Scholars Journal of Applied Medical Sciences
Abbreviated Key Title: Sch J App Med Sci
ISSN 2347-954X (Print) | ISSN 2320-6691 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Physiology

Association of Hypertension with Anthropometric Parameters among Indian Male Adults

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DOI: 10.36347/sjams.2021.v09i08.004 | **Received:** 28.06.2021 | **Accepted:** 02.08.2021 | **Published:** 05.08.2021

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Abstract **Original Research Article**

Obesity is chronic disease characterized by BMI >30 and body fat percentage >20%. It is often associated with non-communicable diseases including cardiovascular diseases like hypertension. While the hypertension has been associated with obesity previously, present study aims to assess association of anthropometric parameters of obesity with hypertension including central obesity indicators and body fat percentage. Total 152 subjects were included for the study, 76 of them were of hypertensive and 76 were controls. All of the participants were subjected to evaluation of obesity parameters. BMI, Waist Hip Ratio, Body Fat Percentage and Ponderal index were found to significantly associated with hypertension**.** While BMI, Waist Hip ratio, body fat percentage and Ponderal index has the significant association with hypertension, central obesity indicators like waist hip ratio and body fat percentage using skinfold thickness measurement also show a significant association with hypertension with higher odds compared to BMI.

Keywords: Hypertension, Overweightness, Obesity, Obesity Indices, Anthropometric measurements.

INTRODUCTION

Obesity is a chronic condition that results due to abnormal or excessive accumulation of body fat that may impair health of a person (WHO, 2020). Often described as a new world syndrome, it is the most neglected yet prevalent disorder of 21th century.

The prevalence of obesity is on rise worldwide. In 2015 there were 2.3 billion overweight adults and over 700 million obese worldwide and Approximately 2.8 million deaths are reported as a result of being overweight or obese (O'Connor DW, 2013) India is following a trend of other developing countries that are steadily becoming more obese. In India, more than 135 million individuals were affected by obesity (Ahirwar R. 2019).

Several systemic complications are associated with obesity, some of which lead to severe impairment of organs and tissues. These complications involve mechanical changes caused by the accumulation of adipose tissue and the numerous cytokines produced by adipocytes (Murray CJ, 1997).

Systemic hypertension is one of the major non communicable diseases associated with obesity, known as the "Silent Killer" because it is generally not detected unless specifically looked for. Although the relationship between obesity and hypertension is well established in children and adults (Hall JE, 2002). However the mechanism by which obesity directly causes hypertension is under investigation.

There are various mechanisms in the pathogenesis of obesity-related hypertension these include Activation of the sympathetic nervous system; High dietary content in fat and carbohydrate has been suggested to acutely stimulate peripheral a_1- and b-adrenergic receptors, leading to elevated sympathetic activity and hypertension (Rocchini AP, 1979).

The arterial-pressure control mechanism of diuresis and natriuresis, according to the principle of infinite feedback gain, seems to be shifted toward higher blood-pressure levels in obese individuals. Plasma renin activity, angiotensinogen, angiotensin II and aldosterone values display significant increase during obesity. Insulin resistance and inflammation may promote an altered profile of vascular function and consequently hypertension. Leptin and other neuropeptides are possible links between obesity and the development of hypertension (Haynes WG, 2005).

Anthropometric measurements are a series of quantitative measurements of the muscle, bone, and adipose tissue used to assess the composition of the body and quantifying body fat. Anthropometric indices are used to assess and categorize the obesity on basis of the distribution of fat. The core elements of anthropometry are height, weight, body mass index (BMI), body circumferences (waist, hip, and limbs), and skinfold thickness. indices like body mass index (BMI) has been the most commonly used proxy for body fat, but it does not measure body fat distribution and in particular, abdominal fat mass. People with a large waist are many times more at risk of ill health, and poor quality of life. These increased risks also apply in people whose BMI is normal but who have a large waist. Hence, anthropometric indices that measure abdominal fat or central obesity such as waist hip ratio (WHR) are increasingly used in research and clinical settings (Mankar S, 2018).

Earlier studies have established that obesity is a major modifiable risk factor of cardiovascular disease, stroke, diabetes mellitus, dyslipidemia, and hypertension, one of the best clinical utilities of anthropometric data is to define obesity.

A cohort study on Brazilian adult male population observed a consistent increase in the systolic and diastolic blood pressure with increasing Waist circumference and BMI (Cassani RS, 2009). Among the skinfold measurements correlated with lood pressure measurements, the central skinfold (subscapular) presented better correlation values compared to the peripheral (triceps) skinfold.

The waist-to-height ratio only changes when there is a change in the numerator (waist circumference (WC)) given that the denominator (height) remains constant in adults. The idea to use waist to height ratio comes from significance of waist circumference as a risk factor for hypertension and along with that lengths of extremities are related to chronic diseases as well (Smits MM, 2012).

Various studies have earlier reported the BMI to be a significant predictor of hypertension. A study by reported the association of BMI with high blood pressure was statistically significant (Brown CD, 2000). Another study found Elevated BMI was associated with increased odds for hypertension in African American and white men (Harris MM, 2000). A study in Northeast India reported that overweight/obese subjects were more likely to have hypertension than those with normal BMI (Mungreiphy NK, 2011).

Measuring anthropometric indices are cheap and easy to use techniques for the assessment of nutritional status of an individual. In order to measure and monitor levels of body fat, accurate methods of determining body composition are needed.

Keeping these all in mind present study is designed to find the association of hypertension with anthropometric parameters including BMI, Waist-Hip ratio, ponderal index, Waist to height ratio and skinfold measurements as anthropometric measurements Body Fat Percentage by Skinfold Thickness Measurement at biceps, triceps, subscaular and suprailliac sites

Materials and Methods

This case control study was conducted in the Department of Physiology, Index Medical College and Research Centre, Indore After approval from the institutional ethical committee informed and written consent was taken from all the participants of the study. A total of 152 male subjects in the age group of 36- 65 years comprising of 76 diagnosed cases of Hypertension and 76 Normotensive as control were selected. Age Matched, Normal healthy nonsmoker males aged 36-65 yrs were taken as controls with no history of any major illness. Exclusion criteria include Smokers, known case of chronic renal disease, endocrine dysfunction and cases with any chronic respiratory illness or acute respiratory infection in last 1 year and those Undergone a recent surgery

Blood pressure measurements were collected using an automatic and validated blood pressure device with the patient seated and after 5 min of rest. The cuff size was selected according to arm circumference. Hypertension was defined if the mean pressure was ≤140mmHg for systolic blood pressure and/or 90mmHg for diastolic blood pressure, or if the patient referred to the use of antihypertensive medication (Vijyan VK, 1990).

For BMI Height was taken in centimeters with subject barefoot, using stadiometer. Height was calculated in meters and Body weight (in Kgs) was measured using the electronic weighing machine. BMI is obtained as Kgs/m2.

The waist-hip ratio is calculated as waist measurement divided by hip measurement. Waist circumference will be measured by placing the measuring tape midway between top of hip bone and the bottom of ribs. Hip circumference will be measured around the maximum circumference of the buttocks by the non-stretchable measuring tape. According to WHO criteria[15], W-H ratio <0.90 was classified as normal whereas W-H ratio >0.90 as obese.

Waist to Height Ratio is a measure of the distribution of body fat. It is calculated by dividing waist circumference (in cm) with the height (in cm) of the individual. Waist to height ratio of 0.5 is taken as a cutoff for central obesity in adults (Ashwell, 2005).

Ponderal index is calculated as height in centimeters divided by cube root of body weight in kilograms. Ponderal index up to 40 is taken as normal and more than 40 is obese (Mankar S 2018).

Large proportion of body fat just under the skin, being the most accessible, the method mostly used for assessing the subcutaneous fat is the measurement of skinfold thickness. Skinfolds were measured at the biceps, mid- triceps, subscapular and supra-iliac regions. Each skinfold was measured three times and reported as average of three measurements. The body fat percentage for that age is taken corresponding sum of skinfold measurements (WHO, 2011). For age groups taken in our study subjects, body fat percentage < 21% is considered as normal while Body fat percentage ≥21% is taken as increased body fat percentage.

Statistical Analysis

The data was compiled and analyzed using appropriate statistical methods using Microsoft Excel and SPSS version 27. Percentage, mean, standard deviation and range were used to summarize the descriptive statistics. Association between two categorical variables was analyzed using chi-square test and odds ratio, multiple logistic regression was used with 95% confidence interval. The P value < 0.05 was taken as statistically significant.

RESULTS

Present Study is a case control study done at Index Medical College and Hospital, Indore on diagnosed Hypertensive individuals. Total 152 cases and controls were taken. Controls were age matched and subjects were divided into three age groups 36-45, 46-55 and 56-65. Mean age of cases was 48.17(±7.6) and for controls it was 48.14(±7.6) in years. (Table 1).

Table 1: Distribution of study subjects according to age

Age in Years	Group		Total n(%)
	Cases, n (%)	Control, n (%)	
36-45	27 (35.5)	27 (35.5)	54 (35.5)
46-55	37 (48.7)	37 (48.7)	74 (48.7)
56-65	12 (15.8)	12 (15.8)	24 (15.8)
Total	76 (100)	76 (100)	152 (100)

When analyzed using chi square test, the BMI was found to be statistically significantly associated with hypertension (P=0.002). using multiple logistic regression for odds ratio with 95% confidence interval the results were compared among age groups considering 36-45 age group as reference, the 46-55 age group had 2.65 times higher chance of getting hypertension with odds ratio 2.65(1.24-5.63), (P=0.012). When results were analyzed the 56-65 age group had 6.11 times higher chance of getting hypertension with higher odds 6.11 (1.62-23.07), P = 0.008 (Table 2).

Table 2: Association between BMI and Hypertension

BMI	Group		Total,n (%)	P value
	Cases,n (%)	Control,n (%)		P=0.002
18.50-24.99	38 (50)	58 (76)	96(63.2)	
25-29.99	26 (34.2)	15 (19.7)	41 (27)	
≥30	12(15.8)	3(3.9)	15(9.9)	
Total	76(100)	76(100)	152(100)	

The results for waist hip ratio was found to be statistically significant using chi square test (P= 0.003) When results were analyzed using binary logistic regression for odds ratio, the waist hip ratio found to be statistically significant with higher odds (P=0.003) as the waist hip ratio increases, the chance for getting hypertension increases. Odds ratio for waist hip ratio was 2.07(1.38-5.25) (Table 3).

Table 3: Association between Waist Hip Ratio and Hypertension

W-H Ratio	Group		Total,n (%)	P value
	Cases,n (%)	Control,n (%)		P=0.003
<0.9	35(46.1)	53(69.7	88(57.9)	
≥0.9	41(53.9)	23(30.3)	64(42.1)	
Total	76(100)	76(100)	152(100)	

when results were analysed for waist height ratio Higher percentage of cases (57%) had increased waist height ratio compared to controls (47%). But this increased waist height ratio among cases and controls was found to be statistically insignificant (P=0.105). When analyzed using binary logistic regression for odds ratio, the increased Waist Height ratio was associated with increased incidence of hypertension with odds 1.47 (0.74-2.93). but this was statistically insignificant (p=0.2).

Association between two categorical variables was analyzed using chi-square test for body fat percentage, for the age groups body fat percentage <21% was taken as normal. Number of Cases with >21% body fat percentage was 53% compared to controls at 26%. The body fat percentage was found to be significantly associated with hypertension using chi square test (P=0.001), (Table 4).

Using multiple logistic regression for odds ratio, the results were found to be statistically significant for age group 46-55 (P=0.001) with more chance of getting hypertension with increase in body fat percentage with higher odds 2.29 (1.72-3.07) compared to 56-65 age group. In 56-65 age group, the results were found to be statistically significant with odds ratio 1.69 (1.23-2.32) with P=0.001, which means that chance of getting hypertension increased compared to 36-45 age group but increased with lower odds compared to 46-55 age group.

Table 4: Association between Body Fat percentage and Hypertension

Body Fat Percentage	Group		Total,n (%)	P Value
	Cases,n (%)	Control,n (%)		P<0.001
<21	36(47.4)	56(73.7)	92(60.5)	
≥21	40(52.6)	20(26.3)	60(39.5)	
Total	76(100)	76(100)	152(100)	

Ponderal index was more increased among cases (30.3%) compared to controls (3.9%) which was statistically significant (P<0.001). using the Binary logistic regression for odds ratio, Ponderal index was found to be associated with hypertension with higher odds 7.74(2.02-27.64). Cases with increased Ponderal index had 7.74 times higher chances of getting hypertension. Results for odds ratio were found to be statistically significant (P=0.003), (Table 5) .

Table 5: Association between Ponderal Index and Hypertension

Ponderal Index	Group		Total,n (%)	P Value
	Cases,n (%)	Control,n (%)		P<0.001
<40	53(69.7)	73(96.1)	126(82.9)	
≥40	23(30.3)	3(3.9)	26(17.1)	
Total	76(100)	76(100)	152(100)	

DISCUSSION

In our study, BMI was found to be significantly associated with hypertension, when analyzed using chi- square test (P=0.002). When analyzed using multiple logistic regression for odds ratio with 95% confidence interval and results were compared among age groups, the 46-55 age group with higher BMI had 2.65 times higher chance of getting hypertension with odds ratio 2.65(1.24-5.63), and these results were found to be statistically significant (P=0.012). the age group 56-65 had 6.11 times higher chance of getting hypertension with higher odds 6.11 (1.62-23.07) with P=0.008.

Similar findings have been reported earlier In a cohort study in Brazilian men, (Cassani RS, 2009), observed a significant Linear correlation between both the systolic and diastolic blood pressure for Body Mass Index.

The results for waist hip ratio was found to be statistically significant using chi square test (P= 0.003). When result were analyzed using binary logistic regression for odds ratio, the waist hip ratio found to be statistically significant with higher odds (P=0.003).

An insignificant correlation observed between waist hip ratio and Hypertension in brazillian population (Cassani RS, 2009). This may be explained by the fact that our population consisted only of men, and some previously published studies did not analyze the influence of waist-to-hip ratio by gender. Also, hip measurements include not only fat tissue but muscle and bones, that can present distinct proportions due to the physical activity involved or aging. In fact, a large hip circumference has been associated with overall health and longevity (Cassani RS, 2009).

However some studies have reported significant correlation between hypertension and WHR. A study reported that elevated WHR was associated with increased odds of hypertension in African American and white men (Harris MM, 2000).

Another study by (Kalani Z, 2015) reported that those having higher waist to hip ratio (WHR) had 2.39 times higher chances of being hypertensive.

When the results were analysed for waist height ratio using chi square test, higher percentage of cases (57%) had increased waist height ratio compared to controls (47%). But this increased waist hip ratio among cases and controls was found to be statistically insignificant (P=0.105). When analyzed using binary logistic regression for odds ratio, the increased body fat percentage was associated with increased number of hypertensive with higher odds 1.86 (0.88-3.94). but this increase in odds was statistically insignificant (p=0.1).

In our study, waist height ratio did not show any significant association with incidence of hypertension, even using the odds ratio the results were statistically insignificant (P=0.2). Our findings regarding the waist height ratio are in contrary with observations by (Cassani RS, 2009) that observed significant association between waist height ratio and hypertension. It may be true in that case when waist height ratio is significantly increased, in our study subjects, the waist height ratio <0.6 was observed in cases and controls. Otherwise it is an excellent indicator of central obesity Waist height ratio only changes when there is a change in the numerator (waist circumference (WC)) given that the denominator (height) remains constant in adults.

The body fat percentage was found to be statistically significantly associated with hypertension using chi square test (P=0.001). and using multiple logistic regression for odds ratio among age groups, the results were found to be statistically significant for age group 46-55 (P=0.2) with more chance of getting hypertension with higher odds 2.29 (1.72-3.07). For age group 56-65 the results were found to be statistically significant with odds ratio 1.69 (1.23-2.32). Age group 46-55 was significantly associated with higher odds2.29 (1.72-3.07) compared to age group 56-65 which was also significantly associated but with a lower odds ratio 1.69(1.23-2.32).

Mushengezi B, (2014) observed Body mass index predicts BP level better than body fat composition and recommended to be used as a measure of increased risk for hypertension.

In our study, body fat percentage<21% was taken as normal. Number of Cases with ≥21% body fat percentage was more at 53% compared to controls 26%. The body fat percentage was found to be statistically significantly associated with hypertension using chi square test (P=0.001). But with BMI with 50% cases overweight and obese compared to 23.6% of controls being overweight and obese. When analyzed using chi square test, the BMI was found to be statistically significantly associated with hypertension (P=0.002).

Body Mass Index and Body Fat Percentage have been found to be significantly associated with hypertension in our study. Also the Increased BMI was better associated with increased odds of getting hypertension the 46-55 age group with higher BMI had 2.65 times higher chance of getting hypertension with odds ratio 2.65(1.24-5.63), and these results were found to be statistically significant (P=0.012). the age group 56-65 had 6.11 times higher chance of getting hypertension with higher odds 6.11 (1.62-23.07) with P=0.008. Body fat percentage was associated with increased odds of hypertension but statistically it was insignificant 1.86 (0.88-3.94) with P=0.1

Increased Ponderal index was found among cases (30.3%) compared to controls (3.9%). Ponderal index was more increased among cases and this increase was statistically significant (P<0.001). Increased Ponderal index was highly associated with increased incidence of hypertension. Using the Binary logistic regression for odds ratio, Ponderal index was associated with hypertension with higher odds 7.74(2.02-27.64). Cases with increased Ponderal index had 7.74 times higher chances of getting hypertension. Results for odds ratio were found to be statistically significant (P=0.003).

Using Ponderal Index as an indices of obesity, our findings are in consistent with the findings of (Mankar S, 2018) found a significant correlation between Ponderal index and hypertension.

The mechanism of obesity-associated hypertension is related to inadequate vasodilatation of blood vessels in response to increased intravascular volume and cardiac output, an effect related with an increased sympathetic nervous system tone and insulin resistance. So, in a group of overweight individuals, higher values of blood pressure are observed.

CONCLUSION

BMI was found to be statistically significantly associated with hypertension (P=0.002). the results were compared among age groups considering 36-45 age group as reference, the 46-55 age group had 2.65 times higher chance of getting hypertension with odds ratio 2.65(1.24-5.63), (P=0.012). When results were analyzed the 56-65 age group had 6.11 times higher chance of getting hypertension with higher odds 6.11 (1.62-23.07), P =0.008.

The results for waist hip ratio was found to be statistically significant using chi square test (P= 0.003) When results were analyzed using binary logistic regression for odds ratio, the waist hip ratio found to be statistically significant with higher odds (P=0.003) as the waist hip ratio increases, the chance for getting hypertension increases.

Association between Waist height ratio and hypertension among cases and controls was found to be statistically insignificant (P=0.105). The increased Waist Height ratio was associated with increased incidence of hypertension with odds 1.47 (0.74-2.93) & P=0.2, but this was statistically insignificant

The body fat percentage was found to be statistically significantly associated with hypertension using chi square test, P=0.001. Age group 46-55 had higher chances of getting hypertension with odds 2.29 (1.72-3.07) compared to age group 36-45. Age group 56-65 which higher chances of getting hypertension compared to age group 36-45 with odds 1.69 (1.23-2.32).

Increased Ponderal index was highly associated with increased incidence of hypertension. Cases with increased Ponderal index had 7.74 times higher chances of getting hypertension compared to Ponderal index<40.

References

- Obesity and overweight [Internet]. [cited 2020 Jan 9]. Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight
- O'Connor, D. W. (2013). The impact of obesity on national and homeland security. NAVAL POSTGRADUATE SCHOOL MONTEREY CA. Available from: https://apps.dtic.mil/docs/citations/ADA589702
- Ahirwar, R., & Mondal, P. R. (2019). Prevalence of obesity in India: A systematic review. Diabetes & Metabolic Syndrome: Clinical Research & Reviews, 13(1), 318-321.
- Murray, C. J., & Lopez, A. D. (1997). Mortality by cause for eight regions of the world: Global Burden of Disease Study. The lancet, 349(9061), 1269-1276.
- Hall, J. E., Crook, E. D., Jones, D. W., Wofford, M. R., & Dubbert, P. M. (2002). Mechanisms of obesity-associated cardiovascular and renal disease. The American journal of the medical sciences, 324(3), 127-137.
- Rocchini, A. P., Yang, J. Q., & Gokee, A. (2004). Hypertension and insulin resistance are not directly related in obese dogs. Hypertension, 43(5), 1011-1016.
- Haynes, W. G. (2005). Role of leptin in obesity-related hypertension. Experimental physiology, 90(5), 683-688.
- Mankar, S. B., Wakode, S. L., Deshpande, S. R., Wakode, N. S., Jiwtode, M. T., & Mishra, N. V. (2018). Association between hypertension and anthropometric indices in adult men: a case control study. International Journal of Community Medicine and Public Health, 5(4), 1514.
- Cassani, R. S., Nobre, F., Pazin-Filho, A., & Schmidt, A. (2009). Relationship between blood pressure and anthropometry in a cohort of Brazilian men: a cross-sectional study. American journal of hypertension, 22(9), 980-984.
- Smits, M. M., Boyko, E. J., Utzschneider, K. M., Leonetti, D. L., McNeely, M. J., Suvag, S., ... & Kahn, S. E. (2012). Arm length is associated with type 2 diabetes mellitus in Japanese-Americans. Diabetologia, 55(6), 1679-1684.
- Brown, C. D., Higgins, M., Donato, K. A., Rohde, F. C., Garrison, R., Obarzanek, E., ... & Horan, M. (2000). Body mass index and the prevalence of hypertension and dyslipidemia. Obesity research, 8(9), 605-619.
- Harris, M. M., Stevens, J., Thomas, N., Schreiner, P., & Folsom, A. R. (2000). Associations of fat distribution and obesity with hypertension in a bi-ethnic population: the ARIC study. Obesity research, 8(7), 516-524.
- Mungreiphy, N. K., Kapoor, S., & Sinha, R. (2011). Association between BMI, blood pressure, and age: study among Tangkhul Naga tribal males of Northeast India. Journal of Anthropology, 2011.
- Vijayan, V. K., Kuppurao, K. V., Venkatesan, P., Sankaran, K., & Prabhakar, R. (1990). Pulmonary function in healthy young adult Indians in Madras. Thorax, 45(8), 611-615.
- Ashwell, M., & Hsieh, S. D. (2005). Six reasons why the waist-to-height ratio is a rapid and effective global indicator for health risks of obesity and how its use could simplify the international public health message on obesity. International journal of food sciences and nutrition, 56(5), 303-307.
- World Health Organization. (2011). Waist circumference and waist-hip ratio: report of a WHO expert consultation, Geneva, 8-11 December 2008. Geneva: World Health Organization.
- Cassani, R. S., Nobre, F., Pazin-Filho, A., & Schmidt, A. (2009). Relationship between blood pressure and anthropometry in a cohort of Brazilian men: a cross-sectional study. American journal of hypertension, 22(9), 980-984.
- Kalani, Z., Salimi, T., & Rafiei, M. (2015). Comparison of obesity indexes BMI, WHR and WC in association with Hypertension: results from a Blood Pressure Status Survey in Iran. Journal of Cardiovascular Disease Research, 6(2), 72-77.
- Mushengezi, B., & Chillo, P. (2014). Association between body fat composition and blood pressure level among secondary school adolescents in Dar es Salaam, Tanzania. The Pan African Medical Journal, 19, 327.