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ORIGINAL RESEARCH

The Usefulness of New Body Indices in Determining the Risk of Cardiovascular Disease in Cases with Obstructive Sleep Apnea Syndrome

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Purpose: Obstructive Sleep Apnea Syndrome (OSAS) is considered a notable independent risk factor for cardiometabolic disorders. The current study aimed to investigate the efficacy of new anthropometric indices, A Body Shape Index (ABSI) and the Body Roundness Index (BRI), in assessing cardiovascular risk (CVR) and cardiovascular disease (CVD) among OSAS patients and to compare them with traditional indices.

Materials and Methods: The records of 281 patients who consulted our sleep center were retrospectively reviewed. Patients were categorized according to OSA severity using AHI values. They were also classified based on cardiovascular conditions (CVR and CVD). ABSI, BRI, and traditional indices [such as body mass index (BMI), neck circumference (NC)] of the patient groups were evaluated.

Results: Of the 281 patients recruited, 218 (77.6%) were diagnosed with OSAS. The distribution of cardiovascular conditions among the OSAS patients was: CVD (20%), CVR (39.8%), and control (40.2%). The new index BRI (Odds ratio-OR: 2.641, 95% CI: 1.24–5.62) has shown better predictive ability for CVR compared to traditional measures, while NC (OR: 1.320, 95% CI: 1.09–1.60) was the only predictor of CVD. Additionally, the BRI had a higher AUC value (0.656) than traditional indices in terms of diagnostic performance in distinguishing CVR. Another new index ABSI was not found to be significant in evaluating cardiovascular conditions.

Conclusion: BRI, one of the new indices, is a useful anthropometric parameter in the CVR assessment of OSAS patients, offering better predictive ability than traditional measurements.

Keywords: anthropometric indices, abdominal obesity, body roundness index, cardiovascular risk, cardiovascular disease, obstructive sleep apnea syndrome

Introduction

Obstructive sleep apnea syndrome (OSAS) is characterized by repeated upper airway collapse, sleep disturbances, and persistent intermittent hypoxia. Along with systemic consequences such as diabetes mellitus (DM), hypertension (HT), arrhythmia, coronary artery disease, and stroke, OSAS is also linked to higher rates of death and morbidity.[1,2]

Obesity, a common health problem worldwide, contributes significantly to the development of OSAS and is among the primary cardiovascular risk factors.[3] Obesity can elevate the risk of premature death, cardiovascular conditions, and type 2 diabetes.[4] The prevalence of CVD is due to increased cardiovascular risk (CVR) factors, especially visceral fat.[5,6] Early determination of obesity is therefore vital for preventing the development of cardiovascular disease (CVD).[7]

Anthropometric measurements are used as important measurements in predicting both obesity and comorbid diseases and new anthropometric indices continue to be investigated.[8]

The use of anthropometric variables for the prediction and diagnosis of OSAS offers a simple, reliable, and cost-effective approach. Anthropometric parameters such as BMI, waist circumference (WC), neck circumference (NC), and waist-hip ratio (WHR) are useful for the general assessment of health status and have a strong correlation with sleep

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apnea.[9–11] Higher anthropometric measurements are typically associated with internal organ fat accumulation. Fat accumulation in the cervical area greatly narrows the upper airway, increasing the risk of CVD and metabolic syndrome.[12] At the same time, extensive epidemiological and clinical studies have shown that upper airway narrowing increases the risk and severity of OSAS.[13] Thus, anthropometric measurements determining obesity can also serve as a tool to determine cardiovascular events.[14] Previous research has shown that OSAS is linked to cardiometabolic disorders through sleep fragmentation and chronic intermittent hypoxia.[15] However, whether there is an independent relationship between these two fundamental features and cardiometabolic disorders remains unclear.[16,17] OSAS is linked to higher rates of mortality as well as morbidity from CVD. It is therefore essential to consider the effect of OSAS on CVD and CVR due to increased CVR in patients with cardiometabolic disorders.[18,19]

Studies conducted in recent years have convincingly demonstrated the effect of obesity on cardiovascular diseases.[20] Anthropometric measurements that are commonly used to classify obesity include BMI and WC. Although BMI is a general indicator of fat percentage, it can be affected by factors such as age, gender, and ethnicity and cannot adequately distinguish visceral fat.[21–23] WC determines abdominal fat but does not take into account height, so parameters such as waist-to-height ratio (WHtR) can offer a more accurate assessment of risk in some cases. However, anthropometric measurements vary according to race and ethnicity and do not provide optimal results in all cases.[24–27] Thus, there is a need to develop new indices that can better evaluate body shape by combining the existing measurements.

Recent studies have highlighted the importance of the regional distribution of body fat and abdominal-type obesity as indicators of morbidity and mortality.[28] Numerous studies have identified a relationship between cardiometabolic diseases and central fat parameters.[29] In this context, A Body Shape Index (ABSI), which evaluates abdominal fat tissue, was defined by Krakauer et al,[30,31] and Body Roundness Index (BRI), which calculates body fat percentage, was defined by Thomas et al[32,33] ABSI has been identified as a parameter that is significantly associated with the risk of premature death and the onset of diabetes, while BRI is used to evaluate health status. However, some studies have reported contrary results for these new anthropometric indices. For example, Maessen et al stated that ABSI is not an appropriate index for defining CVH and CVR factors.[34]

The goal of the current study was to assess whether the new indices BRI and ABSI can be used to predict CVR and CVD in patients with OSAS and to evaluate whether they are superior to traditional anthropometric indices.

Materials and Methods

Study Design and Population

The current research was designed as a retrospective, cross-sectional study evaluating the data of patients who underwent polysomnography (PSG) with a preliminary diagnosis of OSAS at our Sleep Center in the Pulmonology Department between January 2018 and June 2018. Individuals under the age of 18 as well as those diagnosed with narcolepsy, movement disorders, upper airway resistance syndrome, central sleep apnea, or hypoxemic respiratory illness such as interstitial lung disease, COPD, or asthma were excluded from the research. After the initial screening, 281 patients who met our selection criteria were included in the study.

The PSG evaluations were carried out under the American Academy of Sleep Medicine (AASM) guidelines.[35] The patients were divided into four categories based on their AHI scores: no (control, AHI:<5), mild (AHI: 5–15), moderate (AHI: 15–30), and severe (AHI ≥30) OSAS. The participants' demographic information, comprehensive medical history including metabolic and cardiovascular conditions, pharmaceutical history, lifestyle habits, and sleep patterns were collected from their medical records. Additionally, patients were categorized according to the presence of CVR [hypercholesterolemia and/or hypertension (HT)] and CVD [myocardial infarction (MI) and/or stroke]; individuals lacking a history of MI, stroke, HT, and hypercholesterolemia were assigned to the control group.

Polysomnography (PSG)

PSG was conducted on all participants using a 55-channel unit (Alice 6 LDE Sleepware; Philips, Respironics Pennsylvania, USA) that included standard PSG metrics such as electrooculography (EOG) (2 channels), electroencephalography (EEG) (4 channels: C4A1, C3A2, O1A2, O2A1), submental and tibial electromyography (EMG), electrocardiogram (ECG), body position sensor, oronasal airflow sensor, chest and abdominal movement sensors, tracheal microphone, and pulse oximetry. As per the standardized guidelines set forth by the American Academy of Sleep Medicine (AASM), a decrease in airflow by at least 90% from the baseline amplitude for ten seconds was categorized as apnea, while a decrease in airflow by at least 30% from the baseline amplitude for ten seconds combined with a minimum of three units of oxygen desaturation or arousal was categorized as hypopnea. The number of hypopnea and apnea events per hour was defined as the AHI. A decrease in oxygen saturation of 3% or more per hour during sleep was used as the Oxygen Desaturation Index (ODI).

Anthropometric Measurements

Anthropometric measurements were determined from retrospective records and included height, weight, and waist circumference (WC), neck circumference (NC), and hip circumferences (HC). Measurements were taken after a 12-hour fasting period, using standard clinical scales for weight (in kilograms) and a stadiometer for height. All measurements were carried out by the same person to minimize any observer error and reported to the nearest 0.5 cm. NC was determined by measuring the length from the upper edge of the cricothyroid membrane while standing, WC was determined as the distance between the narrowest point between the xiphoid process and the umbilicus, and HC was determined from the widest area in a horizontal position, over the trochanters, with the legs 20–30 cm apart while standing.

Anthropometric measurements such as ABSI, BRI, BMI, WHR, and WHtR were calculated from the weight, height, WC, and HC measurements according to the standardized formulae shown below:[30,32,34,36]

Body Roundness Index (BRI)=364.2 – (365.5 × €), € =$\sqrt{}$(1-(WC/(2π)) ^{2}/ (0.5× Height) ^{2}).

A-Body Shape Index (ABSI)=WC (m)/(BMI $^{2/3}$ × Height [m] $^{1/2}$).

Body Mass Index (BMI)= Weight (kg)/Height (m)^2.

Waist-Hip Ratio (WHR)= Waist (m)/Hip (m).

Waist-to-Height Ratio (WHtR)= Waist (m)/Height (m).

Statistical Analysis

The data generated from the current research were analyzed using the Statistical Package for the Social Sciences (SPSS), version 22 for Windows. Continuous data fit for normal distribution was evaluated using the Kolmogorov–Smirnov test, Q-Q plot, box plot, skewness, and kurtosis. The chi-square test was employed to assess the categorical groups. In the analysis of normally distributed continuous variables, the independent *t*-test and One-Way Analysis of Variance (ANOVA) were utilized to detect group differences. The Pearson correlation test was used to demonstrate the presence of any relationship among the continuous variables. ROC analyses were used for the diagnostic performance of the anthropometric parameters. The variables that can potentially predict the risk of CVD or CVR were evaluated by establishing a (binary) logistic regression model. A p-value below 0.05 was considered statistically significant.

Result

Of the 281 cases participating in the research, 150 (53.4%) were men and 131 (46.6%) were women. The mean age of the participants was 50.04±11.08 years. In this cohort, 218 (77.6%) had OSAS while, 93 (33.1%) were smokers. Among the individuals with OSAS, 42 (19.3%) were assigned to the CVD group, 91 (41.7%) were assigned to the CVR group, and the remaining 85 (39%) were in the control group due to the absence of any cardiovascular conditions.

Of all the patients recruited to the study, 51.6% had HT, 19.6% had a history of MI, 19.2% had hypercholesterolemia, and 0.7% had suffered a stroke. The average anthropometric measurements of the patients were as follows: height: 1.67 ±0.09m, weight: 91.15±18.42 kg, NC: 40.83±3.38cm, WC: 112.50±12.80 cm, HC: 112.75±13.84cm, WHR: 1.002±0.08, BMI: 32.9±6.68 kg/m^2, BRI: 7.41±2.05, ABSI: 0.008±0.007, WHtR: 0.67±0.08, and WHHR: 0.60±0.05.

Significant differences in anthropometric measurements (except ABSI and WHR) were detected between the different OSAS stages (Table 1). Anthropometric measurements other than weight and ABSI also showed significant differences between the CVD and CVR groups when compared to the control group. In addition, smoking prevalence was not

Table 1 Comparison of Patient Characteristics and Anthropometric Measurements According to the Severity of OSAS

	Control n=63	Mild OSAS n=73	Moderate OSAS n=73	Severe OSAS n=72	p-value
Sex n (%)					
Female	35 (26.7)	31 (23.7)	37 (28.2)	28 (21.4)	
Male	28 (18.7)	42 (18.7)	36 (24.0)	44 (29.3)	0.192
Age (mean±)	47.38±1.498*	48.64±10.839	50.62±1.100	53.18±10.296*	0.012
Height (mean±SD)	1.65±0.091	1.65±0.092	1.672±0.080	1.674±0.078	0.526
Weight (mean±SD)	86.62±20.741*	87.66±13.573*	92.32±17.129	97.13±15.635*	0.001
NC (mean±SD)	39.63±3.883*	39.99±2.183*,**	40.86±2.513*,**	42.71±3.880*	<0.0001
WC (mean±SD)	108.86±12.074*	109.18±10.507**	11,247±10.583**	119.10±12.801*	<0.0001
HC (mean±SD)	109.84±13.670*	108.86±11.475**	111.75±12.963**	120.24±14.383*,**	<0.0001
WHR (mean±SD)	0.99±0.075	1.00±0.076	1.01±0.070	0.99±0.082	0.529
BMI (mean±SD)	31.49±7.646*	32.13±5.886	33.24±6.901*	34.78±5.969	0.022
BRI (mean±SD)	6.90±1.940*	6.98±1.867*,**	7.33±1.853*,**	8.36±2.224*,**	<0.0001
ABSI (mean±SD)	0.085±0.0083	0.083±0.0072	0.084±0.0079	0.086±0.0076	0.311
WHtR (mean±SD)	0.65±0.075*	0.66±0.073**	0.67±0.072**	0.71±0.082*,**	<0.0001
WHHR (mean±SD)	0.60±0.05	0.60±0.046	0.60±0.045	0.59±0.044	0.323
AHI (mean±SD)	2.27±1.304*	9.80±2.943*,**	20.83±6.473*,**	55.04±22.878*,**	<0.0001
ODI (mean±SD)	1.73±2.498*	7.30±3.433*,**	18.15±6.270*,**	51.43±20.507*,**	<0.0001
Epworth (mean±SD)	6.02±6.089	4.63±5.298	4.96±5.221	6.71±5.570	0.094
Smoking n (%)					
Yes	41 (21.8)	48 (25.5)	55 (29.3)	44 (23.4)	
No	22 (23.7)	25 (21.9)	18 (9.4)	28 (38.9)	0.311

Notes: Data is presented as mean (SD) or proportion (number). *Significantly different from Controls; ** Significantly different from OSAS degrees.

Abbreviations: NC, Neck Circumference; WC, Waist Circumference; HC, Hip Circumference; WHR, Waist-to-Hip Ratio; BMI, Body Mass Index; BRI, Body Roundness Index; ABSI, A body Shape index; WHtR, Waist-to-Height Ratio; WHHR, (waist/hip)-to-height ratio; AHI, Apnea-Hypopnea Index; ODI, Oxygen Desaturation Index CVD, Cardiovascular Disease; CVR, Cardiovascular Disease Risk.

significantly different among OSAS stages, but there was a significant difference between cardiovascular status groups (Table 2).

According to the logistic regression analysis conducted to confirm the predictive power of anthropometric measurements for the development of CVR in those diagnosed with OSAS, BRI (odds ratio (OR): 2.641, 95% CI: 1.241–5.617, p= 0.012) and NC (OR: 1.196, 95% CI: 1.033–1.383, p= 0.016) were determined as significant anthropometric parameters for CVR. BRI, one of the new anthropometric indices, was the most effective predictor of CVR with its high OR value. When the risk factors associated with CVD in patients with OSAS were evaluated, only NC (OR: 1.320, p= 0.005) was found to be a meaningful predictive factor for CVD (Table 3).

The ROC analysis results in patients with OSAS showed that the discriminative power of BRI, BMI, and NC for CVR was 0.656 (95% CI: 0.576–0.737), 0.640 (95% CI: 0.557–0.723), and 0.605 (95% CI: 0.521–0.689), in terms of AUC values, respectively. BRI (AUC: 0.656) showed the highest diagnostic performance among the anthropometric parameters studied. However, BMI (AUC: 0.640) also had a similar performance to BRI. ROC analysis for CVD in OSAS

Table 2 Comparison of Characteristics and Anthropometric Measurements of OSAS Patients According to Cardiovascular Disease and Cardiovascular Risk Status

	CVD n=42	CVR n=91	Controls n=85	p-value
Sex n (%) Female Male	 21 (%50.0) 21 (%50.0)	 53 (%58.2) 38 (%41.8)	 22 (%25.9) 63 (%74.1)	<0.0001
Age (mean±SD)	55.76±10.20*	53.46±9.78*	45.51±10.16	<0.0001
Height (mean±SD)	1.65±0.07	1.65±0.08*	1.69±0.08	0.008
Weight (mean ±SD)	91.74±19.35	93.79±13.73	91.09±16.30	0.515
NC (mean±SD)	41.60±3.06	41.74±3.78*	40.38±2.14	0.010
WC (mean±SD)	112.26±13.09	116.66±13.31*	111.54±10.06	0.034
HC (mean±SD)	115.21±15.96*	117.56±14.28*	108.65±11.35	<0.0001
WHR (mean±SD)	0,0.7±0.07*	0.99±0.08*	1.02±0.06	<0.0001
BMI (mean±SD)	33.55±6.91	34.58±5.85*	32.11±6.53	0.043
BRI (mean±SD)	7.47±2.15	8.19±2.30*	6.99±1.76	0.001
ABSI (mean±SD)	0.083±0.007	0.084±0.008	0.085±0.006	0.723
WHtR (mean±SD)	0.67±0.08	0.70±0.08*	0.66±0.06	0.002
WHHR (mean±SD)	0.59±0.04	0.60±0.04	0.60±0.04	0.113
Smoking n (%) Yes No	 11 (%26.2) 31 (%73.8)	 22 (%24.2) 69 (%75.8)	 38 (%44.7) 47 (%55.3)	0.009

Note: Data is presented as mean (SD) or proportion (number). *significantly different from control.
Abbreviations: CVD, Cardiovascular Disease; CVR, Cardiovascular Disease Risk; NC, Neck Circumference; WC, Waist Circumference; HC, Hip Circumference; WHR, Waist-to-Hip Ratio; BMI, Body Mass Index; BRI, Body Roundness Index; ABSI, A Body Shape Index; WHtR, Waist-to-Height Ratio; WHHR, (Waist/Hip)-to-Height Ratio.

Table 3 Logistic Regression Analysis for CVR and CVD in Patients with OSAS

Variables	B	S.E.	P	OR	95% C.I. EXP(B)	
					Lower	Upper
For CVR						
BRI	0.971	0.385	0.012	2.641	1.241	5.617
BMI	−0.298	0.152	0.050	0.742	0.551	0.999
NC	0.179	0.074	0.016	1.196	1.033	1.383
WHR	−2.607	2.135	0.222	0.074	0.001	4.840
ABSI	−149.626	83.109	0.072	0.000	0.000	57,661.612

(*Continued*)

Table 3 (Continued).

Variables	B	S.E.	P	OR	95% C.I. EXP(B)	
					Lower	Upper
For CVD						
BRI	0.629	0.432	0.145	1.876	0.805	4.373
BMI	−0.245	0.170	0.149	0.782	0.561	1.092
NC	0.278	0.098	0.005	1.320	1.090	1.600
WHR	−4.743	2.524	0.060	0.009	0.000	1.227
ABSI	−129.589	103.040	0.209	0.000	0.000	2.682E+31

Note: Significant at a value of p<0.05.
Abbreviations: BRI, Body Roundness Index; BMI, Body Mass Index; NC, Neck Circumference; ABSI, A Body Shape Index; WHR, Waist-To-Hip Ratio; B, Standardized regression coefficient, S.E, Standard Error, OR, Odds Ratio, CI, Confidence Interval.

patients showed that both the new and traditional indices lacked discriminative power, except for the relatively weak effect of NC with an AUC of 0.557 (Table 4, Figure 1).

Correlation analyses showed the presence of a substantial correlation between various anthropometric measurements and the oxygen desaturation index (ODI) and AHI (Table 5). A significant positive correlation was found between ODI and NC ($r= 0.44$, $p < 0.001$), BRI ($r= 0.39$, $p < 0.001$), and BMI ($r= 0.26$, $p < 0.001$). However, no strong correlation was found between ABSI ($r= 0.13$, $p= 0.06$) and ODI, and neither the association of ABSI with OSAS severity nor the association with CVR in OSAS patients could be determined.

Table 4 ROC Analysis, AUC Values for CVR and CVD in Patients with OSAS

Variables	Area	Std. Error	Sig.	95% CI	
				Lower Bound	Upper Bound
For CVR					
BRI	0.656	0.041	0.000	0.576	0.737
BMI	0.640	0.042	0.001	0.557	0.723
NC	0.605	0.043	0.016	0.521	0.689
ABSI	0.440	0.044	0.169	0.354	0.526
WHR	0.364	0.042	0.002	0.282	0.447
For CVD					
NC	0.557	0.052	0.252	0.454	0.659
BRI	0.475	0.051	0.611	0.375	0.574
ABSI	0.479	0.052	0.669	0.378	0.580
BMI	0.498	0.051	0.964	0.398	0.598
WHR	0.361	0.042	0.005	0.278	0.443

Abbreviations: NC, Neck Circumference; BRI, Body Roundness Index; ABSI, A Body Shape Index; BMI, Body Mass Index; WHR, Waist to-Hip ratio; CI, Confidence Interval.

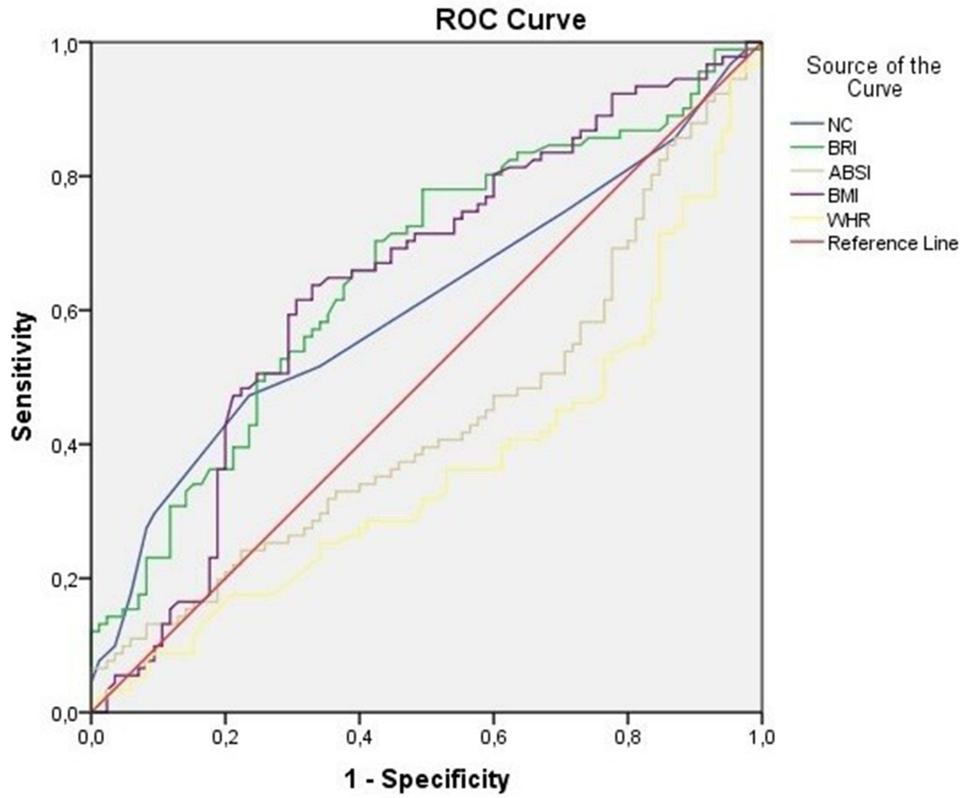

Figure 1 ROC analysis for CVR in patients with OSAS.

Discussion

The current research primarily focused on the effectiveness of novel body indices in assessing the risk of cardiovascular conditions in cases with OSAS. Our findings indicated that BRI, one of the new anthropometric indices, was a useful measure to identify and predict CVR. However, another new index, ABSI, was not an important predictor of CVD or

Table 5 Correlation Between Anthropometric Measurements, ODI and AHI

		WHR	NC	BMI	BRI	ABSI	ODI	AHI	WC	WHtR
WHR	**r**	**1**								
	p									
NC	**r**	0.02	**1**							
	p	0.820								
BMI	**r**	−0.15	0.32	**1**						
	p	0.013	<0.001							
BRI	**r**	0.002	0.33	0.72	**1**					
	p	0.900	<0.001	<0.001						
ABSI	**r**	0.32	0.05	−0.58	0.139	**1**				
	p	<0.001	<0.001	<0.001	0.041					

(*Continued*)

Table 5 (Continued).

		WHR	NC	BMI	BRI	ABSI	ODI	AHI	WC	WHtR
ODI	**r**	0.38	0.44	0.26	0.39	0.13	1			
	p	<0.001	<0.001	<0.001	<0.001	0.063				
AHI	**r**	−0.04	0.43	0.25	0.38	0.13	0.99	1		
	p	0.575	<0.001	<0.001	<0.001	0.552	<0.001			
WC	**r**	0.18	0.46	0.57	0.89	0.34	0.44	0.43	1	
	p	0.008	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		
WHtR	**r**	0.001	0.34	0.72	0.99	0.14	0.08	−0.07	0.89	1
	p	0.983	<0.001	<0.001	<0.001	0.040	0.225	0.269	<0.001	

Abbreviations: WHR, Waist to-Hip ratio; NC, Neck Circumference; BMI, Body Mass Index; BRI, Body Roundness Index; ABSI, A Body Shape Index; AHI, Apnea-Hypopnea Index; ODI, Oxygen Desaturation Index; WC, Waist Circumference; WHtR, Waist-to-Height Ratio; r, Correlation Coefficient; p, *p* value.

CVR in the cohort studied. The new as well as traditional indices other than NC were found to be inadequate as significant predictors in the CVD group.

The relationship between the severity of OSAS and cardiovascular conditions was also assessed in the current study, along with the role of new and traditional anthropometric indices in this interaction. Anthropometric indices such as BRI, BMI, HC, NC, WC, WHR, and WHtR were importantly different in OSAS individuals diagnosed with CVD and CVR in proportion to the control group. However, ABSI did not show any significant difference between the individuals with different cardiovascular conditions in the OSAS patient population.

Upon examining all the patients included in the current study based on their severity of OSAS, anthropometric measurements such as BMI, BRI, HC, WC, NC, WHtR, and WHR, which are markers of abdominal obesity, showed substantial differences between the OSAS groups and the control group. These indices were observed to increase with an increase in the severity of OSAS. Numerous other research have reported that these well-established anthropometric parameters are connected with the severity of OSAS, supporting the results of the current research.

A multitude of research investigations have documented an increase in the association between metabolic disorders and CVD in patients with OSAS.[37,38] Furthermore, a relationship between the anthropometric indices and the Oxygen Desaturation Index (ODI), a parameter indicating the severity of OSAS, has also been reported.

Pathophysiological mechanisms such as intermittent hypoxia, ischemia- reperfusion injuries resulting from sleep fragmentation, and increased sympathetic activity in OSAS patients are implicated in the worsening of cardiovascular conditions.[39,40] From the perspective of hypoxia, ODI is an index that establishes the connection between OSAS and cardiovascular conditions. Correlation analyses carried out in the current study revealed that BRI, along with some traditional OSAS-related anthropometric parameters (such as BMI, NC, and WC), was significantly associated with ODI. However, no relationship could be identified between ODI and ABSI.

Advanced age, smoking, and especially obesity are significant risk factors that can influence the association between OSAS and cardiometabolic diseases.[41] Recent studies have focused more on where the fat is concentrated in the body and how it is distributed, rather than the overall body fat percentage. BMI is often considered a sign of central obesity; however, this measurement ignores important details such as muscle mass and fat distribution.[28,42] Thus, other indices that evaluate abdominal obesity, such as WC, HC, WHtR, and WHR, are also used to estimate cardiovascular risks.[36] The HC measurement is suggested to be a more efficient indicator of mortality risk in comparison to BMI. A high WC and a low HC measurement have been shown to have a stronger association with mortality risk; however, BMI was not found to be a significant indicator in this context.[43,44] Furthermore, the capacity of WHtR to predict cardiometabolic risk factors and mortality risk is supported by various studies.[26] However, mortality analyses were not conducted in this current investigation. Nevertheless, we noticed that WHtR and WC showed significant positive correlations with AHI and ODI and were notably elevated in OSAS patients with CVR and CVD. These findings suggest that certain anthropometric indices may indicate the severity of OSAS and the decline in nocturnal oxygen saturation.

Krakauer et al created ABSI, a novel anthropometric measurement that can estimate both visceral abdominal fat and overall adipose tissue. The ABSI was designed to predict the body's health status independent of body size (BMI, height, and weight) and has been suggested to predict the early mortality rate better than BMI or WC.[30] Some authors have also examined the relationship between ABSI and various adiposity measures, such as BMI, HC, weight, body fat index (BAI), WHR, and WC, stating that ABSI might be the most effective index among these anthropometric measurements in predicting the risk of death.[45,46] However, Maessen et al reported that ABSI did not have a significant predictive value for CVR.[36] We also observed that the ABSI did not show any association with the presence or severity of OSAS and did not show any significant association with CVD and CVR in the OSAS patient population. While the estimated average body height in the study by Krakauer et al was 1.70 meters (m), the mean height of the cohort in the current study was 1.67 m. This indicates that body height may influence the power of ABSI to assess the risk of CVD in the study group, which should be addressed in future studies.

The BRI, created by Thomas et al, is another novel index that evaluates the general health status of patients and estimates the body fat proportion by combining waist and height circumference. BRI allows the estimation of the human body's shape as oval or elliptical. Additionally, it can estimate both visceral adiposity and percent fat distribution in the body with the use of WC according to the height of an individual.[32] Maessen et al reported that BRI could significantly predict CVR but had no superiority over BMI or WC.

In this study, we assessed the novel anthropometric indices BRI and ABSI in comparison with traditional measurements such as BMI, WHR, WC, and NC in the OSAS patient population. To our knowledge, the current study is the first to evaluate CVR in OSAS patients by simultaneously using the new anthropometric measurements BRI and ABSI. We showed that BRI, but not ABSI, was an effective factor in the evaluation of CVR in patients with OSAS. Compared with traditional indices such as BMI, WHR, and NC, BRI (OR: 2.64, p= 0.012) was found to have a better predictive capacity for CVR. Moreover, the diagnostic performance of BRI (AUC 0.650) was the highest among the anthropometric parameters studied. However, it was not significantly superior to BMI (AUC 0.640). For CVD, only NC (OR: 1.320, p= 0.005) was found to be significant in the prediction of the disease among the different indices, but its diagnostic power was weak (AUC 0.557).

We also report that BRI was significantly different between the patients belonging to the different cardiovascular condition groups, while ABSI was not. Additionally, a significant correlation was detected between BRI, ODI, and AHI. Thus, BRI is associated with oxygen desaturation and the severity of OSAS, as well as CVR, and can be considered to be important for the prognosis of OSAS.

Our study underlines the potential of new anthropometric measurements to improve predictive accuracy for cardiometabolic diseases, similar to the observations made by Balat et al.[47] Predicting OSAS and cardiovascular conditions with useful practical anthropometric parameters before methods such as PSG, which require professional personnel and equipment and have more limited accessibility, can make important contributions to clinical practice. These results may support early diagnosis and treatment by accelerating the referral of potential cases to definitive diagnosis.

The lack of a prospective follow-up of the patients, not conducting an analysis of the impact of continuous positive airway pressure therapy on anthropometric indices, and not evaluating the association between these measurements and mortality can be considered limitations of this study.

Conclusions

The outcomes of this study highlight the importance of both new and traditional anthropometric indices in the assessment of cardiovascular conditions in patients with OSAS. One of the novel anthropometric indices, BRI, emerged as a useful measurement for predicting CVR in OSAS patients in the current study, offering better predictive value than traditional measurements. Another novel index, ABSI, was not found to be a useful anthropometric parameter in predicting CVR. More comprehensive studies should be carried out to investigate the causal relationship between OSAS, anthropometric indices, and cardiovascular risks and to determine more useful indices in clinical practice.

Data Sharing Statement

The dataset used and/or analyzed in this study is not publicly available as it was obtained from our Hospital's Hospital Information Management System, but it can be provided by the corresponding author upon reasonable request.

Ethical Approval

The present study was conducted in accordance with by the principles of the Declaration of Helsinki and was approved by the Ethics Committee of S.B. University Konya Training and Research Hospital with the decision dated 07.06.2018 and numbered 16-09. The requirement for written consent was waived by the Ethics Committee of S.B. University Konya Training and Research Hospital because of the retrospective design. Patient confidentiality and data protection were meticulously maintained.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests.

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