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Association Of Visceral Adiposity And Hypertension In A Tertiary Care Centre Of North East India: A Comparative Cross Sectional Study

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Abstract:
Introduction: *Cardiovascular disease is the leading cause of morbidity and mortality worldwide and hypertension is an independent cardiovascular risk factor. The consumption of high-fat food has significantly risen, resulting in a significant increase in average body fat. This has become an important factor in the notable growth in the incidence of chronic diseases, such as hypertension in recent years. Obesity can promote a cascade of secondary cardiometabolic pathologies such as hypertension, hyperlipidemia, insulin resistance and hyperuricemia, alone or in combination, all of which exacerbate the progression of cardiovascular disease (CVD). Body Mass Index (BMI) and Waist-to hip ratio (WHR) have been widely used to judge overweight and obesity. Therefore, this study is sought to assess the waist to hip ratio and visceral adiposity among healthy adults and hypertensive patients.*
Aim & Objectives:
1. To estimate the visceral fat percentage among healthy adults and hypertensive patients.
2. To estimate the waist-hip ratio among healthy adults and hypertensive patients.
3. To compare the visceral fat percentage and waist-hip ratio of healthy adults and hypertensive patients.
Materials and Method: *A hospital based cross sectional study was taken up among 40 hypertensive and 40 healthy adults above the age of 18 years attending at Agartala Government Medical College (AGMC), Agartala. Visceral fat assessment was done by measuring BMI, WHR and using BIA (bioelectrical impedance analysis) for all the study participants.*
Results: *Mean BMI, Visceral fat grade, waist to hip ratio were significantly higher among the hypertensive individuals compared to healthy subjects. The mean BMI of healthy subjects and hypertensive patients was (24.1 ± 4.0) kg/m^2 and (27.9 ± 4.8) kg/m^2 respectively. Mean VF (visceral fat) grade was (10.08 ± 4.00) and (12.85 ± 4.05) among healthy subjects and hypertensive patients respectively and mean WHR was (0.93 ± 0.06) and (1.00 ± 0.05) respectively. There was significant positive correlation of BMI, total body fat, visceral fat grade, waist to hip ratio with SBP and DBP of the study participants.*
Conclusion: *There is a positive association between visceral adiposity and development of hypertension. People with visceral adiposity should take measures to reduce their visceral fat mass and should be regularly monitored for development of hypertension.*
Keywords: *Obesity, Hypertension, BMI (Body Mass Index), visceral fat grade, waist-to-hip ratio (WHR).*

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I. Introduction

Cardiovascular disease is the leading cause of morbidity and mortality worldwide and hypertension is an independent cardiovascular risk factor. According to epidemiologic statistics, there are approximately 1 billion hypertensive patients worldwide, and it is projected that the population of hypertensive patients will increase to 1.292 billion by 2025[1,2]. In the United States, it was found that the prevalence of hypertension in adults is about 32%–46%[3]. Among those aged 60 years and above, the percentage of women suffering from hypertension is about 75%[4]. The prevalence of hypertension is 22.6% in India (24.1% in men and 21.2% in women)[5].

Hypertension due to obesity and overweight has become an important issue, widely studied by scientists, and its prevalence has increased significantly worldwide. With the development of economy, people's eating habits and lifestyles have changed[6]. The consumption of high-fat food has significantly risen, resulting in a significant increase in average body fat. This has become an important factor in the notable growth in the incidence of chronic diseases, such as hypertension in recent years. The WHO and National Public Health Administration reports have observed a significant increase in costs for prevention and treatment of these conditions thus becoming also an important issue[7].

Body Mass Index (BMI) and Waist-to-hip ratio (WHR) have been widely used to judge overweight and obesity. However, this is not able to distinguish between lean and fat mass and does not provide indication of body fat distribution[8]. Several studies have showed that compared to BMI, abdominal obesity measures such as waist circumference, waist-to-hip ratio or visceral fat, are better at predicting cardiovascular disease and its risk factors[9,10]. Visceral fat has been reported to be associated with blood pressure[11].

Obesity can promote a cascade of secondary cardiometabolic pathologies such as hypertension, hyperlipidemia, insulin resistance and hyperuricemia, alone or in combination, all of which exacerbate the progression of cardiovascular disease (CVD)[12]. Differences in adipose tissue distribution may contribute to the heterogeneity of clinical and biological manifestations of obesity. Under conditions of inadequate subcutaneous adipose tissue (SAT) (eg. nutrient overload or lipodystrophy), excess triglyceride is stored ectopically in other depots, such as visceral adipose tissue (VAT), muscle and liver. SAT is relatively metabolically inert and VAT is associated with increased cytokine production and insulin resistance. Thus VAT mass, rather than SAT or the degree of overall adiposity would be associated with the development of hypertension[13].

Excessive visceral fat distribution is accompanied by several alterations at hormonal, inflammatory and endothelial level[14]. The visceral fat distribution is in part affected by genetic factors that also contribute to the increase in blood pressure levels in obese individuals (eg. tumor necrosis factor-α, β^3-adrenergic receptor, G-protein β^3 subunit). Other factors like alcohol intake, cigarette smoking, timing of onset of childhood obesity, changes in daily-life habits, and alteration in lipid profile may also be implicated in the visceral fat distribution and increase in blood pressure values. The Environmental factors like dietary habits, lifestyle, and geographical variations have a great impact on body fat distribution and development of hypertension.

Very few studies have been conducted in North-Eastern part of India especially in Tripura to assess the body fat distribution and its association with hypertension. Tripura, third smallest state of the country, is geographically different from other parts of India and lies in a geographically disadvantageous location. Therefore, this study is sought to assess the waist-to-hip ratio and visceral adiposity among healthy adults and hypertensive patients.

II. Materials And Method

Study Design: Hospital based cross sectional study/comparative study

Study Type: Observational study

Study Duration: Three months

Study Area/Location: Department of Physiology, Agartala Government Medical College (AGMC), Agartala.

Study Population: Hypertensive patients and healthy adults above the age group of 18 years attending at Agartala Government Medical College (AGMC), Agartala were included in the study.

Sampling Procedure: Convenience type of sampling (non-probability) was used to select the participants for the study from among the study population who suitably fulfilled the selection criteria.

Inclusion Criteria:
1. Healthy adults above the age of 18 years.
2. Hypertensive patients of > 18 years
Hypertension was defined as (AHA guideline)[15]
a. Current use of antihypertensive medication
b. Mean systolic blood pressure (SBP) ≥ 140 mmHg and/or mean diastolic blood pressure (DBP) ≥ 90 mmHg.

Exclusion Criteria:
1. Pregnancy
2. Subjects with diabetes mellitus, thyroid deficiency
3. Use of antipsychotic medication, anticancer, and steroid medication

4. Pacemaker or other internal electronic medical device
5. Critically ill individuals

Study Tools:
1. Stadiometer: Bioplus; Height - 200 cm
2. Weight Machine (Mechanical EQ-BR-9201): Brand-Equinox, Weight Limit - 130 kg
3. Sphygmomanometer: Digital
4. Measuring tap: For waist circumference and Hip circumference measurement
5. Body composition monitor: BS 200 Healthsense
6. Case study format

Study Procedure: All the study participants were selected consecutively during the study period following the inclusion and exclusion criteria. Written informed consent was obtained from all the participants. All the participants were personally subjected to detailed history regarding name, age, sex, occupation, socioeconomic status, educational status, medical history and clinical features etc. These findings were recorded in a predesigned and pretested standard questionnaire.
1. **Age** was recorded from the birthdays by calendar to the nearest of the years (<6 months and > 6 months).
2. Standing height was recorded without shoes and with light clothes by a measuring stand with scale to the nearest of centimeters (< 5 mm and > 5 mm)
3. **Weight** was recorded without shoes and with light clothes on a standard electronic weighing machine with a least count of 500 grams
4. Blood pressure was recorded as per the guidelines of the American Heart Association (2009) with the participant in a seated position after a five-minute rest and three measurements was taken with cuff at the level of the right atrium, 2 minutes apart and their average value was recorded as the BP of the participant.
5. **BMI** was calculated by the formula[15]: BMI=Weight (kg)/{Height (m)}^{2}

Asia Pacific Classification	BMI (kg/m^{2})
Underweight	< 18.52
Normal Weight	18.5 - 22.9
Overweight	23 - 24.9
Obese	≥ 25

6. **Visceral fat assessment:** Body composition including total fat mass, Body fat percentage (PBF) and visceral fat grade (VF) was measured by using multi-frequency bioelectrical impedance analysis with 8-point tactile electrodes (BS 200 Healthsense). Impedance was measured within 1–2 min with the subject standing in her/his bare feet and grasping the hand electrodes with arms at 45-degree angle. VF grade between 1-12 was considered healthy, whereas a range between 13-50 was considered as excess visceral fat[16]. Body fat percentage was considered low (<10% for men and <20% for women), normal (10–19% for men and 20–29% for women), and high (≥20% for men and ≥30% for women)[17].
7. **Waist and Hip Ratio (WHR):** Waist (cm) and hip circumference (cm) was measured with participants wearing light clothing to the nearest of centimeters (< 5 mm and > 5 mm) and waist to Hip ratio was calculated. Abdominal obesity (no vs. yes) was classified based on the waist-to-hip ratio of ≥0.90 for males and ≥0.85 for females[18].

Data Analysis:
Data was analyzed using SPSS 20. Descriptive statistics and other suitable statistical tests was used as per applicability. Data was expressed in terms of mean and standard deviation. Correlation was assessed between Waist to Hip ratio, visceral obesity and hypertension. A probability value less than 0.05 was considered as significant.

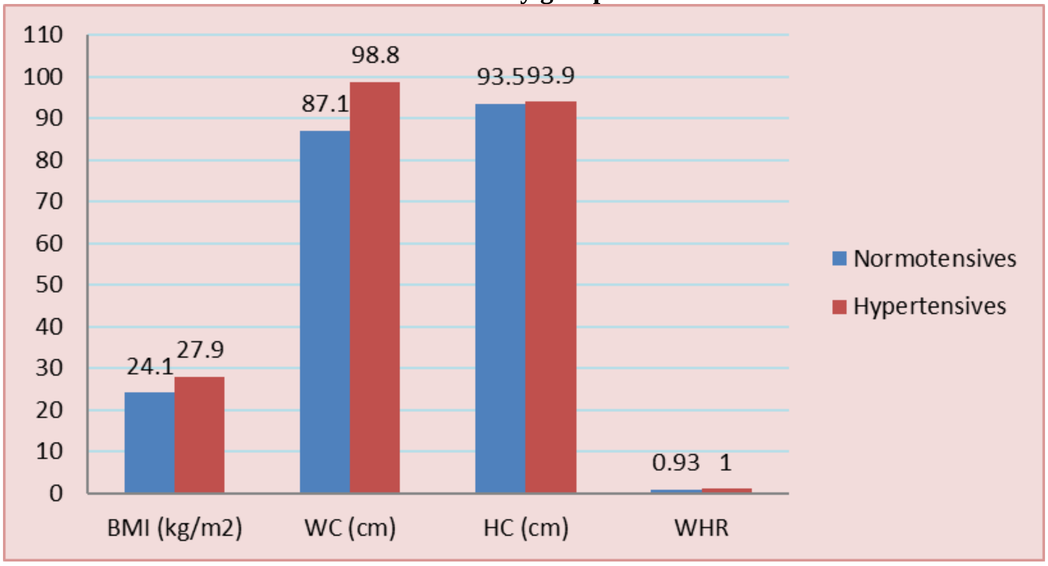
III. Results

The study included 40 healthy and 40 hypertensive adults of more than 18 years of age. Mean SBP was (119.5 ± 9.7) mmHg and (151.9 ± 7.6) mmHg respectively and mean DBP was (73.7 ± 8.3) mmHg and (79.7 ± 9.1) mmHg respectively among healthy subjects and hypertensive patients. Table 1 shows anthropometric variables among the study population. Mean weight and BMI of the hypertensive patients were significantly higher compared to the healthy subjects with p value <0.05 as shown in Table 1. Mean waist circumference, hip circumference and WHR were also significantly higher in hypertensive patients as mentioned in Table 1. Comparison of mean BMI, waist circumference (WC), hip circumference (HC) and waist to hip ratio (WHR) is shown in Figure 1.

Table 1. Anthropometric variables of the study participants (N=80)

Variables	Normotensives (Mean ± Std. Deviation)	Hypertensives (Mean ± Std. Deviation)	P value
Height (cm)	155.90 ± 8.61	154.70 ± 8.99	.544
Weight (Kgs)	58.91 ± 11.66	66.63 ± 10.73	.003
BMI (Kg/m2)	24.1 ± 4.0	27.9 ± 4.8	.000
WC (cm)	87.1 ± 8.3	98.8 ± 11.0	.000
HiPC (cm)	93.5 ± 9.5	93.9 ± 10.6	.019
WHR	0.93 ± 0.06	1.00 ± 0.05	.000

Figure 1: Comparison of BMI, Waist circumference (WC), Hip circumference (HC) and WHR between the study groups

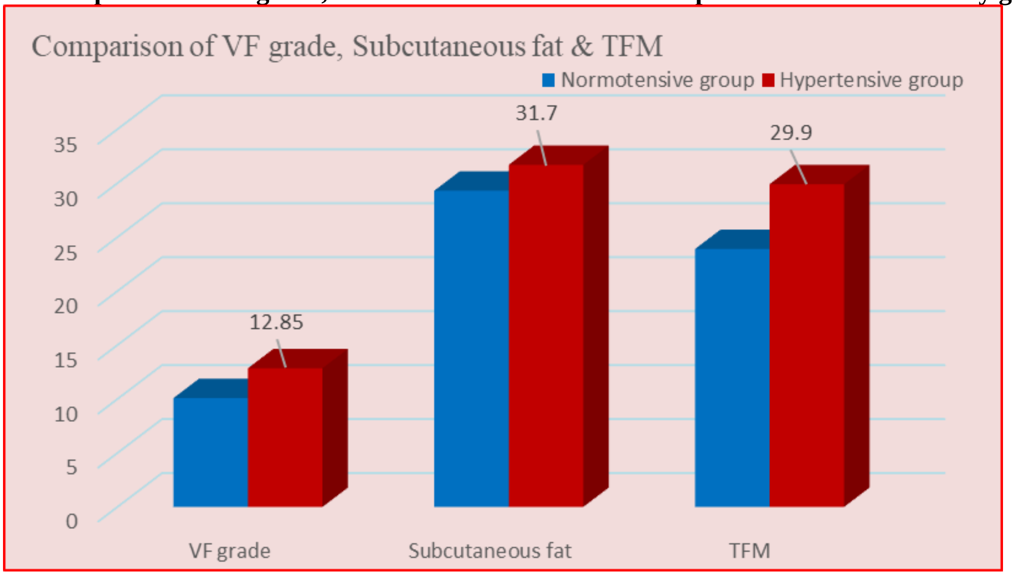


Mean TFM, VF (visceral fat) grade and subcutaneous fat were significantly higher in hypertensive subjects compared to healthy individuals with p value <0.05 as shown in Table 2 and Figure 2.

Table 2. Body fat analysis of the study participants (N=80)

Variables	Normotensives (Mean ± Std. Deviation)	Hypertensives (Mean ± Std. Deviation)	P value
TFM (Kg)	23.9 ± 8.3	29.9 ± 8.2	.002
VF Grade	10.08 ± 4.00	12.85 ± 4.05	.003
Subcutaneous fat (%)	29.3 ± 6.3	31.7 ± 6.3	.085

Figure 2: Comparison of VF grade, subcutaneous fat and TFM comparison between the study groups



Pearson's correlation showed a significant positive association of BMI, total fat mass, VF grade, WC, HC and WHR with SBP of the study participants as shown in Table 3. BMI, total fat mass, VF grade, WC, HC and WHR also had significant positive correlation with DBP of the study participants as shown in Table 4.

Table 3: Pearson's Correlation of anthropometric variables and SBP

VARIABLES	SBP (mmHg)	
	r value	P value
BMI	0.367	0.001
TFM	0.321	0.004
VF Grade	0.301	0.007
Subcutaneous fat	0.212	0.058
WC	0.486	0.000
HC	0.266	0.017
WHR	0.447	0.000

Table 4: Pearson's Correlation of anthropometric variables and DBP

VARIABLES	DBP (mmHg)	
	r value	P value
BMI	0.392	0.000
TFM	0.337	0.002
VF Grade	0.315	0.004
Subcutaneous fat	0.218	0.052
WC	0.451	0.000
HC	0.270	0.015
WHR	0.387	0.000

Correlation of WHR and VF grade with SBP is shown in Figure 3 & 4 respectively. Correlation of WHR and VF grade with DBP is shown in Figure 5 & 6 respectively.

Figure 3: Correlation between waist-to-hip ratio and SBP

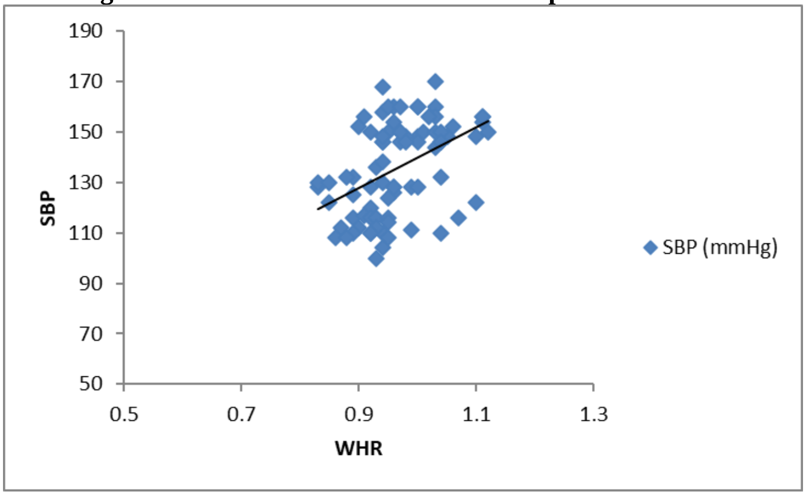


Figure 4: Correlation between visceral fat grade and SBP

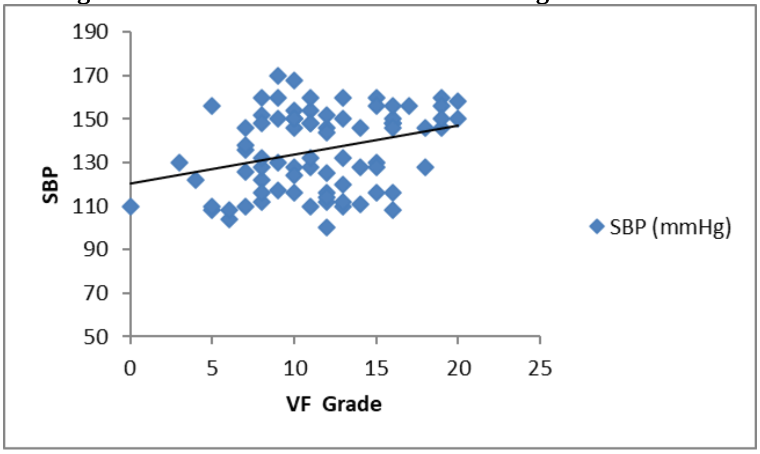


Figure 5: Correlation between waist-to-hip ratio and DBP

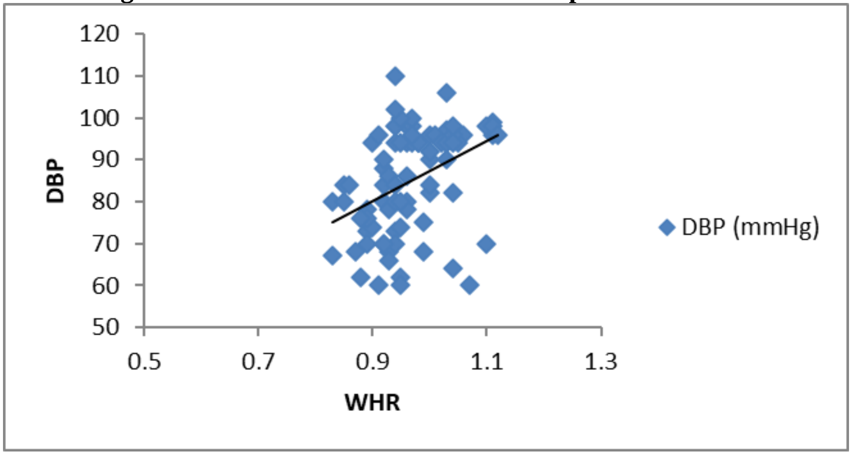
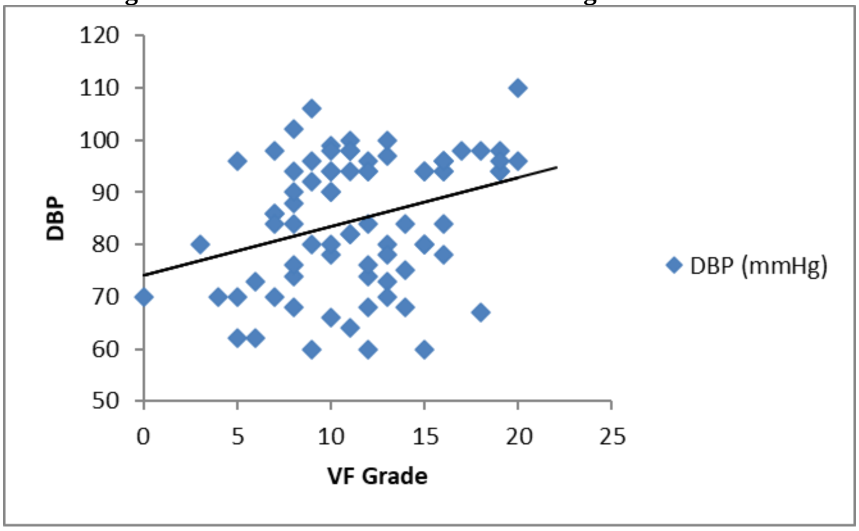


Figure 6: Correlation between visceral fat grade and DBP



IV. Discussion

BMI is the most commonly used index to judge overweight or obesity. Here the BMI is statistically high in hypertensive group compared to normotensive group. Study conducted by Ran Wang and Qiuzhen Wang[6] also revealed that most of the study subjects with hypertension had a BMI within 24-28 kg/m^2.

The waist circumference, waist-to-hip ratio and visceral fat area mainly reflect the distribution of fat in the abdomen. In the present study waist circumference and waist-to-hip ratio are significantly high among the hypertensive group compared to normotensive group. Previous studies have suggested that abdominal obesity is more likely to lead to chronic diseases, like hypertension[6,12]compared to subcutaneous fat and the results of the present study also support this point of view.

Excess energy can either be stored in subcutaneous fat depots or in ectopic locations, such as intrahepatic, peritoneal or retroperitoneal. Such visceral fat depots, particularly retroperitoneal, are specifically associated with incident hypertension. In the present study visceral fat grade is significantly high among the hypertensive group compared to normotensive group. Study conducted by Chandra A et al.[13] also reported an association between VAT (visceral adipose tissue) and incident hypertension.

Hypertension is a highly preventable disease and is associated with several cardiometabolic conditions such as hyperlipidemia, atherosclerosis, inflammation, insulin resistance, diabetes mellitus and obesity. Study conducted by de Oliveira CM et al.[10] found that waist circumference in men and BMI in women, were the anthropometric indicators of adiposity most strongly associated with hypertension. Present study also reveals that waist circumference and BMI are better associated with hypertension.

The results from the study conducted by Chen Y et al.[9] showed that BMI and WC significantly predicted the development of hypertension. Findings of the present study is also in the same line. WC was used as a marker of fat distribution and visceral adiposity.

Visceral fat is being more sensitive to lipolysis and secrete higher amounts of inflammatory cytokines. It is possible that increased adipose tissue releases a variety of adipokines that are related to a decrease in the production of nitric oxide. A decrease in the effect of nitric oxide has been associated with endothelial dysfunction and arterial hypertension.

V. Conclusion:

There is a positive association between visceral adiposity and development of hypertension. The anthropometric measurements and BIA (bioelectrical impedance analysis) are the easy and noninvasive tools for assessment of visceral adiposity. People with visceral adiposity should take measures to reduce their visceral fat mass and should be regularly monitored for development of hypertension.

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Conflict Of Interest: Nil
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