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Factors affecting the optimal CPAP pressure level and a new prediction formula in patients with obstructive sleep apnea syndrome

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Abstract:

BACKGROUND AND AIM: Continuous positive airway pressure (CPAP) treatment is routinely recommended for patients with Obstructive Sleep Apnea Syndrome (OSAS). This study aims to investigate the factors that affect the optimal CPAP pressure level in subjects with OSAS.

METHODS: The records of 100 subjects with OSAS who underwent successful manual titration for CPAP treatment were reviewed retrospectively. In addition to frequently researched variables such as age, Body Mass Index (BMI), Apnea-Hypopnea Index (AHI), and minimum oxygen saturation (SpO_2) level, the effects of variables such as comorbidities, Rapid Eye Movement (REM) and/or position dependence, and type of abnormal respiratory events on optimal CPAP pressure level were analyzed. The descriptive values of the obtained data were calculated as mean±SD and median [Interquartile Range (IQR)]. The statistical significance level was set at $p<0.05$.

RESULTS: The mean age of the subjects was 49.17±10.4, and 81 of them were men. There was a positive relationship between optimal pressure and BMI, AHI, REM AHI, Non-Rapid Eye Movement Apnea-Hypopnea Index (NREM AHI), Supine AHI, and Non-supine AHI (p=0.001). A negative relationship was found between optimal pressure and minimum SpO_2 (p=0.001). Optimal pressure was higher in OSAS subjects without REM and position dependence than in those with position and REM dependence (p=0.001). Optimal pressure was significantly lower in subjects who used nasal masks than in those who used an oro-nasal mask (p=0.001). As a result, an optimal pressure prediction (Ppred) formula was developed: Ppred=9.366+0.117 BMI+0.043 AHI–0.062 Min SpO_2. While the mean optimal pressure (Popt) obtained by manual titration was 9.5±2.45 cmH_2O, the mean pressure obtained by the new formula (Ppred) was 10.3±1.89 cmH_2O (r=0.64, p<0.001).

CONCLUSIONS: In summary, the present study extensively examined the factors that affect optimal CPAP pressure, and a new prediction formula was developed. Also; "Can CPAP pressure prediction formulas be used in a pandemic?" the question has also been discussed.

Keywords:

Obstructive sleep apnea syndrome, optimal CPAP pressure, prediction formula

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Introduction

Obstructive sleep apnea syndrome (OSAS) is a common chronic disease that requires long-term follow-up and treatment, affecting about 2 to 4% of the adult population.[1] Routine treatment with continuous positive airway pressure (CPAP) is recommended for patients with moderate to severe OSAS, and it is also indicated for the treatment of some patients with mild OSAS.[2] Manual titration under full-night polysomnography (PSG) is the gold standard to determine the optimal CPAP pressure level.[1] The optimal CPAP pressure level is crucial for effective treatment; low pressure may lead to inefficient treatment, while high pressure may result in treatment intolerance.[3] Due to the workload in sleep laboratories, CPAP titration appointments are often scheduled to future dates, resulting in treatment delays. Various formulations have been developed to predict the optimal CPAP pressure level for populations in different countries and geographical locations.[4–10] These formulations cannot replace manual titration, but they can improve the success rate and be used during follow-up. Furthermore, in cases where sleep tests cannot be conducted, such as during a pandemic, these formulations can be particularly beneficial in countries with high sleep laboratory workloads.

In formulation studies for the prediction of optimal CPAP pressure, several formulas have been developed using variables such as body mass index (BMI), neck circumference, apnea-hypopnea index (AHI), minimum oxygen saturation (SpO_2), sex, and race. A review published by Macario Camacho et al.[11] in 2015 reported that these formulas are beneficial in increasing the success rate of CPAP; however, they are not completely generalizable, and further studies are needed to prescribe CPAP based on mathematical formulations. Additionally, these studies have not adequately investigated the impact of comorbidities, Rapid Eye Movement (REM) sleep variations, and respiratory event types on the optimal CPAP pressure in subjects with OSAS. Therefore, further studies are needed to clarify these aspects. In this study, our aim was to investigate the influence of factors such as comorbidities and polysomnographic data, including sleep efficiency, sleep stages, REM and/or position dependency, type of abnormal respiratory events, the longest apnea-hypopnea duration, and the type of mask used during titration on the optimal CPAP pressure. We considered variables such as BMI, AHI, and minimum SpO_2 level as well.

Materials and Methods

Study population

We conducted a retrospective review of data for 100 subjects (mean age 49.17±10.4 years, 81 males) who were diagnosed with obstructive sleep apnea syndrome with an AHI value of ≥5 by standard polysomnography and had successful manual CPAP titration between May 2017 and September 2018. Subjects with congestive heart disease, chronic obstructive lung disease, obesity, hypoventilation syndrome, chronic heart disease, a history of narcolepsy, history of alcohol or drug abuse, and central sleep apnea syndrome were excluded. We recorded age, sex, BMI, comorbidities, and polysomnographic data, including sleep efficiency, sleep, and REM latency, sleep stages, AHI, minimum SpO_2 level, REM and/or position dependency, type of respiratory events, the longest apnea-hypopnea duration, optimal CPAP pressure reached during titration, and type of mask used during titration for each subject. We obtained written informed consent from each subject, and the study was approved by the local Ethics Committee (22.05.2020/No: 08). Epworth Sleepiness Scale, neck circumference, and allopathy index were not examined.

Sleep studies

All polysomnography (PSG) studies were conducted in the sleep laboratory under the supervision of a technician using a Nihon Kohden polysomnography device during the spontaneous sleep of the subjects. Measurements of electroencephalography (EEG), electrooculography (EOG), and jaw and leg electromyography (EMG) were performed with electrodes placed according to the international 10-20 system. A full-night polysomnographic recording was obtained, including sleep recording, electrocardiography (ECG), air flow sensor (nasal cannula + oronasal thermistor), chest and abdominal effort belts, snoring sensor, position sensor, and fingertip oximeter. An audio-visual recording was made throughout the night using a video camera system. Scoring of sleep stages and respiratory events was performed by a certified specialist using the PolySmith polysomnographic analytical software, in accordance with the American Academy of Sleep Medicine (AASM) 2014 and 2020 criteria.[12,13] Apnea definitions were based on standard criteria,[12] classifying apneas as central, obstructive, or mixed. An obstructive apnea was defined as a >90% diminution in airflow lasting at least 10 seconds with evidence of respiratory effort. Central apnea was defined as a >90% diminution in airflow lasting at least 10 seconds without evidence of respiratory effort. Mixed apnea was a combination of both obstructive and central apneas. Hypopnea definitions were made according to the AASM 2020 criteria:

a. The peak signal excursions drop by ≥30% of pre-event baseline using nasal pressure (diagnostic study), Positive Airway Pressure (PAP) device flow (titration study), or an alternative hypopnea sensor (diagnostic study).

b. The duration of the ≥30% drop in the signal excursion is ≥10 seconds.

c. There is a ≥3% oxygen desaturation from the pre-event baseline or the event is associated with arousal.[13]

According to the AASM criteria, subjects were classified as normal or having mild, moderate, and severe OSAS based on the apnea-hypopnea index (AHI) thresholds: AHI <5, AHI ≥5 and <15, AHI ≥15 and ≤30, and AHI >30, respectively.[14,15] Although definitions are controversial, subjects with REM AHI/Non-Rapid Eye Movement Apnea-Hypopnea Index (NREM AHI) >2 were considered to have REM-related OSAS,[16] and those with supine AHI/non-supine AHI > 2 were considered to have positional OSAS. According to the type of abnormal respiratory events, subjects with apnea in more than half of the events were recorded as apnea-predominant, and those with hypopnea in more than half of the events were recorded as hypopnea-predominant. Another nighttime manual titration was performed under polysomnography to determine the optimal pressure level for CPAP treatment. CPAP titration was carried out using the REMstar Plus M series C-Flex device (Respironics, USA). CPAP was manually titrated to the lowest effective pressure level following CPAP clinical guidelines.[17] The optimal pressure was defined as the lowest pressure at which the AHI was <5.

Statistical analysis

Descriptive values of the obtained data were calculated as mean±SD (standard deviation) and median [interquartile range (IQR)]. The conformity of the data to normal distribution was examined using the Kolmogorov-Smirnov test. The simple relationships between numerical properties were measured using Spearman correlation. Intergroup differences were assessed using independent sampling t-tests for properties with a normal distribution in two groups, the Mann-Whitney U test for properties without compliance to normality, and the Kruskal-Wallis test for properties with more than two groups. The Bonferroni test was used for multiple comparisons. Furthermore, the relationship between age, BMI, AHI, REM-AHI, Supine-AHI, minimum SpO_2, and optimal pressure was re-evaluated using a multiple regression model, and variables without significant impact were excluded using the stepwise variable selection model. Pearson correlation was performed to evaluate the relationship between optimal pressure (Popt) and pressures calculated by the new formula (model) (Ppred). The statistical significance level was set at p<0.05. Statistical analysis of the available data was performed using IBM Statistical Package for the Social Sciences (SPSS) Statistics version 22 software.

Results

The demographic and polysomnographic data of the subjects categorized by the severity of OSAS are presented in Table 1. The average age of the subjects was 49.17±10.4. Out of these subjects, 81 were men. There were no significant differences observed in age, sex, and BMI between the groups. The polysomnographic data showed that the length of apnea-hypopnea events gradually increased as the severity of obstructive sleep apnea syndrome (OSAS) worsened (p=0.001). Additionally, the majority of respiratory events observed in all groups were hypopneas (p=0.06).

The relationship between the optimal pressure level obtained during manual CPAP titration and quantitatively measurable polysomnographic data was examined, and the results are summarized in Table 2. The analysis revealed a positive relationship between the optimal pressure and variables such as BMI, AHI, REM AHI, NREM AHI, Supine AHI, and Non-supine AHI (p=0.001). Conversely, a negative relationship was found between the optimal pressure and minimum SpO_2 levels (p=0.001). No other significant relationships were observed.

The relationship between the optimal pressure and categorical variables was assessed, and the findings are presented in Table 3. The results showed that the optimal pressure was significantly lower in subjects with hypertension (p=0.007). When evaluating the severity of OSAS, the optimal pressure was higher in subjects with severe OSAS compared to those with mild OSAS (p=0.001). Significant differences in the average optimal pressure were observed among subtypes of OSAS. Multiple comparison tests indicated that the optimal pressure was higher in subjects without REM and position dependence compared to those with position and REM dependence (p=0.001).

Table 1: Demographic and polysomnographic data of patients by severity of Obstructive Sleep Apnea Syndrome (OSAS)

	Mild OSAS (n=11)	Moderate OSAS (n=25)	Severe OSAS (n=64)	p*
Age (years)	47.09±12.684	49.56±9.368	49.50±10.646	0.725
Sex				
Male	9	19	53	0.799
Female	2	6	11	
Body mass index (BMI) (kg/m²)	31.145±4.956	31.580±4.557	33.127±4.540	0.261
Concomitant chronic conditions				
Hypertension (HT) (n)	5	9	15	0.199
Diabetes mellitus (DM) (n)	0	4	6	0.352
Polysomnographic data				
Sleep latency (min)	36.455±36.517	34.360±54.199	21.339±32.858	0.391
REM latency (min)	180.000±103.510	139.340±79.230	133.384±66.395	0.204
Sleep efficiency (%)	89.945±7.693	91.112±7.628	90.889±15.036	0.156
Sleep stage (%)				
N1	7.300±4.853	5.456±2.801	7.045±5.993	**0.004**
N2	17.364±6.953	21.840±11.350	28.405±13.130	0.073
N3	46.400±13.932	47.648±8.988	39.923±16.718	0.955
REM	16.009±6.461	17.248±8.772	17.416±8.778	**0.001**
AHI (apnea+hypopnea/h)	11.473±5.048	21.120±3.191	56.032±20.929	**0.001**
REM-AHI	23.591±11.251	27.608±14.800	53.085±24.157	**0.001**
NREM-AHI	8.427±6.918	19.180±5.305	56.608±23.069	**0.001**
Supine-AHI	16.782±5.358	33.576±18.045	68.276±20.634	**0.001**
Non-supine-AHI	6.709±8.797	12.524±6.389	46.139±27.293	**0.001**
Minimum Oxygen saturation %	85.18±7.782	82.48±4.629	72.18±8.758	**0.001**
The longest apnea-hypopnea duration (sec)	33.64±8.01	35.56±14.169	48.08±17.519	**0.001**
Type of abnormal respiratory event				
Apnea predominant	1	2	18	0.064
Hypopnea predominant	10	23	46	
CPAP titration data				
Optimal pressure (mmHg)	7.55±1.036	8.76±1.832	10.06±2.482	**0.001**
Type of mask				
Nasal	10	17	46	0.384
Oronasal	1	8	17	

*: Kruskal-Wallis analysis. AHI: Apnea hypopnea index, REM: Rapid eye movement, NREM: Non REM, CPAP: Continuous positive airway pressure

Evaluation based on the type of abnormal respiratory events revealed that the optimal pressure was higher in the apnea-predominant group than in the hypopnea-predominant group, but the difference was not statistically significant (p=0.55).

When considering the mask types used during CPAP titration, the optimal pressure was significantly lower in subjects who used nasal masks compared to those who used oronasal masks (p=0.001). No other significant relationships were observed.

During the modeling of the relationship between age, BMI, AHI, Supine AHI, minimum SpO_2, and the longest apnea-hypopnea duration and optimal pressure, age and the longest apnea-hypopnea duration were not included in the formula because no significant relationship was found between them and the optimal pressure (Table 2). Additionally, when developing a multiple regression model of BMI, AHI, REM AHI, Supine AHI, and minimum SpO_2 measurements, the impact of REM AHI and Supine AHI was not found to be significant. Consequently, an optimal pressure prediction (Ppred) formula was developed, incorporating BMI, AHI, and minimum SpO_2 measurements. Based on the results (Table 4):

A one-unit increase in body mass index increased the optimal pressure by 0.117 (p=0.011).

A one-unit increase in AHI increased the optimal pressure by 0.043 (p=0.027).

A one-unit increase in minimum SpO_2 decreased the optimal pressure by 0.062 (p=0.036).

Table 2: The relationship between optimal Continuous Positive Airway Pressure (CPAP) level and polysomnographic data

	Mean±SD	Optimal pressure
		r[a]
Age (years)	49.17±10.415	–0.079
BMI (kg/m²)	32.634±4.695	0.453
Sleep latency (min)	25.955±39.540	–0.061
REM latency (min)	140.458±74.781	0.038
Sleep efficiency (%)	90.771±12.639	–0.127
Sleep stages (%)		
N1	6.682±5.199	0.092
N2	25.614±12.737	0.145
N3	42.648±15.119	–0.114
REM	16.960±8.612	–0.102
AHI (apnea+hypopnea/h)	42.921±25.376	0.500
REM AHI	43.574±24.609	0.390
NREM AHI	42.134±27.573	0.485
Supine AHI	54.243±27.373	0.392
Non-supine AHI	34.032±28.430	0.544
Minimum Oxygen saturation (%)	75.90±9.758	–0.516
The longest apnea-hypopnea (sec)	43.27±17.037	0.061

[a]: Spearman's rho. SD: Standard deviation, BMI: Body mass index, REM: Rapid eye movement, AHI: Apnea hypopnea index, NREM: Non REM

Table 3: The relationship between optimal Continuous Positive Airway Pressure (CPAP) level and categorical variables

	n	Mean±SD	Median (IQR)	p
Sex				
Male	81	9.70±2.576	9 (4)	0.102
Female	19	8.89±1.696	9 (3)	
Hypertension				
No	71	9.994±2.466	10 (4)	**0.007**
Yes	29	8.59±2.147	8 (3)	
Severity of OSAS				
Mild	11	7.55±1.036	7 (1)	**0.001**
Moderate	25	8.76±1.832	8 (4)	
Severe	64	10.20±2.565	10 (4)	
OSAS subtype				
Not available	45	10.78±2.540	11 (4)	**0.001**
Positional	18	9.72±2.164	9.5 (3)	
REM dependent	25	8.20±1.443	8 (2)	
REM and position dependent	12	7.50±1.168	7 (1)	
Type of respiratory event				
Apnea predominant	21	9.86±2.613	10 (4)	0.554
Hypopnea predominant	79	9.47±2.412	9 (4)	
Type of mask				
Nasal	73	8.88±2.061	8 (4)	**0.001**
Oronasal	26	11.27±2.507	11 (4)	

Mann-Whitney U test or Kruskal-Wallis analysis. SD: Standard deviation, IQR: Interquartile range, OSAS: Obstructive Sleep Apnea Syndrome, REM: Rapid eye movement

The model for optimal pressure is as follows:

$$Ppred = 9.366+0.117\ BMI+0.043\ AHI–0.062\ Min\ SpO_2.$$

While the mean optimal pressure (Popt) obtained through manual titration was 9.5±2.45 cmH_2O, the mean pressure obtained by the new formula (Ppred) was 10.3±1.89 cmH_2O. There was a significant correlation between the two pressures ($r=0.64$, $p<0.001$). Analysis of the distribution of the Popt-Ppred difference showed that 69% of subjects had a pressure range of ±2 cmH_2O, and 87% had a pressure range of ±3 cmH_2O.

Table 4: Optimal pressure model overview*

	B	Beta	Sig.	95% CI
(Constant)	9.366		**0.004**	(3.120–15.612)
BMI	0.117	0.228	**0.011**	(0.027–0.207)
AHI	0.043	0.449	**0.027**	(0.005–0.081)
Minimum SpO_2 %	–0.062	–0.249	**0.036**	(–0.119–0.004)

*: Multiple Linear Regression Model with stepwise selection method. Sig.: Significant, CI: Confidence interval, BMI: Body mass index, AHI: Apnea-hipopnea index,SpO_2: Oxygen saturation

Discussion

In this study, we investigated the effects of various factors, such as polysomnographic data (including sleep stages, sleep efficiency, and type of respiratory events), comorbidities (such as hypertension), and mask type, on optimal CPAP pressure (Tables 1, 2). Our main objective was to study factors potentially associated with optimal pressure that have not been adequately investigated, rather than solely developing a new formula. However, during the modeling of factors related to optimal pressure, we also developed a formula using the most related factors: BMI, AHI, and minimum SpO_2 variables.

Continuous positive airway pressure (CPAP) treatment is routinely recommended for patients with moderate to severe OSAS, and it may also be indicated for some patients with mild OSAS. Manual titration under full-night polysomnography (PSG) is considered the gold standard for determining the optimal CPAP pressure level.[1,2] However, conventional manual CPAP titration can be time-consuming, expensive, and have limited accessibility. Therefore, several alternative approaches, such as prediction formulas have been suggested.[18–20] These prediction formulas cannot replace manual CPAP titration, but they can help simplify the initiation of manual titration by reducing the number of pressure changes and time consumption, improving the success of manual CPAP titration by increasing the initial pressure, especially in split-night studies, and enhancing the ease and effectiveness of patient management at home (e.g., CPAP or Automatic Positive Airway Pressure (APAP) titration at home). They can be used as an alternative to manual titration in various cases where manual titration is not feasible (e.g. due to safety concerns or underlying health conditions). For example, nowadays tests have been halted in many sleep laboratories during the pandemic. In addition, pressure prediction formulas can be considered as an alternative to manual titration due to longer waiting times, high costs, and time and resource consumption.

Rowley et al.[21] examined the impact of predictive equations for CPAP treatment on the success of manual titration. They found that manual titration based on predictive equation modestly increased the rate of successful CPAP titrations. Fitzpatrick et al.[22] showed that self-adjustment of a titration at home using a predictive equation was as effective as manual titration under a full-night PSG.

Various predictive equations have been developed for optimal CPAP pressure levels for populations from several countries and different geographic origins.[4–10] These studies often used variables such as body mass index (BMI), neck circumference, apnea-hypopnea index (AHI), minimum oxygen saturation, sex, and race in their pressure prediction formulas. Some studies also used the Epworth sleepiness scale,[8,23] and oxygen desaturation index (ODI).[8, 24] According to these studies, BMI and AHI are the most significant independent predictors of optimal CPAP pressure level.

A review published in 2015 by Macario Camacho et al.[11] covering all these studies, reported that formula studies are beneficial in improving successful CPAP, but they are not fully generalizable, and further studies are required to prescribe CPAP using mathematical equations. Additionally, they indicated that the impact of many factors, including comorbidities, REM sleep variations, and types of respiratory events on optimal CPAP pressure, has not been adequately studied, and further research is needed to improve the formulas.

Similar to other studies, our results showed a positive relationship between optimal pressure and BMI, AHI, REM AHI, NREM AHI, Supine AHI, and Non-supine AHI ($p=0.001$). There was a negative relationship between optimal pressure and minimum SpO_2 ($p=0.001$). No relationship was found between optimal pressure and the duration of REM and other sleep stages among polysomnographic data (Table 2). Interestingly, optimal pressure was significantly lower in OSAS subjects with hypertension (p=0.007). There was a significant difference in mean optimal pressures between subtypes of OSAS. A multiple comparison test showed that optimal pressure was significantly higher in OSAS subjects without REM and position-dependence compared to those with REM and position dependence (p=0.001). This outcome may be mainly attributed to the absence of position and REM dependence among subjects with severe OSAS. Analysis by types of respiratory events showed that optimal pressure was higher in the apnea-predominant group than in the hypopnea-predominant group; however, the difference between them was not statistically significant (p=0.55). Although higher pressures are generally expected to prevent apnea compared to what is required for hypopnea,[11] the difference between pressures was not statistically significant in our study, and thus further studies involving broader case series are required.

Our results also showed that the longest apnea-hypopnea duration increased with the severity of OSAS; however, it was not related to optimal pressure (p=0.55). Analysis by mask types used during CPAP titration showed that optimal pressure was significantly lower in subjects wearing nasal masks compared to those wearing oronasal masks (p=0.001). Subjects with nasal problems or difficulties with nasal masks often preferred oronasal masks during CPAP titration.

In many studies, the study groups included subjects with moderate to severe OSAS.[7,10,24] However, CPAP is also indicated in patients with mild OSAS who experience excessive daytime sleepiness and have concomitant conditions such as hypertension. Our study also included subjects with mild OSAS who received CPAP treatment. Analysis by the severity of OSAS showed that optimal pressure was higher in subjects with severe OSAS than in subjects with mild OSAS, as expected (p=0.001).

There is evidence of sex-related differences in the clinical presentation of OSAS and polysomnographic findings. It is likely that female patients are more obese and have a smaller neck circumference than males.[25] These sex differences are expected to affect the optimal CPAP pressure in patients with OSAS. Schiza et al.[26] evaluated the effect of sex on a CPAP prediction equation in a Greek population and found that sex was a statistically significant factor in predicting CPAP pressure by linear regression. However, in our study, the sex factor was not related to the optimal pressure (p=0.10).

Ethnic differences may also have an impact on the severity of OSAS and pressure differences in CPAP treatment.[27,28] Therefore, prediction formulas have been suggested for many ethnic groups.[4,7,10,22,25,29] Türkiye is located in a geography composed of various ethnic origins between Asia and Europe. Predictive formula studies have also been conducted in Türkiye.[24,30] Unlike these studies, our formula included the combined use of BMI, AHI, and minimum SpO_2 parameters.

The study by Macario Camacho et al.,[11] which reviewed most of the formula studies, found that the mean coefficient value for BMI used in optimal pressure prediction formulas was 0.128 (0.168 in Asian studies and 0.100 in non-Asian studies), the mean coefficient value for AHI was 0.044, and the mean coefficient value for minimum O_2 was 0.065. The coefficient values for BMI, AHI, and minimum O_2 in our formula were 0.117, 0.043, and 0.062, respectively. These coefficients used in our formula were close to the mean coefficients in other studies. We believe that our formula is more practical compared to formulas that include neck circumference, cephalometric measurements, and the Epworth Sleepiness Scale (ESS) in terms of applicability.

We applied our new prediction formula to 100 subjects in our study group. While the mean optimal pressure (Popt) obtained by manual titration was 9.5±2.45 cmH_2O, the mean pressure by the new formula (Pred) was 10.3±1.89 cmH_2O. We found a significant correlation between the two pressures (r=0.64, p<0.001). Analysis of the distribution of the Popt-Ppred difference to validate the accuracy of the formula showed that 69% of subjects had a pressure range of ±2 cmH_2O, and 87% had a pressure range of ±3 cmH_2O. When compared to formulas in other studies,[11] our formula can be considered to have moderate to high accuracy. The pressure achieved by manual titration in many subjects who were diagnosed with severe OSAS, composing the majority of our study group, was lower than the predicted pressure by the formula. It suggests that as the AHI value increases, its effect on optimal pressure is reduced, and a different coefficient can be used above a certain AHI value.

Our study had some limitations. First of all, some anthropometric measurements such as the Epworth

Sleepiness Scale and neck circumference, as well as allopathy index, were not examined. In addition, we applied only our formula to the study group, and we did not validate other formulas; we compared the correlation and accuracy rates of our formula in our study group. Another limitation was the small number of subjects in our study.

In conclusion, the present study extensively examined the factors that affect optimal CPAP pressure, and a new prediction formula was developed. Optimal pressure prediction formulas for CPAP treatment should be studied further. Prediction formulas with increased accuracy can relieve the burden on sleep laboratories, eliminate unnecessary waste of resources, and at least be an effective alternative solution for patients waiting for treatment in cases where sleep laboratory tests cannot be conducted, such as the current pandemic. Especially when potential complications that patients with severe OSAS may experience are considered, initiating CPAP treatment by formula, and close monitoring based on device data seems more reasonable than waiting for a long period for manual titration. Further studies are needed to examine the factors associated with optimal pressure for developing more accurate CPAP pressure predictions and preliminary preparation for successful manual titration.

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Conflicts of interest
There are no conflicts of interest.

Ethics Committee Approval
The study was approved by the Tınaztepe Hospital Ethics Committee (No: 08, Date: 22/05/2020).

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Authorship Contributions
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