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Study of Blood Pressure in Medical Students in Kolkata and Its Variation with BMI, Waist Circumference, Waist-To-Hip Ratio and Waist-To-Height Ratio

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Abstract:
Background: *Obesity, a global health problem is a well-recognized risk factor for hypertension and various other diseases. Both obesity and hypertension have their contribution to the development of cardiovascular disease, an important cause of morbidity and mortality throughout the world.*
Objective: The study was conducted to determine the frequency of hypertension and to understand the relation between blood pressure and obesity indicators.
Materials and methods: *A cross-sectional study involving 200 medical students, aged 19-23 years was carried out. Their blood pressure, height, weight, BMI, waist circumference, waist-hip ratio, waist-height ratio was measured. The data was analyzed by statcalc software. P<0.001 was considered significant.*
Result: *With respect to BMI, systolic and diastolic blood pressure was significantly higher in male overweight and obese subjects and in female obese subjects. In case of male, those overweight with respect to any of WC, WHpR and WHtR, had significantly higher SBP and DBP. In case of female, those who were overweight with respect to any of WC and WHtR had significantly higher SBP and DBP. Both SBP and DBP correlated most with WHpR in case of males and with BMI in case of females.*
Conclusion: *Periodic anthropometric measurements can be used to assess the development and progression of risk factor.*

Introduction

It is estimated that the number of adults with hypertension will touch a staggering 1.56 billion by the year 2025[1]. The growing prevalence of obesity is increasingly recognized as one of the most important risk factors for the development of hypertension. More than 1 billion adults and 10% of children are now classified as overweight or obese.[2] Based on population studies, at least two-thirds of the prevalence of hypertension can be directly attributed to obesity[3] The precise mechanisms linking obesity to hypertension and increased cardiovascular risk are not fully understood. However, neuroendocrine mechanisms and, most recently, factors derived from adipose are thought to play a major role[4]. Obesity might lead to hypertension and cardiovascular disease by activating the renin–angiotensin–aldosterone system, by increasing sympathetic activity, by promoting insulin resistance and leptin resistance, by increased procoagulatory activity and by endothelial dysfunction. Further mechanisms include increased renal sodium reabsorption, causing a shift to the right of the pressure–natriuresis relationship and resulting in volume expansion[5]. Obstructive sleep apnoea may importantly contribute to sympathetic activation in obesity. Finally, obesity itself increases the cardiovascular risk and is an important modifiable risk factor[2]. In overweight and obese subjects, the cardiovascular risk is not significantly increased unless hypertension is present[6] This observation underscores the role of hypertension as a mediator through which obesity may cause cardiovascular disease. Weight loss of 5% is associated with the reduction of angiotensinogen levels by −27%, renin by −43%, aldosterone by −31%, angiotensin-converting enzyme activity by −12% and angiotensinogen expression by −20% in adipose tissue[7]. Furthermore, weight loss has been shown to improve endothelial function[8], decrease sympathetic nerve activity[9] improve baroreflex function.[9] Weight loss is associated with a significant reduction of blood pressure and has beneficial effects on the associated risk factors.

Although there are many studies on the health status of medical students, a target group of particular interest as they are future physicians, the occurrence of obesity and hypertension has not been extensively studied, especially in India.

So the aim of this study is to elucidate the relation, if any, between blood pressure and obesity indicators like BMI, waist circumference, waist-to-hip ratio and waist-to-height ratio.

Materials and Methods

This was a cross-sectional study carried out in the Department of Physiology, IPGME&R, Kolkata after proper approval from Institutional Ethics Committee (IEC). 200 randomly selected medical students of IPGME&R, Kolkata, having their age group between 19 and 23 years served as volunteers. those suffering from endocrine disorder like hypothyroidism were excluded from the study. Subsequently their informed consents were obtained in pre-printed informed consent form. A pre-printed data sheet was used for all subjects to enter the required data.

Body height (BH) was measured to the nearest of 0.1 cm with the help of a wall-mounted graduated

wooden scale[10], fitted with an adjustable horizontal bar to fit over the cranial vault. Readings were taken from the level of the lowest point on the subject's heal to the height of the undersurface of the horizontal bar. Body weight (BW) was measured to the nearest of 0.1kg with the help of a weighing machine[10] properly serviced and calibrated. Readings were taken from the '0' (Zero) reference point. Waist circumference (WC) was measured in centimeter using a tailor's tape at the level of umbilicus in supine posture (according to WHO guidelines)[11]. Hip circumference (HC) was measured in centimeter using a tailor's tape at inter-trochanteric level while standing (according to WHO guidelines)[11]. Body mass index (BMI) was calculated from height and weight using the formula of Quetlet's index [weight (kg)/height^2 (m)]. BMI 18.5 to <23 kg/m^2 was considered normal, BMI ≥ 23kg/m^2 but <25kg/m^2 as overweight and BMI ≥ 25kg/m^2 as obese[12]; this is different from WHO cut-off point[13]. WC (cm) was divided by HC (cm) and BH (m) in order to calculate the waist-to-hip (WHpR) and waist-to-height (WHtR) ratio respectively. Cut-off value between normal and overweight for WC in males was ≥ 90cm and in females it was ≥ 80cm[14]. For WHpR the cut-off value for males was ≥ 0.9 and in females it was ≥ 0.8[14]. The cut-off value for WHtR was ≥ 50.0 in both sexes[15]. Blood pressure was measured with the help of a regularly serviced and calibrated mercury sphygmomano-meter in comfortable sitting posture after five minutes of rest. Two readings separated by two minutes were averaged. As per recommendation, the BP to the nearest 2 mm Hg was recorded[16]. Hypertension was defined by systolic blood pressure (SBP) > 140 mm Hg or diastolic blood pressure (DBP) > 90mm Hg or both[17].

Statistical analysis:-

Statistical analyses were done using the Statcalc version 5.0.4 licensed software. Student t-test was done to analyze the quantitative data and p value determined. Stepwise linear regression techniques were applied to access the extent to which BP depends on the obesity indices. p value < 0.001 was considered significant.

Results and analysis:

In this study 120 (60%) students were male and 80 (40%) students were female. 18% male students were overweight and 19% were obese. But in case of females the values stand at 23% for both overweight and obese. In respect to WC, 30% males and 45% females were overweight. In respect to WHpR, 69% of male students were found to be overweight, whereas the value for female students was an overwhelming 72%. In respect to WHtR, it was found that 38% males and 45% females were overweight.

Table-1 Frequency of Hypertension in males and females.

	Male	Female
SBP (>140 mm Hg)	12.5% (n=15)	5% (n=4)
DBP (>90 mm Hg)	2.5% (n=3)	5% (n=4)

Table-2 Distribution of Blood Pressure according to BMI in males.

	Normal	Overweight	P value	Obese	P value
SBP	120 ± 7.48	131± 8.28	<0.0001	138 ± 10.5	<0.0001
DBP	76.1 ± 5.35	83.5 ± 7.22	<0.0001	87.8 ± 2.82	<0.0001

The tables (2&3) show that there was a significant increase in SBP and DBP in males having BMI ≥ 23kg/m^2 (overweight and obese) but in females the rise in SBP and DBP is significant only in the obese group with BMI ≥ 25 kg/m^2.

Table-3 Distribution of Blood Pressure according to BMI in females.

	Normal	Overweight	P value	Obese	P value
SBP	118 ± 5.85	119 ± 11.3	0.648	136 ± 5.72	<0.0001
DBP	77 ± 5.29	78 ± 7.23	0.547	84.3 ± 8.15	<0.0001

Table-4 Distribution of Blood Pressure in relation to WC in males.

	Normal	Overweight	P value
SBP	120.6 ± 7.4	136.6 ± 9.9	<0.0001
DBP	76.7 ± 5.7	86.8 ± 5.1	<0.0001

Table-5 Distribution of Blood Pressure in relation to WC in females.

	Normal	Overweight	P value
SBP	117 ± 6.09	129 ± 10.5	<0.0001
DBP	75.8 ± 5.06	82.6 ± 7.43	<0.0001

When WC is considered (Table-4 and Table-5) there is significant increase in both SBP and DBP in the overweight group of both sexes, but WHpR (Table-6 and Table-7) shows that in males there is significant rise in SBP and DBP in overweight group but in females, there is no significant rise. Considering WHtR (Table-8 and Table-9) there is significant rise in SBP and DBP in males but in females the rise in SBP is highly significant and the rise in DBP is also significant.

Table-6 Distribution of Blood Pressure in relation to WHpR in males.

	Normal	Overweight	P value
SBP	120 ± 6.91	128 ± 11.7	<0.0001
DBP	74.9 ± 5.13	81.9 ± 6.98	<0.0001

Table-7 Distribution of Blood Pressure in relation to WHpR in females.

	Normal	Overweight	P value
SBP	117 ± 5.15	124 ± 11.1	<0.006
DBP	75.4 ± 5.25	80.2 ± 7.24	<0.006

Table-8 Distribution of Blood Pressure in relation to WHtR in males.

	Normal	Overweight	P value
SBP	119.84 ± 7.52	134.62 ± 9.66	<0.0001
DBP	76.05 ± 5.33	85.87 ± 5.58	<0.0001

Table-9 Distribution of Blood Pressure in relation to WHtR in females.

	Normal	Overweight	P value
SBP	117 ± 6.58	128 ± 11.3	<0.0001
DBP	76.6 ± 5.64	81.6 ± 7.73	<0.001

Prediction of HTN using obesity indices was done by linear regression analyses (Table-10 and Table-11). This shows that in males BMI, WC and WHtR are not significant determinants of HTN. WHpR is a significant variable for SBP and DBP in males. Linear regression analyses in female however show that BMI is a strong obesity index for predicting SBP and DBP. WC, WHpR and WHtR are found to be not significant variables for HTN in females.

Table-10 Regression analysis of BP in relation to obesity indices in males.

Dependent variables	Obesity index	Y intercept	Slope (b)	Pearson R	R^2	P value (<)
SBP	BMI	15.8945	0.0691	0.435	0.1892	0.003
DBP	BMI	15.4151	0.1139	0.41	0.1681	0.005
SBP	WC	101.2869	-0.0566	-0.161	0.0259	0.347
DBP	WC	95.649	-0.0242	-0.036	0.0013	0.836
SBP	WHpR	0.8294	0.001	0.354	0.1253	0.001
DBP	WHpR	0.7923	0.0021	0.422	0.1781	0.0001
SBP	WHtR	0.5461	0.0000	-1	0.0000	1.000
DBP	WHtR	0.3117	0.0026	-1	0.0000	1.000

Table-11 Regression analysis of BP in relation to obesity indices in females.

Dependent variables	Obesity index	Y intercept	Slope (b)	Pearson R	R^2	P value (<)
SBP	BMI	10.7417	0.1156	0.619	0.3832	0.0001
DBP	BMI	12.6231	0.1580	0.569	0.3238	0.0001
SBP	WC	62.3933	0.1648	0.468	0.2190	0.004
DBP	WC	67.5545	0.1946	0.39	0.1521	0.019
SBP	WHpR	0.8012	0.0005	0.125	0.0156	0.349
DBP	WHpR	0.8038	0.0007	0.12	0.0144	0.368
SBP	WHtR	38.2049	0.1284	0.433	0.1875	0.008
DBP	WHtR	39.3722	0.1868	0.432	0.1866	0.009

Discussion

In this study, higher prevalence of hypertension in adolescent males (12.5%) compared to females (5%) is similar to that of Gupta R et al[18] which reported a prevalence of HTN in 5.6% males and 3.1% females. Morar N et al (1998)[19] showed 4.2% of HTN in a study among Indian medical students in South Africa.

A positive correlation of BMI with BP has been shown by many workers[19.] Bogalusa Heart Study[21] (2000) shows that none of the central obesity indices like WC, WHpR and WHtR measurements predicted BP levels of young adults but our study found that all these obesity indices bear significant relation with BP in males and in females only WHpR is not a very good predictor of BP.

This findings is in contrast to the study of Bertsias G et al[20] who have found that BMI is the best obesity index predicting SBP and DBP in males. Gupta R et al[18] have also found importance of BMI for BP.

Summary and Conclusion

In this study substantial proportion of young medical students was overweight and hypertensive. Overweight students had significantly higher BP compared to those with normal BMI. BMI was found to be useful indicator for BP in females while WHpR was a strong predictor of BP in males.

As 40% of our total study population was overweight considering WHtR, so the number of at-risk individuals is much higher. So the crucial factor is the age at which screening and intervention strategies should be initiated, and it should be extended to the general population.

WHpR and WHtR are very simple measures of central adiposity and this study warrants us to suggest their inclusion in the health indices for assessment of overweight in young adults to prevent the epidemic of obesity, hypertension and CVD in India.

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