World Journal of Pharmaceutical Science and Research
www.wjpsronline.com
Research Article
ISSN: 2583-6579
SJIF Impact Factor: 3.454
Year - 2024
Volume: 3; Issue: 2
Page: 308-316

PREDICTIVE VALUES OF SELECTED ANTHROPOMETRIC INDICES FOR METABOLIC SYNDROME; FINDINGS AMONG APPARENTLY HEALTHY RURAL DWELLERS IN SOUTHWESTERN NIGERIA

Joel O. Akande*, Adeleye A. Adeomi[2], Roseline O. Akande*[3], Olufemi J. Idowu[4], Opeyemi O. Oni[5]

[1]Department of Chemical Pathology, LAUTECH, Ogbomoso, Oyo, State, Nigeria.
[2]Department of Community Health, Obafemi Awolowo University, Ile-Ife, Nigeria.
[3]Department of Community Medicine, LAUTECH, Ogbomoso, Oyo, State, Nigeria.
[4]Department of Chemical Pathology, LAUTECH Teaching Hospital, Ogbomoso, Oyo, State, Nigeria.
[5]Department of Internal Medicine, LAUTECH, Ogbomoso.

Article Received: 09 March 2024 || *Article Revised: 01 April 2024* || *Article Accepted: 22 April 2024*

Corresponding Author: Roseline O. Akande
Department of Community Medicine, LAUTECH, Ogbomoso, Oyo, State, Nigeria.
DOI: 10.5281/zenodo.11145493

ABSTRACT

Background: This study assessed predictive values of selected anthropometric indices for metabolic syndrome (MetS) among apparently healthy rural dwellers where health services were not readily accessible and affordable. **Methods**: A community-based cross-sectional study. A total of 271 apparently healthy adults wererecruited using a multi-stage sampling technique with a structured questionnaire to collect data. National Cholesterol Education Program Adult Treatment Panel Third -III criteria (NCEP ATP III) were used. **Results:** A total of 71 (26.2%) had metabolic syndrome based on the NCEP ATP III criteria. The findings for the predictive values of the selected anthropometric indices using their area under the Receiver Operating Characteristic curves were similar to the point bi-serial correlation analysis results. Waist Height ratio had the highest predictive value with an Area Under the Curve (AUC)of 0.801 (95% CI: 0.744 to 0.858), followed by Waist circumference with an AUC of 0.766 (95% CI: 0.705 to 0.827), then Body Mass Index (AUC: 0.762; 95% CI: 0.701 to 0.823) and lastly Waist Hip ratio with a rather poor AUC of 0.624 (95% CI: 0.545 to 0.703), although all were statistically significant. **Conclusion:** Waist Height ratio, Waist circumference, Body Mass Index, and Waist Hip ratio havea moderate positive correlation and predictive value for metabolic syndromes. This can be used asa surrogate tool in the early detection of MetS.

KEYWORDS: Predictive value, metabolic syndromes, anthropometric, rural, healthy.

BACKGROUND

Metabolic syndrome (MetS) is a worldwide epidemic disorder with a high socioeconomic impact due to its association with increased morbidity and mortality.[1] The increasing prevalence of MetS is associated with the nutrition transition, increasing urbanization, nutrition changes from traditional to more westernized diets, and reduced physical activity.[2]

Metabolic syndrome consists of a cluster of several metabolic and physiological abnormalities, including abdominal obesity, impaired glucose tolerance, hypertriglyceridemia, decreased high-density lipoprotein cholesterol (HDL-C), and arterial hypertension. This syndrome increases the risk of developing type 2 diabetes two-fold and cardiovascular diseases (CVDs) by fivefold compared with apparently healthy persons.[3-4]

According to National Health and Nutrition Examination, approximately 30% of overweight and 60% of obese men and women meet the criteria for a diagnosis of Metabolic syndrome.[4] Additionally, the Framingham study found that approximately 80% of essential hypertension (a component of metabolic syndrome) in men and 65% in women could be directly attributed to obesity.[6] Each component of the Metabolic syndrome is an independent risk factor for developing cardiovascular disease and produces a wide spectrum of vascular and cardiac diseases.[4]

Globally, about a quarter of the adult population reported to have MetS,[7] with rates higher than 30% reported in the United States of America.[8,9] Although there is no nationally representativedata on MetS in Nigeria, a systematic review carried out on MetS in Nigeria reported the mean prevalence of MetS is higher than the reported global average of 20 – 25%.[10]

This high prevalence of MetS has led to looking for ways to detect it early and limiting its associated comorbidities. Among the tools proposed for early diagnosis, anthropometric measures stand out as non-invasive techniques. These may be useful in diverse clinical settings, especially in places with scarce healthcare resources, and offer a high cost-efficiency, as they do not require blood tests.[11][12] Recently, several studies have suggested the use of some anthropometric measurements such as neck circumference (NC), body mass index (BMI), waist circumference, waist-hip ratio, waist-height ratio, waist circumference, skin fold thickness, and conicity index topredict MetS.[13][14] Elevated waist circumference (WC) and waist-to-hip ratio (WHR) have been strongly linked to central obesity and MetS.[15]

However, a major limitation reported by the systematic review is that majority of the studies werecarried out in Urban communities alone.[10][16] Furthermore, it is well-documented by previous studies that the predictive power of anthropometric indices is usually population-dependent, and varies across different regions, ethnic and socio-economic groups.[10][17][18][19] Adediran et alin a study done in Nigeria showed that the prevalence of MetS was between 14.9% among urban dwellers while it was 7.7% among rural dwellers.[18] This suggests that urban and rural populations may require different cut-off points and/or use of different anthropometric measurements to diagnose MetS. Hence, more studies are required to elaborate on the predictability of selected anthropometric indices on MetS particularly among rural dwellers, as Nigeria is currently undergoing a rapid epidemiological transition. It is hoped that the findings from this study will inform effective prevention and intervention programs targeted at healthy individuals in the rural communities. Therefore, this study aimed to assess predictive values of selected anthropometric indices for metabolic syndrome among apparently healthy rural dwellerswhere health services are not readily accessible and affordable.

METHODS

Study setting, population and design

This community-based cross-sectional study was carried out in rural communities in Ejigbo Local Government Area (LGA) of Osun State, southwestern Nigeria. Only apparently healthy adults whoare 18 years and above were recruited into the study. Adults who were acutely ill and/or admitted in the hospital, those with sickle cell disease and any conditions predisposing them to increase or decrease weight gain, and those with cancer and any disability that prevented them from standing were excluded from the study.

Sample size Determination

The minimum sample size for the study was determined by the Cochran's formula (Z^2pq/e^2).[20]

Using a prevalence of 23% of MetS obtained among apparently healthy adults from a previous study,[21] a standard normal deviation of 1.96 at 95% confidence level and a 5% margin of error,the minimum sample size was determined. A 10% non-response rate was envisaged and corrected for. Thus, the sample size estimated for the study was two hundred and seventy-one (271).

Sampling Technique

A multi-stage technique was used to recruit the eligible respondents.

Stage 1: Ejigbo was selected from the list of 30 LGAs in Osun State by simple random technique(balloting method).

Stage 2: A list of existing eleven (11) electoral wards was obtained from the LGA secretariat and five wards out of them were chosen using simple random sampling technique (balloting method).

Stage 3: Two (2) streets were selected from each of the 5 wards by simple random method using the balloting technique, making a total of 10 streets.

Stage 4: Involved listing eligible individuals within the households on the selected streets and selection of actual respondents. Where a household has more than one eligible respondent, one of them was chosen via a simple random sampling method and given instructions on overnight fasting before sample collection.

Data collection instrument and methods

A structured questionnaire was used to collect information on the socio-demographic characteristics of the respondents, while the weight was assessed using OMRON digital weighing scale, height using a stadiometer and waist and hip circumference using a tape measure. The weightmeasured in kilograms (kg). Participant was in minimal clothing with shoes off. Height in meters(m) was measured with patients in erect position and unshod. Body mass index (BMI) was calculated from the weight and height as follows: BMI = weight (kg)/Height^2 (m^2). All anthropometric measurements were done according to standard protocols recommended by the International Society for the Advancement of Kinanthropometry.[22] The systolic and diastolic blood pressure was measured using an OMRON digital sphygmomanometer and was done according to the manufacturer's instructions. Three separate readings that were taken at least 5 minutes apart were recorded, and the mean of these readings was eventually used.

High-density lipoprotein cholesterol (HDL- C), triglycerides (TG) and total cholesterol (TC) were measured by the commercial kits manufactured by Randox Laboratories Ltd (Crumlin, County Antrim United Kingdom) using the enzymatic method. The low-density lipoprotein cholesterol (LDL-C) was calculated by the use of Friedewald equation. Fasting plasma glucose was determined using enzymatic oxidation in the presence of glucose oxidase, urea by the Urease- Berthelot method, uric acid by enzymatic colorimetric method and creatinine by modified Jaffe Method.

Measurement of outcome variables

In this study, National Cholesterol Education Program Adult Treatment Panel Third -III criteria (NCEP ATP III) was used. Using NCEP ATP III, at least three out of the following criteria must be present: blood pressure ≥130/85 mm Hg, fasting plasma glucose ≥110 mg/dl (6.1 mmol/l), waist circumference >102 cm in men or >88 cm in women, HDL cholesterol <40 mg/dl (1.03 mmol/l) in men or <50 mg/dL (1.29 mmol/l) in women and plasma triglycerides ≥150 mg/dl (1.7 mmol/L).

The anthropometric indices used in this study were waist circumference (WC), waist-hip ratio (WHR), waist-to-height ratio (WHtR) and the body mass index (BMI), based on findings from previous studies that have shown the selected indices to be strongly associated with MetS.[16,23,24] WHR was derived by diving WC by hip circumference, WHtR was derived by diving the WCby height in centimeters and the body mass index by diving weight in kilogram by height in meterssquared.

Data analysis

The IBM SPSS version 25 (SPSS Inc., Chicago, IL, IBM Version) was used for entry and analysisof the data obtained. The Kolmogorov-Smirnov test was used to assess for normality of distributionof variables. Data were presented using frequency distribution tables and charts. Association between metabolic syndrome and other categorical variables was assessed using Chi-square test, while the two independent sample t-test was used to determine if there is a statistically significantdifference between MetS and the continuous variables. The predictive values of the anthropometricindices were assessed using point bi-serial correlation, linear regression analysis and receiver operating characteristic (ROC) curves, with the area under curves (AUCs). Level of significance was set at $p < 0.05$ for this study.

Ethical considerations

Ethical approval was obtained from Bowen University Teaching Hospital (BUTH) ethical review committee with the ethical approval number NHREC/12/04/2012. The respondents were informed about the nature of the study and that participation was completely voluntary. Written informed consent was obtained from all selected respondents before recruitment into the study. All information gathered were kept confidential and participants were identified using only serial numbers.

RESULTS

The mean age of the respondents was 58.39 ± 15.89 years, with 40.6% (110) being males, and theothers (59.4%, 161) being females. Only 130 (48.0%) completed a minimum of secondary schooleducation and 177 (65.3%) were currently married. The mean (± standard deviation) for the selected anthropometric indices i.e., WC, BMI, WHR and WHtR were 88.74 ± 12.36, 27.04 ± 6.18, 0.89 ± 0.08 and 0.55 ± 0.08 respectively. A total of 71 (26.2%) had metabolic syndrome based on the NCEP ATP III criteria.

Table 1 shows the association between socio-demographic profile, selected anthropometric indices and metabolic syndrome. There were statistically significant associations between MetS and sex (p – 0.013), WC ($p < 0.001$), BMI ($p < 0.001$), WHR ($p = 0.001$) and WHtR ($p < 0.001$). Point bi-serial correlation analysis also revealed statistically significant associations between MetS and allthe selected anthropometric indices ($p < 0.001$) with WHtR having the strongest positive association (correlation coefficient = 0.458), followed by WC (correlation coefficient = 0.423), BMI (correlation coefficient = 0.360) and then WHR (correlation coefficient = 0.219). (Table 2)

The findings for the predictive values of the selected anthropometric indices using their area underthe ROC curves were similar to the point bi-serial correlation analysis results. (Table 3) WHtR had the highest predictive value with an AUC of 0.801 (95% CI: 0.744 to 0.858), followed by WCwith an AUC of 0.766 (95% CI: 0.705 to 0.827), then BMI (AUC:

0.762; 95% CI: 0.701 to 0.823) and lastly WHR with a rather poor AUC of 0.624 (95% CI: 0.545 to 0.703), although all were statistically significant. Figure 1 is a graphical depiction of the comparative predictive values of the anthropometric indices.

Table 1: Association between socio-demographic profile, selected anthropometric indices, and metabolic syndrome (MetS).

Variables	Metabolic syndrome		Statistics
	Absent (n = 200)	Present (n = 71)	
Age (years)	57.7 ± 16.3	60.4 ± 14.5	+0.227
Sex			
Male	90 (81.8)	20 (18.2)	**++0.013***
Female	110 (68.3)	51 (31.7)	
Educational status			
< secondary education	109 (77.3)	32 (22.7)	++0.172
≥ secondary education	91 (70.0)	39 (30.0)	
Marital status			
Currently married	132 (74.6)	45 (25.4)	++0.690
Currently unmarried	68 (72.3)	26 (27.7)	
Waist circumference (cm)	85.63 ± 11.22	97.50 ± 11.23	**+< 0.001***
Body mass index (kg/m^2)	25.72 ± 5.76	30.78 ± 5.83	**+< 0.001***
Waist hip ratio	0.88 ± 0.07	0.92 ± 0.08	**+0.001***
Waist-to-height ratio	0.53 ± 0.07	0.62 ± 0.07	**+< 0.001***

* Statistically significant ++chi-square test used +independent sample t-test used

Table 2: Metabolic syndrome and its association with selected anthropometric indices using point bi-serial correlation analysis.

Variables	Correlation Analysis	
	Coefficient	p-value
Waist-to-height ratio	0.458	**< 0.001***
Waist circumference	0.423	**< 0.001***
Body mass index	0.360	**< 0.001***
Waist-hip ratio	0.219	**< 0.001***

* Statistically significant

Table 3: Area under the ROC curve, 95% confidence interval of selected anthropometric indices predicting metabolic syndrome in the respondents.

Anthropometric parameter	AUC	95% confidence interval		p-value
		Lower	Upper	
Waist-to-height ratio	0.801	0.744	0.858	**< 0.001***
Waist circumference	0.766	0.705	0.827	**< 0.001***
Body mass index	0.762	0.701	0.823	**< 0.001***
Waist-hip ratio	0.624	0.545	0.703	**0.002***

* Statistically significant

AUC – area under ROC curve *ROC - receiver operating characteristic*

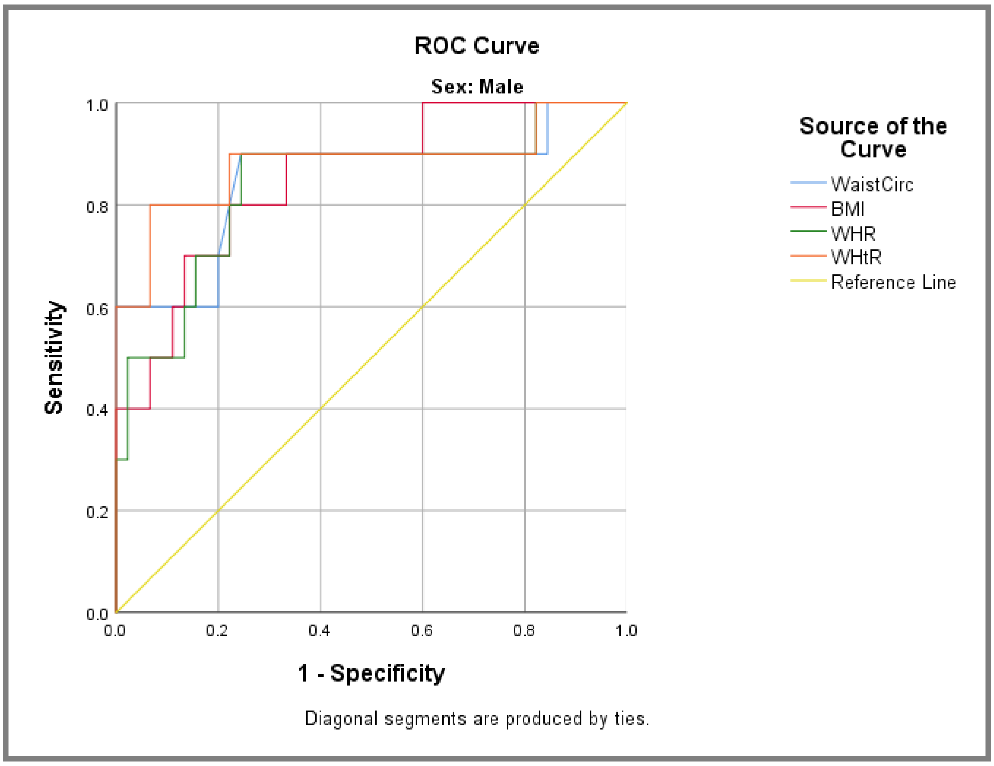

Figure 1: ROC curves for the selected anthropometric indices.

ROC - receiver operating characteristic; WHtR – waist-to-height ratio; WaistCirc – waist circumference; BMI – body mass index; WHR – waist-hip ratio

DISCUSSION

This current study assessed the predictive values of selected anthropometric indices for metabolic syndrome (MetS) among apparently healthy rural dwellers in a poor resource setting. Theprevalence of metabolic syndrome in this study was 26.2%. This is slightly higher than the global average of 20-25%.[10] In a systemic review, similar results were reported by Victor *el tal* in which 31.7%, 27.9% and 28.1% according to the WHO, ATPIII and IDF definitions.[10] Females have a significantly higher prevalence of metabolic syndrome. This may be due to the high rate of obesity especially among married women.[25][21]

In this study, all selected anthropometric measurements; WC, BMI, WHR and WHtR demonstrated significant association with MetS. Other previous studies have reported similar findings.[13][14][15] Gul Sagun et al reported a contrary finding for WC, where they found no significant link with metabolic syndromes in obese and overweight individuals.[11] This may be because WC is more highly correlated with subcutaneous fat tissue than with visceral adipose tissue.[26] Also, WC loses its ability to predict MetS when BMI is ≥30 kg/m^2 in men.[11]

Using point bi-serial correlation to find association among the selected anthropometric indices, WHtR was found to have strongest positive association with MetS and WHR has least association, while WC and BMI come in between in that order. Furthermore, area under the ROC strongly supports WHtR as better predictor of MetS among the selected indices follow closed by WC. This finding has been documented by several studies among various groups and in different environments.[27][28][29][30][31] Studies have also shown that WHtR has an added advantage over isolated waist circumference measurement, because its adjustment for height allows establishment of a single, population-wide cutoff point that remains applicable regardless of gender, age, and ethnicity. Unlike WC which is only gender specific and has poor predicting valuein obese males.[27][32][33]

CONCLUSION

Waist Height ratio, Waist circumference, Body Mass Index, and Waist Hip ratio have a moderate positive correlation and predictive values for metabolic syndrome. These selected, readily available, non-expensive anthropometric indices can be deployed as non-invasive tools in predicting metabolic syndrome. This can serve as a surrogate tool in early detection and treatment to reduce the morbidity and mortality rate of cardiovascular diseases that have been on the increase,especially in semi-urban and rural communities where sophisticated investigations are not readilyavailable and affordable.

Limitations

This study did not compare rural and urban cut-offs for metabolic syndrome among the respondents. Also, lifestyle factors such as smoking, daily activity and dietary habits of the study participants were not assessed. These can be evaluated in future research.

Conflict of Interest

The authors declare no conflicts of interest with this manuscript.

Funding statement

The research work was self-sponsored

Acknowledgment

We acknowledge community people where the work was carried out.

Data Access: It will be made available on request.

Authors' Contributions

This work was carried out in collaboration among all authors. Author **JOA,** proposal writing, sample collection, analysis, data entering interpretation of results and major contributor in writingthe manuscript**, AAA**, data analysis and contributor in the manuscript write up, **ROA**, proposal writing, data collection and contributor in writing the manuscript, **OJI**, sample collection, laboratory analysis, and data entering, **OOO**, data collection and manuscript proofreading.

REFERENCES

1. Mohammad G. Saklayen. The epidemic of the metabolic syndrome. Curr Hypertens Rep, 2018; 20: 1–8.
2. Fong Ted Chun Tat, Ho Rainbow Tin Hung YPSF. Effects of urbanization on metabolic syndrome via dietary intake and physical activity in Chinese adults: Multilevel mediation analysis with latent centering. Soc Sci Med, 2019; 234.
3. Espósito RC, Medeiros PJ, Silva FS, Oliveira AG, Soares Aragão CF, Oliveira Rocha HA, Moreira SA FSV. Prevalence of the metabolic syndrome according to different criteria i DMSO.Diabetes, Metab Syndr Obes Targets Ther, 2018; 11: 401–8.
6. Tune JD, Goodwill AG, Sassoon DJ, Mather KJ. Cardiovascular consequences of metabolic syndrome.

Translational Research, 2017; 183: 57–70.

7. Mendizábal Y, Llorens S, Nava E. Hypertension in Metabolic Syndrome : Vascular Pathophysiology. Int J Hypertens, 2013; 2013 Ldl.
8. International Diabetes Foundation. The IDF consensus worldwide definition of the metabolicsyndrome, 2006.
9. Liang XP, Or CY, Tsoi MF, Cheung CL, Cheung BMY. Prevalence of metabolic syndrome inthe United States National Health and Nutrition Examination Survey (nhanes) 2011–2018. Eur Heart J., 2021; 42 Supplement_1:ehab724.2420.
10. Mozumdar A, Liguori G. Persistent increase of prevalence of metabolic syndrome among U.S.adults: NHANES III to NHANES 1999-2006. Diabetes Care, 2011; 34: 216 – 219.
11. Oguoma VM, Nwose EU, Richards RS. Prevalence of cardio-metabolic syndrome inNigeria : a systematic review. Public Health, 2015; 129: 413–23.
12. Sagun Gul, Oguz Aytekin, Karagoz Engin, Filizer Arzu Tiğli, Tamer Gonca MB. Application of alternative anthropometric measure-ments to predict metabolic syndrome. Clinics, 2014; 69: 347–53.
13. Rafael Molina-Luque, Natalia Ulloa, Andrea Gleisner, Martin Zilic, Manuel Romero- Saldaña GM-R. An Approach to Early Detection of Metabolic Syndrome through Non-Invasive Methods in Obese Children. Child, 2020; 7: 1–12.
14. Mastroeni Silmara Salete de Barros Silva, Mastroeni Marco Fabio, Ekwaru John Paul, Setayeshgar Solmaz, Paul J.Veugelers, Gonçalves Muryel de Carvalho RPH de C. Anthropometric measurements as a potential non-invasive alternative for the diagnosis ofmetabolic syndrome in adolescents. Arch Endocrinol Metab, 2019; 63: 30–9.
15. Nir Y. Krakauer JCK. Anthropometrics, Metabolic Syndrome, and Mortality Hazard. J Obes, 2018; 2018.
16. Wang H, Liu A, Zhao T, Gong X, Pang T, Zhou Y, et al. Comparison of anthropometric indices for predicting the risk of metabolic syndrome and its components in Chinese adults: A prospective, longitudinal study. BMJ Open, 2017; 7: 1–10.
17. Ashwell M, Gunn P, Gibson S. Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors - systematic review and meta-analysis.pdf. Obes Rev., 2012; 13: 275–86.
18. Raimi TH, Fasanmade O, Odusan O, Ohwovoriole AE. The Best Central Adiposity Index in the Prediction of Cardiovascular Risk Factors in South-Western Nigeria. Open J Endocr Metab Dis., 2015; 05: 184–92.
19. Adediran O, Akintunde AA, Edo AE, Opadijo OG, Araoye A. Impact of urbanization andgender on frequency of metabolic syndrome among native Abuja settlers in Nigeria. J Cardiovasc Dis Res., 2012; 3: 191–6.
20. Bener A, Yousafzai MT, Darwish S, Al-Hamaq AOAA, Nasralla EA, Abdul-Ghani M. Obesity index that better predict metabolic syndrome: Body mass index, waist circumference, waist hip ratio, or waist height ratio. J Obes., 2013; 2013.
21. Adam AM. Sample Size Determination in Survey Research. J Sci Res Reports, 2020; 26: 90–7.
22. Adejumo Esther, Ogundahunsi Omobolanle, Adejumo Olusola, Sotunsa John JO. Prevalence of Metabolic Syndrome in a Rural and Urban Community in South-West Nigeria Using Three Different Definitions. Int J Trop Dis Heal, 2017; 24: 1–9.
23. International Society for the Advancement of Kinanthropometry. International standards for anthropometric assessment, 2001; 53–5.
24. Wu Y, Li H, Tao X, Fan Y, Gao Q, Yang J. Optimised anthropometric indices as predictive screening tools for metabolic syndrome in adults : a cross- • sectional study. BMJ Open., 2021; 11: e043952.

25. Adejumo EN, Adejumo AO, Azenabor A, Ekun AO, Enitan SS, Adebola OK, et al. Anthropometric parameter that best predict metabolic syndrome in South Diabetes & Metabolic Syndrome : Clinical Research & Reviews Anthropometric parameter that best predict metabolicsyndrome in South west Nigeria. Diabetes Metab Syndr Clin Res Rev., 2018; 13: 48–54.
26. Norbert Ndubuisi Unamba. Prevalence of Metabolic Syndrome and its Components in an Adult Nigerian Population attending a Tertiary Hospital | Unamba | The Nigerian Health Journal.TNHJ., 2017; 17.
27. Cho GJ, Yoo HJ, Hwang SY, Choi J, Lee KM, Choi KM, et al. Differential relationship between waist circumference and mortality according to age, sex, and body mass index in Korean with age of 30-90 years; a nationwide health insurance database study. BMC Med., 2018; 16: 1–11.
28. Pereira PF, Serrano HMS, Carvalho GQ, Lamounier JA, Peluzio M do CG, Franceschini Sdo CC, et al. Waist and waist-to-height ratio: Useful to identify the metabolic risk of female adolescents? Rev Paul Pediatr., 2011; 29: 372–7.
29. Wickramasinghe VP, Arambepola C, Bandara P, Abeysekera M, Kuruppu S, Dilshan P, et al. Use of waist to Height ratio in assessment metabolic derangements among normal and overweight/obese 5-15 year old individuals. Ceylon J Med Sci., 2017; 54: 18.
30. Kawamoto R, Kikuchi A, Akase T, Ninomiya D, Kumagi T. Usefulness of waist-to-height ratio in screening incident metabolic syndrome among Japanese community-dwelling elderly individuals. PLoS One, 2019; 14: 1–11.
31. Rodea-Montero ER, Evia-Viscarra ML, Apolinar-Jiménez E. Waist-to-height ratio is a betteranthropometric index than waist circumference and BMI in predicting metabolic syndrome among obese mexican adolescents. Int J Endocrinol, 2014; 2014.
32. Pasdar Y, Moradi S, Moludi J, Saiedi S, Moradinazar M, Hamzeh B, et al. Waist-to-height ratio is a better discriminator of cardiovascular disease than other anthropometric indicators inKurdish adults. Sci Rep., 2020; 10: 1–10.
33. Kammar A, Hernández-Hernández M, López-Moreno P, Ortíz-Bueno A, Martínez-Montaño M. Probability and Body Composition of Metabolic Syndrome in Young Adults: Use of theBayes Theorem as Diagnostic Evidence of the Waist-to-Height Ratio. Stats, 2018; 1: 21–31.
34. Rajput R, Rajput M, Bairwa M, Singh J, Saini O, Shankar V. Waist height ratio: A universalscreening tool for prediction of metabolic syndrome in urban and rural population of Haryana. Indian J Endocrinol Metab, 2014; 18: 394–9.