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Correlation Between Waist-to-Height Ratio (WHtR) and Visceral Fat in Obese Adults at Ngoerah Hospital, Bali, Indonesia: A Cross-Sectional

Putu Gizha Satrya Gautama M[1*], I Made Pande Dwipayana[2]

[1]*Medical Doctor Profession Program, Faculty of Medicine, Universitas Udayana, Denpasar, Bali-Indonesia*
[2]*Department of Internal Medicine, Faculty of Medicine, Universitas Udayana/Ngoerah Hospital, Denpasar, Bali-Indonesia*

[*]*Correspondence Author: gizha.gautama@unud.ac.id*

Abstract

Obesity is a major global health problem associated with an increased risk of cardiovascular and metabolic diseases. Visceral fat is central to this risk; however, its direct measurement requires expensive equipment that is not widely available in clinical practice. The waist-to-height ratio (WHtR) is a simple, low-cost anthropometric tool previously associated with cardiovascular and metabolic risk. This study aimed to determine the correlation between WHtR and visceral fat measured by bioelectrical impedance analysis (BIA) in adults with obesity (defined as BMI ⩾25.0 kg/m² according to WHO Asia-Pacific criteria) at Ngoerah Hospital, Bali, Indonesia. A cross-sectional study was conducted at Ngoerah Hospital, Denpasar, Bali, from November 2018 to January 2019. A total of 160 adults with obesity (BMI ⩾25.0 kg/m² according to WHO Asia-Pacific criteria) were enrolled using total sampling. Visceral fat was estimated using BIA. Waist circumference and height were measured using standardized measuring tape, and WHtR was calculated as waist circumference divided by height (both in centimeters). Data were analyzed using Spearman's correlation test after normality testing with the Shapiro–Wilk method. Of the 160 subjects, 87 (54.4%) were male and 73 (45.6%) were female, with a median age of 33 years (range: 22–57). Both waist circumference ($r = 0.658$, $p < 0.001$) and WHtR ($r = 0.676$, $p < 0.001$) showed statistically significant positive correlations with visceral fat, with the magnitude of correlation classified as moderate to strong. Height alone was not significantly associated with visceral fat ($r = 0.098$, $p = 0.217$). WHtR demonstrates a moderate-to-strong positive correlation with visceral fat as measured by BIA in obese adults. These findings support the use of WHtR as a practical and accessible screening tool for visceral adiposity in clinical settings, particularly in populations with limited access to advanced body composition measurement technologies.

Keywords: Obesity, Anthropometry, Waist-to-Height Ratio, Waist Circumference, Visceral Fat, Bioelectrical Impedance Analysis

INTRODUCTION

Obesity remains a major global health problem. According to the World Health Organization (WHO), the prevalence of overweight and obesity has reached 60% worldwide, making it a critical public health concern.(1) In Indonesia, the prevalence of obesity among adults has been rising steadily; however, the country faces a unique challenge: there is still no nationally validated, standardized anthropometric tool recommended by clinical guidelines for visceral fat screening at the primary care level, and significant inconsistency exists in obesity measurement practices among Indonesian clinicians and researchers.(2,3)

Body fat is anatomically divided into subcutaneous and intra-abdominal (visceral) compartments. Visceral fat, which surrounds the mesentery and omentum within the retroperitoneal space, behaves differently from subcutaneous fat and carries greater metabolic risk.[4] Excess visceral fat drives the release of free fatty acids into the portal circulation, promoting insulin resistance, dyslipidemia, and broader features of metabolic syndrome. It also contributes to cardiovascular disease, type 2 diabetes mellitus, and certain malignancies. (4,5)

Accurate measurement of visceral fat traditionally requires advanced imaging modalities such as computed tomography (CT) or magnetic resonance imaging (MRI), which remain the gold standard. However, these methods are costly, not widely available in primary care settings, and involve radiation exposure in the case of CT. Bioelectrical impedance analysis (BIA) offers a more accessible alternative for body composition assessment, although it remains an indirect proxy measure and has its own limitations. (6,7)

Simple anthropometric measures, including body mass index (BMI), waist circumference (WC), and waist-to-hip ratio (WHR), have been widely used as surrogates for body fat assessment. Among these, the waist-to-height ratio (WHtR), calculated by dividing waist circumference by height, has emerged as a promising screening tool. WHtR was first evaluated in the Framingham Heart Study and has been associated with cardiovascular disease progression and the risk of diabetes mellitus. Unlike BMI, WHtR accounts for central adiposity and has demonstrated better discriminative ability for metabolic risk across diverse populations. (8)

Despite the growing body of evidence supporting WHtR as a metabolic risk marker globally, two important gaps remain in the Indonesian context. First, a large Indonesian epidemiological study published in 2025 identified WHtR as the strongest anthropometric predictor of diabetes mellitus and hypertension in the Indonesian population, yet noted that its diagnostic performance had not been extensively studied in Indonesian clinical populations using visceral fat as the reference outcome. (9) Second, although WHtR has been validated against cardiovascular and metabolic outcomes internationally, correlational data directly linking WHtR to visceral fat in hospital-based obese Indonesian populations, particularly in Bali, where ethnic and lifestyle characteristics may differ from those of other Indonesian populations, are absent from the published literature. (10,11) A review of the available Indonesian literature found no prior study specifically examining the correlation between WHtR and BIA-estimated visceral fat in a hospital-based obese adult population in Bali or Indonesia. To the best of our knowledge, the present study is the first to address this question in this population and clinical context. Without local data establishing this association, WHtR cannot be confidently adopted as a surrogate marker of visceral fat in Indonesian clinical guidelines. This study therefore aimed to determine the correlation between WHtR and BIA-measured visceral fat in an obese adult population at a tertiary referral hospital in Bali, Indonesia.

METHODS

Study Design and Setting

This study employed a cross-sectional observational design with an analytical approach. The study was conducted at the Internal Medicine outpatient clinic of Ngoerah General Hospital, Denpasar, Bali, Indonesia, from November 2018 to January 2019.

Participants

Participants were recruited using a total sampling method, in which all eligible patients attending the Internal Medicine outpatient clinic of Ngoerah General Hospital during the study period (November 2018 to January 2019) who met the inclusion criteria were consecutively enrolled. This approach was selected to maximize the number of subjects available during the study period and to minimize selection bias. A total of 160 subjects were enrolled. To verify the adequacy of the sample size for the correlation analysis, a post-hoc power calculation was performed using Fisher's z-transformation. With n = 160, a two-tailed α of 0.05, and an observed correlation coefficient of r = 0.676, the estimated statistical power exceeded 99%, confirming that the sample size was more than adequate to detect the observed correlation.

Inclusion criteria: 1). age 18–60 years; 2). BMI ≥25.0 kg/m², classified as obese according to the WHO Expert Consultation on Obesity criteria adapted for Asian populations, in which a BMI cut-off of ≥ 25.0 kg/m² is recommended as the threshold requiring therapeutic intervention in Asian adults because of their higher cardiovascular and metabolic risk at lower BMI values compared with Western populations;(12) and 3). willingness to participate and ability to provide informed consent.

Exclusion criteria: 1). pregnant or lactating women; 2). presence of ascites, significant peripheral edema, or implanted electronic devices (pacemaker/defibrillator) that could affect the validity of BIA measurements; 3). subjects with missing data on key variables; and 4). individuals with limb amputation or physical conditions precluding standardized anthropometric measurement.

Measurements

All measurements were performed by trained personnel using standardized procedures.

Height: Height was measured using a non-elastic tape measure affixed to a vertical flat wall, with subjects standing upright without shoes, heels together, and the head positioned in the Frankfurt horizontal plane.

Waist circumference: Waist circumference was measured at the midpoint between the lower costal margin and the iliac crest in a horizontal plane at the end of normal expiration. Measurements were performed in duplicate, averaged, and recorded in centimeters.

WHtR: WHtR was calculated by dividing waist circumference (cm) by height (cm).

Body weight and BMI: Body weight was measured using a calibrated digital scale, with subjects wearing light clothing and no shoes. BMI was calculated as weight (kg) divided by height squared (m²).

Blood pressure: Systolic and diastolic blood pressure were measured in a sitting position after at least five minutes of rest using a calibrated sphygmomanometer.

Visceral fat (BIA): Visceral fat was measured using a bioelectrical impedance analysis (BIA) device (Omron KARADA Scan HBF-375, Omron Healthcare, Japan). BIA was selected for the following reasons: 1). it is a validated, non-invasive, and widely reproducible method for body composition assessment in clinical and epidemiological research;(6,7) 2). it has demonstrated acceptable agreement with imaging-based methods for body fat estimation when performed under standardized conditions;(10) 3). although CT scanning was available at this facility, it was not performed because of ethical concerns regarding radiation exposure in the absence of a clinical indication and the logistical constraints of a cross-sectional study; and 4). BIA is the most practically accessible body composition assessment modality in Indonesian hospital outpatient settings, thereby preserving the clinical relevance of the findings. To minimize measurement variability, all subjects were assessed under standardized conditions: after an overnight fast (≥12 hours), following bladder voiding, with no strenuous physical exercise in the preceding 24 hours, and without alcohol or diuretic consumption, in accordance with standard BIA protocols.

Statistical Analysis

All data were analyzed using SPSS for

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Windows version 23.0. Data normality was assessed using the Shapiro–Wilk test. Numerical variables with non-normal distributions were presented as median (minimum–maximum), whereas variables with normal distributions were presented as mean ± standard deviation (SD).
Given that all key numerical variables demonstrated non-normal distributions, Spearman's rank correlation coefficient was used for correlation analysis between WHtR, waist circumference, height, and visceral fat. Statistical significance was defined as $p < 0.05$. The strength of correlation was interpreted as follows: $r < 0.20$, negligible; 0.20–0.39, weak; 0.40–0.59, moderate; 0.60–0.79, moderate-to-strong; and ≥0.80, strong. Spearman's rank correlation was considered the appropriate statistical method for this study because the primary objective was to determine the existence and strength of the association between WHtR and visceral fat. As this study was exploratory and correlational in nature, multivariate regression and receiver operating characteristic (ROC) curve analyses were beyond its scope.

Ethical Considerations

This study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from the Research Ethics Committee of Udayana University/Ngoerah General Hospital. Written informed consent was obtained from all participants.

RESULTS

A total of 160 subjects with obesity were enrolled in this study. Of these, 87 subjects (54.4%) were male and 73 subjects (45.6%) were female. The median age was 33 years (range, 22–57 years). The baseline characteristics of all subjects are presented in Table 1. All numerical variables demonstrated non-normal distributions according to the Shapiro–Wilk test; therefore, data are presented as median (minimum–maximum), and Spearman's rank correlation analysis was applied.

Table 1. Basic characteristics of patients

CHARACTERISTIC	NUMBER OF PATIENT N = 160
Age (years), median (min-max)	33 (22-57)
Waist circumference, median (min-max)	98 (81-131)
Systolic blood pressure, median (min-max)	120 (100-160)
Diastolic blood pressure, median (min-max)	80 (60-100)
BMI, median (min-max)	29,96 (25-46)
Height, median (min-max)	165 (146-184)
Visceral fat, median (min-max)	13,5 (5-145)
WHtR, median (min-max)	0,59 (0,5-0,76)

Continuous variables are presented as median (min –max). BMI: body mass index; WHtR: waist-to-height ratio.

Spearman's correlation analysis demonstrated a statistically significant positive correlation between waist circumference and visceral fat (r = 0.658, 95% CI 0.568–0.734, $p < 0.001$) and between WHtR and visceral fat (r = 0.676, 95% CI 0.589–0.749, $p < 0.001$). Both correlation coefficients fall within the moderate-to-strong range (r = 0.60–0.79) and should be interpreted accordingly. Height alone showed no significant correlation with visceral fat (r = 0.098, 95% CI −0.057 to 0.249, p = 0.217). The 95% confidence intervals were estimated using Fisher's z-transformation. These results are summarized in Table 2, and the corresponding scatter plots are presented in Figure 1.

Table 2. Correlation between waist circumference, height, and WHtR with visceral fat

VARIABEL	*r*	95% CI	*p value*
Waist circumference	0.658	0.568 – 0.734	< 0.001
Height	0.098	-0. 057 – 0.249	0.217
WHtR	0.676	0.589 – 0.749	< 0.001

WHtR: Waist-to-Height Ratio; NS: not significant; CI: confidence interval.

**95% CI for Spearman's r was estimated using Fisher's z-transformation (n = 160). Correlation strength was interpreted as follows: <0.20 negligible; 0.20–0.39 weak; 0.40–0.59 moderate; 0.60–0.79 moderate-to-strong; ≥0.80 strong.*

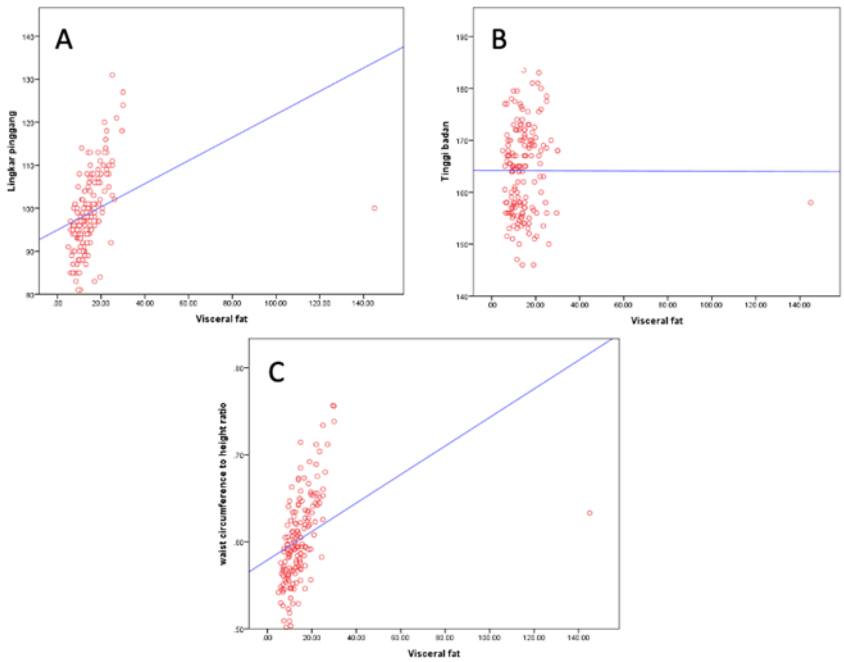

Figure 1. Scatter plot diagrams of the correlation between: A) Waist circumference and visceral fat; B) Height and visceral fat; C) WHtR and visceral fat

DISCUSSION

This cross-sectional study demonstrated that WHtR has a moderate-to-strong positive correlation with visceral fat as estimated by BIA (r = 0.676, 95% CI 0.589–0.749) in obese adults attending a tertiary referral hospital in Bali, Indonesia. Waist circumference showed a comparable correlation (r = 0.658), whereas height alone was not significantly associated with visceral fat (r = 0.098, p = 0.217). The association between WHtR and visceral adiposity has been well established in East Asian, South Asian, and Western populations; this study does not challenge that evidence. Rather, it contributes locally derived data from an Indonesian population.

To the best of our knowledge, no previous published study has specifically examined the correlation between WHtR and BIA-estimated visceral fat in a hospital-based obese adult population in Bali or Indonesia. Available Indonesian studies have investigated BIA-measured visceral fat in relation to metabolic markers, BMI, and lipid profiles, but not in an obese Indonesian cohort using WHtR as the primary anthropometric index. The Balinese population has distinct ethnic, dietary, and lifestyle characteristics that may influence the relationship between WHtR and visceral fat relative to populations studied elsewhere, making local validation clinically relevant.

A 2022 narrative review documented substantial inconsistency in obesity measurement practices across Indonesian institutions,(3) and a 2025 epidemiological study involving 7,699 Indonesian subjects identified WHtR as the strongest anthropometric predictor of cardiometabolic disease while noting that its relationship with visceral fat as a reference outcome had not been examined.(9) No national guideline from PAPDI or PERKENI currently mandates WHtR for visceral fat screening. The present study provides population-specific local evidence that may serve as a preliminary foundation for future guideline development. Although these findings do not alter clinical practice on their own, they address an evidence gap that previously limited such consideration.

Excess visceral fat contributes to a cascade of adverse metabolic events. It increases portal delivery of free fatty acids, thereby promoting insulin resistance, dyslipidemia, and systemic inflammation. It also elevates pro-inflammatory cytokines (interleukin-6 and tumor necrosis factor-α), disrupts adipokine balance (leptin and adiponectin), and increases prothrombotic and vasoactive mediators (plasminogen activator inhibitor-1 and angiotensinogen), collectively resulting in endothelial dysfunction and increased cardiovascular risk.(13,14) This metabolic activity underscores the clinical importance of identifying individuals with elevated visceral fat, even before overt cardiovascular or metabolic disease develops.

The correlation magnitude observed in this study (r = 0.676 for WHtR) is consistent with, although somewhat lower than, that reported by Wu et al. in a study of 111 male subjects, in which WHtR showed a stronger correlation with visceral fat (r = 0.868, p < 0.001).(15) This difference may be attributable to the sex-mixed composition of our study population, as the relationship between WHtR and visceral fat is known to differ between males and females because of sex-specific fat distribution patterns. Sex-stratified subgroup analysis was not performed, representing a limitation of this study and a priority for future research. Previous studies on WHtR and visceral fat have been conducted predominantly in East Asian or Western populations, whereas relatively few have examined this relationship in Indonesian or Balinese populations, in whom ethnic-specific body composition characteristics may differ.(10,11) The present study extends this body of evidence to a Southeast Asian hospital-based population.

A study by Bacopoulou et al. in Greece reported WHtR reference percentiles for abdominal obesity in Greek adolescents and demonstrated that WHtR was a better predictor of abdominal obesity than waist-to-hip ratio (WHR), with a sensitivity of 91% and specificity of 95%.[16] Similarly, a cross-sectional study by Gadekar et al. in healthy Indian adults found significant correlations between several anthropometric indices, including waist circumference, and visceral fat measured by BIA, consistent with the direction of our findings.(17) Our results in Indonesian obese adults extend this body of evidence to a Southeast Asian hospital-based population and further support the cross-ethnic utility of WHtR as an anthropometric screening tool.

BMI remains the most widely used clinical measure of obesity in Indonesia and globally; however, it does not distinguish between fat and lean mass distribution and cannot identify individuals with normal BMI but high visceral fat, a phenotype associated with increased cardiometabolic risk. WHtR addresses this limitation by incorporating waist circumference, which directly reflects central adiposity, normalized to body height. A WHtR cut-off value of >0.5 has been proposed as a simple and memorable threshold for increased cardiometabolic risk across diverse populations, and WHtR has recently been incorporated into the revised criteria of the European Association for the Study of Obesity (EASO) for the assessment of central adiposity.(8)

In the Indonesian healthcare context, BIA devices for visceral fat estimation are predominantly available only in tertiary hospitals and private medical check-up facilities; they are not routinely accessible in primary health centers (*puskesmas*) or community clinics, where the majority of obesity screening occurs. WHtR, which requires only a tape measure and height measurement, can be implemented at all levels of the Indonesian healthcare system at essentially no additional equipment cost, making it a practical surrogate for visceral fat risk stratification in resource-limited settings.

Spearman's correlation was the appropriate method for the primary objective of this study, namely to establish the existence and strength of an association between WHtR and visceral fat rather than to develop a predictive model or determine a diagnostic cut-off. However, correlation alone does not establish predictive or clinical value and does not account for potential confounding variables such as age, sex, and BMI. Multivariate regression would be required to determine whether WHtR independently predicts visceral fat after adjustment for these covariates, whereas ROC curve analysis would be necessary to identify an optimal screening threshold. Neither analysis was performed for two reasons. First, the study was cross-sectional and exploratory in design. Second, ROC analysis requires a binary reference outcome ("high" versus "normal" visceral fat), which cannot be reliably defined from continuous BIA-derived values without a population-specific cut-off validated against imaging-based methods. These limitations reduce the immediate clinical applicability of the findings; future studies using CT or MRI as reference standards should address these gaps. The interpretation of these findings must therefore be considered in light of the methodological limitations discussed below, particularly the use of BIA as a proxy measure, the absence of confounder adjustment, and the hospital-based sampling approach, all of which may affect the internal validity of the study.

Limitations

This study has several limitations. BIA, rather than CT scan or MRI, was used to estimate visceral fat. This matters because BIA provides only an algorithm-derived proxy, not a direct measurement, and is sensitive to hydration status, body geometry, and device-specific assumptions. Height was measured using a tape measure rather than a stadiometer, which may introduce a small systematic directional bias in WHtR values. Recruitment was limited to a single outpatient clinic at a tertiary hospital in Bali over a three-month period. The sample is not representative of community-dwelling obese adults or non-Balinese populations. Age, sex, and BMI were not controlled for, so some portion of the r = 0.676 correlation may reflect these variables rather than WHtR per se; the correlation is unadjusted and exploratory. Multivariate regression and ROC analysis were not performed, and no optimal screening cut-off can be established from these data. These are the gaps that future studies need to address.

CONCLUSION

In this cross-sectional study of 160 obese adults (BMI ⩾25.0 kg/m², based on the WHO Asia-Pacific criteria) at a tertiary referral hospital in Bali, waist-to-height ratio (WHtR) demonstrated a moderate-to-strong positive correlation with BIA-estimated visceral fat (r = 0.676, 95% CI 0.589–0.749, $p < 0.001$). Waist circumference showed a comparable correlation (r = 0.658, 95% CI 0.568–0.734, $p < 0.001$), whereas height alone was not significantly associated with visceral fat. As BIA provides only an indirect estimate of visceral fat, these findings should be interpreted with appropriate caution and do not substitute for imaging-based validation. Nevertheless, within the context of Indonesia's healthcare system, where BIA is not widely available at the primary and secondary care levels, no national guideline currently mandates a standardized visceral fat screening tool, and considerable inconsistency exists in obesity assessment practices, this study provides foundational local evidence to support the adoption of WHtR as a practical, zero-cost surrogate for identifying visceral fat risk in obese patients. WHtR requires only a tape measure and can be applied across all levels of care, including community health centers (*puskesmas*) and other community-based healthcare settings. Future studies should employ gold-standard methods for visceral fat measurement, such as CT or MRI, include sex-stratified and multivariate analyses, and establish population-specific WHtR cut-off values to facilitate its formal incorporation into Indonesian clinical guidelines for obesity management.

REFERENCES

1. World Health Organization. Obesity and overweight. WHO Fact Sheet. Geneva: WHO; 2020.
2. Kementerian Kesehatan RI. Hasil Utama Riset Kesehatan Dasar (Riskesdas) 2018. Jakarta: Badan Penelitian dan Pengembangan Kesehatan; 2018.
3. Nugraha GI, Tahapary DL, Hidayat RW, et al. The urgency in proposing the optimal obesity cutoff value in Indonesian population: a narrative review. Medicine (Baltimore). 2022;101(49):e32256.
4. Klein S. The case of visceral fat: argument for the defense. J Clin Invest. 2004;113(11):1530–1531.
5. Ashtary-Larky D, Daneghian S, Alipour M, et al. Waist circumference to height ratio: better correlation with fat mass than other anthropometric indices during dietary weight loss in different rates. Int J Endocrinol Metab. 2018;16(4):e55023.
6. Snijder MB, Van Dam RM, Visser M, Seidell JC. What aspects of body fat are particularly hazardous and how do we measure them? Int J Epidemiol. 2006;35:83–92.
7. Sun SS, Chumlea WC, Heymsfield SB, et al. Development of bioelectrical impedance analysis prediction equations for body composition with the use of a multicomponent model for use in epidemiologic surveys. Am J Clin Nutr. 2003;77:331–340.
8. Ashwell M, Hsieh SD. Six reasons why the waist-to-height ratio is a rapid and effective global indicator for health risks of obesity and how its use could

simplify the international public health message on obesity. Int J Food Sci Nutr. 2005;56(5):303–7.
9. Sartika RAD, Sigit FS, Shukri NHM, et al. Redefining obesity in the Indonesian population: the critical role of waist-to-height ratio in screening for diabetes mellitus and hypertension. J Nutr Metab. 2025;2025:5815261.
10. Ellis KJ. Human body composition: in vivo methods. Physiol Rev. 2000;80(2):649–680.
11. Wells JCK. The evolution of human adiposity and obesity: where did it all go wrong? Dis Model Mech. 2012;5:595–607.
12. World Health Organization. Waist circumference and waist-hip ratio: report of a WHO expert consultation Geneva, 8–11 December 2008. Geneva: WHO; 2011.
13. Klöting N, Blüher M. Adipocyte dysfunction, inflammation and metabolic syndrome. Rev Endocr Metab Disord. 2014;15:277–287.
14. Van Gaal LF, Mertens IL, De Block CE. Mechanisms linking obesity with cardiovascular disease. Nature. 2006;444:875–880.
15. Wu H, Xu S, Chen L, Zhang H. Waist to height ratio as a predictor of abdominal fat distribution in men. Chinese Journal of Physiology. 2009;52(6):441–445.
16. Bacopoulou F, Efthymiou V, Landis G, Rentoumis A, Chrousos GP. Waist circumference, waist-to-hip ratio, and waist-to-height ratio reference percentiles for abdominal obesity among Greek adolescents. BMC Pediatrics. 2015;15(1):50.
17. Gadekar T, Dudeja P, Basu I, Vashist S, Mukherji S. Correlation of visceral body fat with waist‑hip ratio, waist circumference and body mass index in healthy adults: a cross-sectional study. Medical Journal Armed Forces India. 2020;76:41–46.