Anthropometric assessment of obesity and blood pressure control in patients with hypertension attending the family medicine clinics of Irrua specialist teaching hospital, Irrua, Nigeria.

Oseni TIA[1], Ahmed SD[2], Oku AO[3], Ayoola YA[4], Iyalome, ES[2], Ijika OA[2], Udonwa NE[5].

1. Department of Family Medicine, Edo State University, Uzairue/Lifestyle and Behavioural Medicine Unit, Department of Family Medicine, Irrua Specialist Teaching Hospital, Irrua, Nigeria.
2. Department of Internal Medicine, Irrua Specialist Teaching Hospital, Irrua, Nigeria.
3. Department of Community Medicine, University of Calabar, Calabar, Nigeria.
4. Department of Internal Medicine, Gombe State University, Gombe, Nigeria.
5. Department of Family Medicine, University of Calabar, Calabar, Nigeria.

Abstract

*Introduction**:** Obesity can be a major problem due to its potential to cause a number of health issues, including high blood pressure, diabetes and other cardiovascular diseases. This study aimed to evaluate the association between obesity as assessed by body mass index (BMI), waist-hip ratio (WHR) and waist-height ratio (WHtR) and blood pressure control among patients with hypertension attending the Family Medicine Clinics of Irrua Specialist Teaching Hospital, Irrua, a semi-urban community in Edo State, southern Nigeria. Methods**:** This was a cross-sectional study among 250 patients with hypertension attending the Family clinics of Irrua Specialist Teaching Hospital, aged 18 to 65 years. The anthropometric indices of consenting participants, including BMI, WHR, and WHtR were evaluated and blood pressure was determined. Data was analysed using the statistical package of Social Sciences version 24.0. Result**:** Study participants had a mean age of 51.5 ± 10.0 years, with a mean BMI of 28.60 ± 5.71kg/m^2. The median and interquartile range of the waist-hip ratio and waist-height ratio were 1.02 (1.01, 1.03) and 0.61 (0.58, 0.66) respectively. The proportion of participants with obesity, defined by WHtR, with uncontrolled BP was significantly higher than that for those with controlled BP (63.9% vs 47.5%; p=0.024). Upon adjusting for sociodemographic variables, participants with obesity based on WHtR had 2.71 times the odds of having uncontrolled blood pressure compared to those who did not have obesity. This finding was statistically significant. (aOR=2.71; 95% CI=1.37-5.38; p=0.004). Conclusion: Anthropometric indices remain valuable predictors of blood pressure control. The WHtR, a measure of central obesity, compared to the BMI, was significantly associated with poor blood pressure control.*

Keywords: *Waist height ratio, waist-hip ratio, body mass index, hypertension, anthropometric assessment*

Introduction

Obesity is a complex disease involving an excessive amount of body fat, characterised by the excessive accumulation of adipose tissues across the human body.[1] Hypertension and obesity are among the strongest modifiable risk factors for non-communicable diseases (NCDs) including cardiovascular diseases and diabetes.[2,3] Obesity, especially abdominal obesity, has been shown to play a significant role in the aetiology of hypertension,[4-7] and it is strongly associated with heart diseases, hypertension and diabetes.[5,6,8] Together with hypertension, obesity is a major cause of premature death worldwide.[6,8] Assessing abdominal adiposity in patients with hypertension is therefore important as it may help institute measures to correct it, thereby leading to an improvement in blood pressure control as well as preventing complications of hypertension.

Corresponding author Dr. Tijani Idris Ahmad Oseni, Department of Family Medicine, Edo State University, Uzairue, Nigeria. Email: oseni.tijani@edoyniversity.edu.ng

The most commonly used measurement of obesity in patients with hypertension is the Body Mass Index (BMI).[1,3,7] While it remains the standard measure for general obesity, it does not measure the distribution of adipose tissue in the body, which plays a significant role in the development of cardiovascular diseases. Other measures of obesity that take into account the distribution of body fat include waist-hip-ratio (WHR) and waist-height-ratio (WHtR). WHR and WHtR have been identified as better predictors of HTN compared to BMI.[3,4,6,9] This is because WHR and WHtR measure central obesity, while BMI measures general obesity.[6] WHtR has been identified as highly predictive of hypertension because it considers the impact of both the waist circumference and the height of an individual on body fat composition.[6,10,11] This is important as a short person will not have the same body fat composition as a tall person with the same abdominal and hip circumference. Furthermore, WHtR ≥ 0.5 increases the risk of dyslipidaemia, diabetes mellitus and hypertension.[9] A prospective study of 1,685 normotensive patients with type 2 diabetes mellitus in Iran found WHtR to be a more accurate tool compared to WHR and BMI for predicting hypertension.[4] Another study in Brazil found WHtR to be a better predictor of hypertension regardless of gender and age compared to BMI and Waist Circumference (WC) combined.[10] A Saudi study also reported WHtR as a good diagnostic tool for screening for cardiovascular risk factors and metabolic syndrome among Saudis.[9] A community-based study conducted in Lagos Nigeria among 5,135 adults found WHtR and other measures of central adiposity to be the strongest predictors and independent determinants of hypertension in Nigeria.[2]

The majority of the studies, including those described above, were community-based studies and on normotensive patients. This study aims to determine the association between obesity, assessed by BMI, WHR, and WHtR, and blood pressure control among patients with hypertension attending the Family Medicine Clinics of Irrua Specialist Teaching Hospital, Irrua, a semi-urban community in Edo State, Southern Nigeria. The primary outcome is the assessment of obesity, and the secondary outcome is the association of obesity with blood pressure control.

Material and Methods

Study Design, Setting, and Participants: A cross-sectional study of 250 patients with hypertension attending the Family Medicine Clinics of Irrua Specialist Teaching Hospital (ISTH) was conducted between April and June 2023. The sample size was determined using the Cochran's formula $n= Z^2 pq/ d^2$ and patients were selected using systematic random sampling. Patients were aged 18 to 65 years and were antihypertensive-naive but had blood pressures ≥ 140/90 mmHg taken at least twice at an interval of ≥ ten minutes or were on antihypertensives for at least 6 months. Patients who refused consent, had cognitive impairment, or had chronic kidney disease, heart failure, or other forms of secondary hypertension or complications from hypertension were excluded from the study.

Data Collection: Demographic and clinical data, including age, gender, marital status, occupation, and income, were collected. Blood pressure measurements were taken according to the American Heart Association guidelines using a standard mercury sphygmomanometer and a stethoscope. Three readings were taken at 10-minute intervals after the participant had rested for at least 15 minutes, and the average of the second and third readings was recorded. Hypertension was defined as blood pressure ≥ 140/90 mmHg, while blood pressure was considered controlled if it was < 140/90 mmHg.[12,13]

Anthropometric Measurements: Anthropometric indices including weight, height, waist circumference, and hip circumference were measured according to standardized procedures. Bodyweight was measured using a digital weighing scale to the nearest 0.1 kg, with participants standing without shoes and heavy clothing. Height was measured using a stadiometer to the nearest 0.1cm. Waist circumference (WC) was measured at the midpoint between the lowest rib and the iliac crest to the nearest 0.1 cm with a flexible, non-stretchable tape which was also used to measure hip circumference at the level of the greater trochanters to the nearest 0.1 cm. body Mass Index (BMI), Waist-Hip Ratio (WHR) and Waist-Height Ratio (WHtR) were calculated from these measurements.[4,14,15] Patients were categorised based on WC into those with obesity (>1.02m for males >0.88m for females) and those without obesity (≤ 1.02m for males ≤ 0.88m for females). For WHR, the cut-off value for males was 0.9 while that for females was 0.88. WHtR was used to categorize patients into those with obesity (≥ 0.5) and those without obesity (< 0.5) as recommended.[7]

Statistical Analysis: Data were analysed using the Statistical Package for Social Sciences (SPSS) version 24.0. Continuous variables were summarized using means and standard deviations (SD) or median and interquartile ranges (IQR) as appropriate, while categorical variables were summarized using proportions. Bivariate analysis was done using the Chi-square test, Student's t-test, and Mann-Whitney U test as appropriate. The Odds Ratio (OR) with 95%

Confidence Interval (CI) was used to determine the strength of the association between obesity and uncontrolled blood pressure. Multivariable analysis using logistic regression was conducted to determine the predictors of uncontrolled blood pressure. The level of statistical significance was set at $p < 0.05$.

Ethics approval and consent to participate:
Ethical approval for the study was obtained from the Ethics Committee of Irrua Specialist Teaching Hospital (ISTH/HREC/20230802/446) and the research was carried out in conformity with the Declaration of Helsinki. Written informed consent was obtained from all individual participants included in the study after a detailed explanation of the study to them.

Results

Baseline Characteristics: The mean age of the participants was 51.5 ± 10.0 years, with the majority being female (62.4%). Most participants were married (54.0%), traders 87 (34.8%), with an average monthly income of between N50000 to N99999 118 (47.2%). The sociodemographic characteristics of respondents are shown in Table 1.

Table 1: Sociodemographic Characteristics of Respondents

Variable	Frequency (n=250)	Percent (%)
Age as at Last Birthday (years)		
< 40	46	18.4
40 – 49	47	18.8
50 – 59	92	36.8
≥ 60	65	26.0
Sex		
Female	156	62.4
Male	94	37.6
Marital Status		
Single	12	4.8
Married	135	54.0
Divorced/Separated	47	18.8
Widowed	56	22.4
Occupation		
Artisan	32	12.8
Civil servant	86	34.4
Farmer	29	11.6
Trader	87	34.8
Unemployed	16	6.4
Average Monthly Income (₦)		
< 50,000	72	28.8
50,000 – 99,999	118	47.2
100,000 – 199,999	52	20.8
≥ 200,000	8	3.2

Mean age ± SD in years = 51.5 ± 10.0

Anthropometric Measurements: The mean BMI was 28.60 ± 5.71 kg/m². The median and interquartile range of the waist-hip ratio and waist-height ratio were 1.02 (1.01, 1.03) and 0.61 (0.58, 0.66) respectively.Table 2.

Table 2: Anthropometric Characteristics

Variable	Frequency (n=250)	Per cent (%)
Height (m)		
< 1.60	62	24.8
1.60 – 1.69	119	47.6
1.70 – 1.79	66	26.4
≥ 1.80	3	1.2
Weight (kg)		
< 50.00	8	3.2
50.00 – 69.99	77	30.8
70.00 – 89.99	112	44.8
≥ 90.00	53	21.2
Body Mass Index (kg/m^2)		
< 18.50	5	2.0
18.50 – 24.99	67	26.8
25.00 – 29.99	78	31.2
≥ 30.00	100	40.0
Waist Circumference (m)		
< 0.90	13	5.2
0.90 – 0.99	127	50.8
1.00 – 1.09	52	20.8
1.10 – 1.19	41	16.4
≥ 1.20	17	6.8
Hip Circumference (m)		
< 0.90	5	2.0
0.90 – 0.99	160	64.0
1.00 – 1.09	34	13.6
1.10 – 1.19	44	17.6
≥ 1.20	7	2.8

Obesity Classifications: Using BMI, 100 (40.0%) respondents were found to be with obesity. The number of respondents with obesity increased to 178 (71.2%), 221 (88.4%) and 150 (60.0%)when obesity was measured based on waist circumference, waist-hip ratio and waist height ratio respectively. Table 3.

Table 3: Obesity Classifications

Obesity	Frequency (n=250)	Per cent (%)
According to BMI		
Those without obesity	150	60.0
Those with obesity	100	40.0
According to WC		
Those without obesity	72	28.8
Those with obesity	178	71.2
According to WHR		
Those without obesity	29	11.6
Those with obesity	221	88.4
According to WHtR		
Those without obesity	100	40.0
Those with obesity	150	60.0

Blood Pressure Control: The majority of respondents had uncontrolled blood pressure 191 (76.4%) as illustrated in Table 4.

Table 4: Blood Pressure Control

Blood Pressure Control	Frequency (n=250)	Per cent (%)
Controlled	59	23.6
Uncontrolled	191	76.4

Table 5: Obesity and BP Control

Variable	Controlled BPN=59 n (%)	Uncontrolled BPN=191 n (%)	χ^2	p-value
According to BMI				
Those without obesity	36 (61.0)	114 (59.7)	0.033	0.855
Those with obesity	23 (39.0)	77 (40.3)		
According to WC				
Those without obesity	16 (27.1)	56 (29.3)	0.107	0.744
Those with obesity	43 (72.9)	135 (70.7)		
According to WHR				
Those without obesity	7 (11.9)	22 (11.5)	0.005	0.942
Those with obesity	52 (88.1)	169 (88.5)		
According to WHtR				
Those without obesity	31 (52.5)	69 (36.1)	5.062	0.024
Those with obesity	28 (47.5)	122 (63.9)		

Obesity and BP Control: The proportion of participants with obesity based on WHtR was higher among those with uncontrolled blood pressure compared to controlled blood pressure (63.9% vs 47.5%; p=0.024). Table 5 above.

Table 6; Participants with obesity based on WHtR had higher odds of having uncontrolled blood pressure compared to those without obesity (a OR=2.71; 95% CI=1.37-5.38; p=0.004).

Table 6: Multivariable Binary Logistic Regression showing the Association between Obesity and BP Control

Variable	Adjusted odds ratio	95% CI	p-value
Obesity according to BMI			
Those without obesity	Reference		
Those with obesity	1.28	0.66 – 2.48	0.462
Obesity according to WC			
Those without obesity	Reference		
Those with obesity	1.48	0.46 – 4.73	0.512
Obesity according to WHR			
Those without obesity	Reference		
Those with obesity	0.71	0.23 – 2.18	0.549
Obesity according to WHtR			
Those without obesity	Reference		
Those with obesity	2.71	1.37 – 5.38	0.004

Discussion

This cross-sectional study evaluated the anthropometric assessment of obesity in patients with hypertension attending an outpatient clinic in a rural setting, in Southern Nigeria. We assessed four anthropometric indices, including the body mass index (BMI), waist circumference (WC), waist-hip ratio (WHR) and waist-to-height ratio (WHtR).The mean age of the study population was 51.5 years (51.5± 10.0). This is similar to findings in related studies in Ethiopia.[16, 17]

Our study showed that the prevalence of uncontrolled hypertension in the study population was high (76.4%), higher than reports from previous studies from different ethnic groups and nationalities with Addis Ababa and Tigray Ethiopia (63%)[17,] Iran (61.1%)[18] and South Africa (56.8%)[19]. Earlier studies have reported hypertension, a major health problem in Africa, with an estimated prevalence of 30.8%.[20,21] Perhaps the observed differences in prevalence may not be unconnected with varying lifestyles and practices among the studied populations.

We found in the study, a mean BMI, WC and HC of 28.60 ± 5.71kg/m^2, 1.02 ± 0.09m and 1.01 ± 0.09m respectively. Among the anthropometric indexes, BMI is used commonly for evaluating obesity.[22, 23]Although BMI is the most frequently used index, it does not reflect body fatness uniformly in all populations, and inter-ethnic extrapolations are not justified.[24] The mean BMI finding in our study is consistent with findings in earlier studies in South Eastern Nigeria.[25] We found a mean BMI of 28.6 kg/m^2 which was lower compared with the current definitions of obesity recommended by WHO (BMI ≥30 kg/m^2).[26] However our figures are higher than reported figures more than a decade earlier (2%) among rural dwellers in south-western Nigeria.[27] This may not be unrelated to changing lifestyle patterns and trends of the Nigerian rural populace.

The WC is an essential measure of anthropometry and it directly measures central adiposity. Increasing central adiposity is associated with an increased risk of morbidity and mortality due to an increased risk of diabetes and heart disease[28]. The current study found a mean WC greater than the African-specific WC cut-off points for central obesity of 94 cm for men and 80cm for women which were adopted by the International Diabetic Federation (IDF).[29] Our study demonstrated a median and interquartile range of the waist-hip ratio and waist-height ratio of 1.02 (1.01, 1.03) and 0.61 (0.58, 0.66) respectively.

Furthermore, the inter-relationship of obesity indices was further demonstrated where 40% of the study population had obesity using the BMI. This prevalence was further increased to 71.2%, 88.4% and 60.0% respectively employing WC, WHR and WHtR. Whereas the commonly used obesity index in clinical practice is the BMI, based on our findings, the indices for central obesity (WC, WHR, WHtR) may define obesity more accurately.[30] This finding was statistically significant in the current study.

The study found that central obesity, as measured by WHtR, was significantly associated with poor blood pressure control in these patients. This finding is consistent with previous studies that have demonstrated the superiority of central obesity measures, such as WHtR, in predicting hypertension compared to general obesity measures like BMI.[30,31] The relationship between central obesity and hypertension can be attributed to the fact that abdominal obesity is closely linked to insulin resistance, inflammation, and dyslipidaemia, all of which are key mechanisms in the development of hypertension and other cardiovascular diseases.[4,5,7] WHtR takes into account both waist circumference and height, making it a more accurate measure of abdominal adiposity and distribution.

The study has several implications for clinical practice. Firstly, it underscores the importance of assessing central obesity, especially in patients with hypertension, to identify those at higher risk of poor blood pressure control. Secondly, it emphasizes the need for targeted interventions that address central obesity, such as lifestyle modifications and pharmacotherapy, to improve blood pressure control and reduce the risk of complications.

Limitations

The study has some limitations. Firstly, its cross-sectional design limits the ability to establish a causal relationship between central obesity and blood pressure control. Secondly, the study was conducted at a single centre, which may limit the generalize ability of the findings to other populations. Lastly, the study did not assess other potential confounders, such as dietary habits and physical activity, which could influence the relationship between central obesity and blood pressure control.

Conclusion

In conclusion, central obesity, as measured by the waist-height ratio, is significantly associated with poor blood pressure control in patients with hypertension. These findings highlight the importance of incorporating central obesity assessments into the management of hypertension to identify individuals at higher risk of uncontrolled blood pressure. Further research, including longitudinal studies, is needed to better understand the causal relationship between central obesity and blood pressure control, as well as to explore the effectiveness of interventions targeting central obesity in improving blood pressure outcomes.

Acknowledgements:
The authors would like to thank all the participants who took part in the study.

Availability of data and materials:
Data and materials used for the study will be made available upon request from the corresponding author.

Competing interests:
The authors declare no competing interest whatsoever.

References

1. Hayajneh AA, Alhusban IM, Rababa M, Bani-Hamad D, Al-sabbah S. The Role of Traditional Obesity Parameters In the Prediction of the Coronary Arteries Disease Among Patients Undergoing Cardiac Catheterization: A Systematic Review. International Journal of Africa Nursing Sciences. 2022 May 26:100437.
2. Adegoke O, Ozoh OB, Odeniyi IA, Bello BT, Akinkugbe AO, Ojo OO, et al. Prevalence of obesity and an interrogation of the correlation between anthropometric indices and blood pressures in urban Lagos, Nigeria. Scientific reports. 2021 Feb 10;11(1):3522.
3. Tawfik HM. Waist height ratio and waist circumference in relation to hypertension, Framingham risk score in hospitalized elderly Egyptians. The Egyptian Heart Journal. 2018 Sep 1;70(3):213-6.
4. Moosaie F, FatemiAbhari SM, Deravi N, Karimi Behnagh A, Esteghamati S, Dehghani Firouzabadi F, et al. Waist-to-height ratio is a more accurate tool for predicting hypertension than waist-to-hip circumference and BMI in patients with type 2 diabetes: A prospective study. Frontiers in Public Health. 2021 Oct 7;9:726288.
5. Fan H, Li X, Zheng L, Chen X, Lan Q, Wu H, et al. Abdominal obesity is strongly associated with Cardiovascular Disease and its Risk Factors in Elderly and very Elderly Community-dwelling Chinese. Scientific reports. 2016 Feb 17;6(1):21521.
6. Shrestha R, Upadhyay SK, Khatri B, Bhattarai JR, Kayastha M, Upadhyay MP. BMI, waist to height ratio and waist circumference as a screening tool for hypertension in hospital outpatients: a cross-sectional, non-inferiority study. BMJ open. 2021 Nov 1;11(11):e050096.
7. Alwadeai KS, Almeshari MA, Alghamdi AS, Alshehri AM, Alsaif SS, Al-Heizan MO, et al. Relationship Between Heart Disease and Obesity Indicators Among Adults: A Secondary Data Analysis. Cureus. 2023 Mar 27;15(3).
8. World Health Organization. Hypertension. 2023. Available: https://www.who.int/news-room/fact-sheets/detail/hypertension [Accessed 19 May 2023].
9. Alzeidan R, Fayed A, Rabiee F, Hersi A, Elmorshedy H. Diagnostic performance of waist-to-height ratio in identifying cardiovascular risk factors and metabolic syndrome among adult Saudis: a cross-sectional study. Saudi medical journal. 2020 Mar;41(3):253-60.
10. Corrêa MM, Facchini LA, Thumé E, Oliveira ER, Tomasi E. The ability of waist-to-height ratio to identify health risk. Revista de saúde publica. 2019 Sep 23;53:66.
11. Tseng CH, Chong CK, Chan TT, Bai CH, You SL, Chiou HY, et al. Optimal anthropometric factor cutoffs for hyperglycemia, hypertension and dyslipidemia for the Taiwanese population. Atherosclerosis. 2010 Jun 1;210(2):585-9.
12. Unger T, Borghi C, Charchar F, Khan NA, Poulter NR, Prabhakaran D, et al. 2020 International Society of Hypertension global hypertension practice guidelines. Hypertension. 2020 Jun;75(6):1334-57.
13. Ayogu RN, Ezeh MG, Okafor AM. Prevalence and predictors of different patterns of hypertension among adults aged 20–60 years in rural communities of Southeast Nigeria: a cross-sectional study. Archives of Public Health. 2021 Dec;79(1):1-1.
14. Center for Disease Control. About adult BMI. 2022. Available: https://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html [Accessed 19 May 2023].
15. World Health Organization. Waist Circumference And Waist-Hip Ratio: Report Of A Who Expert Consultation, Geneva. 2011.
16. Amare F, Nedi T, Berhe DF (2020) Blood pressure control practice and determinants among ambulatory hypertensive patients attending primary health care facilities in Addis Ababa. SAGE Open Med 8: 2050312120946521.
17. Berhe DF, Taxis K, Haaijer-Ruskamp FM, Mulugeta A, Mengistu YT, et al. (2022) Hypertension treatment practices and its determinants among ambulatory patients: Retrospective cohort study in Ethiopia. BMJ Open 7: e015743.
18. Mirzaei M, Mirzaei M, Bagheri B, Dehghani A (2020) Awareness, treatment, and control of hypertension and related factors in adult Iranian population. BMC Public Health 20: 667.
19. Masilela C, Pearce B, Ongole JJ, Adeniyi OV, Benjeddou M (2020) Cross-sectional study of prevalence and determinants of uncontrolled hypertension among South African adult residents of Mkhondo municipality. BMC Public Health 20: 1069.
20. Adeloye D, Basquill C. Estimating the prevalence and awareness rates of hypertension in Africa: a systematic analysis. PLoS One. 2014;9(8):e104300.
21. Ataklte F, Erqou S, Kaptoge S, Taye B, Echouffo-Tcheugui JB, Kengne AP. Burden of undiagnosed hypertension in sub-saharan Africa: a systematic review and meta-analysis. Hypertension. 2015;65(2):291–8.
22. Zhang J, Zhu W, Qiu L, Huang L, Fang L. Sex- and Age-Specific Optimal Anthropometric Indices as Screening Tools for Metabolic Syndrome in Chinese Adults. Int J Endocrinol. 2018;2018:1067603
23. Hu H, Wang J, Han X, Li Y, Wang F, Yuan J, et al. BMI, Waist Circumference and All-Cause Mortality in a Middle-Aged and Elderly Chinese Population. J Nutr Health Aging. 2018;22(8):975–81.
24. Hadaegh F, Zabetian A, Harati H, Azizi F. Waist/height ratio as a better predictor of type 2 diabetes compared to body mass index in Tehranian adult men- a 3.6-year prospective study. Exp Clin Endocrinol Diabetes. 2006;114:310–5
25. Egbe EO, Asuquo OA, Ekwere EO, Olufemi F, Ohwovoriole AE. Assessment of anthropometric indices among residents of Calabar, South-East Nigeria. Indian J Endocrinol Metab. 2014 May;18(3):386-93. doi: 10.4103/2230-8210.131196. PMID: 24944936; PMCID: PMC4056140.
26. Geneva: World Health Organisation; 1999. World Health Organisation: Definition, Diagnosis and Classification of DM and its Complications: Report of WHO consultation. Part 1: Diagnosis and Classification of DM. WHO/NCD/NCS/99.2
27. Oladapo OO, et al. A prevalence of cardiometabolic risk factors among a rural Yoruba south-western Nigerian population: A population-based survey. Cardiovasc. J. Afr. 2010;**21**:26–31.

28. Gavriilidou NN, Pihlsgård M, Elmståhl S. Anthropometric reference data for elderly Swedes and its disease-related pattern. Eur J Clin Nutr. 2015 Sep;69(9):1066-75.
29. International Diabetes Federation: Diabetes Atlas. Brussels, International Diabetes Federation. 2009
30. Selvaraj S, et al. Association of central adiposity with adverse cardiac mechanics; findings from the hypertension genetic epidemiology network study. Circ. Cardiovasc. Imaging. 2016;**9**:1–9. doi: 10.1161/CIRCIMAGING.115.004396.
31. Després JP, et al. Abdominal obesity and the metabolic syndrome: Contribution to global cardiometabolic risk. Arterioscler. Thromb. Vasc. Biol. 2008;**28**:1039–1049. doi: 10.1161/ATVBAHA.107.159228