

Original Research Article

Comparative evaluation of waist-to-height ratio and body mass index as predictors of cardiovascular risk among urban adults in Hyderabad, Telangana: a cross-sectional study

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ABSTRACT

Background: Obesity is an important modifiable determinant of cardiovascular disease. Body mass index (BMI), although widely used, does not adequately reflect abdominal adiposity. Waist-to-height ratio (WHtR) may provide a simple alternative for identifying individuals with increased cardiometabolic risk. The aim of the study is to compare WHtR and BMI as predictors of cardiovascular risk among urban adults in Hyderabad, Telangana.

Methods: This cross-sectional study included 70 adults aged 18-60 years. Anthropometric parameters, blood pressure, fasting plasma glucose, and lipid profile were assessed. BMI and WHtR were calculated using standard formulae. Cardiovascular risk was assessed based on the presence of cardiometabolic abnormalities. Receiver operating characteristic (ROC) analysis was performed to compare the discriminatory ability of BMI and WHtR.

Results: The mean age was 41.6±10.8 years. Elevated WHtR (≥ 0.50) was observed in 45 (64.3%) participants, while 39 (55.7%) had BMI ≥ 25 kg/m². Participants with elevated WHtR demonstrated a greater burden of hypertension, dysglycemia, and dyslipidaemia. WHtR showed a higher area under the ROC curve than BMI (0.82 vs 0.71) for identifying increased cardiovascular risk.

Conclusions: WHtR demonstrated better discriminatory ability than BMI for identifying cardiovascular risk and may serve as a simple screening measure in urban Indian adults.

Keywords: Body mass index, Cardiovascular risk, Central obesity, Obesity, Waist-to-height ratio, Urban adults

INTRODUCTION

Cardiovascular diseases (CVDs) constitute a major public health challenge and are closely associated with modifiable metabolic risk factors, including obesity, hypertension, dysglycemia and dyslipidaemia. Obesity contributes to cardiovascular risk through multiple interrelated mechanisms, including insulin resistance,

chronic low-grade inflammation, endothelial dysfunction and adverse alterations in lipid metabolism.^{1,2}

The increasing prevalence of overweight and obesity has made early identification of individuals at cardiometabolic risk an important component of preventive healthcare. Body mass index (BMI), calculated as weight in kilograms divided by height in metres squared, remains one of the

most commonly employed anthropometric indices for classifying general adiposity.³ However, BMI does not provide information regarding the distribution of body fat and may fail to distinguish individuals with excess visceral adiposity from those with comparable BMI but relatively favourable body composition.⁴

This limitation is particularly relevant among South Asian populations. Cardiometabolic abnormalities among South Asians may occur at comparatively lower BMI levels, while central adiposity and visceral fat accumulation may be disproportionately high. Consequently, conventional BMI-based assessment alone may underestimate cardiovascular risk in a proportion of apparently normal-weight individuals.^{5,6}

Central obesity has therefore gained increasing importance in cardiovascular risk assessment. Waist circumference is a simple marker of abdominal adiposity; however, its interpretation may be influenced by sex, ethnicity and body size. Waist-to-height ratio (WHtR), calculated by dividing waist circumference by height using identical units, incorporates an adjustment for stature and can potentially overcome some of these limitations.⁷

Evidence from systematic reviews and meta-analyses indicates that WHtR performs at least as well as, and frequently better than, BMI in discriminating cardiometabolic abnormalities such as hypertension, diabetes mellitus, dyslipidaemia and metabolic syndrome.^{8,9} A WHtR close to 0.5 has consequently been proposed as a practical screening boundary, providing a simple public-health concept that an individual's waist circumference should generally remain below half of their height.^{7,8}

Rajput et al. evaluated multiple anthropometric indices in an Indian population and observed that, although sex-specific waist circumference demonstrated strong predictive ability, WHtR provided the advantage of a single screening value applicable across sexes and residential settings.¹⁰ Similarly, studies conducted among South Asian adults have reported favourable discriminatory performance of WHtR for cardiometabolic risk factors.^{5,11}

Rapid urbanisation, sedentary behaviour, dietary transition and increasing prevalence of obesity have intensified the burden of cardiometabolic risk factors in Indian cities. Simple, inexpensive and non-invasive anthropometric screening measures are particularly valuable because they can be incorporated into routine outpatient care and community-based screening without specialised equipment.

Although BMI continues to be routinely used for obesity assessment, the comparative usefulness of WHtR in identifying cardiovascular risk among urban adults requires further evaluation in different Indian populations. The present study was therefore undertaken to compare

WHtR and BMI as predictors of cardiovascular risk among urban adults in Hyderabad, Telangana, and to determine whether WHtR provides additional discriminatory value over conventional BMI assessment.

METHODS

Study design and setting

A cross-sectional observational study was conducted (November 2025 to April 2026) among urban adults residing in Hyderabad, Telangana, at Shadan Institute of Medical Sciences. The study was designed to compare the discriminatory ability of waist-to-height ratio and body mass index for identifying individuals with cardiovascular risk factors.

Study population

A total of 70 adult participants, aged 18–60 years, were included in the study after obtaining written informed consent.

Inclusion criteria

Adults aged 18–60 years residing in the urban area of Hyderabad and willing to participate and undergo anthropometric, clinical, and biochemical assessment were included.

Exclusion criteria

Pregnant women, individuals with conditions causing marked abdominal distension or oedema, patients with severe acute illness, individuals with physical deformities interfering with accurate anthropometric measurements, and participants unable to provide the required clinical or laboratory information were excluded.

Data collection

A structured proforma was used to record demographic characteristics, relevant medical history, smoking status, history of diabetes mellitus and hypertension, medication use and other cardiovascular risk factors.

Anthropometric measurements

Body weight was measured using a calibrated weighing scale with participants wearing light clothing and without footwear. Height was measured in the standing position without footwear using a stadiometer, with the participant's head maintained in the horizontal plane.

BMI was calculated as: $\text{BMI (kg/m}^2\text{)} = \text{Weight (kg)}/\text{Height}^2\text{ (m}^2\text{)}$

Participants were classified according to BMI categories. Particular attention was also given to $\text{BMI} \geq 25 \text{ kg/m}^2$ as an

indicator of overweight/obesity in the comparative analysis.³

Waist circumference was measured using a non-stretchable measuring tape with the participant standing erect and relaxed. Measurements were obtained at the end of normal expiration using a standard anatomical landmark and were recorded to the nearest 0.1 cm.

WHtR was calculated as: $\text{WHtR} = \text{Waist circumference (cm)} / \text{Height (cm)}$

A WHtR of ≥ 0.50 was considered indicative of increased central adiposity and cardiometabolic risk for the primary screening comparison.⁷⁻⁹

Blood pressure measurement

Blood pressure was recorded after participants had rested in the seated position. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were documented using an appropriately sized cuff. Elevated blood pressure was defined as SBP ≥ 130 mmHg and/or DBP ≥ 85 mmHg or current treatment for previously diagnosed hypertension for the cardiometabolic risk assessment.^{1,10}

Biochemical investigations

After an overnight fast, venous blood samples were collected for estimation of fasting plasma glucose, total cholesterol, triglycerides, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C)

Fasting plasma glucose ≥ 100 mg/dl, triglycerides ≥ 150 mg/dl and reduced HDL-C (< 40 mg/dl in men and < 50 mg/dl in women) were considered cardiometabolic abnormalities, consistent with commonly employed metabolic-risk criteria.^{2,10}

Assessment of cardiovascular risk

For the present study, increased cardiovascular risk was operationally defined as the presence of two or more non-anthropometric cardiometabolic abnormalities, comprising elevated blood pressure, elevated fasting plasma glucose, hypertriglyceridemia and/or reduced HDL-C. This approach was adapted from the analytical framework employed in the reference study so that the predictive ability of BMI and WHtR could be evaluated independently of the anthropometric component itself.¹⁰

Statistical analysis

Data were analysed using appropriate statistical software. Continuous variables were expressed as Mean $\pm$ Standard deviation and categorical variables as frequency and percentage. Differences between groups were assessed using the independent-samples t-test for continuous

variables and Chi-square test or Fisher's exact test for categorical variables, as appropriate.

Pearson's correlation analysis was used to determine relationships between BMI, WHtR and selected cardiovascular risk variables. Receiver operating characteristic (ROC) curves were constructed to assess the ability of BMI and WHtR to discriminate participants with increased cardiovascular risk. Area under the ROC curve (AUC), sensitivity, and specificity were calculated. An AUC closer to 1.0 indicated better discriminatory performance. A $p < 0.05$ was considered statistically significant.

Ethical considerations

The study was conducted in accordance with ethical principles applicable to biomedical research involving human participants. Written informed consent was obtained from all participants, and confidentiality of participant information was maintained.

RESULTS

A total of 70 participants were included in the analysis. The mean age of the study population was 41.6 ± 10.8 years. There were 38 (54.3%) males and 32 (45.7%) females.

The mean BMI of the participants was 25.7 ± 4.1 kg/m², while the mean WHtR was 0.53 ± 0.07 . The mean systolic and diastolic blood pressures were 128.6 ± 15.4 mmHg and 82.1 ± 9.6 mmHg, respectively (Table 1).

Overall, 39 (55.7%) participants had BMI ≥ 25 kg/m², whereas 45 (64.3%) demonstrated WHtR ≥ 0.50 . Thus, WHtR identified an additional proportion of participants with central adiposity who would not necessarily have been identified by the conventional BMI ≥ 25 kg/m² threshold (Table 2).

Participants with WHtR ≥ 0.50 had a significantly greater prevalence of elevated blood pressure, dysglycemia, hypertriglyceridemia, and reduced HDL-C compared with those having WHtR < 0.50 . The presence of at least two cardiometabolic risk factors was observed in 55.6% of participants with elevated WHtR compared with 20.0% among participants with WHtR < 0.50 ($P = 0.004$) (Table 3).

Although BMI ≥ 25 kg/m² was associated with a higher prevalence of several cardiovascular risk factors, the magnitude of discrimination appeared less consistent than that observed with WHtR (Table 4).

Both anthropometric indices demonstrated associations with cardiovascular risk variables. However, WHtR showed consistently stronger correlations with systolic blood pressure, diastolic blood pressure, fasting plasma glucose and triglycerides and a stronger inverse relationship with HDL-C (Table 5).

WHtR demonstrated a larger area under the ROC curve (AUC=0.82) compared with BMI (AUC=0.71). At an optimal cut-off of approximately 0.51, WHtR provided a sensitivity of 83.3% and specificity of 72.5% for

identifying participants with increased cardiovascular risk. These findings indicate that WHtR provided better overall discrimination than BMI in the present study population (Table 6).

Table 1: Baseline characteristics of the study participants (n=70).

Parameters	Values
Age (years), mean±SD	41.6±10.8
Male	38 (54.3%)
Female	32 (45.7%)
Weight (kg), mean±SD	69.8±11.6
Height (cm), mean±SD	164.8±8.7
Waist circumference (cm), mean±SD	86.9±10.7
BMI (kg/m ²), mean±SD	25.7±4.1
WHtR, mean±SD	0.53±0.07
SBP (mmHg), mean±SD	128.6±15.4
DBP (mmHg), mean±SD	82.1±9.6
Fasting plasma glucose (mg/dl)	105.8±24.7
Triglycerides (mg/dl)	151.7±54.3
HDL-C (mg/dl)	43.9±10.1

Table 2: Distribution according to BMI and WHtR categories.

Anthropometric category	Number	Percentage
BMI <18.5 kg/m ²	3	4.3
BMI 18.5–24.9 kg/m ²	28	40.0
BMI 25.0–29.9 kg/m ²	25	35.7
BMI ≥30 kg/m ²	14	20.0
BMI ≥25 kg/m ²	39	55.7
WHtR <0.50	25	35.7
WHtR ≥0.50	45	64.3

Table 3: Cardiovascular risk factors according to WHtR status.

Risk factors	WHtR <0.50 (n=25)	WHtR ≥0.50 (n=45)	P value
Elevated blood pressure	5 (20.0%)	20 (44.4%)	0.041
Fasting glucose ≥100 mg/dl	7 (28.0%)	25 (55.6%)	0.027
Triglycerides ≥150 mg/dl	6 (24.0%)	23 (51.1%)	0.029
Reduced HDL-C	8 (32.0%)	26 (57.8%)	0.039
≥2 cardiometabolic risk factors	5 (20.0%)	25 (55.6%)	0.004

Table 4: Cardiovascular risk according to BMI status.

Parameters	BMI <25 kg/m ² (n=31)	BMI ≥25 kg/m ² (n=39)	P value
Elevated blood pressure	7 (22.6%)	18 (46.2%)	0.040
Fasting glucose ≥100 mg/dl	10 (32.3%)	22 (56.4%)	0.044
Triglycerides ≥150 mg/dl	9 (29.0%)	20 (51.3%)	0.061
Reduced HDL-C	12 (38.7%)	22 (56.4%)	0.141
≥2 cardiometabolic risk factors	9 (29.0%)	21 (53.8%)	0.037

Table 5: Correlation of BMI and WHtR with selected cardiometabolic variables.

Variables	BMI, <i>r</i>	WHtR, <i>r</i>
Systolic blood pressure	0.34	0.46
Diastolic blood pressure	0.29	0.40
Fasting plasma glucose	0.31	0.48

Continued.

Variables	BMI, <i>r</i>	WHtR, <i>r</i>
Triglycerides	0.36	0.51
HDL-C	-0.28	-0.42

Table 6: ROC analysis of BMI and WHtR for predicting increased cardiovascular risk.

Parameters	AUC	95%CI	Cut-off	Sensitivity	Specificity
BMI	0.71	0.59–0.83	24.8 kg/m ²	70.0%	62.5%
WHtR	0.82	0.72–0.92	0.51	83.3%	72.5%

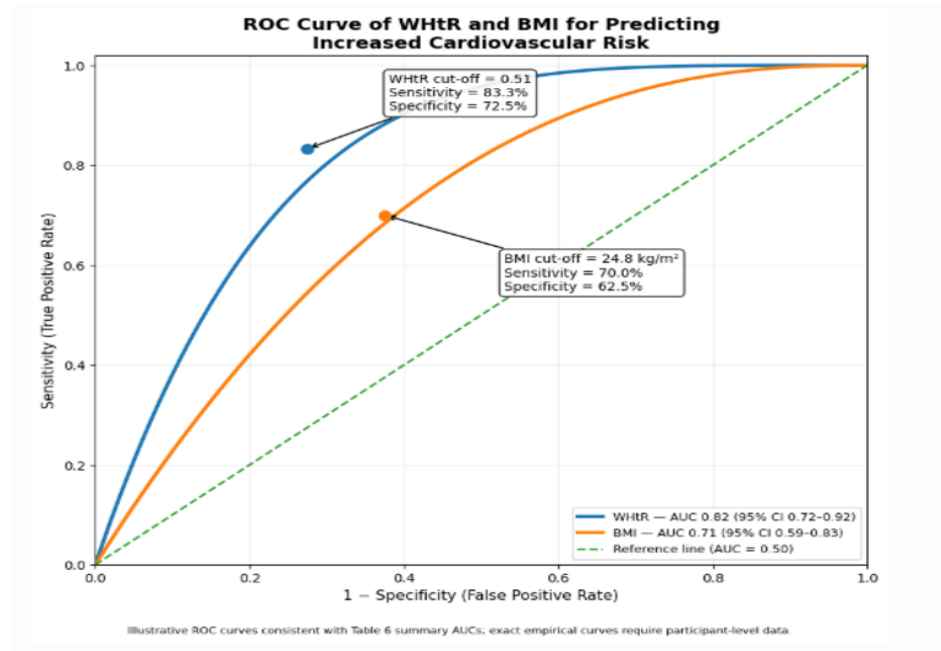


Figure 1: ROC curve of WHtR and BMI for predicting increased cardiovascular risk.

DISCUSSION

The present cross-sectional study compared waist-to-height ratio (WHtR) and body mass index (BMI) as anthropometric predictors of cardiovascular risk among urban adults in Hyderabad, Telangana. The principal finding was that WHtR demonstrated a stronger association with cardiometabolic abnormalities and better discriminatory performance than BMI. Participants with elevated WHtR had a greater prevalence of elevated blood pressure, impaired fasting glucose, hypertriglyceridaemia and reduced high-density lipoprotein cholesterol (HDL-C). These findings emphasize the importance of central adiposity in cardiovascular risk assessment, as visceral fat accumulation is closely associated with insulin resistance, dyslipidaemia, hypertension and other components of metabolic dysfunction.^{1,2}

In the present study, the mean BMI was 25.7±4.1 kg/m² and the mean WHtR was 0.53±0.07. Overall, 39 (55.7%) participants had a BMI ≥25 kg/m², whereas 45 (64.3%) had a WHtR ≥0.50. Thus, WHtR identified a larger proportion of participants with potentially adverse

adiposity than BMI. Although BMI remains a widely accepted and convenient measure of general obesity, it does not adequately characterize body-fat distribution or distinguish visceral from peripheral adiposity.^{3,4} This limitation may be particularly important when BMI is used as the sole anthropometric screening measure.

The relevance of this finding is greater among South Asian populations, who are known to exhibit relatively greater abdominal and visceral adiposity at comparable BMI levels. Cardiometabolic abnormalities may therefore occur even among individuals who are not categorized as obese according to conventional BMI thresholds.⁵ The World Health Organization has also acknowledged that associations between BMI, body-fat percentage and metabolic risk differ among ethnic populations and that Asian populations may experience substantial metabolic risk at comparatively lower BMI values.⁶ These observations provide a rationale for incorporating measures of central adiposity into cardiovascular risk assessment in Indian adults.

WHtR has emerged as a simple anthropometric index that accounts for both waist circumference and stature. A threshold close to 0.50 has frequently been proposed as a practical screening value for increased cardiometabolic risk.⁷ In the present study, 64.3% of participants had $\text{WHtR} \geq 0.50$, and this group demonstrated a significantly greater prevalence of multiple cardiovascular risk factors. The findings are consistent with evidence indicating that maintaining waist circumference below approximately half of an individual's height may represent a simple and clinically interpretable approach to screening for central adiposity.⁷

The superiority of WHtR over BMI observed in the present study is supported by previous systematic evidence. Ashwell et al demonstrated in a systematic review and meta-analysis that WHtR provided better discriminatory ability than BMI for several cardiometabolic risk factors.⁸ Similarly, Savva et al reported that WHtR showed favourable predictive performance for diabetes, metabolic syndrome and related cardiometabolic outcomes.⁹ These findings suggest that anthropometric indices incorporating abdominal fat distribution may provide additional information that is not captured by BMI alone.

The present findings are particularly comparable with those reported by Rajput et al in the reference Indian study.¹⁰ They evaluated BMI, waist circumference, waist-to-hip ratio and WHtR for predicting metabolic syndrome in urban and rural adults from Haryana. WHtR demonstrated favourable discriminatory ability and offered the practical advantage of a common screening value across population groups. Their reported optimal WHtR value of approximately 0.52 is close to the optimal cut-off of 0.51 observed in the present analysis. This similarity suggests that a WHtR threshold around 0.50 may have practical relevance across different Indian populations.

The present observations are also consistent with findings from the CARRS study reported by Patel et al in which several anthropometric indices were evaluated for cardiovascular risk classification among South Asian adults.¹¹ Measures reflecting central obesity, including WHtR and waist circumference, performed favourably for identifying diabetes, hypertension, and other cardiovascular risk factors. Although no single anthropometric measure was uniformly superior for every outcome, the findings supported the clinical relevance of central adiposity when evaluating cardiovascular risk among South Asians.¹¹

The association between WHtR and cardiovascular risk factors was recognized in earlier investigations as well. Hsieh and Yoshinaga reported that WHtR was a simple and useful anthropometric indicator associated with coronary heart disease risk factors.¹² Adjustment of waist circumference for height may improve interpretation of abdominal adiposity because individuals of different

statures may have substantially different metabolic implications for a similar absolute waist circumference.¹²

Ashwell and Gibson further demonstrated the usefulness of WHtR as a screening measure for cardiovascular risk factors.¹³ Their findings suggested that WHtR could identify individuals with adverse cardiometabolic profiles who might not necessarily be recognized through BMI assessment alone. This observation is comparable to the present study, in which $\text{WHtR} \geq 0.50$ identified a larger proportion of at-risk participants than $\text{BMI} \geq 25 \text{ kg/m}^2$.

The importance of abdominal adiposity assessment has also been recognized by the World Health Organization. Waist-based anthropometric measures provide clinically relevant information regarding obesity-related metabolic risk beyond that obtained from body weight alone.¹⁴ However, absolute waist circumference may be influenced by body size, sex and ethnicity. WHtR partially addresses the influence of stature by expressing waist circumference relative to height, thereby offering a simple dimensionless index that may be useful across different population groups.^{7,14}

Evidence specifically from South Asian adults further supports these observations. Jayawardana et al found WHtR to be a useful anthropometric marker for identifying diabetes and cardiometabolic risk among South Asians.¹⁵ Their findings are particularly relevant because South Asian populations tend to accumulate visceral adipose tissue at comparatively lower BMI values.^{5,15} Therefore, assessment based solely on BMI may underestimate metabolic risk in some individuals, whereas WHtR may provide additional information regarding abdominal fat accumulation.

In the present study, participants with $\text{WHtR} \geq 0.50$ had a significantly higher prevalence of elevated blood pressure (44.4% vs 20.0%), elevated fasting plasma glucose (55.6% vs 28.0%), hypertriglyceridemia (51.1% vs 24.0%) and reduced HDL-C (57.8% vs 32.0%) compared with participants having $\text{WHtR} < 0.50$. Furthermore, two or more cardiometabolic abnormalities were present in 55.6% of participants with elevated WHtR compared with only 20.0% among those with $\text{WHtR} < 0.50$. These findings demonstrate that an elevated WHtR was associated with clustering of multiple cardiovascular risk factors rather than with an isolated metabolic abnormality.

$\text{BMI} \geq 25 \text{ kg/m}^2$ was also associated with an increased prevalence of cardiovascular risk factors. However, the differences were comparatively less consistent. While elevated blood pressure and fasting glucose showed significant associations with higher BMI, differences in triglyceride and HDL-C abnormalities did not reach statistical significance.

These observations suggest that BMI remains clinically useful for identifying general adiposity but may provide

less information regarding the metabolic consequences of abdominal fat distribution.^{3,4}

Correlation analysis provided additional support for this interpretation. WHtR demonstrated stronger correlations than BMI with systolic blood pressure ($r=0.46$ vs 0.34), diastolic blood pressure ($r=0.40$ vs 0.29), fasting plasma glucose ($r=0.48$ vs 0.31), triglycerides ($r=0.51$ vs 0.36), and HDL-C ($r=-0.42$ vs -0.28). The consistently stronger relationships observed with WHtR indicate that central adiposity may be more closely related to the clustering of metabolic abnormalities than overall body mass.

ROC analysis further demonstrated the comparative discriminatory advantage of WHtR. WHtR showed an area under the curve (AUC) of 0.82 (95% CI: $0.72-0.92$) compared with 0.71 (95% CI: $0.59-0.83$) for BMI. At an optimal cut-off of 0.51 , WHtR demonstrated 83.3% sensitivity and 72.5% specificity, whereas a BMI cut-off of 24.8 kg/m^2 yielded 70.0% sensitivity and 62.5% specificity. These findings indicate better overall discrimination with WHtR and are broadly consistent with previous Indian, South Asian, and international studies.^{8-11,15}

From a practical perspective, WHtR has several potential advantages. It requires only a measuring tape and height measurement, involves a straightforward calculation and does not require expensive investigations. The availability of a broadly applicable screening threshold around 0.50 may also simplify interpretation in routine clinical practice.^{7,10} In urban populations such as Hyderabad, where sedentary lifestyles, dietary transitions and increasing prevalence of central obesity contribute to cardiometabolic risk, WHtR could therefore complement BMI during routine health assessments.

Nevertheless, WHtR should not be considered a substitute for comprehensive cardiovascular risk evaluation. Anthropometric indices are screening measures and should be interpreted alongside age, blood pressure, glycaemic status, lipid profile, smoking, family history and other established cardiovascular risk determinants. The findings of the present study instead suggest that incorporating WHtR alongside conventional BMI assessment may improve early identification of individuals requiring more detailed cardiometabolic evaluation.

Limitations

The present study has certain limitations. The relatively small sample size of 70 participants limits the precision of subgroup analyses and may restrict generalizability to the broader urban population of Hyderabad. The cross-sectional design establishes associations but cannot determine temporal relationships or predict actual future cardiovascular events. Cardiovascular risk was assessed through clustering of cardiometabolic abnormalities rather than prospective outcomes such as myocardial infarction, stroke, or cardiovascular mortality. Potential confounding

factors such as dietary intake, physical activity, socioeconomic status and family history were not comprehensively evaluated.

Larger prospective and multicentric studies involving diverse populations from Telangana and other regions of India are required to validate these findings. Future research should also examine whether WHtR improves cardiovascular risk prediction when incorporated into established clinical risk models and whether the approximately 0.50 cut-off remains optimal across different age and sex groups.

CONCLUSION

The present study suggests that waist-to-height ratio is a useful and potentially superior anthropometric screening measure compared with body mass index for identifying cardiovascular risk among urban adults. Participants with elevated WHtR demonstrated a greater burden of hypertension, dysglycaemia and dyslipidaemia, while WHtR showed stronger correlations with cardiometabolic abnormalities and a higher area under the ROC curve than BMI.

A WHtR threshold close to 0.5 may provide a simple, inexpensive and easily interpretable approach for identifying adults who require further cardiovascular risk evaluation. Although BMI remains useful for assessing general obesity, incorporation of WHtR into routine clinical and community screening may improve recognition of central adiposity and cardiometabolic risk, particularly among South Asian populations.

Further prospective studies with larger sample sizes are required to confirm these findings and establish population-specific thresholds for predicting future cardiovascular events.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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