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Evaluation of Anthropometric Measurements as Predictor of Hypertension in North Indian Females

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Abstract: Adiposity has been found to be associated with increased risk of non-communicable diseases, especially hypertension, cardiovascular diseases, coronary arteriosclerosis, and overall mortality. The aim of this study was to determine correlations among various anthropometric parameters and blood pressure in North Indian females. A total number of 200 females aged between 25-60 years were included in the study. Their weight, height, waist circumference (WC), hip circumference, systolic blood pressure (SBP) and diastolic blood pressure (DBP) were recorded. Body mass index (BMI), waist hip ratio (WHR) and waist height ratio (WHtR) were calculated subsequently. The relationship between WC, BMI, WHR, WHtR and blood pressure was assessed using Pearson's correlation coefficient analysis. WC, BMI, WHR and WHtR were independently associated with both systolic and diastolic blood pressure. WHR was found to be more closely associated with systolic ($p<0.001$) and diastolic blood pressure ($p<0.001$) than BMI although WC, BMI and WHtR were also found to be closely related with increase in systolic as well as diastolic blood pressure. Total and abdominal obesity are associated with hypertension in females. WC, BMI, WHR and WHtR can be incorporated in routine health examination of patients to predict the risk of future cardiovascular diseases. Also, it is important to decrease the adiposity level in females for substantial reduction in hypertension. Intervention programs to reduce adiposity through lifestyle modification, including exercise and diet, may play a significant role in public health in reducing the incidence of hypertension.

Keywords: Waist circumference, Body mass index, Waist hip ratio, Waist height ratio, Blood pressure.

INTRODUCTION

Hypertension affects 972 million of adult population in year 2000 in both developed and developing countries. Global burden of disease can increase from 26.4% in 2000 to 29.2% in 2025 [1]. Hypertension is an important and independent predictor of death from stroke, cardiovascular and vascular diseases [2]. Hypertension was found to be second leading cause of end stage renal disease after diabetes [3].There is increased prevalence of hypertension and cardiovascular diseases in developing countries [4] which may be attributed to changing life-styles. Estimated deaths in India due to cardiovascular diseases were about 1.59 million in year 2000[5]. Hypertension alone has been reported to be responsible for 24% of cardiovascular deaths and 57% of all stroke deaths [6].

According to the American College of Cardiology (ACC) guidelines (2017) on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure in adults, a new classification for blood pressure has been recommended [7]. According to these guidelines, BP <120mm Hg is considered as normal systolic blood pressure and <80 mm Hg is considered as normal diastolic blood pressure. Systolic blood pressure of 120 to 129 mm Hg and diastolic blood pressure of < 80 mm Hg are classified as elevated blood pressure. So, a large number of population which was previously considered as normal is now included in elevated BP i.e. higher risk category.

Subjects with elevated BP have 1.65 times more risk of developing hypertension than those subjects having normal blood pressure levels [8]. Also, elevated BP and hypertension both are found to be associated with increased risk of cardiovascular diseases, end stage renal disease, subclinical atherosclerosis, and death [9].

Obesity is important health determinant that leads to adverse metabolic changes as increase in blood pressure, unfavourable lipid profile, increased insulin resistance and greater risk of metabolic syndrome, coronary heart disease, stroke, and cancer [10]. Obesity is associated with 2-6 times increase in the risk of developing hypertension. Obesity at young age and being obese in adult life is strongly related to future risk of hypertension. Being obese in adolescence or acquired obesity was found to be associated with a relative risk of 2.7 for hypertension. Becoming normal weight after being obese reduces the risk of hypertension to previous levels [11].

There is increased prevalence of obesity in both developed and developing countries. Most useful epidemiological indicator of obesity as suggested by World Health Organization (WHO) is body mass index (BMI) that has been found to be related to increased risk of hypertension. But, it does not take into account the distribution of body fat and abdominal fat, which can differ greatly across populations and can vary considerably within narrow range of BMI [12]. Abdominal obesity is more closely related to obesity related morbidity and mortality and is measured by Waist circumference (WC), Waist-hip ratio (WHR) and Waist-height ratio (WHtR) [13,14]. Waist circumference may be the best and simple measure of intra-abdominal as well as total fat [15]. WHR was found to have a stronger positive relation with cardiovascular risk factors as hypertension, lipid profile and blood glucose level than BMI [16].

The present study was undertaken to determine the relationship of blood pressure with indices of total and central adiposity such as BMI, WC, WHR and WHtR and to assess relative effectiveness of these indices on blood pressure in middle aged women of Punjab.

MATERIALS AND METHODS

The present cross sectional study was conducted on 200 women aged 25-60 years, randomly selected from general population of Punjab. An informed consent was taken from all the subjects. The study was approved by Institutional Ethical Committee.

A detailed reproductive history of all the women included in the study was taken to exclude any hormonal imbalance. Their general physical and systemic examination was done to exclude any disease such as hepatic, cardiac or renal disorder. None of the subjects was smoker, alcoholic or on any medications such as antihypertensives, hypolipidemics, oral contraceptives, or any other drug known to affect this study. All of them were on mixed diet. Their body weight, height, waist circumference and hip circumference were taken using standard methodology and then derived parameters were calculated.

For BMI, weight in kg on standard weighing machine and height in cm with steel anthropometric rod were measured. BMI was calculated as weight in kg/height in m^2. BMI= 18.5- 24.9 kg/m^2 was considered as acceptable range while BMI= 25-29.9 kg/m^2 was considered as overweight and > 30 kg/m^2 as obese. For WHR, waist circumference in cm at the level of umbilicus and hip circumference in cm at maximum prominence of buttocks were measured with a non-stretchable steel tape. WC >80cm, WHR >0.85 and WHtR >0.5 was taken as obese.

Subjects were asked to take rest for 15 minutes. After that, systolic and diastolic blood pressure in mmHg was measured with mercury sphygmomanometer by auscultatory method at 5 minute intervals for 3 readings and the lowest value was considered. BP= 120/80 mm Hg was taken as normal, 120-139/80-89 mmHg as pre- hypertensive, >140/90 mmHg as hypertension.

STATISTICAL ANALYSIS

Data was analyzed and results were presented as mean +SD. Association between various anthropometric variables, indices and blood pressure was studied using Pearson's correlation coefficient. Results were considered statistically significant with p values < 0.05.

RESULTS

Mean age of study population was 42.3±11.5 years. Table 1 shows the mean ± SD of the various parameters studied in women. Table 2 shows the association of various adiposity measures with systolic and diastolic blood pressure.

Table-1: Selected characteristics of study population

Parameters	Normotensive women (n=100) (Mean ± SD)
Age (years)	42.3±11.5
Waist Circumference (cm)	82.6± 11.8
Body Mass Index (Kg/m^2)	23.6±2.3
Waist Hip Ratio	0.9±0.1
Waist Height Ratio	0.5±0.09
Systolic Blood Pressure (mmHg)	129.2 ± 17.20
Diastolic Blood Pressure (mmHg)	78.6 ± 7.4

Table-2: Association of various adiposity indices with blood pressure

Measurements	Systolic Blood Pressure (mmHg)	Diastolic Blood Pressure (mmHg)
Waist Circumference (cm)	0.430*	0.432*
Body Mass Index (Kg/m^2)	0.578*	0.548*
Waist Hip Ratio	0.768*	0.547*
Waist Height Ratio	0.234*	0.112*

* $p<0.001$

DISCUSSIONS

Obesity is an important risk factor for elevated blood pressure and hypertension, and hence for cardiovascular diseases also. Each 10 Kg weight gain has been found to be associated with increase of 2-3 mmHg in systolic and 1-3 mmHg in diastolic blood pressure [17]. Decrease in systolic blood pressure of 5 mmHg will result in 14% reduction in the risk of stroke and a 9% reduction in the risk of coronary heart disease [7]. Our study documents the association of hypertension with anthropometric measurements in North Indian females that seems to be contributing to the epidemic of cardiovascular disease. Anthropometric measurements and other indices of obesity as WC, BMI, WHR and WHtR have been found to have positive association with hypertension in other studies also [18-21].

Obesity occurs due to physiological reasons such as increased calorie intake, unbalanced diets and decreased physical activity, which are modifiable risk factors for hypertension or pathological reasons such as genetic, metabolic, endocrinal, neurogenic, environmental and psychogenic factors [22]. Increased weight gain as measured by BMI is associated with hypertension. Increased BMI leads to an increase in body fluid volume and hence peripheral resistance due to hyperinsulinemia, cell membrane alteration and increased activity of renin-angiotensin system that leads to constriction and structural hypertrophy, and cardiac output [23] leading to increased blood pressure. Increased central obesity as measured by WC, WHR and WHtR and its positive correlation with hypertension can be explained by an increase in visceral fat that leads to increased leptin, increased insulin resistance and dyslipidemia [17,23,24].

Obesity is related to genetic resistance of leptin receptors to leptin resulting in higher plasma levels of leptin in obese persons who eat more despite increased levels of leptin as compared to thin persons. Physiologically, Leptin acts on hypothalamus and brown adipose tissues to cause decreased food intake and increased energy consumption [25]. Central obesity alone increases the risk of hypertension even among subjects having normal BMI because of insulin resistance [26,27]. Increased weight gain is associated with insulin resistance which results in hyperinsulinemia, dyslipidemia and accelerated development of atherosclerosis together known as metabolic syndrome[22, 25] Increased insulin levels lead to increased activity of sympathetic nervous system, increased cardiac activity and hence increased blood pressure [22].

CONCLUSION

Our study documents significant effect of general as well as central adiposity on blood pressure. Serious evaluation of increasing burden of this public health problem, for prevention of cardiovascular diseases, should target weight reduction strategy. Weight reduction and maintenance strategies should focus on a healthy diet and increased physical activity. Effective and appropriate programs should be set up for improving nutritional status and lifestyle modification of society. Public should be made aware of such programs. Our study has limitations also. Study sample is not representative of whole population as only females are included in the study, so findings cannot be generalized to whole population. Also sample size was limited. Despite these limitations, our study highlights important aspect of public health which is modifiable risk factor to limit the epidemic of cardiovascular diseases.

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