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Impact of Anthropometric Indices on Residual Obstructive Sleep Apnea and Pressure Requirements During APAP Therapy

APAP Tedavisi Sırasında Antropometrik İndekslerin Rezidüel Obstrüktif Uyku Apnesi ve Basınç Gereksinimleri Üzerine Etkisi

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ABSTRACT Objective: This study investigated the predictive value of conventional anthropometric indices, such as body mass index (BMI), and novel indices, including the Body Roundness Index (BRI) and waist-to-neck ratio (WNR), for residual obstructive sleep apnea (OSA) and therapeutic pressure requirements during auto-adjusting positive airway pressure (APAP) therapy in patients with moderate-to-severe OSA. **Material and Methods:** Data from 58 adults with moderate-to-severe OSA who were switched to APAP due to continuous PAP intolerance were retrospectively reviewed. Anthropometric measurements (height, weight, waist, and neck circumference) were obtained, and BRI and WNR were calculated. Residual OSA was defined as a post-treatment Apnea-Hypopnea Index (AHI) ≥5 events/hour. Patients were classified according to residual OSA status, and group differences in anthropometric parameters and pressure requirements were analyzed. Logistic regression and receiver operating characteristic analyses were performed. **Results:** APAP therapy reduced mean AHI by 91.2%; however, residual OSA persisted in 36.2% of patients (n=21), who required significantly higher minimum ($p<0.001$), maximum ($p<0.001$), and mean ($p<0.001$) therapeutic pressures. Among all anthropometric indices, only BMI was significantly higher in patients with residual OSA (34.18 vs. 30.84 kg/m², $p=0.045$). BMI independently predicted residual OSA (area under the curve=0.686; cutoff=31.25 kg/m²), whereas BRI and WNR showed no significant predictive value. **Conclusion:** BMI is a simple and accessible anthropometric marker that modestly predicts residual OSA and higher APAP pressure requirements, outperforming more complex indices such as BRI and WNR. These findings suggest that overall adiposity has a greater clinical impact on APAP treatment outcomes than regional fat distribution.

Keywords: Anthropometry; body mass index; apnea; sleep; positive-pressure respiration

ÖZET Amaç: Bu çalışma, orta-şiddetli obstrüktif uyku apnesi (OUA) olan hastalarda otomatik ayarlanan pozitif havayolu basıncı [adjusting positive airway pressure (APAP)] tedavisi sırasında rezidüel OUA varlığını ve terapötik basınç gereksinimlerini öngörmede, beden kitle indeksi (BKİ) gibi konvansiyonel antropometrik indeksler ile Beden Yuvarlaklık İndeksi [Body Roundness Index (BRI)] ve bel-boyun oranı [waist-to-neck ratio (WNR)] gibi yeni indekslerin prediktif değerini araştırmayı amaçlamıştır. **Gereç ve Yöntemler:** Sürekli PAP intoleransı nedeniyle APAP tedavisine geçilen orta-şiddetli OUA tanılı 58 erişkin hastanın verileri retrospektif olarak incelendi. Antropometrik ölçümler (boy, kilo, bel ve boyun çevresi) kaydedildi ve BRI ile WNR hesaplandı. Rezidüel OUA, tedavi sonrası Apne-Hipopne İndeksi (AHİ) ≥5 olay/saat olarak tanımlandı. Hastalar rezidüel OUA durumuna göre sınıflandırıldı ve antropometrik parametreler ile basınç gereksinimlerindeki grup farkları analiz edildi. Lojistik regresyon ve alıcı işletim karakteristiği analizleri uygulandı. **Bulgular:** APAP tedavisi ortalama AHİ'yi %91,2 oranında azalttı; ancak hastaların %36,2'sinde (n=21) rezidüel OUA devam etti ve bu hastalarda minimum ($p<0,001$), maksimum ($p<0,001$) ve ortalama ($p<0,001$) terapötik basınç gereksinimleri anlamlı derecede daha yüksekti. Tüm antropometrik indeksler arasında yalnızca BKİ, rezidüel OUA bulunan hastalarda anlamlı olarak daha yüksekti (34,18'e karşı 30,84 kg/m², $p=0,045$). BKİ, rezidüel OUA'yı bağımsız olarak öngördü (eğri altında kalan alan=0,686; eşik değer=31,25 kg/m²), buna karşın BRI ve WNR anlamlı bir prediktif değer göstermedi. **Sonuç:** BKİ, rezidüel OUA varlığını ve daha yüksek APAP basınç gereksinimlerini mütevazı düzeyde öngörebilen, basit ve erişilebilir bir antropometrik belirteçtir ve BRI ile WNR gibi daha karmaşık indekslerden üstün görünmektedir. Bu bulgular, APAP tedavi sonuçları üzerinde bölgesel yağ dağılımından ziyade genel adipositenin daha büyük bir klinik etkiye sahip olduğunu düşündürmektedir.

Anahtar Kelimeler: Antropometri; beden kitle indeksi; apne; uyku; pozitif basınçlı solunum

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Obstructive sleep apnea (OSA) -also referred to as OSA syndrome-is a common sleep disorder characterized by recurrent partial or complete collapse of the upper airway during sleep.[1] It is among the most prevalent chronic sleep conditions, affecting up to 936 million adults worldwide. In high-income countries, population-based estimates suggest adult prevalence rates ranging from 23% to 46%.[2] If left untreated, the condition can lead to significant health consequences, including an increased risk of cardiovascular diseases, metabolic disorders, and neurological complications.[1,3]

Positive airway pressure (PAP) therapy remains the first-line intervention, demonstrating robust efficacy in reducing respiratory events and improving patient-reported symptoms.[4] Additional management strategies include positional therapy, weight loss interventions, and various surgical procedures.[5] Nevertheless sustaining long-term adherence to PAP is challenging; across diverse patient cohorts, chronic adherence rates range from 30% to 60%. This variability underscores that adherence is a complex, multifactorial construct not determined by clinical efficacy alone.[6,7]

Risk factors for OSA include obesity, male sex, older age, specific craniofacial morphologies, and ethnicity. The prevalence of OSA is increasing, driven by rising rates of obesity and the enhanced sensitivity of diagnostic modalities.[5]

Excess cervical adiposity increases pharyngeal collapsibility, whereas visceral fat accumulation reduces lung volumes and intensifies upper-airway obstruction.[8] Neck circumference (NC) has been investigated as a complementary marker for OSA, functioning as a direct surrogate for upper-airway fat deposition. The STOP-Bang Questionnaire -an extensively validated screening tool for OSA- includes NC as one of its eight items. The NC criterion (commonly defined as >40 cm) contributes to risk stratification and enhances the tool's high-sensitivity identification of individuals at elevated risk for OSA.[9] Traditional anthropometric measures -body mass index (BMI) and waist circumference (WC)- have long been used to assess obesity-related OSA risk.[10] In recent years, novel indices have been proposed to better characterize abdominal adiposity. The Body Roundness Index (BRI), developed by Thomas et al., integrates WC and height within an elliptical model to estimate total and visceral fat percentage, providing a more refined measure of central adiposity.[11] Multiple studies have shown that BRI correlates positively with OSA prevalence and severity and, in some settings, outperforms BMI and WC in identifying individuals at high risk of OSA.[12]

In this study, we evaluated how specific individual anthropometric measures -particularly the relatively novel BRI- influence PAP titration pressures and residual OSA, which constitute central components of OSA management. Given the scarcity of research examining anthropometry in relation to PAP titration, this work presents one of the first multivariable, head-to-head assessments of BRI -along with BMI and the waist-to-neck ratio (WNR)- for predicting PAP pressure requirements and residual Apnea-Hypopnea Index (AHI).

MATERIAL AND METHODS

STUDY DESIGN AND PARTICIPANTS

This retrospective observational study was conducted at the Department of Otorhinolaryngology of Ankara Bilkent City Hospital. Medical records of adult patients with obstructive sleep apnea (OSA) who were followed in the otorhinolaryngology outpatient clinic between January 2017 and June 2025 were retrospectively reviewed.

Patients had previously undergone overnight polysomnography (PSG) and positive airway pressure (PAP) titration studies at accredited sleep laboratories. They were referred to our outpatient clinic because of PAP intolerance, inadequate treatment response, or routine follow-up after PAP initiation. PSG and PAP titration data, together with clinical follow-up records, were retrieved from the patients' medical records.

All patients were initially titrated with continuous positive airway pressure (CPAP). Patients who could not tolerate CPAP were switched to either bilevel PAP or automatic positive airway pressure (APAP), according to clinical evaluation. Only pa-

tients who continued treatment with APAP were included in the present analysis

Inclusion criteria were as follows:

- Age ≥18 years,
- Diagnosis of moderate-to-severe OSA confirmed by overnight polysomnography (AHI 15-30/h=moderate, AHI >30/h=severe).
- Treatment with APAP
- Availability of complete anthropometric measurements and treatment follow-up data.

Patients with central sleep apnea, other sleep-related breathing disorders, significant cardiopulmonary comorbidities, or incomplete data were excluded. In addition, patients with the following comorbidities or conditions were not considered eligible for APAP as an initial therapy and therefore excluded: congestive heart failure, chronic opioid use, significant pulmonary disease (e.g., chronic obstructive pulmonary disease), neuromuscular disorders, previous uvulopalatopharyngoplasty, patients requiring supplemental oxygen during sleep, and those expected to have nocturnal arterial oxyhemoglobin desaturation due to conditions other than OSA (including hypoventilation syndromes and central sleep apnea). For these patients, in-laboratory attended polysomnography (PSG) with manual CPAP or bilevel PAP titration remains the gold standard, as tighter and more complex monitoring of respiratory functions is generally required. Thus, the APAP group in this study was selected based on these exclusion criteria.

PAP Titration and Treatment

Overnight, in-laboratory PSG was performed according to the American Academy of Sleep Medicine guidelines. PAP titration was initiated with CPAP. If CPAP was not tolerated, APAP was instituted with a pressure range of 4-22 cmH_2O. For each patient, the minimum, maximum, and mean treatment pressures were recorded. Post-treatment AHI values under APAP were obtained from device downloads and PSG follow-up.

Residual OSA was defined as a post-treatment AHI ≥5 events/hour. Patients were categorized into 2 groups based on their post-treatment AHI values: those with residual OSA (AHI ≥5 events/hour) and those without residual OSA (AHI <5 events/hour).

$$BMI\cdot(kg/m^2)=weight\cdot(kg)/height\cdot(m)^2$$

$$BRI= 364.2 - 365.5 \times \sqrt{1 - \frac{\left(\frac{WC}{2\pi}\right)^2}{(0.5\times Height)^2}}$$

$$WNR=WC/NC$$

At our center, APAP devices are routinely interrogated at about 4 weeks to assess residual respiratory events and adjust therapy if needed. Consequently, the "posttreatment" AHI values analyzed here reflect the residual AHI recorded during the first month of APAP therapy, obtained from device downloads and, where available, follow-up polysomnography.

Anthropometric Measurements

Standing height (cm), body weight (kg), WC (cm), and NC (cm) were measured in the upright position with participants wearing light clothing and using a standardized, non-elastic measuring tape by a single experienced investigator to minimize interobserver variability. Based on these measurements, the following indices were calculated:

All measurements were performed in the upright position with light clothing and standardized protocols.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Ethics Committee of Ankara Bilkent City Hospital (TABED) under protocol number 1-25-1581, dated August 13, 2025. The study was conducted following the principles of the Declaration of Helsinki. Written informed consent to participate was obtained from all patients included in the study.

STATISTICAL ANALYSIS

All statistical analyses were performed using IBM SPSS Statistics (version 30.0, IBM Corp., Armonk, NY, USA). Continuous variables were expressed as

mean±standard deviation, and categorical variables as frequencies and percentages. Patients were divided into 2 groups based on posttreatment AHI values (residual OSA vs. no residual OSA). Group comparisons of anthropometric parameters between these groups were performed using independent sample tests (Student's *t*-test or Mann-Whitney *U test* for continuous variables and chi-square or Fisher's exact test for categorical variables). Logistic regression models were applied to evaluate the predictive value of BMI, BRI, and WNR for differentiating patients with residual OSA from those without; results were reported as odds ratios with 95 % confidence intervals (CI). Receiver operating characteristic (ROC) curve analysis was conducted to determine diagnostic performance, and optimal cutoff values were identified based on sensitivity and specificity. A two-tailed *p* value <0.05 was considered statistically significant.

A priori power analysis was performed based on data from a previously published study.[13] Assuming a two-sided t-test with an alpha level of 0.05, a mean difference of 90, standard deviations of 3.95 (Group 1) and 3.24 (Group 2), and sample sizes of 21 and 37 for each group, respectively, the calculated power was ≥0.80. These parameters indicate that our current sample size is sufficient to detect a statistically significant difference with confidence.

TABLE 1: Baseline characteristics of study participants (n=58)

	Minimum	Maximum	X̄	SD
Age (years)	27	81	48.34	11.96
Height (cm)	148	191	175.13	9.95
Weight (kg)	58	140	97.96	17.34
NC (cm)	38	48	42.41	1.96
WC (cm)	74	152	113.84	17.97
BMI (kg/m²)	23.88	52.95	32.05	6.13
BRI	3.17	16.24	6.87	2.88
WNR	1.89	3.3	2.66	0.32
AHI	31.1	113.1	56.8	23.34
Post-treatment AHI	0.6	10.3	4.46	2.51
Minimum pressure (cmH_2O)	4	14	5.79	2.25
Maximum pressure (cmH_2O)	10.5	22	14.5	1.89
Mean pressure (cmH_2O)	7.25	18	10.11	1.86
Percentage reduction in AHI	79.21	98.72	91.18	3.99

SD: Standard deviation; NC: Neck circumference; WC: Waist circumference; BMI: Body mass index; BRI: Body Roundness Index; WNR: Waist to neck ratio; AHI: Apnea-Hypopnea Index

RESULTS

PATIENT CHARACTERISTICS

A total of 58 patients with moderate-to-severe OSA who fulfilled the inclusion criteria were analyzed. The mean age of the cohort was 48.34±11.96 years, with a mean BMI of 32.05±6.13 kg/m². NC and WC averaged 42.41±1.96 cm and 113.84±17.97 cm, respectively. The mean baseline AHI was 56.8±23.34 events/h, which decreased to 4.46±2.51 events/h after APAP treatment, corresponding to an overall mean AHI reduction of 91.18% (range 79.21-98.72%). Baseline demographic and anthropometric characteristics are summarized in Table 1.

RESIDUAL OSA

Residual OSA, defined as a post-treatment AHI ≥5/h, was observed in 21 patients (36.2%). As shown in Table 2, patients with residual OSA had significantly higher body weight (104.42±19.54 vs. 94.29±15.03 kg, p=0.031) and BMI (34.18±6.69 vs. 30.84±5.52 kg/m², p=0.045) compared with those without residual OSA. No significant differences were detected between the groups in terms of age, height, NC, WC, BRI, or WNR.

TABLE 2: Comparison of factors according to the presence of residual AHI or RDI

	Residual OSA	n	X̄	SD	p value
Age (years)	Absent	37	49.08	10.58	0.53
	Present	21	47.04	14.25	
Height (cm)	Absent	37	175.27	10.04	0.89
	Present	21	174.9	10.02	
Weight (kg)	Absent	37	94.29	15.03	**0.031**
	Present	21	104.42	19.54	
NC (cm)	Absent	37	42.24	1.83	0.38
	Present	21	42.71	2.19	
WC (cm)	Absent	37	111.81	16.99	0.25
	Present	21	117.42	19.50	
BMI (kg/m²)	Absent	37	30.84	5.52	**0.045**
	Present	21	34.18	6.69	
BRI	Absent	37	6.57	2.80	0.28
	Present	21	7.42	3.03	
WNR	Absent	37	2.63	0.30	0.26
	Present	21	2.73	0.33	

AHI: Apnea-Hypopnea Index; RDI: Respiratory Disturbance Index; OSA: Obstructive sleep apnea; SD: Standard deviation; NC: Neck circumference; WC: Waist circumference; BMI: Body mass index; BRI: Body Roundness Index; WNR: Waist to neck ratio

CORRELATION OF PAP TITRATION PRESSURES WITH ANTHROPOMETRIC MEASUREMENTS, AGE, AND SEX

Mean pressure was strongly correlated with indices of adiposity, including BMI (r=0.70, p<0.001), body weight (r=0.67, p<0.001), abdominal circumference (r=0.57, p<0.001), BRI (r=0.59, p<0.001), WNR (r=0.54, p<0.001), and NC (r=0.49, p<0.001).

Similar patterns were observed for the minimum and maximum pressures. Minimum pressure was significantly associated with BMI (r=0.69, p<0.001) and weight (r=0.60, p<0.001), whereas maximum pressure showed moderate correlations with BMI (r=0.48, p<0.001) and abdominal circumference (r=0.42, p=0.001).

No significant correlations were found between pressure variables and age (r=-0.17 to -0.20, p>0.05) or sex (r=0.15 to 0.20, p>0.05).

Overall, the results suggest that increased adiposity and central obesity are strongly associated with higher PAP titration pressures, whereas age and sex do not significantly influence pressure requirements. As shown in Table 3.

TABLE 3: Correlation of PAP titration pressures with anthropometric measurements, age, and sex

	Minimum pressure		Maximum pressure		Mean pressure	
Variable	**r value**	**p value**	**r value**	**p value**	**r value**	**p value**
Sex	0.24	0.07	-0.03	0.84	0.15	0.26
Age (years)	-0.04	0.77	-0.20	0.14	-0.09	0.48
Height	-0.17	0.21	0.04	0.75	-0.09	0.52
Weight	0.60	**<0.001**	0.53	<0.001	0.67	**<0.001**
NC	0.47	**<0.001**	0.31	0.017	0.49	**<0.001**
WC	0.53	**<0.001**	0.42	0.001	0.57	**<0.001**
BMI (kg/m²)	0.69	**<0.001**	0.48	<0.001	0.70	**<0.001**
BRI	0.59	**<0.001**	0.39	0.003	0.59	**<0.001**
WNR	0.50	**<0.001**	0.42	0.001	0.54	**<0.001**

Pearson's correlation coefficients (r) are shown. PAP: Positive airway pressure; NC: Neck circumference; WC: Waist circumference; BMI: Body mass index; BRI: Body Roundness Index; WNR: Waist to neck ratio

TABLE 4: Comparison of APAP pressure requirements according to residual OSA status

	Residual OSA	n	$\bar{X}$	SD	p value
Minimum pressure (cmH_2O)	Absent	37	5.06	1.59	**<0.001**
	Present	21	7.07	2.68	
Maximum pressure (cmH_2O)	Absent	37	13.81	1.50	**<0.001**
	Present	21	15.73	1.92	
Mean pressure (cmH_2O)	Absent	37	9.38	1.24	**<0.001**
	Present	21	11.40	2.10	

APAP: Adjusting positive airway pressure; OSA: Obstructive sleep apnea; SD: Standard deviation

APAP Pressure Requirements

APAP pressure requirements according to residual OSA status are presented in Table 4. Patients with residual OSA required significantly higher therapeutic pressures: minimum (7.07±2.68 vs. 5.06±1.59 cmH_2O, p<0.001), maximum (15.73±1.92 vs. 13.81±1.5 cmH_2O, p<0.001), and mean pressures (11.4±2.1 vs. 9.38±1.24 cmH_2O, p<0.001).

Predictive Value of BMI

The diagnostic performance of BMI in predicting residual OSA is summarized in Table 5 and illustrated in Figure 1 (ROC curve). ROC analysis demonstrated that BMI was the only anthropometric index with significant predictive value. A BMI cut-off of 31.25 kg/m² yielded an area under the curve (AUC) of 0.686 (95% CI: 0.54-0.83, p=0.013), with 71.4% sensitivity and 70.3% specificity for predicting residual OSA. Neither BRI nor WNR showed significant predictive capacity.

TABLE 5: Diagnostic performance of BMI and weight in predicting residual OSA: ROC curve analysis

	Cut off	AUC	Sensitivity	Specificity	p value	%95 CI lower-upper bound	
BMI (kg/m²)	31.25	0.686	0.714	0.703	**0.013**	0.540	0.832
Weight (kg)	95.5	0.692	0.810	0.595	**0.010**	0.545	0.839

BMI: Body mass index; OSA: Obstructive sleep apnea; ROC; Receiver operating characteristic; AUC: Area under the curve; CI: Confidence interval

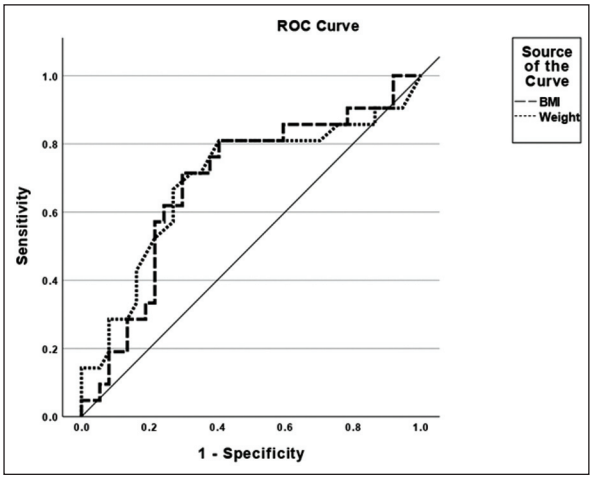

FIGURE 1: Diagnostic performance of BMI and body weight in predicting residual obstructive sleep apnea under APAP therapy: ROC curve analysis
BMI: Body mass index; APAP: Adjusting positive airway pressure; ROC; Receiver operating characteristic

DISCUSSION

In this retrospective analysis, we evaluated 58 patients with moderate-to-severe OSA who underwent APAP therapy. Participants were stratified according to their posttreatment residual AHI into a residual OSA group (AHI ≥5 events·h^{-1}) and a nonresidual group (AHI <5 events·h^{-1}). Patients with residual OSA exhibited significantly higher body weight and BMI, whereas sex, age, height, neck, and abdominal circumferences, WNR, and BRI did not differ between groups. Nevertheless, the residual OSA cohort required significantly greater minimum, maximum, and mean therapeutic pressures during APAP. Assessing the performance of anthropometric indices for predicting residual OSA, our univariate ROC analysis demonstrated that both BMI and body weight were statistically significant predictors (Table 5). Notably, body weight (AUC=0.692; 81.0% sensitivity) exhibited a marginally superior diagnostic performance compared to BMI (AUC=0.686; 71.4% sensitivity) in this univariate context. However, when these variables -which are expectedly highly collinear- were introduced into the multivariable logistic regression model to assess independent contributions, BMI emerged as the *sole independent* anthropometric predictor of residual OSA. This finding suggests that while both metrics capture the risk associated with general adiposity, BMI may represent a more standardized and independent measure. Nevertheless, the diagnostic utility of BMI must be interpreted with caution. The identified cutoff of 31.25 kg/m² (71.4% sensitivity, 70.3% specificity) and the corresponding AUC of 0.686, while statistically significant (p=0.013), indicate only "fair" or "modest" clinical discriminatory power. Therefore, our findings underscore that general adiposity is a fundamental determinant, but BMI should be regarded as an accessible ancillary tool for risk stratification rather than a definitive standalone marker for predicting residual disease.

In accordance with established criteria, we considered therapy successful when the residual AHI was <5 events·h^{-1} or when the AHI decreased by more than 50 % from baseline to <20 events·h^{-1}, in the absence of persistent symptoms during treatment.[14] By applying these benchmarks, all 58 participants in our cohort met the definition of therapeutic success. Specifically, 37 subjects achieved a residual AHI of <5 events·h^{-1}, while the remaining 21 patients exhibited post-treatment AHI values ≤13.3 events·h^{-1}. According to our predefined criterion for residual OSA (AHI ≥5 events·h^{-1}), these patients were categorized as having residual disease. Overall, APAP therapy resulted in a mean AHI reduction of 91.18% (range, 79.21-98.72%), underscoring its high therapeutic efficacy across the study population.

Long-term data on the efficacy of CPAP are scarce, yet a decadelong followup study reported that the baseline AHI of 49.2±26.1 events·h^{-1} fell to 1.7±2.9 at 3 months, 1.7±3.4 at 1 year and 3.4±5.4 at 10 years. These observations indicate that CPAP therapy yields clinically meaningful reductions in AHI and maintains stable control over extended periods.[14] In our series, patients received APAP, and long-term follow-up was not available; nevertheless, titration data showed that a baseline AHI of 56.8±23.34 events·h^{-1} declined to 4.46±2.51 after treatment. Although the initial AHI was higher than in the 10-year CPAP study, every patient satisfied the predefined success criteria and 37 achieved a residual AHI <5

events·h^{-1}, demonstrating that APAP can produce substantial short-term reductions even in severe cases. Moreover, a metaanalysis of 23 randomized controlled trials found no clinically significant differences in average PAP usage between autoadjusting and continuous modes, and repeated analyses have confirmed that patient-centered outcomes do not differ meaningfully between autoadjusting or bilevel PAP and standard CPAP.[15] These findings suggest that APAP is a viable alternative to standard CPAP, though longer-term comparative studies are warranted to elucidate its durability.

Uniken Venema et al., in their decadelong follow-up, observed that relapse in AHI may occur despite relatively stable BMI values; they speculated that fluid accumulation or redistribution and local fat apposition in the head and neck might contribute to long-term changes in the efficacy of mandibular advancement devices and CPAP therapy.[14] In contrast, our study identified only body weight and BMI as predictors of residual OSA. This finding implies that general obesity, rather than regional anthropometric indices, may drive residual disease, and that variations in treatment response over many years could reflect broader physiological changes, such as alterations in total body weight, shifts in fat distribution, and modifications in muscle and connective tissue composition. As these parameters can fluctuate substantially over a 10-year period, it is plausible that corresponding changes in airway collapsibility and ventilatory mechanics influence posttreatment AHI independently of static neck or waist measurements.

A comparable laboratory investigation by Kollár et al. focused exclusively on 40 previously healthy male persons. They observed statistically significant correlations between nearly all anthropometric and body-composition measures and sleep-apnea indices. Within the obstructive-apnea subgroup, greater obesity severity and multiple markers of adiposity (e.g., BMI, waist-hip ratio, and skinfold thickness) were positively associated with higher titration pressures. In contrast, among patients with central sleep apnea, higher titration pressures were associated only with percentage body fat and waist–hip ratio. Notably, none of the anthropometric parameters showed a significant positive correlation with the residual AHI during PAP titration, leading the authors to contend that obesity does not substantially contribute to titration failure or residual respiratory events.[13]

In our cohort, anthropometric measurements were likewise related to the treatment pressures generated by APAP; patients with residual OSA required higher minimum, maximum, and mean pressures than those without residual events. However, only body weight and BMI differed significantly between participants with and without residual OSA, and multivariate analyses identified BMI as an independent predictor of residual disease. Divergences between our findings and those of Kollár et al. may be attributable to differences in the study populations (male-only versus a mixed-sex cohort) or to the PAP modalities used (bilevel/continuous PAP versus APAP). Whereas the laboratory study incorporated sophisticated metrics, such as skinfold thickness and visceral fat area, our investigation employed newer indices, such as the BRI and the WNR; these indices did not capture residual OSA, suggesting that the overall burden of obesity -rather than its regional distribution- may exert a more decisive influence on residual AHI.

Fashanu et al. reported that manual CPAP titration overestimates therapeutic pressure requirements; after 30 days of APAP use, the 90th/95th percentile pressures were lower than the pressures determined by manual titration, and BMI alone predicted the need for higher pressures. The study also highlighted that residual AHI recorded during APAP treatment was lower than the residual AHI observed during manual titration and that the discrepancy in pressure and residual events reached statistical significance only in patients with the highest BMI and most severe OSA. Multivariate analyses confirmed that BMI was the sole predictor of higher manually derived therapeutic pressure.[16] These findings are consistent with our observation that individuals with residual OSA required higher therapeutic pressures and that BMI predicts residual OSA. In obese patients, increased cervical adiposity promotes upper airway collapse and thoracic obesity reduces functional residual capacity (FRC), which together necessitate higher PAP pressures to maintain airway patency.[8] A sepa-

rate investigation found that BMI >35 kg·m^{-2} predicts lower rates of successful CPAP titration; in our cohort, a BMI cutoff of 31.25 kg·m^{-2} was associated with a greater likelihood of residual OSA.[17]

A 2020 investigation into factors influencing optimal CPAP titration found that patients requiring pressures above 9 cm H_2O exhibited significantly larger neck and WCs and higher hypopharyngeal collapse scores than those whose optimal pressure was ≤9 cm H_2O. In multivariate logistic regression, NC and retrolingual lateral wall collapse emerged as independent predictors of higher therapeutic pressure. These data underscore the importance of upperairway anatomy in determining pressure requirements.[18] In our cohort, treatment pressures correlated strongly with anthropometric measurements, yet residual OSA was associated only with body weight and BMI. The absence of a significant relationship between neck or WC and residual OSA may reflect differences in measurement protocols or the dynamic APAP algorithm adjusting pressure continuously across sleep stages. Furthermore, the majority of participants in Kırgezen et al. study presented advanced hypopharyngeal collapse and retrolingual narrowing, whereas our patients did not undergo systematic upperairway evaluation. Without a detailed assessment of cervical and pharyngeal morphology, waist and NCs alone may therefore be insufficient to predict residual AHI.

Our finding that residual OSA was associated only with general measures of adiposity, namely, BMI and body weight, implies that the relationship between visceral adiposity and upperairway collapse may be more complex than previously appreciated. Elevated BMI can signify substantial thoracic fat deposition and reduced lung volumes even in the absence of increased NC; obesity is known to reduce FRC and total lung capacity, thereby increasing the propensity for airway closure and decreasing chestwall compliance.[8] Such reductions in FRC amplify intrathoracic negative pressure during apneas and may diminish upperairway muscle tone, necessitating higher pressures from the APAP device and contributing to residual events. The inability of the BRI and WNR to predict residual OSA underscores their limitations as proxies for visceral adiposity: BRI relies chiefly on WC and height and does not reflect cervical fat deposition, which is a key driver of airway obstruction. Furthermore, we did not incorporate direct assessments of upperairway morphology -such as imaging, Mallampati scores, or pharyngeal collapse tests- so anthropometric proxies alone may not capture the full range of biological determinants of residual AHI.

LIMITATIONS

Several caveats should be considered when interpreting the present findings. First, the retrospective design and single-center setting constrain causal inference and may introduce selection bias; only patients who transitioned from CPAP to APAP and had complete data were analyzed, which might not represent the broader OSA population. This selection bias may have consequential implications for our findings. CPAP intolerance may be correlated with specific patient phenotypes, such as those requiring higher therapeutic pressures or possessing distinct anatomical features (e.g., elevated BMI or increased pharyngeal collapsibility). It is plausible that the therapeutic response to APAP in this specific cohort -patients who have already failed CPAP- differs systematically from that of a *de novo* APAP-treated population. Therefore, our results may primarily reflect outcomes within a CPAP-refractory subgroup, and their generalizability should be considered accordingly. Second, the sample of 58 individuals affords limited statistical power, particularly for subgroup analyses, and may have prevented the detection of subtle associations between anthropometric indices and residual disease. Third, the cohort comprised only moderate-to-severe OSA patients treated with a single APAP algorithm; thus, the results may not be generalizable to milder phenotypes or to other autotitrating devices employing different pressure algorithms.

Moreover, although BMI, BRI, and WNR ratio were assessed, dynamic changes in body composition, muscle mass, and connective tissue over time were not captured-factors such as fluid shifts that could influence long-term PAP efficacy were therefore unaccounted for. Airway morphology was not systematically evaluated via imaging or clinical grading (e.g., Mallampati

score), hindering the evaluation of anatomical contributors to residual OSA. Finally, follow-up was restricted to short-term posttitration outcomes; to substantiate and expand these observations, longitudinal data on adherence, weight change, and residual AHI under extended APAP therapy are required.

CONCLUSION

This study shows that APAP therapy markedly reduces the API in moderate-to-severe OSA, yet about one-third of patients exhibit residual disease. Overall obesity, as reflected by body weight and BMI, correlated strongly with higher pressure requirements and residual events, whereas the BRI and WNR did not provide additional predictive value. These findings underscore the need for weight-management strategies to optimize APAP outcomes and suggest that simple measures of global adiposity suffice for risk stratification. Prospective, long-term studies incorporating detailed body composition and airway assessments are warranted to confirm these observations and refine personalized treatment approaches.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Burak Çelik, Fatih Gül;* ***Design:*** *Burak Çelik, Fatih Gül;* ***Control/Supervision:*** *Mehmet Ali Bababdemez;* ***Data Collection and/or Processing:*** *Alihan Topal, Kadir Şinasi Bulut;* ***Analysis and/or Interpretation:*** *Serkan Şerifler;* ***Literature Review:*** *Burak Çelik;* ***Writing the Article:*** *Burak Çelik;* ***Critical Review:*** *Mehmet Ali Bababdemez, Fatih Gül;* ***References and Fundings:*** *Burak Çelik;* ***Materials:*** *Burak Çelik.*

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