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Correlation Between Body Fat Composition and Blood Pressure Level Among Medical Students in a Tertiary Care Teaching Hospital In Pokhara, Nepal

Indu Tiwari,[1] Anshu Bhattarai,[1] Poonam Karmacharya,[1] Preetu Gurung[2]
[1]Manipal College of Medical Sciences, Pokhara, Nepal, [2]Universal College of Medical Sciences, Bhairahawa, Nepal.

ABSTRACT

Introduction

Increase in body fat is a common finding in young adults due to sedentary lifestyle and unhealthy dietary habits predisposing an individual to increase in blood pressure which is a common cause of cardiovascular morbidity and mortality. This study aimed to determine the association between body fat composition and BP level in young adults.

Methods

A cross sectional study was conducted among 350 students of Manipal College of Medical Sciences from January to June, 2020. A structured proforma was used to collect the required information about the subjects and measurement of height, weight, waist and hip circumference, BP was done following standard methods. Body fat percentage was assessed by skinfold thickness.

Results

The prevalence of were overweight and obesity was found to be 35.14%. Systolic, diastolic and combined hypertension was found in 64.7%, 53.26% and 57.64% respectively, in overweight and obese population. Increase in body fat percentage in boys and increase in waist hip ratio in girls showed no correlation with increase in systolic, diastolic and mean arterial pressure. However, increase in BMI was strongly correlated ($p<0.05$) with increase in all the measures of blood pressure- systolic, diastolic and mean arterial pressure.

Conclusions

Body mass index is a better predictor of increased blood pressure level than body fat percentage and waist hip ratio.

Keywords: body fat percentage; body mass index; hypertension; obesity; waist hip ratio.

Correspondence: Dr. Indu Tiwari, Department of Physiology, Manipal College of Medical Sciences, Pokhara, Nepal. E-mail: indutiwariji@gmail.com. Phone: +977-9856062203.

INTRODUCTION

Increased body fat is one of the major health burdens in today's worlds and is considered to be major cardiovascular risk factor. Increased consumption of energy dense and processed foods with high sugar, salt and saturated fat contents combined with reduced physical activity is contributory to this rapid rise in obesity. Studies have shown overweight and obese individuals to be at higher risk of hypertension while reducing weight results in a reduced blood pressure.[1] Commonly used method to determine body fat include the determination of body mass index (BMI), waist circumference (WC), waist to hip ratio (WHR) and skinfold thickness (SFT). Though BMI is widely accepted for the measure of increased body fat and its positive correlation with hypertension is well established, the inability to recognize fat from fat free masses has questioned its reliability.[2] Some studies claim WHR to be a better indicator of obesity,[3] while some consider assessment of SFT to be more accurate for body fat assessment.[4] This study aims to correlate BMI, WHR and SFT with BP in normal subjects assuming increase in these measures should result in increased BP.

METHODS

A cross-sectional descriptive study conducted among 350 students in Manipal College of Medical Sciences for a duration of 6 months (January to June 2020) after obtaining ethical clearance from the Institutional Review Committee of Manipal College of Medical Sciences (MCOMs). The participants were selected by random sampling among the first and second year MBBS students at MCOMS. . Students with presence of any self-reported acute illness or fever were excluded. The nature of the study was explained to the students and informed consent was taken. Then, anthropometric values like weight, height, SFT, WC, WHR and BMI were measured or calculated with the use of standard techniques. Weight measurement was carried out by a digital weighing scale (Camry BR9011) after the subject had removed shoes, heavy clothes and objects and recorded in kilograms (kgs). Height was measured using a stadiometer (Seca, CEO123, and USA), with subjects wearing no shoes and averaged to the nearest centimeter (cm). BMI was calculated by dividing the person's weight in kgs by the square of their height in metres. BMI categories were determined according to world health organization (WHO) criteria with overweight as above 25, obese above 30, normal between 18.5 to 24.99 and underweight below 18.5. Waist circumference was measured mid-way between the anterior superior iliac spine and the lowest rib and hip circumference at the widest region in buttock area. A non-elastic measuring tape was used for this purpose and was recorded to the nearest centimeter. Dividing waist circumference by hip circumference gave the WHR. According to WHO, WHR >0.90 in males and >0.85 in females are obese. SFT was obtained using a skin fold calliper (Trimcal 4000) at standardized sites for boys and girls. The skinfold was picked between the thumb and the index finger so as to include two thicknesses of the skin and subcutaneous fat. Callipers were located about one centimeter from the finger with the callipers halfway up the fold of the skin. All the measurements were taken on the right side of the body with the subject standing upright and relaxed. SFT was measured at three sites- different for males and females. Diagonal skinfold of chest and vertical skinfold of abdomen and thigh on the right side was measured in males. In females, diagonal skinfold of suprailiac and vertical skinfold of thigh and triceps of the right side was measured. For better accuracy, measurements were done twice and average value was considered. The measurement was recorded in millimetres (mm). The sum of three skinfold measurements was used to calculate body density, according to Jackson and Pollock equation.[5,6] Body density was calculated as follows; For girls: Body Density

= 1.0994921 - 0.0009929*sum + 0.0000023*sum2 - 0.0001392*age. For boys: Body Density = 1.1093800 - 0.0008267*sum + 0.0000016*sum2 - 0.0002574*age. Where sum = sum of three skinfold thicknesses as mentioned above. After obtaining the body density, body fat percent was estimated using the Siri formula[7] as follows; Percent fat (%) = ((495 / Body Density) -450) * 100. Subjects were classified into underfat, healthy, overfat and obese according to specific charts for age and sex of the subject.[8] Blood pressure was taken using a mercury sphygmomanometer. Measurements were done in a quiet room after a 5 minutes rest. A total of three readings were taken, 5 minutes apart. The average of the last two readings was taken as the subject's BP. Hypertension was defined as blood pressure ≥140 and /or 90mmHg. Mean arterial pressure (MAP) was calculated using the formula; MAP = Diastolic BP + 1/3(Systolic BP-Diastolic BP). The calculated BMI, WC, WHR and SFT were entered in SPSS 16 for analysis. 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.

RESULTS

The study population included 350 (192 boys and 158 girls) young adults. The mean ±SD age of the total population was 20.25 ±1.08 years, with girls being on average 0.11 years older than boys, Table 1. On average boys were taller than girls, (170.40± 7.78 cm versus 158.88 ± 5.45 cm), p<0.001. The mean weight was also significantly higher in boys than in girls, (71.54± 14.36 kgs versus 54.83±9.36 kgs), p<0.001.When compared to girls, boys had significantly higher mean values for BMI as well as waist hip ratio, p<0.001. Body fat percentage was found to be greater in girls compared to boys (25.40±5.42 versus 14.29±5.42). The mean ±SD systolic and diastolic BP of the total population was 121.93 ±13.19 mmHg and 81.92 ±9.51 mmHg, respectively. Boys had higher mean values of systolic BP (124.75 ±11.13 versus 118.51 ±14.6 mmHg) as well as diastolic BP (85.41±8.63 versus 77.67± 8.80).The proportion of both systolic and diastolic hypertension was found to be greater in girls than in boys (5.7% versus 4.16% and 6.32% versus 4.16% respectively).Eighty five (24.28%) adults had a combination of both systolic and diastolic hypertension (Table 1).

Table 1. Demographic and anthropometric measurements by gender.

Characteristics	Boys(n=192)	Girls(n=158)	P-value
Age (years)	20.20±1.04	20.31±1.14	0.17
Height (cm)	170.40±7.78	158.88±5.45	<0.001
Weight (kgs)	71.54±14.36	54.83±9.36	<0.001
Body mass index (kg/m^2)	24.65±4.30	21.88±3.98	<0.001
Waist hip ratio(cm)	0.88±0.07	0.79±0.05	<0.001
Proportion with overweight and obesity n(%)	41.66%	27.21%	<0.001
Systolic blood pressure (mmHg)	124.75±11.12	118±14.6	<0.001
Proportion with systolic hypertension n (%)	4.16%	5.70%	0.018
Diastolic blood pressure (mmHg)	85.41±8.63	77.67±8.80	<0.001
Proportion with diastolic hypertension n (%)	4.16%	6.32%	<0.001
Mean arterial pressure (mmHg)	98.37±8.87	91.25±8.65	<0.001
Proportion with systolic and diastolic Hypertension n (%)	37.50%	8.22%	0.001

The proportions of young adults with underweight, healthy, overweight and obesity by BMI categorization was 8.33%, 50%, 25% and 16.66% respectively among boys, and 23.41%, 49.36%, 43% and 0% respectively among girls. This difference was statistically significant, p<0.001. The mean total body fat percent for girls was more than that of boys (25.40 ± 5.42% versus 14.29 ± 5.42%). The proportion of adults with underfat, healthy, overfat and obesity by fat percentage categorization was 4.16%, 83.33%, 12.5% and 0% respectively among boys and 15.18%, 74.05%, 10.75% and 0% respectively among girls. This difference was statistically significant, p<0.001. All the measures of adiposity correlated positively and significantly with mean SBP, DBP as well as MAP in the total population (all p<0.05), Table 2.When analysis was separated for boys and girls, all the conventional measures of adiposity (age, height, weight, BMI, waist hip ratio) except body fat correlated positively with increase in mean systolic BP in boys. Diastolic BP showed no correlation with WHR and BF%. MAP also showed no association with BF% (Table 2).

Table 2. Correlates of systolic blood pressure, diastolic blood pressure and mean arterial pressure in the total population and in boys and girls.

Variables	SBP (mmHg)			DBP (mmHg)			MAP (mmHg)		
	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls
Age (years)	.333**	.640**	.117NS	.309**	.525**	.181*	.365**	.612**	.191*
Height(cm)	.146**	.171**	.243**	.304**	.175*	-.131NS	.271**	.189**	-.222**
Weight (kg)	.508**	.448**	.564**	.407**	.255**	.222**	.506**	.351**	.472**
BMI(kg/m^2)	.535**	.400**	.614**	.299**	.150*	.257**	.445**	.260**	.523**
WHR	.212**	.278**	.150NS	.187*	.113NS	.054NS	.234NS	.185*	.118NS
BF%	.239**	.104NS	.072NS	.388**	.085NS	.190*	.361**	.084NS	.168*

In girls, age, WHR and BF% showed no correlation with systolic BP. Height and WHR didn't show any relationship with mean DBP and increased WHR also showed no association with increased MAP. In the total population, the prevalence of systolic and diastolic hypertension increased in a step-wise fashion with increase in BMI, Figure1. The prevalence of systolic hypertension was 0%, 35.30%, 64.70% and 0% among adults who were underweight, healthy, overweight and

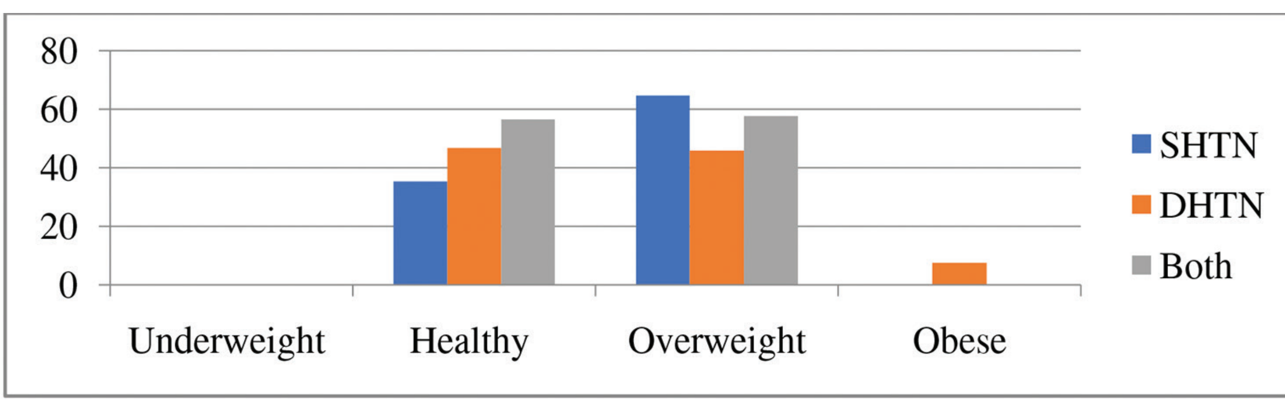

Figure 1. Prevalence of systolic, diastolic and combination of both hypertension in underweight, healthy, overweight and obese adults according to BMI.

obese, respectively. Diastolic hypertension was found in 0%, 46.72%, 45.79% and 7.47% among underweight, healthy, overweight and obese adolescents respectively. Combination of both systolic and diastolic hypertension was seen in 56.47% of healthy and 57.64% of overweight population (Figure 1).

When BF% was used to categorize subjects into underfat, healthy, overfat and obese groups, fat percentage categorization could not differentiate those with overfat and obesity in terms of the prevalence of systolic and diastolic hypertension. However, a combination of both systolic and diastolic hypertension was seen in 41.4%of the population who were overfat, (Figure 2).

contributing factors to hypertension in young people. In our study BMI, WHR and BF% were indices used as predictors of obesity. SBP as well as DBP was found to be higher in boys than in girls- a common finding in numerous studies possibly caused due to differential effects of estrogens and androgens on the expression and activity of the components of the renin–angiotensin system.[9] The proportion of young adults with systolic and diastolic hypertension was 4.85% and 5.14% respectively while 24.28% of the population had both systolic and diastolic hypertension. The prevalence of both systolic and diastolic hypertension was found to be greater in girls than in boys. The findings are however different from those found in a study conducted by Alhawari et al. among college students where boys had greater prevalence of both systolic and diastolic hypertension.[10]

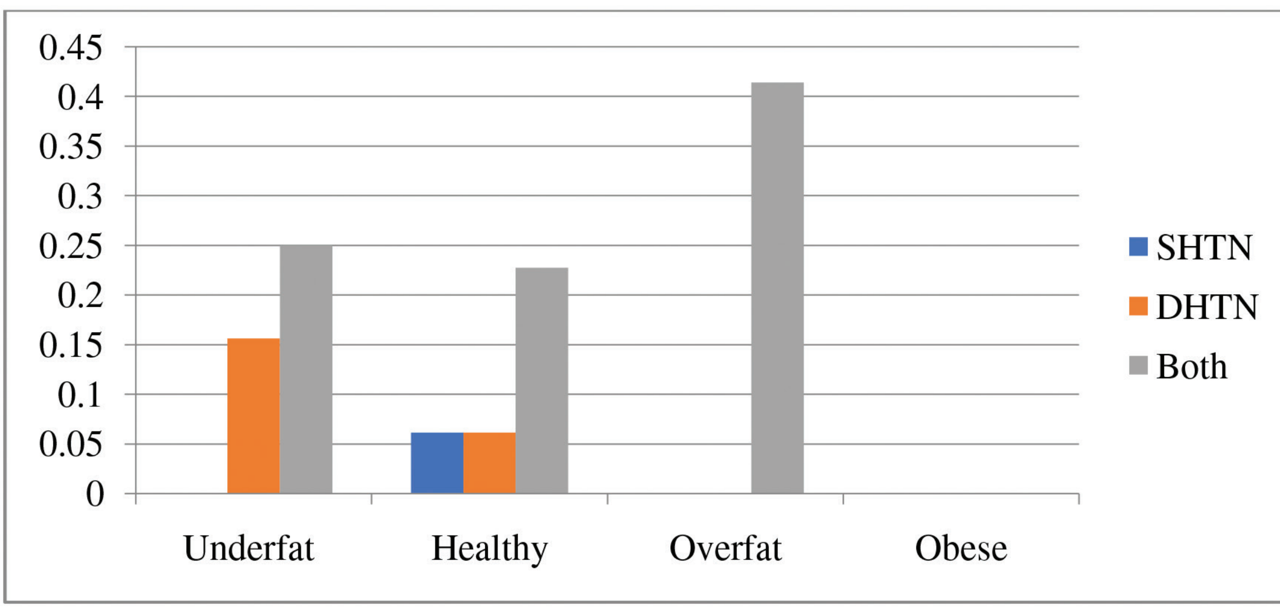

Figure 2. Prevalence of systolic, diastolic and both hypertension in underfat, healthy, overfat and obese adults according to BFP.

In 77 adults with obesity according to the increased waist hip ratio, 16.88% had systolic hypertension, 10.38% had diastolic hypertension and 50.64% had both systolic and diastolic hypertension.

DISCUSSION

Obesity is generally considered one of the major

The relationship between body composition and BP levels has well been established in epidemiological studies, where BP is positively correlated with age, weight, height as well as height/weight measurements.[11, 12] Traditionally, body composition has been estimated by BMI as well as WHR and these have been shown to positively correlate with levels of BP and this study was no different. An additional method of using BF% to determine body composition and to its association with increased BP was implemented. BF% positively and significantly correlated with systolic as well as diastolic BP, similar to results of the study performed in southern Brazil which showed that compared to individuals with lower BFP, individuals who were with higher BFP were prone to have a greater risk of hypertension.[13] Recently, research conducted in South Korea indicated that increased BFP was associated with the high risk of hypertension even in non-obese subjects.[14] However, Alvin Chandra et al. found that neither total nor subcutaneous adiposity was related to the onset of hypertension.[15]

However, in multivariate analysis body fat percent was not independently associated with MAP, which is a measure that takes account the systolic and diastolic BP of the individual. These findings have been reported by other previous researchers.[16, 17] Although inaccurate skinfold measurement could have contributed to the poor or lack of association between body fat percentage and MAP, this factor if present would be negligible as all measurements were done by the same person and in pre-specified anatomical sites.

One of the most important finding of this study is that BMI categorization into underweight, healthy, overweight and obesity showed 100% of young adults with systolic hypertension to be overweight. Combination of both systolic and diastolic hypertension was seen in 57.6% of the subjects who were obese. This correlation of obesity with increased blood pressure is documented by multiple studies in different parts of the world.[18, 19] This obesity associated hypertension is contributed to increased sympathetic nervous system activity, increased renal sodium retention secondary to insulin resistance/hyperinsulinemia, and obesity mediated inflammation.[18]

When WHR was used as a determinant of body composition, 47.6% of adults who were obese had a combination of systolic and diastolic hypertension. 13.95% had systolic hypertension and 9.30% had diastolic hypertension. The findings were similar to that of a study carried out by Chaudhary et al. which established a positive correlation between BO and WHR.[20] However, a negative correlation was observed between WHR and BP in a study carried out by Taylor et al. in New Zealand.[21]

This pattern was not however the same with body fat percent, where systolic and diastolic hypertension was not observed in obese and ovefat population showing the superiority of BMI over fat percentage in relation to BP and hypertension in this study population. This finding was similar to a study which aimed to establish a relationship of the blood pressure's level and skinfold thickness but concluded BMI to be a better predictor than SFT.[22] It could be contributed to use of skinfold callipers rather than use of more accurate means of body fat percent analysis such as bioelectric impedance analysis or dual energy x-ray absorptiometry. However skinfold callipers being one of the validated methods of measuring body fat composition is comparatively cheaper and can easily be applied in clinical settings.

CONCLUSIONS

BMI correlated better with increased levels of BP in comparison to body fat percentage measured by skinfold thickness method and WHR in this population. High BMI should be used as a measure of increased risk for hypertension among adolescents.

Conflict of Interest: None Declared

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