# Is there any relationship between the time spent in respiratory events and cardiovascular morbidity in obstructive sleep apnea patients?

Dilber Yilmaz Durmaz<sup>1</sup>, DAygul Gunes<sup>2</sup>, DTekin Yildiz<sup>3</sup>

<sup>1</sup>Clinic of Pulmonary Disease, Bandirma State Hospital, Balikesir, Turkey

<sup>2</sup>Department of Neurology, Bursa Yuksek Ihtisas Education and Research Hospital, Bursa, Turkey

<sup>3</sup>Department of Pulmonary Diseases, Sureyyapasa Pulmonary Disease and Pulmonary Surgery Training and Research Hospital, Istanbul, Turkey

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#### Abstract

**Aim:** The importance of the duration of respiratory events, in addition to the number, in the evaluation of obstructive sleep apnea (OSA) is gradually increasing. We aimed to investigate whether parameter including the number and duration of respiratory events predict cardiovascular mortality.

**Material and Methods:** A retrospective study included 200 patients with OSA (100 severe, 50 moderate, 50 mild). Time spent during respiratory events, including the number and duration of respiratory events, was calculated for each respiratory event. Obstructive apnea time (OAT), hypopnea time (HT), total apnea time (TAT), and total respiratory event time (TRET) were obtained. The relationship between cardiovascular diseases of the patients and the time spent during respiratory events was examined.

**Results:** There was no relationship between the cardiovascular diseases and the time spent during respiratory events in the mild, moderate and all OSA group; however, the prolonged OAT (p=0.024) and TAT (p=0.039) in the severe OSA group were associated with an increase in the cardiovascular diseases, independent of other variables. However, the relationship between apnea-hypopnea index (AHI) and cardiovascular diseases in mild, moderate, severe, and all OSA was not significant.

**Conclusion:** Using parameters including the duration of respiratory events in addition to AHI may be more useful to understand the comorbidities of OSA particularly cardiovascular diseases.

Keywords: Cardiovascular disease; duration; obstructive sleep apnea; respiratory event

## **INTRODUCTION**

Obstructive sleep apnea (OSA) is a sleep disorder characterized by the repetitive partial or complete collapse of the upper airway, leading to transient hypoxemia and arousals during sleep. It is a common disorder, with prevalence estimated at 10-17% for men and 3-9% for women; associated with excessive daytime sleepiness, increased overall morbidity, and mortality (1). Apnea-hypopnea index (AHI) has been used as the main parameter to diagnose and classify the severity of the disease; defined as the average number of respiratory events per hour of sleep, regardless of the duration of the event. In recent years, studies evaluating the contribution of the duration of respiratory events in addition to the number of respiratory events in OSA have been carried out (2-9).

Cardiovascular diseases are common in the general population worldwide. It was estimated to result in 17.3

million deaths worldwide in 2012 and 2013, a number that is expected to be 23.6 million by 2030 (10). OSA has been associated with many different forms of cardiovascular diseases including hypertension, stroke, heart failure, coronary artery disease, and atrial fibrillation (11). One of the reasons for differences in cardiovascular diseases, non-cardiovascular morbidities, mortality, and response to therapy could be various respiratory event durations in OSA patients with the same severity. However, the number of studies examining the relationship between duration of respiratory events and cardiovascular morbidity in OSA is limited (8,12-14).

We hypothesized that there may be a relationship between the time spent during respiratory events and cardiovascular morbidity in OSA patients. So in this study, we aimed to evaluate the parameter "time spent during respiratory events" (second/hour) which includes the number and duration together, separately for each respiratory event;

Received: 17.07.2020 Accepted: 05.10.2020 Available online: 21.10.2020 Corresponding Author: Dilber Yilmaz Durmaz, Clinic of Pulmonary Disease, Bandirma State Hospital, Balıkesir, Turkey E-mail: drdilberyilmaz@gmail.com evaluated with the polysomnographic sleep parameters and cardiovascular morbidity in OSA patients.

## **MATERIAL and METHODS**

#### **Patients and Study Design**

A retrospective clinical study included 200 OSA patients (100 severe, 50 moderate, 50 mild) who were >18 years of age and who were followed up in the sleep center. The diagnosis of OSA by PSG was supported by the American Academy of Sleep Medicine (AASM). Demographic parameters were extracted from the patient medical records. The Ethics Committee approved the study protocol (2011-KAEK-25 2019/10-24).

#### Polysomnography

PSG in the sleep laboratory included continuous electroencephalographic (EEG) polygraphic recording using EEG leads, the use of right and left electrooculographic leads, and chin electromyography for sleep staging. Electrocardiography (ECG) monitoring during sleep, airflow measurement at the nose and mouth, chest and abdominal respiratory movements were measured during sleep. Arterial oxygen saturation was measured with pulse oximetry. All sleep studies were interpreted according to the manual of the AASM for the Scoring of Sleep, by certified sleep physicians. Apnea was identified when the airflow amplitude in the nasal cannula was <10% of baseline and when no flow occurred on the oral airflow sensor (thermistor). Hypopneas was identified when the amplitude of the airflow was reduced by 30% from the baseline, the event was followed by 4% desaturation. The AHI was defined as the total number of apnea and hypopnea events per hour of sleep. Oxygen desaturation index (ODI) represents the average number of desaturation events (4%) per hour of sleep.

### **Time Spent in Respiratory Events**

The mean obstructive apnea duration (MOAD), mean total apnea duration (MTAD), mean hypopnea duration (MHD), and the number of each respiratory event were multiplied for each respiratory event separately and divided by the total sleep time. So the time spent during each respiratory event (second/hour); obstructive apnea time (OAT), hypopnea time (HT), total apnea time (TAT), and total respiratory event time (TRET) were obtained.

### Cardiovascular Diseases

Cardiovascular diseases of the patients were retrospectively screened from the medical record system. Hypertension, heart failure, cardiac arrhythmias, and ischemic heart diseases were included.

#### **Statistical Analysis**

Data were expressed as the mean ± standard deviation (SD) or the median (interquartile range). The relationship between times spent in respiratory events (OAT, TAT, HT, TRET) and independent predictive variables were analyzed using linear regression with the enter method. Data were analyzed using IBM SPSS statistics 22.0 (SPSS Inc., Chicago, IL, USA). The value of p<0.05 was considered statistically significant

## RESULTS

This retrospective study included 200 OSA patients. The demographic characteristics of the study population were summarized (Table 1). Times spent in respiratory events with polysomnographic parameters and blood oxygenation parameters were evaluated (Table 2).

Time spent in respiratory events and presence of the cardiovascular diseases were evaluated (Table 3). There was no relationship between the cardiovascular diseases and the time spent during respiratory events in the mild, moderate and all OSA group; however, the prolonged OAT (p=0.024) and TAT (p=0.039) in the severe OSA group were associated with an increase in the cardiovascular diseases, independent of other variables. No association was found between AHI and cardiovascular diseases in mild, moderate, severe, and all OSA.

Table 1. Demographic	characteristics of the stu	dy population				
	Mild OSA	Moderate OSA	Severe OSA	Total	Test value	р
Age (mean±SD)	44.6±10.3	50.0±11.6	51.35±11.4	49.3±11.5	6.181*	0.002
Gender (M/F)	21/29	28/22	65/35	114/86	7.222**	0.027
Height cm	162.5 (150-195)	167.4±9.1	168.9±8.5	167.5 (148-195)	9.494#	0.009
Weight kg	80.5(55-155)	86.2±13.1	93.5(70-145)	86 (55-155)	26.086#	<0.001
BMI kg/m²	28.7 (22-61)	30.0(23-42)	32.75(22-54)	30.5 (22-61)	13.324#	0.001
AHI	8.9(5.1-14.9)	21.1(15.5-29.8)	60.9 (33.3-131.6)	31.6 (5.1-131.6)	167.916#	<0.001
OAT (sec/hr)	25.6(0-162.0)	84(0-541.7)	756.8(4.4-2792.4)	180.9 (0-2792.4)	116.684#	<0.001
TAT (sec/hr)	33.4(0-162)	99.7(0-546.5)	847.5 (4.4-2792.4)	192.2 (0-2792.4)	117.404#	<0.001
HT (sec/hr)	207.7±129.5	434.7±164.2	360.6(0-1372.9)	327.9 (0-1372.9)	32.825#	<0.001
TRET (sec/hr)	219.6(99.8-517.5)	578.1±155.0	1304.2(457.4-2794.4)	719.1 (99.8-2794.4)	153.52 <sup>6#</sup>	<0.001

SD: standard deviation. BMI: body mass index, AHI: apnea hypopnea index, OAT: obstructive apnea time, TAT: total apnea time, HT: hypopnea time, TRET: total respiratory event time. Values represent median (min-max). \*one-way ANOVA \*\*Chi-Square test. . #Kruskal-Wallis test

Attend         Attend         State         Attend         State         Attend         State         Attend         State         Attend         State	Table 2. Multiple linear regression analysis models for OAT, TAT, HT and 1	linear regressio	n analysis moo	dels for 0	_	ET as depend	ent variable	es and age, gende	er, BMI, polyse	omnograph	RET as dependent variables and age, gender, BMI, polysomnographic parameters as independent variables	ndependent va	ariables	
CSA serverity pacefinicant points         SSA         pacefinicant points         SSA         pacefinicant points         SSA         pacefinicant points         pacefinitity points         pacefinicant points <th></th> <th></th> <th></th> <th>OAT</th> <th></th> <th></th> <th>TAT</th> <th></th> <th></th> <th>노</th> <th></th> <th></th> <th>TRET</th> <th></th>				OAT			TAT			노			TRET	
Mid GSA 0001 086 001/00100 0015 0023 0165 0173 2569 0367 0155/574 0006 0000 0025     Sevee GSA 0001 0816 0001/0010 0015 0025 0059 0167 0155/574 001 0155/574 001 0155/574     Mid GSA 0001 0816 0001/0017 0180 0349 0171/2014 0100 0000     Sevee GSA 0250 0011 01007/43 036 0371 0201 0231 0230 0391     Mid GSA 0270 0011 01007/43 036 0010 0127/0656 113/473 0222 12337/533 0100 0002     Sevee GSA 0250 0011 01007/43 036 0000 0127/0655 0364 0101 013/95/573 0201 0230 0391     Mid GSA 0270 0012 0010 0010 0010 0010 0017/0656     Mid GSA 0270 0011 0129/0457 0230 0391     Mid GSA 0220 0011 0127/045 036 0010 0127/055 0364 0010 0127/0566 030     Sevee GSA 0230 0011 0129/0457 030 0010 000     Mid GSA 0230 0011 0129/0417 0101 0231 0232 1233     Mid GSA 0011 0220/055 0364 0001 0127/0566 030     Mid GSA 0011 0220/055 0364 0001 0127/0566 0100 000     Mid GSA 0011 0239 0022 0012 010     Mid GSA 0001 0220/055 0001 0017 0134 0101 0234     Mid GSA 0001 0220/055 0001 0035     Mid GSA 0001 0220/055 0001 0037     Mid GSA 0001 0220/055 0001 0037     Mid GSA 0001 0220/055 0000 0057     Mid GSA 0001 0220/055 0001 0037     Mid GSA 0001 0236 0001 01334 0117 258/1149 0001 0738     Sevee GSA 0010 0207002 0001 0354 0001 0334 0117 758/1147 0001 0738     Sevee GSA 0010 0207002 0001 0354 0001 2358 0001 0237     Mid GSA 0001 0236 0001 0238 0001/0011 0334 0117 758/1147 0001 0738     Sevee GSA 0010 02070 000 0353 0001/0011 0334 0117 758/1147 0001 0738     Sevee GSA 0010 02070 000 0353 0001 0235 0134 0003     Sevee GSA 0010 02070 000 0351 0011 0334 0117 758/1147 0001 0738     Sevee GSA 0010 0202 0001 0238 0001/0011 0134 01013     Mid GSA 0001 0258 0001 0253 0104 0003     Sevee GSA 0011 0258 0005 0058 0106     Mid GSA 0011 0259 0001 0238 0001 0238     Mid GSA 0011 0251 0001 0238 0001 0238     Mid GSA 0011 0258 0001 0238 0001 0238     Mid GSA 0011 0238 0001 023     Mid GSA 0011 0258 0001 0001 0011 0011 0011 0011 0011     Mid GSA 0011 0011 0011 0011 0011 0011 0011 00		<b>OSA</b> severity	β coefficient	p value		3 coefficient	p value	95% CI	β coefficient	p value		3 coefficient	p value	95% CI
Matcles         0.001         0.015         0.001         0.011         0.001         0.011         0.011         0.011         0.011         0.011         0.011         0.011         0.011         0.011         0.011         0.011         0.011         0.011         0.011         0.011         0.012         0.011         <	Age	Mild OSA	0.001	0.896	-0.014/0.016	-0.001	0.887	-0.015/0.013	2.904	0.040	0.135/5.674	0.006	0.002	0.002/0.009
Name         Obs         O 001         O 011         O 010         O 011         O 0111         O 0111 <tho 0111<="" th=""> <tho 0111<="" th="">         O 01</tho></tho>		Mod.OSA	0.020	0.051	<0.001/0.040	0.015	0.082	-0.002/0.033	-1.055	0.721	-6.979/4.869	0.001	0.535	-0.002/0.005
Mild CSA         0.007         0.011         0.102/0.133         0.036         0.001         0.011         0.102/0.133         0.013         0.0266         0.001         0.0266/0.131         0.0011         0.001         0.001 <t< th=""><th></th><th>Severe OSA</th><th>0.001</th><th>0.816</th><th>-0.007/0.009</th><th>0.000</th><th>0.916</th><th>-0.008/0.007</th><th>2.629</th><th>0.367</th><th>-3.127/8.384</th><th>-0.001</th><th>0.418</th><th>-0.003/0.001</th></t<>		Severe OSA	0.001	0.816	-0.007/0.009	0.000	0.916	-0.008/0.007	2.629	0.367	-3.127/8.384	-0.001	0.418	-0.003/0.001
Mid CSA         0.223         0.011         0.102/10.123         0.334         0.0021         0.530         0.327         0.011         0.021         0.530           Mod CSA         0.551         0.013         0.102/10.1230         0.334         0.001         0.327/10.536         1.1236         0.113         0.639         0.001         0.556/0.013         0.557/0.013         0.550         0.001         0.556/0.014         0.136         0.001         0.556/0.014         0.136         0.001         0.556/0.014         0.136         0.001         0.556/0.013         0.556/0.014         0.136         0.001         0.556/0.014         0.001         0.556         0.001         0.556/0.014         0.001         0.556/0.014         0.001         0.556/0.014         0.556/0.014         0.018         0.001         0.556/0.014         0.001         0.556/0.013         0.566/0.014         0.738         0.001         0.556/0.014         0.738         0.001         0.001         0.556/0.014         0.738         0.001         0.021         0.001         0.001         0.001         0.001         0.001         0.001         0.001         0.001         0.001         0.001         0.001         0.001         0.001         0.001 <th0.001< th="">         0.001         0.001</th0.001<>		AII OSA	0.007	0.041	0.000/0.014	0.006	0.080	-0.001/0.012	3.060	0.070	-0.250/6.371	0.004	0.002	0.001/0.007
ModGSA         0.051         0.006         0.001/130         0.33         0.001         0.253         0.031         0.001         0.056           r         MIOSA         0.33         0.001         0.056/0.322         0.036         0.011         0.011         0.011         0.011         0.001         0.056         0.0111         0.011         0.0111	Gender	Mild OSA	0.423	0.011	0.102/0.743	0.346	0.022	0.052/0.640	-9.091	0.749	-66.131/47.949	0.036	0.307	-0.034/0.105
Swere CIS         0.024         0.017         0.017         0.016         0.016         0.016         0.016         0.016         0.016         0.016         0.016         0.016         0.016         0.016         0.016         0.016         0.016         0.016         0.016         0.018         0.001         0.220/0.552         0.364         0.001         0.220/0.552         0.001         0.220/0.552         0.001         0.025/0.017         0.018         0.001         0.025/0.017         0.013         0.001         0.025/0.014         0.018         0.001         0.025         0.001 <th0.013< th=""> <th0.010< th=""> <th0.011< t<="" th=""><th></th><th>Mod.OSA</th><th>0.515</th><th>0.050</th><th>&lt;0.001/1.030</th><th>0.394</th><th>0.085</th><th>-0.057/0.845</th><th>-77.373</th><th>0.292</th><th>-223.87/69.131</th><th>0.021</th><th>0.630</th><th>-0.068/0.111</th></th0.011<></th0.010<></th0.013<>		Mod.OSA	0.515	0.050	<0.001/1.030	0.394	0.085	-0.057/0.845	-77.373	0.292	-223.87/69.131	0.021	0.630	-0.068/0.111
n         Mid OSA         0.301         -0.001         0.254         0.001         0.266/-0.015         0.101         0.014         0.103         0.013         0.001         0.728         0.011         0.014         0.105         0.011         0.014         0.105         0.011         0.014         0.105         0.011         0.013         0.011         0.011         0.011         0.013         0.011         0.011         0.013         0.011         0.011 <th0.011< th="">         0.013         0.011</th0.011<>		Severe OSA	0.254	0.012	0.057/0.452	0.316	0.001	0.127/0.505	-112.083	0.137	-260.459/36.293	0.081	0.004	0.027/0.135
**         Midl GSA         -0.035         0.0640.015         -0.035         0.001         0.055         0.001         0.055         0.001         0.055         0.001         0.055         0.001         0.055         0.001         0.055         0.001         0.055         0.001         0.055         0.001         0.055         0.001         0.055         0.001         0.055         0.001         0.055         0.001         0.055         0.001         0.055         0.001         0.556         0.001         0.550         0.001         0.550         0.001         0.550         0.001         0.550         0.001         0.550         0.001         0.551         0.001         0.551         0.001         0.553         0.001         0.733         0.011         0.001         0.553         0.001         0.733         0.011         0.561         0.001         0.733         0.001         0.733         0.001         0.733         0.001         0.733         0.001         0.733         0.001         0.733         0.001         0.733         0.001         0.733         0.001         0.733         0.001         0.733         0.001         0.733         0.001         0.733         0.001         0.733 <th0.001< th="">         0.733</th0.001<>		AII OSA	0.391	<0.001	0.220/0.562	0.364	<0.001	0.206/0.522	-20.884	0.610	-101.49/59.729	0.108	0.001	0.046/0.171
Mol CSA         - 0.004         0.88         - 0.053/0.007         - 0.013         0.553/0.007         - 0.013         0.553/0.007         - 0.013         0.553/0.007         - 0.013         0.033/0.001         0.033         - 0.014         - 2.157/2.433         0.001         0.253           All CSA         - 0.001         0.551         - 0.003/0.002         - 0.001         0.040/-0.101         0.583         - 0.001         0.033/0.001         0.010         0.275         - 0.001         0.277         - 0.001         0.033/0.001         0.033         0.033/0.001         0.033         0.033/0.001         0.033         0.033/0.001         0.033         0.033/0.001         0.033         0.033/0.001         0.033         0.033/0.001         0.033         0.033/0.001         0.033         0.033/0.001         0.033         0.033/0.001         0.033         0.033/0.001         0.033         0.033/0.001         0.033         0.033/0.001         0.033         0.033/0.001         0.033         0.033/0.001         0.033         0.033/0.001         0.031         0.033         0.033/0.001         0.031         0.033/0.001         0.031         0.033/0.001         0.031         0.033/0.001         0.031         0.033         0.033/0.001         0.031         0.033/0.001         0.001         0.033/0.001 <th>BMI kg/m<sup>2</sup></th> <th>Mild OSA</th> <th>-0.035</th> <th>0.022</th> <th>-0.064/-0.005</th> <th>-0.035</th> <th>0.001</th> <th>-0.056/-0.014</th> <th>1.736</th> <th>0.404</th> <th>-2.421/5.892</th> <th>0.001</th> <th>0.728</th> <th>-0.004/0.006</th>	BMI kg/m <sup>2</sup>	Mild OSA	-0.035	0.022	-0.064/-0.005	-0.035	0.001	-0.056/-0.014	1.736	0.404	-2.421/5.892	0.001	0.728	-0.004/0.006
Seree (SA         -0.017         0.017         0.013         0.0334         0.104         -0.1532         0.001         0.173           MIG (SA         -0.001         0.561         -0.00370005         -0.001         0.565         -0.001         0.573           Mid (SA         -0.001         0.561         -0.00370025         -0.001         0.586         -0.001         0.561         -0.0010         0.561         -0.0010         0.586         -0.001         0.586         -0.0010         0.586         -0.0010         0.586         -0.0010         0.586         -0.0010         0.586         -0.0010         0.586         -0.0010         0.586         -0.0010         0.586         -0.0010         0.586         -0.0010         0.586         -0.0010         0.586         -0.0010         0.586         -0.0010         0.586         -0.0010         0.586         -0.0010         0.586         -0.0010         0.586         -0.0010         0.586         -0.0119         0.002         0.586         -0.0100         0.586         -0.0119         0.002         0.006         0.006         0.006         0.001         0.001         0.001         0.001         0.001         0.001         0.001         0.001         0.001         0.001         0.0	1	Mod.OSA	-0.004	0.886	-0.055/0.047	-0.013	0.554	-0.058/0.031	4.984	0.441	-7.961/17.929	0.000	0.953	-0.008/0.008
MIGSA         0.002         0.003/002         -0.001         0.001         0.001         0.055//1.14.1         0.001         0.530           Midd OSA         0.001         0.237         -0.0010         0.037         0.001         0.536         0.000         0.530           Serere OSA         0.001         0.277         -0.001/0001         0.002         0.285         -0.0010         0.336         0.001         0.001         0.773           Serere OSA         0.001         0.277         -0.011/0.001         0.000         0.335         0.265//1.036         0.000         0.536           Serere OSA         0.001         0.377         0.011/0.001         0.000         0.335         0.0237/15         0.000         0.335           Serere OSA         0.001         0.347         0.011/0.012         0.011         0.335         0.273         0.001         0.035         0.001         0.035         0.000         0.335         0.353         0.001         0.035         0.001         0.035         0.001         0.035         0.001         0.035         0.001         0.035         0.001         0.035         0.001         0.035         0.001         0.035         0.001         0.035         0.001         0.001		Severe OSA	-0.017	0.051	-0.033/0.000	-0.017	0.034	-0.033/-0.001	10.394	0.104	-2.195/22.983	0.001	0.828	-0.004/0.005
Mid IOSA         0.001         0.561         -0.003/002         0.001         0.561         -0.003/002         0.001         0.561         0.000         0.560           P(%)         Mid IOSA         0.001         0.571         -0.001/002         0.001         0.571         0.000         0.561           Servere ISA         0.001         0.871         -0.001/002         0.001         0.881         -0.001/002         0.013         0.773         -0.254/0.161         0.000         0.573           P(%)         Mid OSA         -0.010         0.841         -0.001/0022         0.013         0.773         -0.254/0.161         0.000         0.573           Server OSA         0.010         0.841         -0.017/0107         0.001         0.832         -0.017/01017         0.000         0.833         0.000         0.936           Mid OSA         0.017         0.184         -0.017         0.184         -0.017         0.184         -0.017         0.184         -0.017         0.184         -0.016         0.001         0.003         0.013         0.023         0.017         0.023         0.024         0.017         0.003         0.013         0.024         0.017         0.016         0.001         0.001         0.001		AII OSA	-0.020	0.009	-0.036/-0.005	-0.027	<0.001	-0.040/-0.014	10.857	0.001	4.267/17.447	0.001	0.733	-0.004/0.006
ModIOSA         0.002         0.338         0.0007/001         0.000         0.578         0.0007/0010         0.001         0.578           Severe SA         0.001         0.371         0.001/0001         0.003         0.338         0.001/0002         0.156         0.024/0.016         0.000         0.015           Prof SA         0.001         0.371         0.001/0010         0.338         0.001/0010         0.338         0.006         0.035         0.034/0.016         0.006         0.015           Prod GSA         0.010         0.311         0.001/0021         0.003         0.033         0.036         0.338         0.035         0.344/0.916         0.000         0.015           Mod GSA         0.011         0.011         0.011         0.011         0.011         0.011         0.013         0.025         0.035/0.013         0.003         0.035           Mid GSA         0.011         0.011         0.011         0.011         0.011         0.011         0.013         0.023         0.013         0.023         0.013         0.023         0.013         0.023         0.010         0.013           Mid GSA         0.011         0.011         0.011         0.011         0.011         0.011	TST	Mild OSA	-0.001	0.561	-0.003/0.002	-0.001	0.629	-0.003/0.002	0.169	0.441	-0.269/0.607	0.000	0.500	0.000/0.001
Serree GSA         0.001         0.277         -0.001/0.002         0.001         0.005         0.006         0.006           All OSA         -0.001         0.381         -0.001/0.001         0.383         -0.001/0.001         0.383         -0.001         0.001         0.001         0.001         0.001         0.001         0.001         0.001         0.001         0.001         0.001         0.001         0.001         0.001         0.003		Mod.OSA	0.002	0.368	-0.002/0.005	0.002	0.275	-0.001/0.005	0.065	0.899	-0.965/1.095	0.000	0.578	0.000/0.001
MI 0SA         -0.001         0.891         -0.001/0.001         0.004         0.883         -0.001/0.001         0.385         -0.245/0.916         0.000         0.125           P(%)         Mid 0SA         -0.010         0.891         -0.001/0.001         0.004         0.883         -0.0015         0.017         0.0014         0.035         0.005		Severe OSA	0.001	0.277	-0.001/0.002	0.001	0.358	-0.001/0.002	0.136	0.779	-0.828/1.101	0.000	0.016	0.000/0.001
p(%)         Miid GSA         -0.010         0.444         -0.037/0.017         -0.06         0.630         -0.032/0.019         -1.362         0.597         -6.523/3.788         -0.005         0.018         0.001         0.833           Sivere GSA         0.016         0.077         -0.017/0.012         0.001         0.037         -5.382         0.737         -2.154/51.668         0.001         0.833           Sivere GSA         0.017         0.156         -0.017/1.0017         0.143         -0.017/0.017         -5.349         0.556         -0.001         0.934           AllOSA         0.017         0.156         -0.017/0.017         0.013         0.003         0.234         0.001         0.944           Miid OSA         0.017         0.156         -0.017/0.017         0.013         0.003         0.234         0.003         0.944           Miid OSA         0.017         0.186         -0.017/0.017         0.13         0.003         0.234         0.001         0.944           Miid OSA         0.017         0.187         -0.017/0.017         0.134         0.001         0.944         0.001         0.944           Miid OSA         0.017         0.013         0.013         0.013         0.0147 <th></th> <th>AII OSA</th> <th>-0.001</th> <th>0.891</th> <th>-0.001/0.001</th> <th>0.000</th> <th>0.853</th> <th>-0.001/0.001</th> <th>0.336</th> <th>0.256</th> <th>-0.245/0.916</th> <th>0.000</th> <th>0.125</th> <th>0.000/0.001</th>		AII OSA	-0.001	0.891	-0.001/0.001	0.000	0.853	-0.001/0.001	0.336	0.256	-0.245/0.916	0.000	0.125	0.000/0.001
Mod.OSA         0.006         0.860         -0.067/0.080         -0.003         0.773         -0.074/0.055         -2.1554/18.908         -0.001         0.838           Severe OSA         0.016         0.070         -0.017/0.012         0.017         0.013         0.035         0.055         0.001         0.931           eep(%)         Severe OSA         0.017         0.013         0.007         0.025         0.001         0.032         0.001         0.934           Mod.OSA         0.017         0.013         0.013         0.017         0.013         0.001         0.033         0.011           Mod.OSA	REM Sleep(%)	Mild OSA	-0.010	0.444	-0.037/0.017	-0.006	0.630	-0.032/0.019	-1.362	0.597	-6.523/3.798	-0.005	0.119	-0.011/0.001
Severe OSA         0.016         0.070         -0.001/0.012         0.011         0.011         0.013         0.053         0.065         0.003         0.003		Mod.OSA	0.006	0.860	-0.067/0.080	-0.009	0.773	-0.074/0.055	-2.823	0.794	-24.554/18.908	-0.001	0.838	-0.015/0.012
All OSA         0.004         0.568         -0.011/0.019         0.003         0.690         -0.011/0.017         -2.319         0.528         -9.553/4.915         0.003         0.292           Mid OSA         -0.017         0.156         -0.041/0.007         0.013         0.013         5.752         0.216         -1.4726         261001         0.944           Mid OSA         -0.017         0.153         -0.005/0.019         0.006         0.282         -0.005/0.0103         5.752         0.216         -1.4719         2.0031         0.994           Mid OSA         0.001         0.081         -0.052         -0.005/0.013         0.001         0.947         -0.001         0.944         0.001         0.994         0.743         -4.726.261         0.001         0.944           Mod OSA         0.013         0.023         0.0101         0.917         0.013         0.001         0.944         0.001         0.934           Mid OSA         0.011         0.017         0.025         0.002/0.020         0.013         0.001         0.944         0.001         0.944         0.001         0.944           Mod OSA         0.011         0.022         0.002/0.020         0.013         0.017         0.014 <th< th=""><th></th><th>Severe OSA</th><th>0.016</th><th>0.070</th><th>-0.001/0.032</th><th>0.015</th><th>0.071</th><th>-0.001/0.031</th><th>-5.988</th><th>0.350</th><th>-18.645/6.668</th><th>0.005</th><th>0.056</th><th>0.001/0.010</th></th<>		Severe OSA	0.016	0.070	-0.001/0.032	0.015	0.071	-0.001/0.031	-5.988	0.350	-18.645/6.668	0.005	0.056	0.001/0.010
Mild OSA         -0.017         0.150         -0.041/0.007         -0.017         0.133         0.023         0.017         0.2180/1.176         <0.001		AII OSA	0.004	0.568	-0.011/0.019	0.003	0.690	-0.011/0.017	-2.319	0.528	-9.553/4.915	0.003	0.292	-0.003/0.009
Mod GSA         0.015         0.669         -0.054/0.084         0.001         0.970         -0.059/0.062         -1.772         0.860         -21.896/18.352         -0.001         0.994           eep(%)         Severe OSA         0.007         0.253         -0.005/0.019         0.005         0.222         -0.009/0.012         0.897         -0.001         0.991         -0.033         0.111		Mild OSA	-0.017	0.150	-0.041/0.007	-0.017	0.143	-0.039/0.006	2.534	0.277	-2.108/7.176	<0.001	0.944	-0.005/0.006
eep(%)         Severe OSA         0.007         0.263         -0.005/0.019         0.006         0.282         -0.005/0.018         -5.752         0.216         -14.19.19/3.415         0.003         0.111           Mod OSA         0.001         0.807         -0.004/0.012         0.001         0.816         -0.009/0.012         0.884         0.743         -4.72/6.261         0.003         0.013         0.005         0.001         0.931           Mod OSA         0.013         0.013         0.00240.024         0.011         0.012         0.0024         -5.339         0.602         -5.539         0.006         -0.001         0.931           eep(%)         Mid OSA         0.011         0.013         0.002/0.024         0.013         0.0017/0.029         0.006         0.001         0.931         -2.767         0.201         2.0017/0.010         0.001         0.031           eep(%)         Mid OSA         0.011         0.012         0.022/0.022         0.011         0.017/0.013         0.001         0.013         0.001         0.031         0.011         0.011         0.011         0.011         0.017         0.011         0.017         0.011         0.017         0.017         0.014/1755         0.002         0.0101         <	Stage 1	Mod.OSA	0.015	0.669	-0.054/0.084	0.001	0.970	-0.059/0.062	-1.772	0.860	-21.896/18.352	-0.001	0.994	-0.012/0.012
All OSA         0.001         0.807         -0.010/0.012         0.001         0.816         -0.009/0.012         0.816         -0.009/0.012         0.834         0.743         -4.472/6.261         0.004         0.095           eeP(%)         Severe OSA         0.011         0.012         0.012/0.024         0.013         0.002/0.024         0.013         0.022/0.026         0.001         0.011         0.013         0.002/0.026         0.001         0.011         0.011         0.013         0.002/0.026         0.011         0.002/0.026         0.001         0.011         0.011         0.013         0.002/0.026         0.001         0.011         0.011         0.013         0.002/0.026         0.001         0.011         0.012         0.002/0.026         0.001         0.011         0.020/0.021         0.011         0.011         0.001         0.012         0.0111         0.011         0.011 <t< th=""><th>NREM Sleep(%)</th><th>Severe OSA</th><th>0.007</th><th>0.263</th><th>-0.005/0.019</th><th>0.006</th><th>0.282</th><th>-0.005/0.018</th><th>-5.752</th><th>0.216</th><th>-14.919/3.415</th><th>0.003</th><th>0.111</th><th>-0.001/0.006</th></t<>	NREM Sleep(%)	Severe OSA	0.007	0.263	-0.005/0.019	0.006	0.282	-0.005/0.018	-5.752	0.216	-14.919/3.415	0.003	0.111	-0.001/0.006
Mod.OSA         0.023         0.497         -0.045/0.092         0.008         0.782         -0.052/0.068         -5.239         0.602         -25.331/14.913         -0.001         0.931           eep(%)         Severe OSA         0.013         0.022/0.024         0.013         0.0012/0.024         0.013         0.002/0.024         -5.339         0.006         -0.001         0.933           eep(%)         All OSA         0.011         0.013         0.022/0.026         0.014         0.002/0.024         -8.329         0.062         -25.331/14.913         -0.001         0.933           eep(%)         Mid OSA         0.011         0.013         0.002/0.026         0.0147         0.0017         0.026         -5.497         0.566         -5.6391/14.755         -0.002         0.015           eep(%)         Mid OSA         0.021         0.233         -0.017/0.007         0.363         0.767         -2.096/2.823         -0.002         0.015           severe OSA         0.021         0.539         -0.044/0.001         -0.017/0.007         0.363         0.767         -2.096/2.823         -0.002         0.717           Mod.OSA         0.218         0.023         -0.017/0.017         0.363         0.767         -2.16/14.755 <t< th=""><th></th><th>AII OSA</th><th>0.001</th><th>0.807</th><th>-0.010/0.012</th><th>0.001</th><th>0.816</th><th>-0.009/0.012</th><th>0.894</th><th>0.743</th><th>-4.472/6.261</th><th>0.004</th><th>0.096</th><th>-0.001/0.008</th></t<>		AII OSA	0.001	0.807	-0.010/0.012	0.001	0.816	-0.009/0.012	0.894	0.743	-4.472/6.261	0.004	0.096	-0.001/0.008
eep (%)         Severe OSA         0.013         0.002/0.024         0.013         0.002/0.024         0.013         0.002/0.026         -0.001         -7.020/1.485         0.006         -0.001         -0.015         -0.001         -0.015         -0.001         -0.017         0.005         0.011         0.001         0.013         0.002/0.026         -0.001         0.011         0.001         0.001         0.013         0.002/0.018         -2.767         0.201         -7.020/1.485         0.006         -0.001           eep (%)         Mild OSA         0.021         0.233         -0.004/0.001         -0.002         0.151         -2.767         0.201         -7.020/1.485         0.006         -0.001           eep (%)         Mild OSA         0.021         0.233         -0.004/0.001         -0.002         0.233         -0.002/0.023         0.767         -2.065/2.823         -0.002         0.783           severe OSA         -0.001         0.025         -0.024/0.001         -0.002         0.333         -0.021         0.011         0.001         0.012         0.012         0.012         0.012         0.012         0.012         0.012         0.012         0.012         0.012         0.012         0.012         0.012         0.012 <th0< th=""><th>Stage 2</th><th>Mod.OSA</th><th>0.023</th><th>0.497</th><th>-0.045/0.092</th><th>0.008</th><th>0.782</th><th>-0.052/0.068</th><th>-5.239</th><th>0.602</th><th>-25.391/14.913</th><th>-0.001</th><th>0.931</th><th>-0.013/0.012</th></th0<>	Stage 2	Mod.OSA	0.023	0.497	-0.045/0.092	0.008	0.782	-0.052/0.068	-5.239	0.602	-25.391/14.913	-0.001	0.931	-0.013/0.012
HIOSA         0.011         0.013         0.002/0.020         0.011         0.013         0.002/0.026         0.001         0.011/0.007         0.201         -7.020/1.485         0.006         <0.001	NREM Sleep(%)	Severe OSA	0.013	0.023	0.002/0.024	0.013	0.019	0.002/0.024	-8.329	0.052	-16.718/0.059	0.006	<0.001	0.003/0.009
Nile         0.007         0.295         -0.020/0.006         -0.005         0.417         -0.017/0.007         0.363         0.767         -2.096/2.823         -0.002         0.151           Mod.OSA         0.021         0.539         -0.044/0.001         0.005         0.867         -0.056/0.066         -5.497         0.586         -2.057/49/14.755         -0.002         0.788           Severe OSA         -0.001         0.506         -0.044/0.001         -0.017         0.087         -0.017         0.987         -2.151/2.117         0.001         0.953           Severe OSA         -0.001         0.506         -0.002         0.233         -0.004/0.001         -0.017         0.877         -2.166/16.16         -0.002         0.780           Mild OSA         0.218         0.123         -0.062/0.498         0.233         -0.001         0.017         0.486         -1.084/3.811         0.001         0.780           Mild OSA         0.218         0.122         -0.002         0.134         0.203         0.101         -0.017         0.486         -0.017         0.486         -0.017         0.486         -0.176         0.024         -0.021         0.021         0.023         -0.001         0.017         0.246         0.017	Stage 3	AII OSA	0.011	0.013	0.002/0.020	0.010	0.014	0.002/0.018	-2.767	0.201	-7.020/1.485	0.006	<0.001	0.003/0.010
Mod.OSA         0.021         0.539         -0.048/0.001         0.005         0.867         -0.056/0.066         -5.497         0.586         -25.749/14.755         -0.002         0.788           Severe OSA         -0.002         0.273         -0.004/0.001         -0.002         0.238         -0.004/0.001         -0.017         0.987         -2.151/2.117         0.001         0.953           All OSA         -0.001         0.506         -0.005/0.002         -0.002         0.343         -0.001/0.017         0.987         -2.151/2.117         0.001         0.953           Mild OSA         0.218         0.039         0.012/0.424         0.196         0.048         0.002/0.391         -24.077         0.235         -1.084/3.811         0.001         0.953           Severe OSA         0.031         0.122/0.498         0.203         0.101         -0.042/0.448         80.426         0.056         -1.684/3.811         0.001         0.456           Mod.OSA         0.218         0.122/0.493         0.203         0.101         -0.042/0.448         80.426         0.001         -2.5749/14.755         0.001         0.456           Mod.OSA         0.218         0.012/0.448         0.203         0.011         0.015/0.426         0.001	NKEM SIEEP(%)	Mild OSA	-0.007	0.295	-0.020/0.006	-0.005	0.417	-0.017/0.007	0.363	0.767	-2.096/2.823	-0.002	0.151	-0.005/0.001
Severe OSA         -0.002         0.273         -0.004/0.001         -0.017         0.987         -2.151/2.117         0.001         0.953           All OSA         -0.001         0.506         -0.005/0.002         -0.007         0.343         -0.001         0.0567         -0.017         0.987         -2.151/2.117         0.001         0.953           All OSA         -0.001         0.506         -0.005/0.002         -0.007         0.343         -0.007         0.343         -0.017         0.867         -2.151/2.117         0.001         0.780           Mild OSA         0.218         0.239         -0.001         0.027/0.391         -2.4.077         0.235         -64.416/16.261         -0.017         0.486           Mod.OSA         0.218         0.122/0.428         0.191         -0.042/0.052         -19.664         0.050         -160.866/0.013         -0.020         0.425           Severe OSA         0.031         0.012/0.052         0.033         <0.001         0.038/0.080         -18.715 <b>&lt;0.001</b> -0.023 <b>&lt;0.011 0.253 &lt;0.01</b> Mild OSA         0.052         -0.062/0.022         0.033         <0.001         0.038/0.080         -18.715 <b>&lt;0.001</b> -0.023		Mod.OSA	0.021	0.539	-0.048/0.091	0.005	0.867	-0.056/0.066	-5.497	0.586	-25.749/14.755	-0.002	0.788	-0.014/0.011
All 0SA         -0.001         0.506         -0.005/0.002         -0.005/0.002         0.343         -0.005/0.002         0.540         0.465         -1.084/3.811         0.000         0.780           Mild 0SA         0.218         0.039         0.012/0.424         0.196         0.048         0.002/0.391         -24.077         0.235         -64.416/16.261         -0.017         0.486           Mod 0SA         0.218         0.123         -0.062/0.498         0.203         0.101         -0.042/0.448         -80.426         0.050         -160.866/0.013         -0.021         0.425           Severe 0SA         0.031         0.002         0.012/0.050         0.033         <0.001         0.038/0.080         -18.715 <b>-0.01</b> 0.023         -0.001         0.425         -0.021         0.042 <b>-0.021</b> 0.042         -0.021         0.014 <b>-0.021</b> 0.042         -0.021         0.050         -1.084/3.811         0.001         -0.022         -0.017         0.456         -1.084/3.811         0.012         -0.017         0.456         -0.021         -0.017         0.012         -0.012         -0.012         -0.021         -0.014 <b>-0.011</b> -0.014         -0.011         -0.014         -0.011         -		Severe OSA	-0.002	0.273	-0.004/0.001	-0.002	0.238	-0.004/0.001	-0.017	0.987	-2.151/2.117	0.001	0.953	-0.001/0.001
Mild OSA         0.218         0.039         0.012/0.424         0.196         0.048         0.002/0.391         -24.077         0.235         -64.416/16.261         -0.017         0.486           Mod.OSA         0.218         0.123         -0.062/0.498         0.203         0.101         -0.042/0.448         -80.426         0.050         -160.866/0.013         -0.020         0.425           Severe OSA         0.031         0.022         0.032         -0.041         0.033/0.052         -19.664         0.064         -32.733/-6.595         0.014 <b>&lt;0.001</b> All OSA         0.055 <b>&lt;0.001</b> 0.032/0.077         0.059         <0.001         0.015/0.052         -19.664         0.004         -32.733/-6.595         0.014 <b>&lt;0.001</b> All OSA         0.055 <b>&lt;0.001</b> 0.032/0.077         0.059         <0.001         -18.715 <b>&lt;0.001</b> -32.733/-6.595         0.014 <b>&lt;0.001</b> Mild OSA         0.052         0.049         0.032/0.027         0.030         0.239         -18.715 <b>&lt;0.001</b> 29.799/50.630         0.063 <b>&lt;0.001</b> Mod.OSA         0.052 <b>0.049</b> 0.001         0.038/0.017 <b>0.021 20.0</b>		AII OSA	-0.001	0.506	-0.005/0.002	-0.002	0.343	-0.005/0.002	0.640	0.465	-1.084/3.811	0.000	0.780	-0.001/0.002
0.203         0.101         -0.042/0.448         -80.426         0.050         -160.866/0.013         -0.020         0.425           0.033         <0.001         0.015/0.052         -19.664 <b>0.004</b> -32.733/-6.595         0.014 <b>&lt;0.001</b> 0.059         <0.001         0.038/0.080         -18.715 <b>&lt;0.001</b> -28.283/-9.146         0.023 <b>&lt;0.001</b> -0.030         0.239         -0.080/0.021         40.214 <b>&lt;0.001</b> 29.799/50.630         0.063 <b>&lt;0.001</b> -0.031         0.239         -0.080/0.021         40.214 <b>&lt;0.001</b> 29.799/50.630         0.063 <b>&lt;0.001</b> 0.037         0.110         -0.099/0.082         17.802 <b>0.022</b> 2.734/32.870         0.019 <b>&lt;0.001</b> 0.013         <0.011         0.008/0.017         -0.010         0.095         -3.450/3.430         0.016 <b>&lt;0.001</b> 0.025         <0.001         0.021/0.028         1.086         0.077         -0.199/3.811         0.011 <b>&lt;0.001</b> 0.025         <0.010         0.021/0.028         1.086         0.077         -0.199/3.811         0.011 <b>&lt;0.001</b> <th>MOD</th> <th>Mild OSA</th> <th>0.218</th> <th>0.039</th> <th>0.012/0.424</th> <th>0.196</th> <th>0.048</th> <th>0.002/0.391</th> <th>-24.077</th> <th>0.235</th> <th>-64.416/16.261</th> <th>-0.017</th> <th>0.486</th> <th>-0.066/0.032</th>	MOD	Mild OSA	0.218	0.039	0.012/0.424	0.196	0.048	0.002/0.391	-24.077	0.235	-64.416/16.261	-0.017	0.486	-0.066/0.032
0.033       <0.001       0.015/0.052       -19.664       0.004       -32.733/-6.595       0.014       <0.001         0.059       <0.001       0.038/0.080       -18.715       <0.001       -28.283/-9.146       0.023       <0.001         -0.030       0.239       -0.080/0.021       40.214       <0.001       -28.283/-9.146       0.053       <0.001         -0.030       0.239       -0.080/0.021       40.214       <0.001       29.799/50.630       0.063       <0.001         0.037       0.110       -0.099/0.082       17.802 <b>0.022</b> 2.734/32.870       0.019       <0.001         0.013       <0.011       0.0995       -3.450/3.430       0.0106       <0.001         0.025       <0.011       0.0995       -3.450/3.430       0.011       <0.001         0.025       <0.011       0.0995       -3.450/3.431       0.011       <0.001         0.025       <0.011       0.0295       -3.450/3.431       0.011       <0.001         0.025       <0.011       0.0295       0.019/3.811       0.011       <0.001         0.025       <0.011       0.021/0.028       1.086       0.077       -0.199/3.811       0.011       <0.001         .025 </th <th></th> <th>Mod.OSA</th> <th>0.218</th> <th>0.123</th> <th>-0.062/0.498</th> <th>0.203</th> <th>0.101</th> <th>-0.042/0.448</th> <th>-80.426</th> <th>0.050</th> <th>-160.866/0.013</th> <th>-0.020</th> <th>0.425</th> <th>-0.069/0.030</th>		Mod.OSA	0.218	0.123	-0.062/0.498	0.203	0.101	-0.042/0.448	-80.426	0.050	-160.866/0.013	-0.020	0.425	-0.069/0.030
0.059         <0.001		Severe OSA	0.031	0.002	0.012/0.050	0.033	<0.001	0.015/0.052	-19.664	0.004	-32.733/-6.595	0.014	<0.001	0.008/0.019
-0.030         0.239         -0.080/0.021         40.214         <0.001		AII OSA	0.055	<0.001	0.032/0.077	0.059	<0.001	0.038/0.080	-18.715	<0.001	-28.283/-9.146	0.023	<0.001	0.014/0.032
0.037 0.110 -0.009/0.082 17.802 0.022 2.734/32.870 0.019 <0.001 0.013 <0.001 0.008/0.017 -0.010 0.995 -3.450/3.430 0.006 <0.001 0.025 <0.001 0.021/0.028 1.086 0.077 -0.199/3.811 0.011 <0.001 : mean oxygen desaturation, ODI: oxygen desaturation index, OAI: obstructive apnea time, TAT: total apnea time	IQO	Mild OSA	-0.031	0.244	-0.085/0.022	-0.030	0.239	-0.080/0.021	40.214	<0.001	29.799/50.630	0.063	<0.001	0.050/0.076
0.013 <0.001 0.008/0.017 -0.010 0.995 -3.450/3.430 0.006 <0.001 0.025 <0.001 0.021 0.021/0.028 1.086 0.077 -0.199/3.811 0.011 <0.001 0.021 0.021/0.028 0.001 0.017 0.019/3.811 0.011 content of the conte		Mod.OSA	0.052	0.049	0.000/0.105	0.037	0.110	-0.009/0.082	17.802	0.022	2.734/32.870	0.019	<0.001	0.010/0.028
0.025 <0.001 0.021/0.028 1.086 0.077 -0.199/3.811 0.011 <b>&lt;0.001</b> : mean oxygen desaturation, ODI: oxygen desaturation index, OAT: obstructive apnea time, TAT: total apnea time,		Severe OSA	0.012	<0.001	0.007/0.017	0.013	<0.001	0.008/0.017	-0.010	0.995	-3.450/3.430	0.006	<0.001	0.005/0.007
		AII OSA	0.024	<0.001	0.020/0.028	0.025	<0.001	0.021/0.028	1.086	0.077	-0.199/3.811	0.011	<0.001	0.010/0.013
	<b>CI:</b> confidence int	erval, BMI: bod)	r mass index, T	ST: total s		nean oxygen (	desaturatio	n, ODI: oxygen de	esaturation in	lex, OAT: o	bstructive apnea ti	me, TAT: total	apnea tim	Ġ

Table 2. Multiple linear regression analysis models for OAT, TAT, HT and TRET as dependent variables and age, gender, BMI, polysomnographic parameters as independent variables

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	OAT				TAT			HT		1	RET			AHI	
OSA severity	β coefficient	p value	95% CI	β coefficient	p value	95% CI	β coefficient	p value	95% CI	β coefficient	p value	95% CI	β coefficient	p value	95% CI
Mild OSA	-0.135	0.317	-0.405/ 0.135	-0.135	0.317	-0.405/ 0.135	-9.768	0.811	-91.805/ 72.269	-0.051	0.399	-0.172/ 0.070	-0.959	0.346	-2.989/ 1.071
Moderate OSA	0.299	0.116	-0.077/ 0.674	0.230	0.156	-0.092/ 0.552	-20.875	0.680	-122.27/ 80.520	0.010	0.780	-0.064/ 0.085	1.928	0.190	-0.991/ 4.848
Severe OSA	0.267	0.024	0.036/ 0.498	0.242	0.039	0.012/ 0.471	-58.412	0.419	-201.23/ 84.409	0.072	0.098	-0.014/ 0.158	8.787	0.084	-1.199/ 18.773
All OSA	-0.126	0.263	-0.348/ 0.095	-0.126	0.254	-0.343/ 0.091	-65.296	0.096	-142.19/ 11.605	-0.116	0.194	-0.213/ -0.019	-6.920	0.099	-15.158/ 1.318

CI: confidence interval, OAT: obstructive apnea time, TAT: total apnea time, HT: hypopnea time, TRET: total respiratory event time, AHI: apnea hypopnea index, p<0.05 is significant

# DISCUSSION

The current diagnosis and severity classification of OSA is based on the number of respiratory events. In recent years, however, it has been shown that, in addition to the number of respiratory events, the duration of respiratory events contributes to the assessment of the OSA, accompanying morbidities and mortality. OSA has been associated with increased morbidity and mortality related to cardiovascular disease. Therefore the relationship between time spent during the respiratory events (parameter combining the number and duration of respiratory events) and cardiovascular diseases evaluated in the present study.

Population-based studies have shown an association between OSA and cardiovascular diseases (15,16). Intermittent hypoxia, a major pathophysiological change caused by OSA, causes increasing sympathetic nerve activity, systemic inflammation, and endothelial cell injury, which may also aggravate cardiovascular diseases including hypertension, arrhythmia, and arteriosclerosis (17). The data about the relationship between cardiovascular diseases and duration of respiratory events or parameters including duration of respiratory events in OSA are limited (8,12-14). It is shown that OSA patients with longer MAD (mean apneahypopnea duration) have more and worse hypertension than patients with shorter MAD (8). The reason for poor blood pressure control could be low oxygen saturation associated with longer MAD in this study. Also in the rat model of OSA, it was found that longer apnea-hypopnea duration is related to more hypertension (12). One of the two studies examining the relationship between cardiovascular disease with the duration and number of respiratory events together; showed that non-fatal cardiovascular events and cardiovascular mortality are higher in severe OSA formed based on adjusted-AHI (13). In this study adjusted AHI was found to be an independent risk factor for non-fatal cardiovascular events. According to the second one, hypertensive women have lower apnea and apnea-hypopnea time and hypertensive men have

higher hypopnea time (14). However, female patients were more obese and older than male patients in that study. In our study, cardiovascular diseases were related to OAT and TAT only in severe OSA patients, independent of other variables (age, gender, BMI). However, HT or TRET was not related to cardiovascular morbidity. Regarding oxygenation parameters, both MOD and ODI were associated with OAT and TAT; so cardiovascular diseases associated with OSA could be due to a higher number of deoxygenation attacks together with a continuous lower oxygen level. AHI alone is not capable of explaining cardiovascular morbidity in OSA, so the parameters including the duration of respiratory events are more useful in understanding OSA and its effects.

Mortality in OSA associated with low mean oxygen saturation, high ODI, and presence of comorbidities such as congestive heart failure, coronary artery disease, diabetes mellitus, and chronic obstructive pulmonary disease (COPD) (18). It is found that longer MAD was associated with lower oxygen saturation in patients with severe OSA (2). Also, longer MOAD, MMAD (mean mix apnea duration), MCAD (mean central apnea), MTAD, MHD were related to deeper mean oxygen desaturation in patients with severe OSA and this relationship was stronger, especially with MOAD and MTAD (5). Similarly longer OAT and TAT in mild, severe, and all OSA group and longer TRET in severe and all OSA group were associated with higher MOD in our study. So nocturnal hypoxemia is more related to time spent in apnea rather than hypopnea in severe and all OSA patients. Nocturnal hypoxia may be one of the reasons for the relation between OAT, TAT, and cardiovascular diseases in severe OSA patients.

Obesity is an important risk factor for the development of OSA. It was shown that as the degree of obesity increases the severity of OSA also increase (19). Also, the remission of OSA was found as 93.4% after gastric bypass surgery (20). However, BMI shortens the duration of apneas and hypopneas (5,6). This can be explained by the positive correlation between AHI and BMI. As AHI increases with

the same total sleep time, the duration of respiratory events decreases. In this study also higher BMI was associated with shorter OAT in mild and all OSA group and shorter mild, severe, and all OSA group.

## CONCLUSION

In this study, the parameter, time spent in respiratory events, was evaluated, which include the number and duration of respiratory events together. Cardiovascular diseases were higher in severe OSA patients who have higher OAT and TAT. However, this relationship does not exist with AHI alone in the same group. Also, no relationship was found between the time spent during respiratory events and cardiovascular diseases in mild and moderate OSA patients. Therefore, to better understand the effects of OSA in terms of accompanying morbidities (cardiovascular diseases and others), it can be useful to use parameters including the duration of respiratory events in addition to AHI alone.

The limitations of this study were being retrospective, single-center study, and also having a small study population. Cardiovascular diseases of the patients were screened retrospectively only from the medical record system. There is still a need for further prospective, large scale, controlled studies to examine the relationship between the time spent during respiratory events and other parameters like comorbidities especially cardiovascular complications associated with OSA.

Competing interests: The authors declare that they have no competing interest.

Financial Disclosure: There are no financial supports.

Ethical approval: The study was approved by the Health Sciences University Bursa Higher Specialization Education and Research Ethics Committee (2011-KAEK-25 2019/10-24).

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