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A Study to correlate blood pressure with anthropometric measurements among adolescent medical students of PK Das Institute of Medical Sciences, Palakkad

Dr Nimisha V[1*], Dr. Santhosh Viswan[2], Dr.Jagathlal PC[3]

[1]Assistant Professor, Department of Biochemistry, PK Das Institute of Medical Sciences, Vaniyamkulam, Palakkad, Kerala, India. Email: nimisha098@gmail.com, Orcid ID: 0000-0001-5972-8408. *Corresponding author

[2]Professor & HOD, Department of Biochemistry, KarpagaVinayaga Institute of Medical Sciences and Research Center, Maduranthakam, Tamil Nadu, India. Email: santhoshviswan13@gmail.com, Orcid ID: 0000-0002-4797-6938

[3]Professor & HOD, Department of Biochemistry, PK Das Institute of Medical Sciences, Vaniyamkulam, Palakkad, Kerala, India. Email: laljagath@gmail.com. Orcid ID: 0000-0002-5536-5336

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Abstract

Background: Hypertension is a risk factor for various cardiometabolic diseases. Obesity is associated with hypertension,for which various pathophysiological pathways have been found.Hence getting an anthropometric measurement which correlates best with blood pressure will help in early diagnosis of obesity. Many new anthropometric measurements have been suggested due to the shortcomings identified with using Body Mass Index like Abdominal Volume Index, A body Shape Index and Body Roundness Index.**Methods**: After taking approval from institutional scientific and ethics committee this study was started. 55 adolescent students were selected by cyclic stratified random sampling. Physical parameters like Blood pressure, height, weight, waist circumference, hip circumference were taken. These values were put into various formulae to derive the anthopometric measurements like Waist Hip Ratio, Body Mass Index, Abdominal Volume Index, A body Shape Index and Body Roundness Index. These measurements were correlated with systolic and diastolic blood pressure.**Results**: 69.1% girls and 30.9% boys were a part of the study. A significant positive correlation was found between Systolic Blood Pressure and Waist circumference, Hip circumference, Waist hip ratio, Body Mass Index, Abdominal Volume Index and Body Roundness Index. The maximum correlation was found with Waist circumference.**Conclusion**: It is necessary that anthropometric measurements which take adiposity into consideration be used so that obesity can be picked up much before it exerts its ill effects like systemic Hypertension.

Keywords: Anthropometric Measurements, Adolescent, Blood pressure

INTRODUCTION

According to the global burden of disease 2019 report of Lancet, one of the highest jump in risk factor prevalence for hypertension was in the form of increased Body Mass Index (BMI). Also the level 2 risk factor globally for attributable death was high systolic blood pressure, which accounted for 10·8 million of all deaths in 2019.[1]

In 2019, ischaemic heart disease and stroke were the top-ranked causes of DALYs in

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both the 50–74-year and 75-years-and-older age groups. Since 1990, there has been a marked shift towards a greater proportion of burden due to non-communicable diseases and injuries. In 2019, there were 11 countries where non-communicable disease and injury constituted more than half of all disease burden.[1]

Many longitudinal studies conducted over decades have concluded that childhood hypertension correlates with adult hypertension. In that case taking care of risk factors of hypertension at an early stage will definitely help in preventing or even the extending the time of onset of hypertension.

Hypertension itself is a risk factor for cardiovascular diseases. Many studies have shown that prevalence of hypertension is increasing in younger population in the age group of 18-39 years which is being pointed at obesity at young age due to unhealthy eating habits.[2,3]Prehypertension and hypertension among this age group can be extrapolated to cardiovascular events at a later age. Previous studies have shown that obesity was mainly responsible for development of hypertension in 15% males and 20% females.[4]Obesity which is divided into various classes based on Body Mass Index (BMI) is foreseen as an important and preventable risk factor for various cardiometabolic disorders. The World Health Organization adopted the classification of BMI to identify persons with not only underweight but also obesity and Morbid obesity.According to WHO factsheet dated April 1, 2020 the prevalence of obesity has tripled since 1975. Also, overweight and obesity are killing more number of people than underweight .The prevalence of obesity among children of age 5-19 years increased from 4% in 1975 to 19% in 2016. The low to middle income countries are fighting a war not only with communicable diseases but also non communicable diseases. Almost half of children below 5 years of age with obesity were from Asia. This has been attributed to calorie dense, micronutrient poor, high sugar food items which are available at a lower cost.[5]All these points prove that we need to be extra vigilant in order to not only diagnose but also prevent obesity.

It was in the 1900s that medical importance of body fatness came into the limelight. The insurance companies used a weight to height ratio to give an approximation of overweight and obese people. But it was realised after many years that this does into take into consideration the bone mass. It was noted that a person's leg length has an effect on weight adjusted for person's weight. Hence a mathematical formula was searched which would negate the leg length issue. Thus was born the concept of BMI, which till today boasts of a high position in anthropometric measurements and is used to classify a person as obese and non obese. The World Health organization too uses this parameter to classify persons under different classifications of body weight. BMI earlier known as quetelet index is calculated as Body mass in kg divided by square of ht in meters. By squaring the height, body mass distribution is achieved at each level of height as it decreases the effect of leg length. Recently though some points are coming forward which are making the extensive use of BMI as an anthropometric measurement questionable.For example it has been noted that there has been an upward population trend with regards to body weight and height and the author suggests that tuning of BMI ranges is necessary to accommodate the same. Also BMI gives no information

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regarding body fat location as according to the study conducted years ago by Dr Jon Vogue, it was found that body fat location in the upper part was much more linked to cardiovascular events compared to lower body fat. Also visceral fat accumulation, abdominal girth have been most linked to coronary heart disease, hypertension. In this case BMI as a measurement falls short in identifying the same. Hence other measurements which give an idea about fat distribution need to be looked into. In this regard various measurements like Waist Circumference (WC), Waist Hip Ratio(WHR), Body Roundness Index (BRI), A body shape Index(ABSI),Abdominal Volume Index (AVI) have come into forefront which use mathematical formulae to identify body fat distribution and possible risks of future comorbidities.[6]

What becomes the need of the hour is to find out which anthropometric measurement gives the closest estimate of risk due to obesity so that precautions can be taken to prevent future development of associated diseases. If such measurements are used from a young age it may be possible to slow disease progression.

Body roundness index (BRI) was developed by Thomas et al to quantify height independent individual body shape. It was found to have a better prediction of percent body fat (derived from Dual Energy X ray Absorptiometry and percentage of visceral adipose tissue (derived from MRI) compared to BMI or waist circumference and hip circumference.[7] Body Adiposity Index (BAI) was developed to reflect percent body fat for different ethnicities without correction.Dual energy X-ray absorptiometry was used as gold standard. Hip circumference and height were taken as bases for creating the mathematical equation,BAI= (Hip circumference/height$^{1.5}$)-18.

Although BMI is used at a large scale but it has many shortcomings. BMI does not indicate the body fat distribution and is affected by gender, ethnic differences and age. Hence finding anthropometric measurements which are able to identify body fat and especially central body fat distribution will go a long way in identifying the people who actually have risk factor for cardiometabolic events. In this regard various measurements like Waist circumference(WC), Waist Hip Ratio(WHR), Body Adiposity Index(BAI), a body Shape Index (ABSI), Abdominal Volume Index (AVI) have been developed to give a clearer picture of the same.

This study was done to know the correlation of various anthropometric measurementswith blood pressure of Adolescent medical students of PK Das Medical College.

MATERIALS AND METHODS

The primary objective of this study was to determine the correlation of blood pressure with various anthropometric measurements.

The study was started after getting approval from the institutional scientific committee and ethics committee.

The sampling strategy used for this study was Circular Systematic Random Sampling. As the study was conducted in a Medical College setting, the sample size was determined after making necessary corrections for determination of sample size for a finite population. The prevalence of

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hypertension among adolescents was taken as 15.3% based on a previous study.[8]

As the study included only adolescents, a list of all adolescent students studying in PK Das Medical College was prepared. There were a total of 150 students at the point when the study was conducted. The list of students was selected from the attendance roll that was available. All the students were listed alphabetically. Every 2nd student was selected from the list by employing circular systematic random sampling method.Hence a total of 55 students were involved in the study.

A pre tested semi structured questionnaire was administered to the students with prior written consent from them.

Study Design: After getting approval from institutional scientific and ethics committee this study was started. 55 students,both girls and boys in age group of 19-20 years were made a part of the study.

Blood pressure was measured using Sphygmomanometer.Blood pressure was checked using standard protocol, wherein the average of last two readings of the three readings was taken.Weight was measured to the nearest 0.1 Kg using a calibrated analogue weighing machine. Height was measured using stadiometer to nearest 1 cm. Waist circumference was measured using a non-stretchable tape in horizontal plane, midway between the lowest rib margin and iliac crest at the mid axillary line at maximal point of normal expiration. Hip circumference was measured at the maximum extension of the buttocks posteriorly and pubic symphysis anteriorly using a non-stretchable tape in horizontal plane. Body mass index was calculated as body mass in kg divided by square of height in metres. WHR or waist hip ratio was calculated by dividing waist circumference in cm by hip circumference in cm. Weight classification based on BMI (kg/m2)was as follows: < 18.5: underweight; 18.5–24.9: normal; 25.0–29.9: overweight; ≥ 30.0: obese {class I: 30.0–34.9;class II: 35.0–39.9; class III: ≥ 40)[9].

Following formulae were used to calculate Body adiposity index, A body shape index, Abdominal Volume Index and Body Roundness Index. These were entered in excel sheets and formulae were used to derive the results.

a. Body adiposity index (BAI): {hip circumference (cm)/height$^{1.5}$ ($m^{1.5}$)} – 18
b. A body shape Index (ABSI): WC(m)/[$BMI^{2/3}$(kg/m^2)$Height^{1/2}$(m)]
c. Abdominal Volume Index(AVI): [WC^2(cm)+0.7(WC-HC)^2(cm)]/1000
d. Body Roundness Index(BRI): 364.2-365.5[1-$\pi^{-2}WC^2$ (m)$Height^{-2}$ (m)]$^{1/2}$

Data analysis:
Data was entered in Microsoft excel and cleaned. It was then copied into SPSS version 15.0 for analysis.The relation between anthropometric indices and blood pressure were examined using Pearson's correlation analysis. Level of significance was set at a two-tailed p value of < 0.05.

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RESULTS

This study was conducted among 55 first year adolescent MBBS students after taking permission from scientific and ethics committee. Out of the 55 students, 17 that is 30.9 % were boys and 69.1% were girls.

Mean BMI among females was found to be 20.5 ± 4.15 kg/m^2 compared to males where it was found to be 23.6 ± 2.9 kg/m^2. Mean Waist Circumference among females was found to be lower (72.7 ± 8.55 cm) compared to males which was 79.8 ± 7.7 cm. On the other hand mean waist hip ratio among females was found to be 0.7 ± 0.05 whereas in males it was found to be 0.8± 0.04. The mean values of Waist circumference, Hip circumference, waist hip ratio, BMI, BRI, AVI were found to be higher in males compared to females whereas BAI and ABSI were found to be higher in females.The difference in means between males and females was found to be significant in case of BMI, AVI, WC, WHR, SBP and BAI.

It was found that on the whole there was a positive and significant correlation of systolic BP with Waist circumference, Hip circumference,and Waist hip ratio, BMI, AVI and BRI. The maximum correlation was found with Waist circumference. No significant correlation was found between these physical parameters and Diastolic blood pressure.

As for girls, SBP was found to have a positive correlation with WC, WHR, AVI and BRI, the maximum being with waist circumference.Again DBP showed no correlation with any physical parameter.In boys both SBP and DBP showed no correlation with any parameter. BMI which has been used as a gold standard to rate obesity was found to have a positive significant correlation with all the physical parameters except ABSI with which it showed a significant negative correlation.Maximum correlation was found with BRI.

Table 1: Distribution of participants based on gender

Gender	Number	Percent
Males	17	30.9
Females	38	69.1

Table 2: Pearson correlation table for whole group (n=55)

	WC	HC	WHR	BMI	BAI	ABSI	AVI	BRI
SBP	0.456**	0.383**	0.367**	0.369**	0.003	-0.022	0.453**	0.296*
DBP	0.012	0.075	-0.063	0.030	-0.069	-0.085	0.012	-.054

** Correlation is significant at the 0.01 level (2 tailed)
*Correlation is significant at the 0.05 level (2- tailed)

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Table 3: Pearson correlation table for females (n=38)

	WC	HC	WHR	BMI	BAI	ABSI	AVI	BRI
SBP	0.385*	0.274	-0.366*	0.261	0.189	0.137	0.384*	0.345*
DBP	-0.061	-0.057	-0.047	-0.066	-0.072	0.002	-0.066	-.060

** Correlation is significant at the 0.01 level (2 tailed)
*Correlation is significant at the 0.05 level (2- tailed)

Table 4: Pearson correlation table for males (n=17)

	WC	HC	WHR	BMI	BAI	ABSI	AVI	BRI
SBP	0.261	0.425	-0.067	0.249	0.863	0.846	0.279	0.740
DBP	-0.001	0.317	-0.360	0.144	0.142	-0.284	0.015	-0.100

** Correlation is significant at the 0.01 level (2 tailed)
*Correlation is significant at the 0.05 level (2- tailed)

DISCUSSION

In this study it was found that there was a positive and significant correlation of systolic BP with Waist circumference, Hip circumference, waist hip ratio, BMI, AVI and BRI. No significant correlation was found between these physical parameters and Diastolic blood pressure. In females was found to have a positive correlation with WC, WHR, AVI and BRI. No significant correlation found between DBP and anthropometric measurements. In case of males no significant correlations found between SBP, DBP with anthropometric measurements.

Similar to our study, a study done on Iranian primary school students a positive and significant correlation was found between Blood Pressure and waist circumference compared to other anthropometric measurements.[10]

In a study on Brazilian Men, a linear significant correlation was found between both systolic and diastolic blood pressure and all anthropometric measurements except systolic blood pressure and waist hip ratio. Also anthropometric measurements were larger in hypertensives compared to normotensives.The difference from our study could be due to a smaller sample size and also the age group under consideration wherein we have taken an adolescent population and other studies have included adult population.[11]

This study was conducted in a medical college set up. Hence it would not be wrong to assume that the students involved in this study may have been in a better position to have knowledge about lifestyle diseases such as hypertension and its effects. Hence the results cannot be extrapolated to a general adolescent population. Although all precautions were taken to not allow any bias to creep in, Systematic Random sampling

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inherently may cause bias in sample selection.

In a study wherein Prevalence and associated risk factors of Hypertension were studied among UrbanSchool Adolescents in Lady Bhore Catchment Area of Bhopal City it was found that the Prevalenceof hypertension among adolescents was 15.3 %(14.04% among boys and 17.3 % among girls) and the prevalence of pre hypertension was 19.8% (19.0% of boys and 20.9% of girls were pre hypertensive).[8]

Obese individuals are found to be at increased risk for diabetes, hypertension, renal failure, and other cardiovasculardiseases.[12] At the level of kidneys various factors like activation of sympathetic nervous system and Renin Angiotensin System and increase in aldosterone associated with obesity can cause abnormal sodium retention and raised arterial pressure, also renal damage can be caused by compression of kidneys by surrounding fat.[13]

Perivascular fat has been proposed to have an important role in vascular events associated with obesity.Vascular tone modulation has been found as one of the actions of adipose tissue surrounding blood vessels.[14]

High circulating free fatty acids have been found to activate sympathetic nervous system and hence increase blood pressure.[15]

Leptin has its effect on appetite. It has been found now that it acts on hypothalamus to increase blood pressure by sympathetic nervous system activation, hence explaining the hypertension causation due to high leptin in obesity.This increase in sympathetic nervous system activation is mediated by ventromedial and dorsomedial hypothalamus.[16]

Low Ghrelin and Adiponectin have also been found as independent risk factors for hypertension. Ghrelin acts in the nucleus of solitary tract to suppress renal sympathetic activity and to decrease arterial pressure.[17]
Renin Angiotensin System of hypertension has shown its involvement in obesity hypertension.[18]

In a meta-analysisof longitudinal studies which were done to track down blood pressure from childhood to adulthood it was found that elevated blood pressure in childhood predicts adult hypertension.[19] Keeping risk factors like obesity in check whose prevention can altogether delay or prevent the onset of hypertension in check is an essential component for good health.

In a study by ShammiLuhar etal a forecast for prevalence of obesity by 2040 in India was studied, by using system of multi-state life tables and it was found that the prevalence of overweight in Indian adults aged 20-69 will be more than double between 2010 and 2040, while the prevalence of obesity will triple . In this case it is more that clear that the plethora of other health issues like hypertension etc will also increase which are associated with obesity.[20]

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CONCLUSION

This study and many more studies are all pointing out to one statement and that is 'prevention is better that cure'. We all need to come together to ensure preventive care by encouraging the younger generation to involve in physical activities like exercise, sports etc, to take a good balanced diet instead of indulging in palatal pleasure by consuming junk food and also learn the art of meditation and yoga. As is said, a stitch in time saves nine. Here what will be saved are our upcoming generations from health issues like obesity, hypertension, cardiovascular events. Our aim should be to wrong these forecasts which are nothing but mathematical and statistical calculations and take strong fruitful steps towards preventing obesity and associated diseases.

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