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Correlation of Blood Pressure with Body Mass Index, Waist Circumference and Waist by Hip Ratio

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ABSTRACT

Background: The Body Mass Index, Waist Circumference and Waist by Hip ratio have linear relation with increase in blood pressure. This study will correlate blood pressure with these anthropometric measures in normal subjects to find out the subtle increase in which of these measure would linearly increase blood pressure. The aim is to find the better anthropometric measure to relate with blood pressure changes.

Methods: One hundred and seventy five healthy medical students were enrolled for the study in Manipal College of Medical Sciences, Pokhara after getting ethical clearance. The mean reading of right brachial arterial blood pressure with mercury manometer in sitting position was taken. For anthropometric measures, body weight was measured in weighing scale and height and circumferences of waist and hip were taken with non elastic measuring tape. The data were used to derive required variables.

Results: Out of 175 participants, 59% were male and remaining female. The non obese participants were 46.3% followed by obese (22.9%) as per Asia Pacific Guidelines for The Body Mass Index. The positive correlation of increase in Systolic and Diastolic components of blood pressure was statistically highly significant [P=0.00] in female with normal Waist Circumference and Waist by Hip ratio. However in general, SBP was positively correlated with Waist by Hip ratio [r=0.44] and DBP was positively correlated with Waist Circumference [r=0.43] and were statistically highly significant [P=0.00].

Conclusions: The Waist Circumference and Waist by Hip Ratio have stronger correlation with blood pressure components than Body Mass Index even in normal subjects.

Keywords: Blood pressure; body mass index; hip ratio; waist: waist circumference.

INTRODUCTION

The progressive increase in blood Pressure (BP) occurs with increase in adipose tissue.[1] This adiposity if located centrally in abdomen can be measured by Waist Circumference (WC) and Waist by Hip Ratio (WHR).[2] Studies claimed that the central distribution of body fat is associated with increase in BP independent of body mass index (BMI).[3]

BMI is universally accepted measure for obesity and its positive correlation with hypertension is well documented.[4] However, BMI is unable to recognize between fat and fat free masses.[5] Further, it is proposed to revise for Asians due to increase prevalence of chronic diseases in lower range.[6]

BMI, WC and WHR thus have proven correlation with hypertension with the query of one being better. Hence, the study is designed to correlate these measures with BP in normal subjects with the assumption that the subtle increase in the most effective measure should increase BP in normal context also.

METHODS

This cross-sectional study was carried out in Manipal College of Medical Sciences in between December, 2017 to February 2018 after getting ethical clearance from the Institutional Review Committee. The total number of participants was 175 which include both healthy male and female volunteers. These participants were Asians with the age in between 18-23 years. The participation was done by verbally informed consent. The weight of the participants was obtained with a digital weighing scale. The height was taken with reference of a measuring tape pasted on a firm wall with the foot kept upon the firm even surfaced floor. The non elastic measuring

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tapes were used to measure waist circumference at the narrowest region between lowest rib and iliac crest at expiratory phase and hip circumference at the widest region in the buttock area. The Blood pressure was taken in right arm in sitting relaxed position with mercury sphygmomanometer at the level of heart. It was strictly observed that the BP Cuff bladder would cover at least 80% of arm circumference. The mean of three readings of systolic and diastolic components was taken in consideration. All the precautions like removal of extra clothes, shoes or relaxed mental state were considered during the procedure. The following classification of BMI as proposed by Asia Pacific Guideline was taken in consideration.

S.N	BMI(Asia-Pacific Guidelines) kg/m^2	Categories
1.	<18.5	Underweight
2.	18.5-22.9	Normal
3.	23-24.9	Overweight
4.	≥25	Obese

The Waist Circumference and Waist by Hip ratio were categorized as normal and risk groups as follows.

Group	Waist Circumference (WC)		Waist-Hip Ratio (WHR)	
	Male	Female	Male	Female
Normal	<90cm	<80cm	≤0.90	≤0.85
Risk	≥90cm	≥80cm	>0.90	>0.85

The BMI, WC and WHR were thus calculated in above mentioned categories and entered in SPSS version 16 for analysis. The Pearson's correlation test was applied for correlating the components of BP with the anthropometric measures considered. The correlation was considered to be significant if $P<0.05$, highly significant if $P<0.001$ and not significant if $P>0.05$ taking confidence interval of 95%.

RESULTS

Out of 175 participants 59% were male and remaining female. The distributive analysis of BMI distribution according to the Asia-Pacific Guidelines resulted maximum were in normal category (46%) followed by obese (22.9%) (Table1). However, overweight was more common than obese in case of male. The mean of Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) was found to be within normal range within all classes of BMI in both gender.

The SBP and DBP seemed to have positive correlation with increasing BMI in all classes of BMI except overweight class in male but were statistically insignificant. There was no statistical correlation between SBP and DBP with increasing BMI in different BMI classes in female participants also (Table 2).

Table 1. Gender-wise Distribution of Participants in different BMI classes (Asia-Pacific Guidelines) with respective mean of Systolic and Diastolic Blood Pressure (n=175).

BMI Class	Male			Female		
	N(%)	Mean of		N(%)	Mean of	
		SBP (mm Hg)	DBP (mm Hg)		SBP (mm Hg)	DBP (mm Hg)
1	11 (10.6%)	114 ±12.07	75.63 ±10.11	8 (11.3%)	91.5 ±11.6	62.5 ±9.48
2	54 (51.9%)	120.3 ±10.39	77.25 ±9.62	27 (38%)	106.7 ±9.62	73.18 ±9.13
3	20 (19.2%)	115.9 ±11.2	76.3 ±9.76	15 (21%)	109.7 ±10.9	71.06 ±10.55
4	19 (18.3%)	121.58 ±12.69	77.47 ±9.7	21 (29.6%)	113.67 ±14.89	76.38 ±9.20

Table 2. Genderwise Correlation of BMI with SBP and DBP in different BMI Classes (Asia Pacific Guidelines).

	BMI	SBP		DBP	
Gender	Class	R	P	R	P
Male	1	0.37	0.25	0.25	0.45
	2	0.12	0.37	0.05	0.71
	3	-0.28	0.21	-0.25	0.28
	4	0.16	0.49	0.32	0.17
Female	1	-0.10	0.80	-0.29	0.47
	2	0.04	0.82	-0.26	0.17
	3	-0.02	0.92	-0.16	0.55
	4	-0.24	0.27	-0.01	0.96

The correlation of increase in SBP and DBP with increasing WC was positive with statistically highly significant association in female with WC<80cm. (Table 3).

Table 3. Genderwise Correlation of WC with SBP and DBP in different WC categories.

Gender [n=175]	WC categories in cm [n]	SBP		DBP	
		R	P	R	P
Male[104]	<90 [76]	0.12	0.22	0.02	0.37
	≥90 [28]	-0.26	0.73	-0.07	0.92
Female[71]	<80[61]	0.48	0.00	0.44	0.00
	≥80[10]	0.54	0.10	-0.11	0.76

The correlation of increase in WHR with increase in SBP and DBP was found to be positive and statistically significant in female participants only with WHR ≤0.85 class (Table 4).

Table 4. Genderwise Correlation of WHR with SBP and DBP in different WHR categories.

Gender [n]	WHR categories [n]	SBP		DBP	
		R	P	R	P
Male[104]	≤0.9[101]	0.71	0.48	0.05	0.58
	>0.9[3]	0.95	0.19	-0.65	0.54
Female[71]	≤0.85[71]	0.46	0.00	0.37	0.00
	>0.85				No data

The increase in SBP and DBP when correlated with increase in BMI, WC or WHR in total participants showed that increase in SBP was more positively correlated (R=0.44) with increase in WHR and was statistically highly significant (P=0.00). However, increase in DBP was more positively correlated (R=0.31) with increase in WC and was also statistically highly significant (P=0.00) (Table 5).

Table 5. Correlation of SBP and DBP with BMI, WC and WHR in general.

Anthropometric Measures	SBP		DBP	
	R	P	R	P
BMI	0.16	0.02	0.13	0.08
WC	0.43	0.00	0.31	0.00
WHR	0.44	0.00	0.28	0.00

DISCUSSION

The distribution of BMI as per Asia-Pacific Guidelines in 175 participants showed that maximum was normal followed by obese group (22.9%).Similar higher prevalence of obesity (32.5%) was also found in Eastern Nepal.[9] The abdominal obesity as described by waist circumference IDF categorization was 26.9% and 14.1% in male and female participants respectively in this study. By taking in consideration of WHR, it was 2.9% in male and nil in female participants. The correlation of SBP and DBP with BMI in it's different classes according to Asia-Pacific Guidelines were found to be not significant. This was in contrast to the positive correlation of Blood Pressure (BP) with increasing BMI.[2] The increase in SBP was positively co-related with increase in WC and WHR in male of normal group only but was statistically insignificant and similar positive co-relation was seen in female too with statistically highly significance[P=0]. This was similar to the conclusion of WHR being strongly correlated with BP in adolescents girls.[10] In general, the total participants had increase in SBP positively correlated with increase in WHR and increase in DBP positively correlated with increase in WC with statistically high significance. This overall finding was in contrast with the finding of positive correlation of BP with BMI seen in Korean adolescent in comparison to other anthropometric measures.[11]

The overall finding of the positive correlation of SBP and DBP with increasing WHR and WC from healthy participants of this study suggests that the abdominal adiposity better correlates with increase in blood pressure in non hypertensive group as well. However, certain limitations were present in the study. The equal participation from both gender seemed lacking. The participants were adult group but the study if conducted in elderly people might be more impactful to relate with hypertension. Moreover, the comparative study of these variables in normotensive and hypertensive groups can widen the horizon of this finding.

CONCLUSIONS

This study finds WHR to be strongly correlated with increase in SBP and WC to be strongly correlated with increase in DBP in comparison to BMI even in healthy subjects.

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