ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

# Analysis of Body Fat Composition Using Bioelectrical Impedance Method among Young Normotensives and Pre Hypertensive Individuals.

**Deepika V[1], Vijayakumar R[3]*, Latha S[3], and Jayakumar P[2].**

[1]Department of Physiology, Sri Manakula Vinayagar Medical College And Hospital, Puducherry - 605 107, India.
[2]Director, Sri Lakshmi Narayana Institute of Medical Sciences, Affiliated to Bharath University, Puducherry - 605 502, India.
[3]Department of Physiology, Sri Lakshmi Narayana Institute of Medical Sciences, Affiliated to Bharath University, Puducherry - 605 502, India.

**ABSTRACT**

It is well documented that body fat composition is altered in hypertensive individuals leading to increased cardiovascular risk. However an early impact of more common "prehypertension" on body fat composition among young adults is the area that remains unexplored. The present study was aimed at the same by comparing and correlating with normotensives, so that the cardiovascular risk could be addressed early in them. A total of 150 medical students in the age group of 18-25 years, were recruited for the study. They were divided based on their gender and their blood pressure as normotensives and prehypertensives, and their body fat composition was analyzed using bioelectrical impedance. Student's t test and Pearson's correlation was used for statistical analysis. BMI showed a significant raise among the prehypertensive group (females; p=0.0003 and males p=0.001) compared to normotensives. Total body fat, visceral fat, subcutaneous fat and resting metabolism showed a significant raise and skeletal fat showed a significant decrease among the prehypertensive group of both sexes. BMI, visceral fat and resting metabolism were found to be positively correlated with all blood pressure parameters. The significant variation in body fat composition in prehypertensives compared with normotensives indicates the existence of autonomic imbalance and a higher cardiovascular risk, suggesting lifestyle modification at a younger age to prevent or retard the progression of disease.

**Keywords**: Prehypertension, Bioeletrical impedence, Body fat composition, Visceral fat.

***Corresponding author***

ISSN: 0975-8585

## INTRODUCTION

This year, the hub of the World Health Day is on one of the main non-communicable disease (NCD) risk factors, hypertension. In India, it is the foremost NCD risk and estimated to be attributable for nearly 10 per cent of all deaths. [1] Even a slightly elevated blood pressure within the normal range is allied with cardiovascular morbidity and mortality. [2] Therefore, in 2003, a new category: pre hypertension (systolic blood pressure (SBP) is from 120 to 139 mmHg, and/or diastolic blood pressure (DBP) is from 80 to 89 mmHg) was introduced in the Seventh Report of the Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC-7). [3] In view with the increasing prevalence rates of pre hypertension among adults blood pressure assessment in all young individuals at every opportunity is both prudent and justified.

Research revealed that overweight and obesity, are the main risk factors for pre hypertension [4-6] and the pattern of body fat distribution in the body also plays a key role in the development of cardiovascular diseases. Evidence that hypertension is related to increases in body fat is well established [7] but review represents very mere studies to document about body fat percentage and its distribution in pre hypertensives. Central fat is documented to have adverse effects compared to peripheral fat. [8] Anthropometric measurements and body mass index (BMI) are the simple markers used in this context. While the BMI calculates the overall fat, waist circumference (WC) identifies the central fat. BMI, although useful clinically, it does not fully encompass the multifaceted biology of excess adiposity. With this proclivity it seems reasonably worthy to know body composition and body fat percentage in prehypertensives.

There is spectrum of methods available to assess body fat such as magnetic resonance imaging (MRI), dual-energy X-ray absorptiometry (DXA), computerized tomography (CT) and body density calculated from hydrostatic weighing (HW). These methods are highly complicated, expensive and not feasible for large study groups and with apparently healthy individuals. Therefore, a simple, validated, [9] reliable [10], cost-effective, fast, non invasive, fairly accurate and a promising tool for assessing body fat is bioelectrical impedance analysis (BIA). Measuring the conductance offered by the body on passage of small amount of alternating current almost 1- 10μA forms the basis behind BIA measurement. [11] Also it is documented that body fat percentage calculated by BIA was not significantly different from DXA and HW. [12]

There is lack of awareness regarding this instrument and the various valuable parameters being measured by it, which have immense prognostic value. No study till date has documented BIA usage among pre hypertensive young individuals. Hence, the present study aimed to evaluate and correlate the various anthropometric parameters and body composition using BIA among young pre hypertensive and normotensive individuals.

## MATERIALS AND METHODOLOGY

The cross sectional study consisted of 150 healthy young individuals of age group 18-20 years, undergoing first year MBBS course in Sri Manakula Vinayagar Medical College, Puducherry. Written informed consent was obtained from all subjects and the protocol was approved by the Human Research Ethics committee.

A detailed review of medical history through structured questionnaire and physical examination were performed. Subjects with systolic blood pressure >140 mmHg, diastolic blood pressure > 90 mmHg, subjects with ongoing medical illness or any drug treatment were excluded from the study.

**Various anthropometric measurements:**

The individuals were weighed to nearest 0.1 kg and measured according to standardized procedures, wearing light clothing and not wearing footwear. We used a mechanical branded scale with coupled standiometer and height was recorded to nearest 0.1cm. WC was measured using a rubber measuring tape, horizontally halfway between the lower border of the rib cage and the iliac crest in the standing position. Hip circumference was measured over light clothing at the widest point over the buttocks and waist hip ratio was obtained by dividing the waist circumference by hip circumference.. BMI was calculated as weight in kilograms divided by height (in meter squared).

**Body composition measurement:**

After entering age, gender and height taken by standiometer subject was allowed to stand on the instrument after its calibration. A digital, portable noninvasive instrument Omron KaradaScan ( Model HBF-510, Japan) working on principle of tetra polar bioelectrical impedance analysis was used that passes electric current of 500 μAmp at frequency 5 kHz to scan the whole body to derive regional body composition.

**Blood pressure recording:**

BP was measured in the right arm in the sitting position using a standard mercury sphygmomanometer after a 10-minute rest period. Three measurements were taken at 5 minutes interval and the mean of three measurements was considered for analysis. Based on the blood pressure measurements, the study participants of both sexes were divided as normotensives (Systolic BP <120mmHg, Diastolic BP < 80mmHg) and pre hypertensives (Systolic BP: 120 -139 mmHg and / or diastolic BP 80-89 mmHg).

**Statistical analysis:**

The data was entered on Microsoft Excel spreadsheet and mean ± standard deviation were calculated. All calculations were accomplished by Graph Pad InStat 3 software. We evaluated difference between both groups for various anthropometric data, body composition parameters and blood pressure by student's t test and correlation between various parameters by using Karl Pearson's correlation. A p value < 0.05 was taken for statistical significance.

## RESULTS

Out of 150 subjects, only 94 individuals satisfied the inclusion criteria and were selected as study participants. Of the 94 subjects, 59 were females and 35 were males. Of the 59 females, 40 were normotensives and 19 reported to have pre hypertension and among the 35 males, 13 were normotensives and 22 reported to have pre hypertension.

The mean age group was found to be 18.16±0.75 years. There was no significant difference in the age among the female and male normotensive and prehypertensive groups (females: 18.13±0.46 Vs 18.11±0.4) (males: 18.07± 0.28 Vs 18.32±0.95)

**Blood pressure parameters:**

In both sexes, SBP was significantly higher in prehypertensives compared to normotensives, p<0.0001 in females and p<0.001 in males while DBP was significantly higher among the prehypertensive females only; p<0.0001. The other parameters like pulse pressure (females: 42.48±5.48 vs 47.32±5.2 and males: 43.38±8.68 vs 56.41±7.68), mean arterial pressure (females: 76.1±6.48vs 86.90±20.8 and males: 75.69±6.51 vs 88.14±7.82), and rate pressure product (females: 83.33±10.55vs 110±29.47and males: 83.71±9.24 vs 114.01±14.40), were also found to be significantly higher in the prehypertensive group of both sexes.

**Table1 represents the various blood pressure parameters that showed significant difference between both sexes; normotensive and pre hypertensive groups.**

| BP parametes | FEMALES (n=59) | | p value | MALES (n=35) | | p value |
|---|---|---|---|---|---|---|
| | Normotensives (n=40) | PreHTN (n=19) | | Normotensives (n=13) | PreHTN (n=22) | |
| SBP | 109.18±6.16 | 126.84±6.78 | <0.0001* | 110.46±5.75 | 129.05±6.40 | <0.001* |
| DBP | 66.7±5.61 | 79.53±6.5 | <0.0001* | 67.08±9.23 | 72.63±7.99 | =0.06 |
| HR | 76.1±6.48 | 86.89±20.85 | 0.003* | 75.69±6.51 | 88.13±7.82 | <0.0001* |
| PP | 42.48±5.48 | 47.32±5.2 | =0.002* | 43.38±8.68 | 56.41±7.68 | <0.001* |
| MAP | 76.1±6.48 | 86.90±20.8 | =0.004* | 75.69±6.51 | 88.14±7.82 | 0.0001* |
| RPP | 83.33±10.55 | 110±29.47 | <0.0001* | 83.71±9.24 | 114.01±14.40 | <0.0001* |

**Anthropometric parameters:**

ISSN: 0975-8585

The weight (females: 55.96±10.22 vs 67.38±14.58 and males: 68.7±12.2 vs 85.67±22.71), BMI (females: 22.38±3.40 vs 26.65±5.01and males: 22.6±3.28 vs 28.68±5.84), waist circumference (females: 81.64±10.11vs 88.74±15.36 and males: 84.23±8.8 vs 96.88±15.75), hip circumference (females: 93.3±9.5 vs 105.26±15.49 and males: 95.85±7.19 vs 106.6±13.78), and waist-hip ratio (females: 0.87±0.048 vs 0.84±0.07 and males: 0.87±0.04 vs 0.91±0.04), were reported to be significantly higher among both sexes prehypertensive individuals.

**Table 2 represents the various anthropometric measurements between the two sexes, normotensives and pre hypertensives.**

| Anthropometric Parameters | FEMALES (n=59) | | p value | MALES (n=35) | | p value |
|---|---|---|---|---|---|---|
| | Normotensives (n=40) | PreHTN (n=19) | | Normotensives (n=13) | PreHTN (n=22) | |
| Height (cms) | 157.91±6.59 | 158.71±6.86 | 0.66 | 171.69±8.65 | 172±7.1 | 0.91 |
| Weight (Kgs) | 55.96±10.22 | 67.38±14.58 | 0.001* | 68.7±12.2 | 85.67±22.71 | =0.01* |
| BMI | 22.38±3.40 | 26.65±5.01 | 0.0003* | 22.6±3.28 | 28.68±5.84 | 0.001* |
| WC (cms) | 81.64±10.11 | 88.74±15.36 | 0.03* | 84.23±8.8 | 96.88±15.75 | 0.02* |
| HC (cms) | 93.3±9.5 | 105.26±15.49 | 0.0006* | 95.85±7.19 | 106.6±13.78 | 0.01* |
| WtHR | 0.87±0.048 | 0.84±0.07 | =0.04* | 0.87±0.04 | 0.91±0.04 | 0.08 |

**Body fat composition:**

Total body fat was found to be significantly higher among the prehypertensive individuals of both females and males groups with p value 0.03 and 0.01 respectively. Similarly, visceral fat also showed a significant increase among prehypertensives of both sexes with p value 0.0003 and 0.002 in females and males respectively. Also resting metabolism among the prehypertensive group of both sexes showed a significant increase with p value 0.002 and 0.005 in females and males respectively.

Subcutaneous fat percentage in whole body (females: 26.28±4.42vs 30.6±7and males: 14.52±4.56 vs 18.8±5.4), trunk (females: 22.79±4.07 vs 26.72±6.56 and males: 12.85±4.43 vs 17.62±6) and in arms (females: 44.05±5.99 vs 48.42±8.85 and males: 21.25±5.99 vs 27.4±7.5) showed a significant increase among the prehypertensive group whereas skeletal fat in trunk (females: 20.61±2.41 vs 19.02±3.07 and males: 28.18±4.15 vs 24.7±4.6) reported a significant decrease among the prehypertensive group.

**Table 3 represents the body fat composition of the two sexes, normotensives and pre hypertensives.**

| Body Fat composition | FEMALES (n=59) | | p value | MALES (n=35) | | p value |
|---|---|---|---|---|---|---|
| | Normotensives (n=40) | PreHTN (n=19) | | Normotensives (n=13) | PreHTN (n=22) | |
| Body fat % | 31.68±4.16 | 34.48±5.78 | 0.03* | 19.77±6.62 | 26.85±8.15 | 0.01* |
| Visceral fat % | 3.83±2.64 | 7.05±3.78 | 0.0003* | 5.8±2.98 | 11.83±6.16 | 0.002* |
| Resting metabolism | 1211.95± 162.92 | 1368.53± 201.39 | 0.002* | 1568.54± 157.19 | 1820.64± 283.24 | 0.005* |
| **Subcutaneous Fat** Whole body % | 26.28±4.42 | 30.6±7 | 0.005* | 14.52±4.56 | 18.8±5.4 | 0.02* |
| Trunk % | 22.79±4.07 | 26.72±6.56 | 0.006* | 12.85±4.43 | 17.62±6 | 0.01* |
| Arms % | 44.05±5.99 | 48.42±8.85 | 0.02* | 21.25±5.99 | 27.4±7.5 | 0.01* |
| Legs % | 40.24±5.65 | 43.97±10.6 | 0.08 | 20.6±6.5 | 27.85±9.31 | 0.01* |
| **Skeletal Fat** Whole body % | 25.4±2.22 | 24.13±3.4 | 0.08 | 34.76±3.01 | 32.04±3 | 0.01* |
| Trunk % | 20.61±2.41 | 19.02±3.07 | 0.03* | 28.18±4.15 | 24.7±4.6 | 0.03* |
| Arms % | 28.6±4.82 | 24.46±6.35 | 0.007* | 40.42±2.3 | 36.96±3.83 | 0.006* |
| Legs % | 37.06±3.86 | 37.52±3.42 | 0.65 | 50.42±6.58 | 49.29±2.87 | 0.48 |

ISSN: 0975-8585

**Table 4 represents the Pearson's correlation (r) of blood pressure parameters with anthropometric and body composition parameters**

| Parameters | SBP | DBP | HR | PP | RPP |
|---|---|---|---|---|---|
| BMI | 0.61** | 0.37* | 0.36* | 0.42* | 0.51** |
| WC | 0.48* | 0.26 | 0.28 | 0.37* | 0.40* |
| HC | 0.53** | 0.28 | 0.25 | 0.41* | 0.40* |
| Waist Hip ratio | 0.08 | 0.04 | 0.15 | 0.07 | 0.41* |
| BF | 0.16 | 0.32* | 0.17 | -0.10 | 0.19 |
| VF | 0.59** | 0.32* | 0.38* | 0.46* | 0.51** |
| RM | 0.56** | 0.19 | 0.26 | 0.55** | 0.41* |

**Correlation of blood pressure parameters with with anthropometric and body composition parameters.**

BMI, the clinically most accepted measure of obesity was found to be positively correlated with all blood pressure parameters, SBP (r=0.61), DBP (r=0.37), HR (r=0.36), PP (r=0.42) and RPP (r=0.51). Visceral fat was also found to be positively correlated to all BP parameters, SBP (r=0.59), DBP (r=0.32), HR (r=0.38), PP (r=0.46) and RPP (r=0.51). Resting metabolism was positively correlated with SBP, PP and RPP.

## DISCUSSION

The overall prevalence rate of pre hypertension in our study group was 43.61% which was higher compared to 37.45% prevalence reported from a study in a medical college in Andhra Pradesh. [13] The prevalence of pre hypertension among females was 32.20% and among males it was 62.86%, similar results are reported by studies indicating that prehypertension prevalence is higher among males than females. [14, 15]

In our study we report a significant increase in the BMI, WC, HC and Waist hip ratio among the prehypertensive group of both sexes. Positive correlation is reported in our study between SBP and BMI, HC, visceral fat and resting metabolism. As similar study reported a strong positive correlation between systolic BP and BMI, WC as well as waist hip ratio. [16]

Total body fat and visceral fat were also found to be significantly increased in prehypertensives of both genders with visceral fat showing positive correlation with all blood pressure parameters. Rate pressure product; a valuable cardiac function marker and pulse pressure; a surrogate of arterial stiffness, both are known to be significantly increase among the prehypertensives signifying that the sympathetic tone is dominant among the aforementioned group.

Leptin is a hormone secreted almost exclusively by adipocytes in blood and is shown to increase blood pressure when infused chronically due to heightened sympathetic outflow. [17] It is shown that visceral adipose tissue specifically secretes several biologically active peptides that are found to promote smooth muscle cell proliferation and contribute to the development of atherosclerosis. [18]

Resting metabolism was significantly increased in prehypertensives in both sexes. The basal metabolic rate (BMR) measures the minimum amount of energy required to maintain physiological functions at rest [19]. There is great literature controversy regarding whether the obese have a lower metabolic rate than their lean counterparts. It is reported that BMR is positively associated with increased blood pressure. [20] One possible explanation is that the sympathetic tone in prehypertensives is significantly high [21] and is closely involved with energy regulation, and that can lead to a twofold increase in BMR. [22]

Whole body subcutaneous fat was reported to be higher in females compared to males, also the prehypertensive group of both sexes showed a significant rise than the normotensives. Subcutaneous fat in trunk showed an extreme significant increase in prehypertensive group of both sexes. A pattern of excess fat in the central region is associated with augmented cardiovascular risks, such as elevated blood pressure, compared with a pattern of fat deposits in the limb region (peripheral fat). [23, 24]

Skeletal fat showed a significant decrease among the prehypertensive group compared to the normotensives of both sexes. Decreased skeletal muscle mass may be due to higher percentage of intra

muscular adipose tissue (IMAT), [25] an ectopic fat depot which is speculated to have role in inflammatory pathways. [26, 27] Excess fat mass has been directly implicated in increased circulating levels of proinflammatory cytokines such as tumor necrosis factor alpha (TNF$\alpha$), interleukin-6 (IL-6), and C-reactive protein (CRP), [28] which causes structural and endothelial dysfunctioning. [29] Skeletal muscle atrophy along with excess subcutaneous fat deposition is among the one of the unwanted deleterious outcome of prehypertension.

## CONCLUSION

Assessment of body fat and regional fat distribution among the pre hypertensive group provides an opportunity to reverse or retard the rate of progression of disease by intensive lifestyle modifications to prevent severe cardiovascular injury. This simple cost effective method can provide an opportunity to monitor the change in body composition and improve patient care.

## REFERENCES


[1] Patel V, Chatterji S, Chisholm D, et al. Lancet 2011; 377: 413-28.
[2] Lewington S, Clarke R, Qizilbash N, et al. Lancet 2002; 360:1903-1913.
[3] Chobanian AV, Bakris GL, Black HR, et al. JNC 7 report. JAMA 2003; 289:2560-2572.
[4] Laura P and Svetkey. Hypertension 2005; 45: 1056-1061.
[5] Pei-Shan Tsai, Tian-Lu Ke, Chun-Jen Huang, et al. Journal of Hypertension 2005; 23:1355-1360.
[6] Kyung Mook Choi, Hye Soon Park, Jee Hye Han, et al. Journal of Hypertension 2006; 24: 1515-1521.
[7] Bao W, Threefoot SA, Srinivasan SR, et al. Am J Hypertens. 1995; 8 (7): 657-65.
[8] Sardinha LB, Teixeira PJ, Guedes DP, et al. Metabolism 2000; 49:1379–1385.
[9] Lukaski HC, Bolonchuk WW, Hall CB, et al. J Appl Physiol. 1986 ; 60(4):1327-32.
[10] Tsui EY, Gao XJ and Zinman B. Diabetic Medicine 1998; 15: 125-128.
[11] National Institutes of Health Technology Assessment Conference Statement. Am J Clin Nutr 1996; 64: 524-532.
[12] Erceg DN, Dieli-Conwright CM, Rossuello AE, et al. Nutr Res 2010; 30:297-304.
[13] Chitrapu RV and Thakkallapalli ZM. J NTR Univ Health Sci 2015; 4:8-12.
[14] Asmathulla S, Rajagovindan D, Sathyapriya V et al. Indian J Physiol Pharmacol. 2011; 55(4):343-50.
[15] Singh R B, et al.Prevalence and risk factors for prehypertension and hypertension in five Indian cities. Acta Cardiol 2011; 66(1):29-37.
[16] Odili NV, Egor FO, Osarenmwinda IM et al. Tropical Journal of Pharmaceutical Research 2014; 13 (12): 2109-2114.
[17] Rahmouni K and Morgan DA. Hypertension. 2007; 49:647–652.
[18] Yiannikouris F, Gupte M, Putnam K et al. s L. Current Opinion in Nephrology and Hypertension. 2010; 19 (2):195-200.
[19] Westerterp KR. J Exp Biol 2001; 204:3183-7.
[20] Luke A, Adeyemo A, Kramer H, et al. 2004. Hypertension 43:555– 560.
[21] Monroe MB, Seals DR, Shapiro LF, et al. Am J Physiol Endocrinol Metab 2001; 280:E740-E744.
[22] Kannel WB, Cupples LA, Ramaswamy R, et al. J Clin Epidemiol. 1991; 44:183–190.
[23] Williams MJ, Hunter GR*,* Kekes-Szabo *T*, et al. Am J Clin Nutr. 1997; 65:855– 860.
[24] Sardinha LB, Teixeira PJ, Guedes DP, et al.. Metabolism. 2000; 49:1379 –1385.
[25] Karampinos DC, Baum T, Nardo L, et al. J Magn Reson Imaging. 2012; 35(4): 899–907.
[26] Beasley LE, Koster A, Newman AB, et al. Obesity (Silver Spring). May 2009;17(5):1062-1069.
[27] Malavazos AE, Corsi MM, Ermetici F, et al. Nut Metab Cardiovas Dis. 2007; 17(4):294-302.
[28] Pou KM, Massaro JM, Hoffmann U, et al. Circulation. 2007; 116(11): 1234-1241.
[29] Giardina JB, Green GM, Cockrell KL, et al. Am J Physiol Regul Integr Comp Physiol 2002; 283: R130 – R143.