

## A Study to Investigate the Association of Body Mass Index (BMI) Measurements in Adult Hypertensive Patients: A Comparative Study

Manju Kumari<sup>1</sup>, Abhiranjan Prasad<sup>2</sup>, Jitendra Kumar<sup>3</sup>

<sup>1</sup>Tutor, Department of Pharmacology, Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar, India

<sup>2</sup>Senior Resident, Department of General Surgery, Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar, India

<sup>3</sup>Associate Professor and HOD, Department of Pharmacology, Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar, India

Received: 19-02-2024 / Revised: 15-03-2024 / Accepted: 24-04-2024

Corresponding Author: Dr. Abhiranjan Prasad

Conflict of interest: Nil

### Abstract

**Aim:** The aim of the present study was to investigate the association of body mass index (BMI) measurements in adult hypertensive patients with normal weight and overweight including obesity.

**Methods:** The study was carried out at Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar, India. The study included 100 patients aged 32- 90 years of hypertension after taking well informed written consent.

**Results:** The mean values for weight, height and BMI according to sex were comparable in the study. In men and women, the dominant class of BMI category was overweight. We found that hypertensive patients who have a normal weight or were underweight have normal/low blood pressure. Blood pressure was significantly higher in patients who are overweight or obese.

**Conclusion:** The present study concluded the significant relations between body weight and blood pressure. The relationship between body weight and hypertension in our study were not influenced by gender. This proves the importance of losing weight for hypertension subjects in order to improve the blood pressure control and reducing its complications. A modest weight loss, especially when maintain over time, significantly reduces the risk of complication associated with hypertension in overweight adults.

**Keywords:** Body mass index, Hypertension, Normal weight, Overweight, Obesity

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

### Introduction

Obesity has reached pandemic proportions worldwide over the past five decades. [1] According to the World Health Organization, the global prevalence of adults with a body mass index (BMI) exceeding 23.9 kg/m<sup>2</sup> increased by 27.5% from 1980 to 2013, while children experienced a staggering 47.1% increase. [2,3] Extensive reports have linked high BMI to an elevated risk of various diseases, such as diabetes [4], cardiovascular disease [5], cancer [6] and musculoskeletal disorders [7], all of which adversely affect the overall quality of life. Notably, the incidence of hypertension all around the world was calculated as 25% within adult people in 2020, with projections indicating a rise to 29% by 2025. [8] Moreover, it has been observed that obesity contributes to 60–70% of hypertension cases, with the obese population facing a 3–4 times higher risk than individuals with a normal weight. [9]

A systematic review demonstrated that meeting higher numbers of ideal health metrics, including a normal BMI, was correlated with lower prevalence and incidence of both cardiovascular and non-cardiovascular diseases. [10] The link between obesity and hypertension is complex, considering that obesity-related hypertension is closely associated with other diseases in the course of the obesity. In general, obesity, which is usually determined by BMI, is one of the principal risk factors for hypertension [11] and the prevalence of hypertension increases with rising BMI. [12,13] However, BMI, as the most frequent anthropometric measure used, does not reflect body fat distribution, and there has recently been some doubt concerning it as a convenient indicator of high body weight and obesity. Similarly, there are concerns about its capability to predict the risk of hypertension and CVD. [14,15]

Obesity, its attendant health consequences and consequent health burden, is expected to reach epidemic proportions in developing countries like India. [16] An increase in the dimension of this problem has been reported in the high socio-economic group in India. A study in Delhi revealed even higher prevalence (32-50%) of overweight (body mass index (BMI) >25) among adults belonging to high income group as compared with 16.2-20% in those belonging to middle income group. [17] BMI, calculated as weight in kg/height in meters squared, is most widely used to estimate the prevalence of obesity or underweight within a population. The relationship between BMI and blood pressure has long been the subject of epidemiological research. Positive association of BMI and blood pressure has also been reported among Asian populations. India in a process of rapid economic development and modernization with changing life style factors has an increasing trend of hypertension especially among urban population. [16]

The aim of the present study was to investigate the association of body mass index (BMI) measurements in adult hypertensive patients with normal weight and overweight including obesity.

#### Materials and Methods

The study was carried out at Department of Pharmacology, Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar, India. We conducted a cross-sectional survey by questionnaire to first identify the weight status of patients and subsequently to assess the association of blood pressure with body weight. The study included 100 patients aged 32- 90 years of hypertension after taking well informed written consent. The participants were chosen randomly. Each participant had to fill in a questionnaire about their weight.

#### Inclusion and Exclusion Criteria

We included hypertensive subjects who aged over 30 years. We recruited only patients consulted in the hospital who accepted to participate in the study after receiving an explanation of its objectives. We excluded all hypertensive patients suffering from another disease or a complication of hypertension. We have included hypertensive subjects that were under treatment' but we excluded patients with resistant hypertension defined as blood pressure values which remained high despite the concomitant

use of three antihypertensive drugs, according to the guidelines.<sup>8,9</sup> None of the participants used any vitamins, mineral supplements or oral contraceptives. None of the females were pregnant or breastfeeding.

#### Body Mass Index Measurements

Measurement of body weight (in kilograms) was performed using an electronic balance' and height (in meters) was measured using a body stadiometer. BMI (kg/m<sup>2</sup>) was calculated by weight (in kilograms) divided by the square of height (in meters)' Adults were classified according to their BMI into two groups: normal weight (BMI: 18.5-24.9 kg/m<sup>2</sup>) and overweight (BMI: 25.0-29.9 kg/m<sup>2</sup>) including obese (BMI: >30 kg/m<sup>2</sup>).

#### Blood Pressure Measurement

Blood pressure measurements were made in the presence of the attending physician. We have performed three reading and considered the average of readings as the patient blood pressure. The measurements are expressed in millimeters of mercury (mm Hg). Normal blood pressure is defined as a systolic blood pressure between 120 and 139 mmHg and/or diastolic blood pressure 80 to 89 mmHg. Above these values, we could diagnose hypertension.

After blood pressure measurement, a questionnaire was distributed to patients in order to learn about their socio- economic status, physical activity, as well as their usual daily food intake. We used a 24 h reminder to estimate dietary intake of the subjects surveyed. After collecting the data from our study, we opted for the division of the population into two groups according to BMI: Group 1: normal weight; Group 2: overweight and obesity.

#### Statistical Analyses

Data were expressed as mean±SD. We used Statistical package for social sciences (SPSS) 20.0 for Windows for statistical analyses. A p<0.05 was considered statistically significant with a confidence interval of 90%. The student t-test was used to compare means of anthropometric measurement and blood parameters between groups and the Chi-square test was used for comparing percentage values.

#### Results

**Table 1: Mean values of weight, height and BMI**

BMI	Men	Women	P value
	Mean±SD	Mean±SD	
Weight (kg)	74.76±13.17	75.25±12.78	0.042
Height (cm)	174.56± 3.16	163.67± 4.36	0.045
BMI (kg/m <sup>2</sup> )	24.36 ±4.60	27.23±4.54	0.055

The mean values for weight, height and BMI according to sex were comparable in the study.

**Table 2: Blood pressure according to body weight**

	Men		Women		P value
BP	Systolic	Diastolic	Systolic	Diastolic	
Underweight	121.00±08.00	71.00±07.00	-	-	0.016
Normal	134.00±15.75	82.00±04.64	127.33±16.56	82.19±11.19	0.64
Overweight	153.00±07.73	79.00±09.00	139.71±16.64	89.72±12.38	0.034
Obesity	137.00±07.00	83.00±08.00	135.35±12.39	89.21±12.18	0.016

In men and women, the dominant class of BMI category was overweight. We found that hypertensive patients who have a normal weight or were underweight have normal/low blood pressure. Blood pressure was significantly higher in patients who are overweight or obese.

### Discussion

Due to industrialization and urbanization, the standard of living continues to rise particularly in developing countries. This has led to weight gain and obesity, which are posing a threat to the health of citizens. Obesity is perhaps the most prevalent form of malnutrition in developing countries, both among adults and children. Studies have demonstrated that obesity is related to elevated systolic blood pressure (SBP) and diastolic blood pressure (DBP) elevation, dyslipidemia, diabetes, etc. [18-20]

The mean values for weight, height and BMI according to sex were comparable in the study. In men and women, the dominant class of BMI category was overweight. We found that hypertensive patients who have a normal weight or were underweight have normal/low blood pressure. Blood pressure was significantly higher in patients who are overweight or obese. The frequency of poorly controlled blood pressure values was reported to be significantly greater in men. [21] Women are more often aware of their hypertension diagnosis than men. [22] This study showed that the rate of obese women is two times greater than that of men. Obesity is considered one of the most important cardiovascular risk factors that causes and maintains other risk factors such as hypertension. [23] Body weight is not only regarded as a risk factor for hypertension, but also a parameter that controls the health status of hypertensive patients, the progression of the disease and the treatment of the disease.

Gender differences in blood pressure are detectable during adolescence and persist through adulthood. In all ethnic groups, men tend to have higher mean SBP and DBP than women, and through middle age, the prevalence of hypertension is higher among men than women. [24] Premenopausal women have quantitatively more lipoprotein lipase (LPL) and higher LPL activity in gluteal and femoral subcutaneous regions, which contain fat cells larger

than those in men but these differences disappear after menopause. [25] Men show minimal regional variation in fat cell size or LPL activity. These differences may explain the tendency for premenopausal women to deposit fat preferentially in lower body fat depots. The higher level of intraabdominal tissue found in men compared with premenopausal women seems to explain, in part, the greater prevalence of dyslipidaemia and Chronic Heart Disease (CHD) in men than in premenopausal women. Cross-sectional and prospective epidemiological studies have shown that blood pressure and, worse still, hypertension increase significantly with higher body BMI and waist circumference (WC). [26] The rules for a healthy lifestyle and eating habits can sometimes be enough to normalize blood pressure and must always be available. These recommendations include: weight loss, aiming to maintain BMI below 23.5 kg/m<sup>2</sup>, or at least to obtain a reduction of 10% of initial weight; decreased consumption of salt, if possible less than 6 gm/day, increased consumption of dietary fiber, especially with a diet rich in vegetables and fruits, and reduce that of fat, especially the saturated fats (thus, it was shown that a vegetarian diet reduces blood pressure by 5.2 mmHg in average); increasing potassium consumption; fight against well known hypertension risk factors (smoking, high cholesterol levels, diabetes, physical inactivity; use a low- dose estrogen pill). [27] The reduction in these risk factors is recommended to prevent and/or treat hypertension. [28]

### Conclusion

The present study concluded the significant relations between body weight and blood pressure. The relationship between body weight and hypertension in our study were not influenced by gender. This proves the importance of losing weight for hypertension subjects in order to improve the blood pressure control and reducing its complications. A modest weight loss, especially when maintain over time, significantly reduces the risk of complication associated with hypertension in overweight adults.

### References

1. Blüher M. Obesity: global epidemiology and pathogenesis. *Nat Rev Endocrinol.* 2019 May; 15(5):288-298.

2. Hruby A, Hu FB. The Epidemiology of Obesity: A Big Picture. *Pharmacoeconomics*. 2015 Jul;33(7):673-89.
3. Zhu Q, Huang B, Li Q, Huang L, Shu W, Xu L, Deng Q, Ye Z, Li C, Liu P. Body mass index and waist-to-hip ratio misclassification of overweight and obesity in Chinese military personnel. *Journal of physiological anthropology*. 2020 Dec;39:1-2.
4. Kim SA, Lim K, Lee JK, Kang D, Shin S. Metabolically healthy obesity and the risk of all-cause and cardiovascular disease mortality in a Korean population: a prospective cohort study. *BMJ Open*. 2021 Sep 6;11(9):e049063.
5. Chen Y, Zhang XP, Yuan J, Cai B, Wang XL, Wu XL, Zhang YH, Zhang XY, Yin T, Zhu XH, Gu YJ, Cui SW, Lu ZQ, Li XY. Association of body mass index and age with incident diabetes in Chinese adults: a population-based cohort study. *BMJ Open*. 2018 Sep 28;8(9):e021768.
6. Hendriks SH, Schrijnders D, van Hateren KJ, Groenier KH, Siesling S, Maas AHM, Landman GWD, Bilo HJG, Kleefstra N. Association between body mass index and obesity-related cancer risk in men and women with type 2 diabetes in primary care in the Netherlands: a cohort study (ZODIAC-56). *BMJ Open*. 2018 Jan 24;8(1):e018859.
7. Liu S, Wang B, Fan S, Wang Y, Zhan Y, Ye D. Global burden of musculoskeletal disorders and attributable factors in 204 countries and territories: a secondary analysis of the Global Burden of Disease 2019 study. *BMJ Open*. 2022 Jun 29;12(6):e062183.
8. Gu D, Reynolds K, Wu X, Chen J, Duan X, Reynolds RF, Whelton PK, He J. Prevalence of the metabolic syndrome and overweight among adults in China. *The Lancet*. 2005 Apr 16;365(9468):1398-405.
9. Weng C, Shen Z, Li X, Jiang W, Peng L, Yuan H, Yang K, Wang J. Effects of chemerin/CMKLR1 in obesity-induced hypertension and potential mechanism. *Am J Transl Res*. 2017 Jun 15;9(6):3096-3104.
10. Younus A, Aneni EC, Spatz ES, Osondu CU, Roberson L, Ogunmoroti O, Malik R, Ali SS, Aziz M, Feldman T, Virani SS, Maziak W, Agatston AS, Veledar E, Nasir K. A Systematic Review of the Prevalence and Outcomes of Ideal Cardiovascular Health in US and Non-US Populations. *Mayo Clin Proc*. 2016 May;91(5):649-70.
11. Kapetanakis VV, Rudnicka AR, Wathern AK, Lennon L, Papacosta O, Cook DG, Wannamethee SG, Whincup PH, Owen CG. Adiposity in early, middle and later adult life and cardiometabolic risk markers in later life: findings from the British regional heart study. *PLoS One*. 2014 Dec 4;9(12):e114289.
12. Lee CY, Lin WT, Tsai S, Hung YC, Wu PW, Yang YC, Chan TF, Huang HL, Weng YL, Chiu YW, Huang CT, Lee CH. Association of Parental Overweight and Cardiometabolic Diseases and Pediatric Adiposity and Lifestyle Factors with Cardiovascular Risk Factor Clustering in Adolescents. *Nutrients*. 2016 Sep 13;8(9):567.
13. Crawford AG, Cote C, Couto J, Daskiran M, Gunnarsson C, Haas K, Haas S, Nigam SC, Schuette R. Prevalence of obesity, type II diabetes mellitus, hyperlipidemia, and hypertension in the United States: findings from the GE Centricity Electronic Medical Record database. *Popul Health Manag*. 2010 Jun;13(3):151-61.
14. Flegal KM, Graubard BI. Estimates of excess deaths associated with body mass index and other anthropometric variables. *Am J Clin Nutr*. 2009 Apr;89(4):1213-9.
15. Pischon T. Commentary: Use of the body mass index to assess the risk of health outcomes: time to say goodbye? *Int J Epidemiol*. 2010 Apr;39(2):528-9.
16. Srikanth J, Jayant Kumar K, Narasimha NS. Factors influencing obesity among urban high school children Bangalore City. *Indian J Nutr Dietet*. 2011;48:8-17.
17. Nutrition Foundation of India . Obesity in urban middle class in Delhi. 1999 Scientific Report 15.
18. Freedman DS, Perry G. Body composition and health status among children and adolescents. *Prev Med*. 2000;31:34-53.
19. Sorof J, Daniels S. Obesity hypertension in children: a problem of epidemic proportions. *Hypertension*. 2002 Oct;40(4):441-7.
20. Yusuf S, Hawken S, Ounpuu S, Bautista L, Franzosi MG, Commerford P, Lang CC, Rumboldt Z, Onen CL, Lisheng L, Tanomsup S, Wangai P Jr, Razak F, Sharma AM, Anand SS; INTERHEART Study Investigators. Obesity and the risk of myocardial infarction in 27,000 participants from 52 countries: a case-control study. *Lancet*. 2005 Nov 5;366(9497):1640-9.
21. Hypertension Study Group. Prevalence, awareness, treatment and control of hypertension among the elderly in Bangladesh and India: a multicentre study. *Bulletin of the World health Organization*. 2001;79(6):490.
22. Kaur M. Blood pressure trends and hypertension among rural and urban Jat women of Haryana, India. *Collegium antropologicum*. 2012 Mar 28;36(1):139-44.
23. Gupta R, Sharma KK, Gupta A, Agrawal A, Mohan I, Gupta VP, Khedar RS, Guptha S. Persistent high prevalence of cardiovascular risk factors in the urban middle class in India:

- Jaipur Heart Watch-5. J Assoc Physicians India. 2012 Mar 1;60(3):11-6.
24. Stamler J, Stamler R, Riedlinger WF, Algera G, Roberts RH. Hypertension screening of 1 million Americans. Community Hypertension Evaluation Clinic (CHEC) program, 1973 through 1975. JAMA. 1976 May 24;235(21):2299-306.
25. Vague J, editor. Metabolic Complications of Human Obesities: Proceedings of the 6th International Meeting of Endocrinology, Marseille, 30 May-1 June 1985. Excerpta Medica; 1985.
26. Williams PT. Increases in weight and body size increase the odds for hypertension during 7 years of follow-up. Obesity. 2008 Nov;16(11):2541-8.
27. He FJ, Li J, MacGregor GA. Effect of longer term modest salt reduction on blood pressure: Cochrane systematic review and meta-analysis of randomised trials. Bmj. 2013 Apr 4;346.
28. Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, Bray GA, Vogt TM, Cutler JA, Windhauser MM, Lin PH. A clinical trial of the effects of dietary patterns on blood pressure. New England journal of medicine. 1997 Apr 17;336(16):1117-24.