

## To Determine the Correlation between Anthropometric Variables of Obesity and Hypertension at NGMC: A Tertiary Care Hospital

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### ABSTRACT

**Aim:** Obesity is associated with the metabolic risk factors such as high blood pressure, body fat abnormality, and glucose intolerance which may influence the morbidity and mortality due to cardiovascular diseases. The present study is to determine the correlation of common anthropometric indices of obesity with blood pressure among population in mid-western region of Nepal. The result will provide us insight on relevant anthropometric indices for predicting hypertension based on linear correlation calculated from our data. **Methods:** We screened 500 healthy subjects to study the correlation between anthropometric indices and blood pressure. **Result:** Our result showed strong correlation between Sum of Skin fold, waist circumference, and waist hip ratio with blood pressure (systolic blood pressure, diastolic blood pressure and mean arterial blood pressure). However some of the anthropometric indices like hip circumference and body mass index did not have significant correlation with blood pressure. **Conclusion:** Provided obesity related morbidity and mortality is burgeoning in our society it is imperative to identify right indicators of cardiovascular disease for specific population. Relevant anthropometric indices can serve as excellent indicators if used based of scientific validation.

**Key words:** Anthropometric variables, blood pressure, obesity

### INTRODUCTION

Obesity is associated with the metabolic risk factors such as high blood pressure (BP), body fat abnormality, and glucose intolerance which may influence the morbidity and mortality due to cardiovascular diseases (CVD)<sup>1,2</sup>. Most of these deleterious effects are more likely if the excess body fat is mainly stored in the upper body, with abdominal visceral fat being the most critical when evaluating the health risks of obesity<sup>1</sup>. Decreased physical activity, increased consumption of calorie-dense foods and psychosocial stress are few among many factors behind increased obesity among population<sup>3</sup>.

Body Mass Index (BMI) as well as other measures of fat distribution including Waist Circumference (WC) and Waist Hip Ratio (WHR) has been correlated with the cardiovascular risk in many studies<sup>4</sup>. Many of these studies have been done in the American, European and the East Asian population<sup>5-7</sup>. In the past

decade, CVD has become burgeoning problem in South Asian population<sup>8</sup> due to changing diet and lifestyle, it is imperative to have similar studies in this population. So far, only few studies confined to specific population has been conducted the south Asian population. Moreover studies have suggested that people of this origin have increased cardiovascular risk due to more centralized deposition of body fat with higher mean of WC and WHR compared to Europeans<sup>8-10</sup>. It has recently been shown that South Asian children have higher body mass adjusted BP levels than white American–Caucasian children<sup>11</sup>. Furthermore, WHO has also lowered the cutoffs for overweight and obesity for the Asian population, which again points to the fact that Asian and especially south Asian population suffers from an overall higher obesity related cardiovascular risk<sup>6</sup>. Therefore understanding the relation of adiposity with CVD in to specific population is essential.

Hypertension (HTN) or high BP is a chronic medical condition in which the BP in the arteries is elevated<sup>12</sup>. The relationship between obesity and HTN is well established<sup>13,14</sup>. Obese subjects display higher BP levels than non-obese individuals even in the normotensive range<sup>15</sup>. Data estimates that around 7.1 million die especially among middle, and old-age adults due to high Bp<sup>16</sup>. Though many CVD can occur to hypertensive patients BP is mostly common and usually the harbingers most of them. Studies have elucidated the function of adipose tissue derivatives (adipokines and cytokines), neurohumoral pathways, metabolic functions and modulation of pressor/depressor mechanisms. High-caloric intake increases norepinephrine turnover in peripheral tissues, raises resting

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plasma norepinephrine concentrations. High dietary content in fat and carbohydrate has been suggested to acutely stimulate peripheral alpha - and beta-adrenergic receptors, leading to elevated sympathetic activity and HTN.<sup>17</sup> Abdominal obesity is considered to be more dangerous than general obesity because the visceral fat has been shown to secrete certain cytokines and chemicals that are involved in atherogenesis and alterations in the autonomic balance<sup>18</sup>.

A number of clinical measurements for obesity have been used to determine susceptibility to CVD<sup>19</sup>. The association between HTN and obesity was first recognized through research undertaken in Framingham heart study. Even though with the presence of the modern techniques, anthropometric measurements such as height, weight, BMI and WHR etc. are traditionally important method to study the genetic structure and prediction of risk factors of many complex diseases in human health<sup>20</sup>. These anthropometric indices has shown to have an association with many CVD including BP, however there seem to be inconsistent finding. This inconsistency in the relation could be due to the nature of relation being population specific and depending on many other factors like dietary culture, exercise habits, lifestyle and overall environment<sup>20</sup>.

The different studies have tried to relate the relationship of BMI and WHR to BP<sup>21-24</sup>. Therefore, one basic question raises that which one of the anthropometric measurements could be an appropriate to track the elevated BP in general population. Our study aims to answer if all measures of anthropometric variable has similar correlation with BP irrespective of gender and age. This will lead us to determine the relationship between these measures and the BP; and thus to identify their effectiveness in screening the individuals with higher BP.

**MATERIAL AND METHODS**

This cross sectional prospective study was conducted in Nepalgunj Medical College Teaching Hospital (NGMCTH) Subjects of this study were patients attending outpatient department (OPD) of the department of medicine of NGMCTH, Nepalgunj from date 2015-5-3 to 2016-6-8. The healthy subjects of the age range 30 to 55 years who gave the consent were included in the study. The subjects with the history of HTN in past 5 years were excluded from our study.

The anthropometric measurements were measured by standard procedures. The height was measured by stadiometer with subjects having their shoes removed<sup>25</sup>. The measuring tape was used to measure the WC at the level of the narrowest point between the lowest rib margin and the iliac crest<sup>26,27</sup>. The hip circumference (HC) was measured at the level of maximum extension of the buttocks when subject is standing straight with arms by sides and feet together. The measurement was made

with a stretch-resistant tape that was wrapped snugly around the buttocks in a horizontal plane. The height, HC and WC measurement were recorded to the nearest 0.1 cm. The body weights of the subjects was measured in light clothing, without shoes<sup>25</sup>. BMI was determined by dividing weight in kilogram (kg) by height in square meter (m<sup>2</sup>)<sup>28</sup>. The WHR was determined by dividing the WC by the HC.<sup>26, 27</sup> The international standard for anthropometric assessment published by the International Society for the Advancement of Kianthropometry, was used for measuring the skin folds.<sup>26,29</sup> Measurement were recorded to the nearest 0.05 cm by using the slim guide skinfold caliper.<sup>26,29</sup> The measurements of systolic(SBP) and diastolic blood pressure (DBP) were taken with the help of mercury sphygmomanometer in a sitting position when subjects are in fully resting state. Mean arterial blood pressure (MAP) was calculated for each of the two readings taken for SBP and DBP<sup>30-32</sup>.

**Data Analysis**

Microsoft Excel and Statistical program available in SPSS 16 (Statistical Package for Social Science) for Windows computer operating systems are utilized in this analysis. BMI, WHR, subcutaneous fat, HC, WC were compared with SBP, DBP, MAP using Pearson Correlation coefficient test. The data analysis were considered significant at P <0.05.

**RESULTS**

500 subjects qualifying the inclusion criteria were screened for anthropometric variables of obesity and BP. Most of the subjects (52.6%) in the study are in the age range (36 - 45yrs) as shown in the demographic provided in the Table I.

Age (years)	Males (n=278)	Females (n=222)	Total (n=500)
30-35	45	29	74
36-40	82	50	132
41-45	62	69	131
46-50	52	38	90
51-55	37	36	73

**Table I: Distribution of subjects according to age**

BP (mmHg)	Male (n=278)	Female (n=222)	Total (n=500)
Normotensive (< 93.3)	107	155	262
Prehypertension (93.3- 106.7)	138	51	189
Stage 1 HTN (107- 119)	30	15	45
Stage 2 HTN (> 120)	3	1	4

Correlation significant at \*p<0.05, \*\*p<0.001

**Table II: Distribution of subjects according to classification of BP (MAP)**

The distribution of subjects according to the blood pressure classification in the Table II depicts that 52.4%, 37.8%, 9.0% and 0.8% of total population were normotensive, prehypertensive, stage 1 HTN and stage 2 HTN respectively. The distribution also clearly shows the prevalence of HTN (prehypertension, stage 1 HTN and stage 2 HTN) in male population (61.5%) compared to female population (30.2%).

Table III provides the mean and standard deviation (S.D) of the basic measurements in male and female subjects. The fourth column in the table gives p-value, where value of less than 0.05 indicates significant difference between male and female. The result shows that WHR, MAP, HC and Abd. SF were significantly

Parameters	Normotensive (mean±s.d)	Hypertensive (mean±s.d)	p-value
DBP	84.55±8.34	94.18±10.91	0.01*
SBP	117.22±7.12	132.22±7.02	0.03*
MAP	92.78±3.39	105.18±6.56	0.01*
BMI	27.95± 2.96	32.87±3.39	0.04*
WHR	0.88±0.15	0.99±0.11	0.01*
WC	100.44±9.2	114.04±11.56	0.00**
HC	111.65±6.8	120.91±7.55	0.06
SSF	30.30±5.16	37.49±6.80	0.02*
Abd. SF	45.56±4.50	65.65±7.00	0.00**

Correlation significant at \*p<0.05, \*\*p<0.001

**Table III: BP and anthropometric indices among participants according to the presence of hypertension**

	BMI			WHR			HC		
	Male	Female	Overall	Male	Female	Overall	Male	Female	Overall
SBP	0.08	0.09	0.08	0.04*	0.06	0.04*	0.08	0.10	0.11
DBP	0.04*	0.08	0.07	0.03*	0.01*	0.03*	0.21	0.32	0.10
MAP	0.66	0.07	0.07	0.03*	0.02*	0.04*	0.08	0.12	0.09

Correlation significant at \*p<0.05, \*\*p<0.001

**Table IV: Linear correlation between anthropometric indices (weight, BMI and WHR) and systolic and diastolic blood pressure**

	WC			SSF			Abd. SF		
	Male	Female	Overall	Male	Female	Overall	Male	Female	Overall
SBP	0.04*	0.06	0.07	0.02*	0.04*	0.02*	0.01*	0.01*	0.01*
DBP	0.03*	0.05	0.03*	0.00**	0.03*	0.04*	0.00**	0.00**	0.00**
MAP	0.03*	0.02*	0.04*	0.00**	0.02*	0.01*	0.00**	0.04*	0.00**

**Table V: Linear correlation between anthropometric indices (HC, WC and SSF) and systolic and diastolic blood pressure**

different in both gender. Mean values of height, weight, HC, WC, SSF, abdominal skinfold and MAP were found to be significantly higher in males as compared with females. The mean values of all the skinfold thicknesses, that is, biceps, triceps, subscapular, and suprailiac were higher among females than males. Similarly mean values of BMI and fat percentage were also higher among females.

The linear correlation between anthropometric indices and the BP (SBP, DBP and MAP) is presented in Table IV and Table V. The result clearly indicates that BMI does not have significant correlation with most of anthropometric indices except DBP which has significant correlation. Age was found to have positive and statistically significant correlation with both SBP and DBP among males as well as females subjects (data not shown). The strongest correlation of BP was reported with SSF, WC and WHR. Overall the DBP has stronger correlation with anthropometric variables compared with SBP.

The anthropometric variables included in this study provides estimation of the fat percentage, so the Table VI provides the correlation between anthropometric variables (BMI, WHR, WC and HC) and SSF (estimation of body fat percentage). The results show that the BMI, WHR, WC and HC is highly correlated with SSF. WHR and WC has strongest correlation with SSF with p-value of 0.01 and 0.04 respectively in males. However the WC has the strongest correlation with the SSF in females with the p-value of 0.03. The BMI and WHR did not have significant correlation with SSF among female subjects.

## DISCUSSION

Many studies have reported the relation of BP, one of the most common CVD with anthropometric parameters such as BMI, WHR, WC, HC, SF etc<sup>1-4</sup>. There are inconsistencies in their

Fold (SSF) with anthropometric variables

Parameter	SSF	
	Male	Female
BMI	0.05	0.2
WHR	0.01*	0.65
WC	0.04*	0.03
HC	0.53	0.11

Table I : Age distribution of cases by age

Table VI: Correlation of sum of skin

finding, which can be ascribed to the diversity in sample population. Additionally, there might be some methodological differences behind inconsistency in results. However one should not undermine that correlation of anthropometric variable with fitness parameters such as BP and pulse rate can be affected by lifestyle, exercise habits, over all environment and genetics among the population. Therefore our study was aimed to determine the relationship of parameters in small cohort of population in Nepal, where any of such studies has not been reported.

The study screened 880 random subjects attending NGMCTH; among which 500 subjects who met the inclusion criteria were selected. Among 500 subjects 52.4%, 37.8%, 9.0% and 0.8% of total population were normotensive, prehypertensive, stage 1 HTN and stage 2 HTN respectively. Provided the subjects included in this study were not diagnosed with HTN in past five years. Our calculated result, where 48% of sample population were in hypertensive range indicates the lack of awareness as well as it highlights the impeding problem of hypertension in the population.

The present study provides the correlation of BMI, WC, WHR, SSF and Abd SF with BP suggesting the better anthropometric for predicting HTN in both sexes. The results presented in the table IV and V indicates that the SSF, Abd. SF, WHR and WC had the strongest correlation with BP in both male as well as in female. However, the HC did not have significant correlation with BP among female subjects. Our results as shown in table also indicates that DBP has strongest correlation with many of anthropometric variables (WHR, WC, HC and BMI). The DBP is the direct measure of total peripheral resistance and is less fluctuating than SBP which is mainly a direct measure of cardiac output<sup>33</sup>. Moreover SSF is the indirect measure of total fat percentage and our result in table VI shows that WC has strong and significant correlation with SSF. However WHR is correlated with SSF only among female subjects. Therefore from the combined result from table IV, V and VI we can conclude that

SSF abdominal skinfold has strong and significant correlation with HTN thus can be recommended as a useful screening tool for predicting HTN. However whenever measuring skin fold is not feasible WC and WHR can be reliable indicator of HTN based on our results. Our result also confirms with some of other studies that have found that WHR have been found to be a more efficient predictor of HTN than the BMI<sup>34-40</sup>. The result also indorses the statement from one of research article that if obesity is redefined using WHR instead of BMI, the proportion of people categorized as at risk of heart attack worldwide increases threefold<sup>41</sup>. Therefore our study have found that WC and WHR are good indicator of cardiovascular risk factors, body fat distribution and HTN and should be incorporated into a public message and awareness programs.

### CONCLUSION

Body fat percentage measured by skinfold thickness method predict blood pressure level better than BMI in this population. High WC & WHR should be used as a measure of increased risk for hypertension among this population and should be incorporated into a public message and awareness programs.

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