

BMJ Open Association of anthropometry indices and metabolic syndrome in Iranians: a cross-sectional study of the Fasa adult cohort study

Maryam Seyhoon,¹ Afsane Ahmadi ,² Morteza Zare,² Mahdi Honardoust ,¹ Najmeh Hejazi,² Mohammad Ali Mohsenpour ,¹ R Homayounfar ³

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¹Student Research Committee, School of Nutrition and Food Sciences, Shiraz University of Medical Sciences, Shiraz, Iran (the Islamic Republic of)

²Nutrition Research Center, Department of Clinical Nutrition, School of Nutrition and Food Sciences, Shiraz University of Medical Sciences, Shiraz, Iran (the Islamic Republic of)

³National Nutrition and Food Technology Research Institute, Faculty of Nutrition and Food Technology, Shahid Beheshti University of Medical Sciences, Tehran, Iran (the Islamic Republic of)

Correspondence to

Dr Afsane Ahmadi;
ahmadi.afsane@gmail.com

ABSTRACT

Objectives To evaluate the associations between anthropometric indices and components of metabolic syndrome (MetS), including blood pressure, fasting blood sugar (FBS), triglycerides, high-density lipoprotein cholesterol and waist circumference (WC) in Iranian adults.

Design Cross-sectional analysis of baseline data from a population-based cohort.

Setting Fasa adults' cohort study, a rural community-based cohort in Fars province, Iran.

Participants A total of 1550 adults aged 35–70 years with MetS, identified from among 10 118 cohort participants using the National Cholesterol Education Programme Adult Treatment Programme III criteria.

Primary outcome measures The anthropometric indices include abdominal volume index (AVI), a body shape index (ABSI), atherogenic index of plasma (AIP), body roundness index (BRI), body adiposity index (BAI), conicity index, ponderal index and visceral adiposity index (VAI).

Results Participants (56.1% female) with a mean age of 49.8±9.5 years. AVI was significantly associated with systolic blood pressure (SBP) ($\beta=0.010$, $p<0.001$) and diastolic blood pressure (DBP) ($\beta=0.031$, $p<0.001$). BAI was linked to FBS ($\beta=0.053$, $p<0.001$), DBP ($\beta=0.006$, $p=0.022$) and WC ($\beta=0.001$, $p=0.034$). BRI was positively associated with FBS ($\beta=0.001$, $p=0.049$), SBP ($\beta=0.006$, $p=0.006$) and DBP ($\beta=0.023$, $p<0.001$). AIP was significantly correlated with FBS ($\beta=0.002$, $p=0.003$), SBP ($\beta=0.017$, $p<0.001$) and DBP ($\beta=0.030$, $p<0.001$). VAI was associated with SBP and DBP in both men and women (eg, DBP in men: $\beta=0.023$, $p<0.001$). ABSI showed a negative association with SBP ($\beta=-0.006$, $p=0.015$).

Conclusions Anthropometric indices, including VAI, AIP, BAI, BRI and AVI, exhibit significant associations with key components of MetS in Iranian adults, particularly blood pressure, glycaemic markers and central adiposity. Among these, BAI showed the strongest correlation with MetS parameters, while ABSI displayed the weakest.

INTRODUCTION

One of the major concerns in global health is metabolic syndrome (MetS). According to the criteria defined by the National Cholesterol Education Programme Adult Treatment Programme III (NCEP-ATP III), the

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ Census sampling of the Fasa adult cohort (n=10 118) with predefined inclusion/exclusion criteria.
- ⇒ Assessments were done using standardised protocols with calibrated instruments in a large population, and data were interpreted after controlling for the potential confounders.
- ⇒ Eight anthropometric indices (body adiposity index, conicity index, a body shape index, abdominal volume index, body roundness index, ponderal index, visceral adiposity index and atherogenic index of plasma) were computed using validated formulas, enabling direct methodological comparison.
- ⇒ Cross-sectional design and limited dietary data may impede possible causal inference and allow residual confounding despite adjustment for age, sex, physical activity and energy intake.

simultaneous presence of various metabolic abnormalities, such as hypertension, dyslipidaemia, insulin resistance and central obesity, is the characteristic of this syndrome.¹ MetS prevalence is growing around the world.² The MetS prevalence in Iran is 0.26, and the incidence is 97.96 per 1000.³ Metabolic risk factors can largely affect chronic diseases, particularly cardiovascular diseases and diabetes. These factors have a crucial role in increasing the prevalence and severity of these conditions.⁴ It has been indicated that individuals diagnosed with MetS experience a significantly higher mortality rate compared with those who do not have MetS.⁵ The impact of central obesity, body fat and their effect on the development of MetS is considered a significant challenge in clinical research.⁶

Anthropometric measurements are commonly acknowledged as non-invasive, cost-efficient and uncomplicated methods that can efficiently evaluate body fat distribution, general health status and potential risk of developing diseases.^{7,8} Frequently used

resistance, systemic inflammation (eg, elevated CRP) and altered adipokine secretion, particularly lower adiponectin and higher leptin levels.^{25 73} AIP, defined as $\log(\text{TG}/\text{HDL-C})$, serves as a surrogate for atherogenic small dense LDL particles and is linked to endothelial dysfunction, oxidative stress and insulin resistance.⁷⁴ BAI estimates body fat percentage and correlates positively with insulin resistance, fasting glucose and blood pressure. It is also associated with inflammatory cytokines and adverse lipid profiles.³⁹ ABSI, though less predictive of inflammation than traditional indices, is designed to reflect body shape independent of BMI and has been shown to relate to cardiometabolic mortality risk.⁴¹ AVI estimates the volume of abdominal fat and has demonstrated strong links with impaired glucose tolerance and type 2 diabetes, due to its close correlation with visceral fat.⁷⁵ BRI approximates body fat percentage and visceral adipose tissue and is associated with elevated blood pressure, TG and decreased HDL levels.⁷⁶ C-Index, derived from WC, height and weight, reflects central obesity and has been correlated with hypertension, hyperglycaemia and dyslipidaemia in various populations.⁴⁶ PI, traditionally used in paediatric populations, has recently been linked with cardiometabolic risk in adults as well. Studies have reported associations with WC, blood pressure and lipid disturbances, suggesting it may be a useful screening tool when adjusted for age and sex.⁷⁷

The primary strength of the present research lies in its pioneering investigation into the correlation between MetS parameters and obesity-related indicators among individuals with MetS, using data from the FACS.¹⁹ Despite variations in demographic, geographic and lifestyle factors across the study populations worldwide, both the present study and previous research indicate the usefulness of anthropometric indicators in recognising people at a higher risk of MetS within this region. The observed discrepancies between our findings and some previous studies may partly arise from methodological differences. Variations in population characteristics (eg, age distribution, sex ratio, ethnicity and rural vs urban lifestyle) can influence anthropometric profiles and metabolic risk factors. Furthermore, differences in measurement techniques, such as the type of device used for blood pressure or anthropometric assessments, fasting duration before biochemical sampling or formula variations in calculating indices like AVI and VAI, could contribute to inconsistent results across studies. These methodological variations should be considered when interpreting comparative findings.

However, the cross-sectional design of the study facilitates the evaluation of the relationship between two variables but does not establish the cause-and-effect relationship. In addition, dietary intake and medical history were based on self-report, making them vulnerable to recall and reporting biases. On the other hand, the study population is rural adults from a single province, limiting external validity and generalisability to urban settings or other ethnic groups. Moreover, this study is limited to

Iranian adults; thus, future studies are needed to confirm these findings in different populations.

Our findings have several potential applications in clinical and public health practice. The strong associations observed between AVI, AIP, VAI and key MetS components suggest these indices could be integrated into routine screening programmes in primary care to identify individuals at high cardiometabolic risk earlier and more accurately than BMI or WC alone. Because these measures are derived from simple anthropometric data, they can be implemented cost-effectively in community and rural health centres without advanced equipment. In clinical settings, these indices could be incorporated into electronic medical record systems to flag patients at risk during routine check-ups, prompting early lifestyle interventions or further diagnostic testing. Developing population-specific cut-off values for Iranian adults would allow their integration into national screening algorithms, complementing existing MetS criteria. Furthermore, due to their non-invasive nature and minimal training requirements, these indices are particularly suitable for large-scale public health programmes and resource-limited settings where laboratory testing may not be feasible.

On a policy level, adopting Iranian-specific cut-offs for these indices in national guidelines may improve early detection of MetS and its complications. It is recommended that direct methodologies, including DEXA and BIA methods, be used to accurately determine body fat levels. In addition, future prospective studies are warranted to evaluate the predictive performance of these anthropometric indices for long-term cardiometabolic outcomes, such as incident cardiovascular diseases or type 2 diabetes. Moreover, assessing their responsiveness in intervention programmes, such as lifestyle modification or weight reduction strategies, would further establish their clinical utility.

CONCLUSION

This study demonstrated that anthropometric indices, including VAI, AIP, BAI, BRI and AVI, exhibit significant associations with key components of MetS in Iranian adults, particularly blood pressure, glycaemic markers and central adiposity. Among these, BAI showed the strongest correlation with MetS parameters, while ABSI displayed the weakest.

Social media Mahdi Honardoust, Instagram @honardoust_diet/reels/&ved=2ahUKEwih252ypY-QAxVt2QIHHzbINesQFnoECBwQAQ&usg=AOvVaw3eLYMPD44HrtHlyalYMaVW

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