in foster care, ages 9–11 years were included study. Adverse childhood experiences and community violence exposure were assessed. All participants have at least one adverse childhood experiences. Sleep problems were measured with the Child Behavior Checklist. Delinquency acts were measured with 5 questions from the Adolescent Risk Behaviors Scale It was showed that sleep partially mediated the association between adverse childhood experiences and delinquency (38).

A study was performed to investigate the effect of OSA on crime. Ten sex offenders who were diagnosed with OSA and under continuous positive airway pressure (CPAP) treatment were included to this study. They compared the Buss-Perry Aggression Questionnaire before and after CPAP treatment and founded that after treatment scores were significantly lower. After treatment the subscales about anger, physical aggression, hostility, and verbal aggression were lower too. In this study, a correlation was found between BDI and OSA in OSA patients.

Even though it is a limitation that scales cannot diagnose definitively, we think that it contributes to the literature in terms of revealing the relationship between violent and non-violent behaviors and sleep disorders.

CONCLUSION

Do sleep problems predispose crime, or does antisocial behavior result in sleep disorder? In the planning phase of this study; it was the aim of the study to evaluate the tendency of violence in patients with sleep-disordered breathing. There was no significant relationship between violent and non-violent behaviors and AHI. However, there was a significant relationship between ESS and BDI, BAI and NVOBS. There may be common neurophysiological activation mechanisms of sleep and violence action. Today, violent behavior and sleep problems increase and further research is needed to investigate the relationship between sleep problems and violent behavior.

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