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Body shape index (ABSI), body roundness index (BRI) and risk factors of metabolic syndrome among overweight and obese adults: a cross-sectional study

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Abstract

Background Metabolic syndrome (MetS) is one of the most significant public health issues worldwide, which increases the risk of various diseases. Epidemiological evidence suggests that newer anthropometric measures, such as a body shape index (ABSI) and body roundness index (BRI) can be used to predict MetS. However, anthropometric measures to predict the risk for MetS should be clarified in each population. Therefore, this study aimed to examine the association between ABSI, BRI, and MetS risk factors among overweight and obese Iranian adults.

Methods This cross-sectional study included 347 overweight and obese individuals [body mass index (BMI) > 25 kg/m2] aged 20–50 years in Tabriz, Iran. Anthropometric measures were assessed, including BMI, waist circumference (WC), and waist-to-hip ratio (WHR). Additionally, ABSI and BRI were calculated based on the collected data. Blood pressure was measured using standard protocols. Body composition also was measured using body impedance analysis (BIA). Enzymatic-colorimetric methods were used to assess serum glucose and lipids, and enzyme-linked immunosorbent assay (ELISA) kits were used to measure insulin levels.

Results Participants with higher ABSI exhibited significantly higher systolic blood pressure (SBP) ($P=0.001$), diastolic blood pressure (DBP) ($P=0.010$), and triglyceride (TG) levels ($P<0.001$), along with significantly lower high-density lipoprotein cholesterol (HDL-C) levels ($P<0.001$). In the crude model, individuals in the highest ABSI tertile (tertile 3) had a higher likelihood of having higher SBP (OR: 1.032; 95% CI: 1.014–1.051) and DBP (OR: 1.33; 95% CI: 1.009–1.058), as well as a significant association with lower HDL-C levels (OR: 0.945; 95% CI: 0.918–0.973). Additionally, both ABSI tertile 2 (OR: 1.005; 95% CI: 1.001–1.008) and tertile 3 (OR: 0.993; 95% CI: 1.003–1.011) were linked to a higher likelihood of having higher TG levels. No significant associations were found between BRI tertiles and MetS risk factors.

Conclusion According to our results, ABSI and BRI are poor predictors of MetS risk variables, in overweight and obese individuals. High ABSI is only slightly linked with high SBP, DBP, and TG and low HDL-C. However, longitudinal and long-term investigations are encouraged to verify the efficacy of these two measures.

This study is not a clinical trial and no registry number is required.

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Keywords A body shape index, Body roundness index, Metabolic syndrome, Obesity, Overweight

Background

Metabolic syndrome (MetS) or insulin resistance syndrome [1] is a multifaceted condition defined by a combination of related factors that elevate the likelihood of developing cardiovascular atherosclerotic diseases and type 2 diabetes mellitus [2]. According to the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) criteria, MetS is present if an individual meets three or more of the following five conditions: a waist circumference greater than 40 inches in men or 35 inches in women, blood pressure higher than 130/85 mmHg, fasting triglyceride levels exceeding 150 mg/dl, fasting HDL cholesterol levels below 40 mg/dl for men or 50 mg/dl for women, and fasting blood sugar levels above 100 mg/dl [3]. MetS prevalence estimates differ based on the diagnostic criteria. The worldwide prevalence of metabolic syndrome (MetS) is about 25% based on race, age, and sex factors [4]. Nearly one-third of the over-20 Iranian population has MetS, with varying prevalence rates reported in different regions [5]. MetS increases the risk of other chronic diseases, including cancer, neurological diseases, and non-alcoholic fatty liver disease which are associated with reproductive, lipid, and circulatory disorders, and increased mortality [6–11]. The modification of lifestyle and improvement of anthropometric indicators are effective in the treatment and prevention of MetS [12, 13].

Visceral adiposity is a key factor in the development of MetS [14]. Traditionally, visceral obesity has been assessed using central obesity-related anthropometric measures, such as waist circumference (WC) [15], body mass index (BMI) [16], and waist-to-hip ratio (WHR) [17], given that visceral fat predominantly accumulates in the abdominal region. However, research has shown that these indices may not fully characterize fat distribution. BMI, for instance, provides a general estimate of obesity but does not account for variations in fat levels among individuals with similar BMI values [18]. WC, on the other hand, may be influenced by body size, making its interpretative value less clear [19]. Additionally, some studies have indicated that WHR is a weaker indicator of visceral obesity compared to WC and BMI [20].

There is a substantial amount of epidemiological evidence indicating that basic anthropometric measures, along with more recent measures like body roundness index (BRI) and a body shape index (ABSI), can serve as predictors of MetS [21]. Using cost-effective and straightforward measurements to identify MetS in low-income countries with limited resources is paramount for public health and healthcare [22]. ABSI index is calculated based on WC, weight, and height measurements; a high ABSI indicates that WC is higher than expected for a given height and weight and that visceral fat is more concentrated in the abdominal region [23]. Studies have demonstrated that ABSI can diagnose MetS independently if potential confounding factors, such as BMI, are considered [21, 24, 25]. Krakauer et al. [23] demonstrated that ABSI predicts mortality risk more precisely than WC. In addition, the BRI index performed better than BMI, waist-hip ratio (WHR), and BAI in predicting MetS and its components [21, 26]. BRI is utilized to quantify body shape irrespective of height. This index slightly enhanced the prediction of body fat and visceral fat percentage compared to BMI, WC, and hip circumference (HC) [27]. In the study by Li et al. [28], BRI performed better than other anthropometric indices for predicting cardiovascular disease risk factors.

Given the high prevalence of MetS in Iran, it seems necessary to investigate the relationship between inexpensive and novel measures and MetS risk factors. Common indices like BMI and WC can only predict MetS to a certain extent [28]. Due to the lack of research on this topic in Iran, we devised this study to examine the association between ABSI, BRI, and MetS risk factors.

Methods

Participants

This study involved 347 overweight or obese individuals residing in Tabriz, Iran, selected from two recent studies conducted at Tabriz University of Medical Sciences (TUOMS) [29–31]. The flow chart of the study is depicted in Fig. 1. The participants were selected through the outpatient clinics of TUOMS using public announcements and the distribution of advertisements and posters containing general information regarding the inclusion criteria. These criteria included an age range of 20–50 years and a BMI greater than 25 kg/m2. The exclusion criteria encompassed pregnancy, lactation, menopause, recent bariatric surgery, history of cardiovascular disease, cancer, liver or kidney disease, diabetes mellitus, and the use of medications that may impact weight. Informed consent was obtained from all participants, and the study protocol was approved by the TUOMS ethics committee.

General characteristics and anthropometric assessments

Trained interviewers collected demographic information such as age, gender, and medical history using a predetermined questionnaire. Body composition such as fat mass (FM), and fat-free mass (FFM) was determined using BIA (Tanita, BC-418 MA, Tokyo, Japan). Height and weight were measured with a wall-mounted stadiometer and a Seca scale (Seca Co., Hamburg, Germany), with 0.5 cm

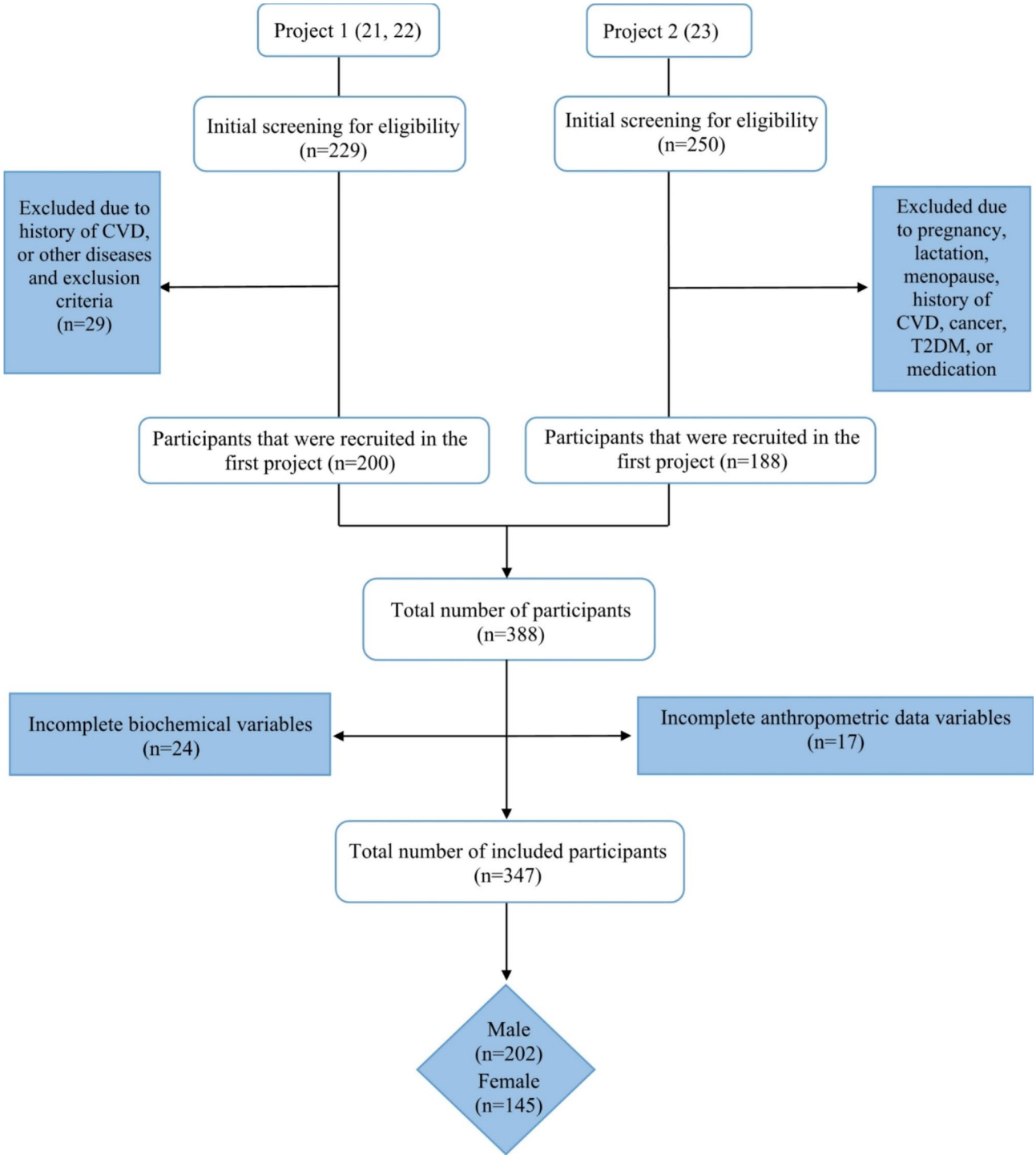

Fig. 1 Study flowchart. The subjects were selected from two projects conducted at Tabriz University of Medical Sciences

and 0.1 kg precisions, respectively. A shortened IPAQ [32] version was used to assess physical activity. The WC at the costal border and the iliac crest was measured with a tape measure with 0.1 cm precision. The hip circumference (HC) was measured at its broadest point. A conventional mercury sphygmomanometer (Riester, Diplomat 1002, Jungingen, Germany) was used to read blood pressure twice in the left arm at 15-minute intervals, and the average of the two readings was used for analysis. The anthropometric variables analyzed were the BMI, which was calculated by dividing weight in kilograms by height in meters squared (underweight < 18.5, normal 18.5–24.9, overweight 25-29.9, and obese ≥ 30), WHR, which was calculated by dividing waist circumference by

hip circumference, ABSI, and BRI. In order to determine the ABSI and BRI indices, the following Eqs. (23, 27) were used:

$$ABSI = \frac{WC}{BMI^{\frac{2}{3}} \times Height^{\frac{1}{2}}} \; and \; BRI$$
$$= 364.2 - 365.5 \times \sqrt{1 - \left(\frac{\left(\frac{WC}{2}\right)^2}{(0.5 \times Height)^2}\right)}$$

We categorized the ABSI and BRI into tertiles. For ABSI, values less than 0.080 were classified as tertile 1, values between 0.080 and 0.083 were designated as tertile 2, and values greater than 0.083 were assigned to tertile 3. Similarly, for BRI, values less than 5.540 were categorized as tertile 1, values between 5.540 and 6.824 were classified as tertile 2, and values exceeding 6.824 were designated as tertile 3.

Sampling procedure

After 12 h of fasting, 10 ml of venous blood was drawn from each participant for biochemical analysis. At 4 °C, serum and plasma samples were separated by centrifugation at 4500 rpm for 10 min. A sample was frozen at -70 degrees Celsius until analysis. A commercial reagent kit (Pars Azmoun, Tehran, Iran) was used to measure fasting blood sugar (FBS), total cholesterol (TC), triglycerides (TG), and HDL-C in the serum. Moreover, the Friedewald equation was utilized to calculate the quantity of low-density lipoprotein cholesterol (LDL-C) [33]. Enzyme-linked immunosorbent assay (ELISA) kits were used to assess the insulin concentration in the blood (ELISA; Monobind Insulin AccuBind, Lake Forest, CA, USA).

Biochemical evaluation

For biochemical evaluation, 10 ml of fasting venous blood was collected from all participants. Serum and plasma samples were separated by centrifugation at 4500 rpm for 10 min at 4 °C. A sample was frozen at -70 °C until analysis. A commercial kit (Pars Azmoun, Tehran, Iran) was used to determine TC, TG, HDL-C, and FBS. In addition, the Friedewald equation was used to determine the level of LDL-C [33]. ELISA kits evaluated blood insulin levels.

Statistical analysis

Statistical analyses were conducted using SPSS software version 26 (IBM Corp., Armonk, NY, USA), with a predetermined significance threshold of 0.05. Categorical variables were presented as percentages and continuous variables were reported as mean and standard deviation. To compare continuous variables, analysis of covariance was employed, while the $\chi 2$ test was utilized for categorical data. Additionally, multinomial logistic regression was performed to examine the association between ABSI and BRI tertiles and biochemical parameters, providing estimates of odds ratios (ORs) and 95% confidence intervals (CIs) in both unadjusted and multivariable-adjusted models.

Results

Table 1 presents a comparison of the demographic and anthropometric characteristics of participants across ABSI tertiles. Subjects in the higher ABSI tertiles exhibited significantly greater age, FFM, and WHR, while their

Table 1 General characteristics of participants by ABSI and BRI tertiles

Variables	Tertiles of ABSI, mean (SD)					Tertiles of BRI, mean (SD)				
	1st tertile (*n* = 116)	2nd tertile (*n* = 116)	3rd tertile (*n* = 115)	*P*-value	*P*-value*	1st tertile (*n* = 116)	2nd tertile (*n* = 116)	3rd tertile (*n* = 115)	*P*-value	*P*-value*
Age (year)	38.75 (9.12)	39.60 (8.48)	44.03 (9.28)	**< 0.001**	-	39.77 (9.44)	39.76 (8.62)	42.79 (9.23)	**0.015**	-
BMI (kg/m^2)	35.11 (4.54)	32.64 (4.30)	32.63 (5.14)	**< 0.001**	**< 0.001**	29.72 (4.24)	32.30 (3.39)	35.78 (4.65)	**< 0.001**	**< 0.001**
Sex [male n (%)]	31 (26.7)	84 (72.4)	87 (75.6)	**< 0.001**	-	76 (65.5)	73 (62.9)	53 (46.1)	**0.002**	-
FM (%)	36.65 (8.77)	31.89 (9.35)	30.90 (7.92)	**< 0.001**	0.934	30.90 (8.16)	31.47 (9.00)	37.72 (8.55)	**< 0.001**	**< 0.001**
FFM (%)	56.77 (11.36)	66.66 (11.97)	66.73 (10.35)	**< 0.001**	**0.005**	64.53 (13.43)	61.78 (12.81)	61.10 (11.11)	0.292	0.210
WC (cm)	103.97 (9.71)	108.35 (8.76)	108.04 (9.82)	**< 0.001**	0.273	101.14 (9.59)	106.22 (6.99)	112.84 (8.34)	**< 0.001**	**< 0.001**
WHR	0.88 (0.07)	0.95 (0.06)	0.98 (0.07)	**< 0.001**	**< 0.001**	0.91 (0.07)	0.94 (0.08)	0.95 (0.07)	**0.001**	**< 0.001**
PA (MET.min/week)	1491.80 (2199.37)	2958.35 (4238.69)	2277.46 (2848.34)	**0.021**	0.244	1858.29 (2883.63)	2703.97 (3607.64)	1920.08 (3080.29)	0.269	0.258

Abbreviations; ABSI, a body shape index; BRI, body roundness index; BMI, body mass index; FM, fat mass; FFM, fat free mass; WC, waist circumference; WHR, waist to hip ratio; PA, physical activity All data are expressed as mean (±SD). *P*-values derived from one-way ANOVA *All variables were adjusted for age and sex

Table 2 Crude and multivariable adjusted ORs and 95% CIs for MetS risk factors across tertiles of the ABSI

Variables	Tertiles of ABSI							
	Crude ORs (95% CI)				Model I[a] ORs (95% CI)			
	1st (*n* = 113)	2nd (*n* = 113)	3rd (*n* = 113)		1st (*n* = 113)	2nd (*n* = 113)	3rd (*n* = 113)	
SBP (mmHg)	1	1.012 (0.995–1.028)	**1.032 (1.014–1.051)**	**< 0.001**	1	1.000 (0.982–1.019)	1.012 (0.992–1.033)	0.242
DBP (mmHg)	1	1.001 (0.979–1.023)	**1.033 (1.009–1.058)**	**0.007**	1	0.990 (0.965–1.016)	1.011 (0.983–1.039)	0.438
FBS (mg/dl)	1	1.006 (0.992–1.019)	0.993 (0.977–1.010)	0.420	1	1.001 (0.986–1.016)	0.984 (0.966–1.003)	0.097
TC (mg/dL)	1	0.999 (0.992–1.006)	1.005 (0.998–1.012)	0.196	1	0.997 (0.990–1.005)	1.003 (0.995–1.011)	0.421
LDL-C (mg/dL)	1	1.000 (0.991–1.008)	1.005 (0.997–1.013)	0.247	1	0.998 (0.989–1.007)	1.003 (0.994–1.013)	0.456
HDL-C (mg/dL)	1	0.967 (0.941–1.994)	**0.945 (0.918–0.973)**	**< 0.001**	1	0.992(0.963–1.023)	0.970 (0.938–1.002)	0.069
TG (mg/dL)	1	**1.005 (1.001–1.008)**	**1.007 (1.003–1.011)**	**< 0.001**	1	1.002 (0.998–1.006)	1.004 (1.000-1.008)	0.026
Insulin (μIU/mL)	1	0.993 (0.970–1.017)	1.004 (0.983–1.026)	0.691	1	0.995 (0.967–1.024)	1.003 (0.974–1.032)	0.853

*$P<0.05$; [a] Model I: adjusted for age and sex. Abbreviations; SBP, systolic blood pressure; DBP, diastolic blood pressure; FBS, fasting blood sugar; TC, total cholesterol; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TG, triglyceride

Table 3 Crude and multivariable adjusted ORs and 95% CIs for MetS risk factors across tertiles of the BRI

Variables	Tertiles of BRI							
	Crude ORs (95% CI)				Model I[a] ORs (95% CI)			
	1st (*n* = 113)	2nd (*n* = 113)	3rd (*n* = 113)		1st (*n* = 113)	2nd (*n* = 113)	3rd (*n* = 113)	
SBP (mmHg)	1	0.999 (0.984–1.015)	1.007 (0.991–1.024)	0.909	1	1.000 (0.983–1.017)	1.005 (0.988–1.023)	0.554
DBP (mmHg)	1	0.995 (0.973–1.017)	1.008 (0.985–1.030)	0.644	1	0.995 (0.972–1.018)	1.002 (0.978–1.026)	0.890
FBS (mg/dl)	1	1.006 (0.990–1.022)	1.009 (0.994–1.025)	0.496	1	1.005 (0.990–1.021)	1.008 (0.993–1.023)	0.291
TC (mg/dL)	1	1.001 (0.994–1.008)	1.001 (0.994–1.008)	0.777	1	1.001 (0.994–1.008)	1.000 (0.993–1.007)	0.959
LDL-C (mg/dL)	1	0.996 (0.987–1.004)	0.999 (0.991–1.007)	0.287	1	0.996 (0.987–1.004)	0.998 (0.990–1.007)	0.708
HDL-C (mg/dL)	1	0.998 (0.971–1.026)	1.003 (0.976–1.031)	0.908	1	0.995 (0.966–1.024)	0.987 (0.958–1.016)	0.369
TG (mg/dL)	1	1.001 (0.998–1.003)	0.997 (0.994-1.000)	0.675	1	1.001 (0.998–1.003)	0.997 (0.994–1.001)	0.120
Insulin (μIU/mL)	1	1.030 (0.999–1.062)	1.028 (0.997–1.059)	0.060	1	1.030 (0.999–1.062)	1.023 (0.993–1.055)	0.136

*$P<0.05$; [a] Model I: adjusted for age and sex. Abbreviations; SBP, systolic blood pressure; DBP, diastolic blood pressure; FBS, fasting blood sugar; TC, total cholesterol; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; TG, triglyceride

BMI and FM were comparatively lower. Additionally, participants in ABSI tertile 2 demonstrated the highest WC and physical activity (PA) levels. Similarly, Table 1 compares these variables across BRI tertiles and reveals that higher BRI was correlated with higher BMI, FM, WC, and WHR but lower FFM. Notably, participants in ABSI tertile 3 were the oldest, while those in ABSI tertile 2 showed the highest PA levels.

The odds ratios (OR) and 95% confidence intervals (CI) for MetS risk factors across different ABSI tertiles, based on both crude and adjusted models for age and gender, are presented in Table 2. In the crude model, participants in ABSI tertile 3 demonstrated a greater likelihood of having higher SBP (OR: 1.032; 95% CI: 1.014–1.051) and DBP (OR: 1.33; 95% CI: 1.009–1.058). Additionally, a significant association was observed between ABSI tertile 3 and lower HDL-C levels (OR: 0.945; 95% CI: 0.918–0.973). Moreover, both ABSI tertile 2 (OR: 1.005; 95% CI: 1.001–1.008) and ABSI tertile 3 (OR: 0.993; 95% CI: 1.003–1.011) were linked to an increased likelihood of higher triglyceride (TG) levels. However, in the adjusted model (Model I), no significant associations between ABSI tertiles and MetS risk factors were observed.

Table 3 presents the OR and 95% CI for MetS risk factors across BRI tertiles, considering both crude and adjusted models. No significant associations between BRI tertiles and MetS risk factors were identified in either the crude model or Model I.

Participants with higher ABSI exhibited significantly higher levels of SBP ($P=0.001$), DBP ($P=0.010$), and triglycerides (TG) ($P<0.001$). In contrast, higher ABSI was associated with significantly lower levels of HDL-C ($P<0.001$) (see Table 4). Additionally, Table 5 indicates that there were no statistically significant differences in metabolic syndrome (MetS) risk factors among the various BRI tertiles.

Table 4 MetS risk factors of participants across different tertiles of ABSI

Variables	Tertiles of ABSI, mean (SD)			
	1st tertile (*n* = 116)	2nd tertile (*n* = 116)	3rd tertile (*n* = 115)	*P*-value
SBP (mmHg)	119.43 (15.34)	122.37 (18.45)	127.21 (16.35)	**0.001**
DBP (mmHg)	80.37 (11.56)	80.51 (13.40)	84.47 (9.36)	**0.010**
FBS (mg/dl)	92.44 (12.24)	94.80 (27.94)	90.73 (12.95)	0.272
TC (mg/dL)	189.89 (32.88)	188.33 (37.28)	196.15 (39.30)	0.230
LDL-C (mg/dL)	122.22 (30.67)	121.74 (32.46)	127.11 (32.31)	0.367
HDL-C (mg/dL)	46.01 (9.47)	42.89 (9.53)	41.07 (8.95)	**< 0.001**
TG (mg/dL)	127.46 (72.67)	152.77 (99.05)	177.41 (101.86)	**< 0.001**
Insulin (μIU/mL)	16.27 (10.79)	15.24 (8.55)	17.21 (20.64)	0.664

Abbreviations; SBP, systolic blood pressure; DBP, diastolic blood pressure; FBS, fasting blood sugar; TC, total cholesterol; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; TG, triglyceride. All data are expressed as mean (± SD). *P*-values derived from one-way ANOVA. *All variables were adjusted for age and sex

Table 5 MetS risk factors of participants across different tertiles of BRI

Variables	Tertiles of BRI, mean (SD)			
	1st tertile (*n* = 116)	2nd tertile (*n* = 116)	3rd tertile (*n* = 115)	*P*-value
SBP (mmHg)	122.43 (19.36)	122.18 (14.69)	124.34 (14.70)	0.548
DBP (mmHg)	81.68 (12.18)	80.96 (11.73)	82.68 (11.17)	0.531
FBS (mg/dl)	91.13 (19.02)	92.66 (12.85)	94.15 (24.02)	0.492
TC (mg/dL)	190.65 (41.31)	192.02 (29.17)	191.65 (38.73)	0.958
LDL-C (mg/dL)	125.45 (34.52)	120.98 (27.20)	124.65 (33.42)	0.526
HDL-C (mg/dL)	43.28 (9.57)	43.13 (9.64)	43.56 (9.41)	0.942
TG (mg/dL)	157.68 (80.64)	163.32 (122.06)	136.92 (70.10)	0.079
Insulin (μIU/mL)	13.80 10.74)	17.55 (19.31)	17.11 (8.75)	0.156

Abbreviations; SBP, systolic blood pressure; DBP, diastolic blood pressure; FBS, fasting blood sugar; TC, total cholesterol; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; TG, triglyceride. All data are expressed as mean (± SD). *P*-values derived from one-way ANOVA. *All variables were adjusted for age and sex

Discussion

In a recent cross-sectional study, we investigate the associations between ABSI and BRI scores and MetS risk factors in 347 overweight and obese persons in Tabriz, Iran. Our results showed that higher SBP and DBP and lower HDL-C were significantly related to the highest ABSI tertile. Additionally, the risk of elevated TG substantially increases with increasing ABSI tertile. However, none of these risk variables were significantly correlated with BRI.

Our results demonstrate a small but significant association between greater ABSI tertiles and several risk variables of MetS, including higher SBP, DBP, and TG and lower HDL-C. The results of previous studies that have attempted to establish a link between ABSI and MetS risk variables have been inconsistent. For example, Sugiura et al. (2021) discovered that ABSI had a substantial inverse connection with SBP, DBP, LDL-C, FBS, and TG and might be used to identify people with MetS [24]. In another retrospective study, Bertoli et al. analyzed data from 6,081 Caucasian adults and assessed the joint contribution of ABSI and BMI to cardio-metabolic outcomes, finding that ABSI was associated with multiple components of MetS [34]. In cross-sectional research of 9,555 Iranian adults, Haghighatdoost et al. (2014) found that ABSI is a poor predictor of MetS risk variables [25]. Stefanescu et al. (2019), in a study of 1,825 individuals [21], reported that, compared to other anthropometric measurements, ABSI was not a reliable predictor of MetS. Because some people in the group who were classified as obese based on their BMI could have been classified as normal if evaluated with ABSI, the prevalence of obesity will be relatively lower if the criterion is based on ABSI. The low reliability of ABSI in predicting MetS, which is closely connected to obesity, may be at least partially attributable to the fact that ABSI can distinguish between fat and lean mass [23].

Higher ABSI is significantly associated with an elevated risk of higher SBP and DBP, as shown by our research. Our findings are consistent with those of Haghighatdoost et al., who found a positive correlation between ABSI and SBP in adults aged 35 to 54. In addition, a positive correlation was observed among women aged 35 to 54 between ABSI and DBP. There was a positive association with TG in men and women aged 18 to 54 but no significant correlation with HDL-C [25]. Also, Kasaeian et al. conducted a study involving 4,200 Iranian students aged 7 to 18, revealing a significant association between ABSI and z-BMI, WC, SBP, and DBP ($P<0.001$). The authors

proposed that ABSI could be a valuable anthropometric index for predicting MetS [35]. Recent studies found that an increase in WC may raise BP independently of changes in BMI [36, 37]. In addition, there is a negative correlation between height and BP [38, 39]. BMI may have a direct effect on blood pressure that is independent of other clinical risk factors [40, 41]. In this regard, ABSI, an indicator based on WC, weight, and height, maybe a good predictor of SBP and DBP.

Our research confirmed that greater ABSI tertiles are linked to lower HDL-C and higher TG levels. Kajikawa et al. [42] showed that ABSI had a strong positive correlation with TG and a negative correlation with HDL-C. A higher ABSI suggests a larger WC, a greater volume concentration in the central body area [23], and more visceral fat [43] than would be predicted by a person's height and weight. Serum triglycerides have been found to correlate positively with visceral fat level, while HDL-C has been found to correlate negatively with visceral fat rating [44]. By analyzing WC, Kissebah et al. [45] found that central obesity and visceral fat are linked to lipid metabolic disorders.

This investigation found no evidence of a connection between BRI and the risk factors for developing MetS. Previous studies' findings on this matter are inconsistent which are reported below. Although the BRI exhibited strong discriminatory power for MetS in adults of both sexes from different populations, WC and WHtR performed best when screening for MetS, for example, according to meta-analysis research by Rico-Martín et al. [26]. In a study of Peruvian adults, Stefanescu et al. [21] determined that BRI performed similarly to or better than BMI and WC in predicting MetS and its components, and that a one-unit higher BRI was associated with a 2.43-fold greater risk of MetS. Also, Zhenhan et al. carried out a study using data from the National Health and Nutrition Examination Survey (1999–2018) with 47,303 participants to explore the relationship between body roundness index (BRI) and metabolic syndrome (MetS). The findings indicate that higher BRI levels are independently associated with MetS and can effectively identify individuals at risk for early intervention [46]. In a study of Chinese postmenopausal women, Liu et al. [47] discovered that BRI was not more accurate at predicting MetS than conventional obesity indices. The discrepancies are likely the result of various study populations and sample sizes. In addition, Thomas et al. [27] designed BRI to develop a new geometrical index that combines height, waist circumference (WC), and hip circumference (HC) and relates this index to total and visceral body fat. Another possible explanation for BRI's poor performance is that we employed it in a cross-sectional study to predict risk variables for MetS. Our data showed that SBP, DBP, FBS, LDL-C, and HDL-C were slightly higher in the highest BRI tertiles, whereas TG, TC, and insulin were slightly lower.

This research has several limitations. Due to the study's cross-sectional design, we could not confirm that the MetS risk factors presented in this study are the cause of MetS. Future research should investigate the longitudinal relationship between the two new anthropometric indices and MetS. In addition, since chronic diseases are multifactorial disorders, lifestyle, and heredity may confound the relationship between anthropometry and chronic diseases in addition to anthropometric measures. Our research was conducted on a population residing in northwestern Iran whose body morphology and metabolic indices may be affected by their distinctive lifestyle. As stated, the two new anthropometric indices were initially developed in Western countries (the United States) and should be modified for use in other populations, as suggested by other studies [48, 49]. Moreover, the small sample size may explain the null results observed in this study. The sampling method may have introduced bias, as recruiting participants through advertisements likely attracted individuals more concerned about their health.

In conclusion, it was found that both ABSI and BRI are limited in their predictive value for MetS risk variables in overweight and obese individuals. Specifically, higher ABSI showed only a weak association with higher SBP, DBP, and TG levels, and lower HDL-C, suggesting that these indices may not be reliable standalone indicators of MetS risk in this population. Given these results, it is recommended that further longitudinal studies and long-term investigations be conducted with larger sample sizes to more comprehensively assess the potential utility of ABSI and BRI in predicting MetS, and to determine whether they can contribute meaningfully to clinical assessments alongside other established measures.

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Author contributions
The final paper was read and approved by all writers. Research was supervised by MAF, and she also played a key role in designing the study. Together, SF and AH helped with the statistical analysis and drafted the article.

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Data availability
The datasets generated and/or analyzed during the current study are not publicly available due to some restrictions that applied by the ethical committee but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study protocol has been approved by the ethics committee of the Tabriz University of Medical Sciences (registration code: IR.TBZMED.REC.1402.498). Written informed consent was obtained from all of the participants before participation in the study. All methods in the current research were performed in accordance with the declaration of Helsinki's guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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