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ASSOCIATION OF BODY MASS INDEX (BMI) WITH BLOOD PRESSURE IN ADULT FEMALES

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A B S T R A C T

Overweight and Obesity which come under Non-Communicable Diseases (NCDs) as chronic diseases. The relevance of both hypertension and Obesity as important public health challenges is increasing worldwide. In India too there is sharp rise in number of children and adolescents with Obesity. The present study has been conducted among the adult females, a total of 305 sample size with age range of 20 to 70 years in Tirupati town of Tirupati district, Andhra Pradesh. This study is a cross sectional, collected and documented information on Blood Pressure (BP – Systolic and Diastolic), anthropometric indicators (Height, Weight, BMI) besides social and environmental factors using pretested questionnaires were utilized. The overall objective of the present study is to assess the prevalence of hypertension and its association with Anthropometric measures (Body Mass indicators) in a group of adult females.

The outcome of the study reveals adults with higher BMI are at risk in developing high Blood Pressure (BP). Therefore, Weight and Body Mass Index (BMI) are showing strong positive correlation with systolic and Diastolic Blood Pressure levels.

Keywords: Obesity, Blood Pressure, Systolic, Diastolic, Body Mass Index, Hypertension, Correlation, Prevalence, Non-Communicable Diseases (NCDs).

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INTRODUCTION

The World Health Organization (WHO) and other health related National/International organizations hitherto had been focusing on tackling the issues like infection/infectious diseases and under nutrition/malnourishment. However, in the recent past attention has been focused towards the prevention and management of chronic Non-Communicable Diseases such as cardiovascular disease (CVD), Cancer and Diabetes mellitus and Obesity etc., which are also called as Affluent diseases. According to WHO, Non-Communicable Diseases (NCD) are responsible for a significantly increased total number of deaths in the next decade. NCD deaths are projected to increase by 15% globally between 2010 and 2020 (to 44 million deaths). The greatest increases will be in the regions of Africa, South-East Asia and the Eastern Mediterranean, where they will increase by over 20% (WHO). In contrast, in the European region, WHO estimates there will be no increase in NCDs. In the African Region, NCDs will cause around 3.9 million deaths by 2020.

The regions that are projected to have the greatest total number of NCD deaths in 2020 are South-East Asia (10.4 million deaths) and the Western Pacific (12.3 million deaths) (WHO, 2002). Several risk factors are responsible for the causation of NCD's. Of which, Obesity is a serious nutritional problem, as it increases the risk of morbidity from several pathologies, including hypertension, dyslipidemia, type 2 diabetes, coronary heart disease, stroke, non-alcoholic fatty liver disease, osteoarthritis, sleep apnea, and endometrial, breast, prostate, and colon cancers (WHO, 2013).

Overweight and obesity pose a major risk for chronic diseases, which include hypertension, type 2 diabetes, cardiovascular diseases, stroke, musculoskeletal disorders and certain forms of cancer (Tesfaye et al. 2007). Globally, there are more than one billion overweight adults; at least 300 million of them are obese. High Blood Pressure (BP) is estimated to cause 7.1 million deaths, about 13% of the total. About 62% of cardiovascular diseases (CVDs) and 49% of ischemic heart diseases (IHDs) are attributable to suboptimal BP (systolic >115mm Hg). The relevance of both hypertension and obesity, as important public health challenges, is increasing worldwide.

Compared with the year 2000, the number of adults with hypertension is predicted to increase by 60% to a total of 1.56 billion by the year 2025 (Kearney et al. 2005). Frequent exposure to energy dense foods and leisure time physical activity, the number of overweight and obese individual's increases to epidemic proportions (WHO 2002).

Similar observations were noticed with different body mass indicators elsewhere (Reddy et al. 2010). Population studies have clearly identified the role of obesity in developing hypertension, but the degree of association and the mechanism is yet to be elucidated as both the obesity and hypertension of life style mediated conditions.

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Presently in India also there is sharp rise in number of children and adolescents with obesity. Overweight children have a greater chance of becoming overweight adolescents and obese adults compared to children of normal weight (Sorof et al., 2002). The severity of obesity and age of onset affect the likelihood of persistence of obesity into adulthood and thus entrainment of obesity induced morbidities like pre-hypertension and hypertension (Dietz et al., 1999). Numerous health problems are associated with adolescent overweight including hypertension, respiratory disease, several orthopaedic disorders, diabetes mellitus and elevated serum lipid concentrations (Gortmaker et al., 1993). Obese children are also reported to have increased heart rate variability (Riva et al., 2001) and blood pressure variability (Sorof et al., 2002).

DEFINITION AND ASSESSMENT OF OBESITY

The obesity has been defined as a condition of abnormal or excessive fat accumulation in adipose tissue, to the extent that health may be impaired (WHO consultation on obesity, 2000).

Overweight refers to increased body weight in relation to weight, when compared to the same standard of acceptable or desirable weight. Obesity is defined as an excessively high amount of fat or adipose tissue in relation to lean body mass (Stunkard, and Wadden, 1993).

BMI (Body Mass Index) defined as body weight in kilograms divided by the square of height in meters (kg/m2), is used as the measure of obesity. BMI is an accepted measure of obesity in clinical practice, and its use in children has been supported internationally by the International Obesity Task Force (IOTF), which agreed that it provides a reasonable index of adiposity (Barlow and Dietz, 1998) and in that it is a simple and inexpensive measure. It provides reliable estimations, with the exceptions of extremes of age, height, and musculature (Freedman and Sherry, 2009).

In the developed countries, the prevalence of obesity and hypertension is increasing. Various studies are available which demonstrate the burden of these Non- Communicable Diseases (Sorof et al., 2002; Kapil et al., 2002). To prevent Non- Communicable Diseases like obesity, hypertension primordial prevention is very essential. In this context the present study aims to determine the distribution of blood pressure and prevalence of hypertension among adults age >20 years and correlate it (Body Mass indicators) with their anthropometric measurements.

MATERIALS AND METHODS

The present study has been conducted among the adult females, a total of 305 in the age range of 20 to 70 years in Tirupati town of Tirupati district, Andhra Pradesh. The present study is a cross sectional one, to collect and document information on blood pressure, anthropometric indicators, social & environmental factors using pretested questionnaires.

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Figure 1: India Map Showing Andhra Pradesh State

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Figure 2: Andhra Pradesh State Showing Tirupati as The Urban Research Area/ Study

Andhra Pradesh lies between 12°41' and 22°N latitude and 77° and 84°40'E longitude, and is bordered by Maharashtra, Chhattisgarh, Telangana and Orissa in the North, the Bay of Bengal in the East, Tamil Nadu to the South and Karnataka to the West. Among the other states, which are situated on the country's coastal area, Andhra Pradesh has got a coastline of around 972 km, which gives it the 3rd longest coastline in the nation. Two major rivers, the Godavari and the Krishna run across the state. The state includes the eastern part of Deccan plateau as well as a considerable part of the Eastern Ghats. The Tirupati comes under Rayalaseema region. The Tirupati district lies between 13021’54’’ – 14008' northern latitude and between 79005'42’’ and 80004’10’' eastern longitude (Fig.1 & 2).

The objectives of the study have been explained to all the subjects before obtaining their consent to participate in the study. Each subject was personally interviewed to get the data such as his/her name, age, place of birth, health history, smoking and drinking habit, physical activity, level of education and family income.

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Blood Pressure: The arterial blood pressure of each subject has measured by using mercury sphygmomanometer and stethoscope. The sphygmomanometer consists of a cuff, inflation bulb with a control value for pumping air and a measuring scale for measuring mercury level. The stethoscope is used to observe the change of sounds in the brachial artery. The instrument works on the principle that pressure balances the mercury column.

The subject is asked to sit comfortably. The cuff is wrapped round the left upper arm with its lower border about 2.5 cm above the elbow. The pulse of the radial artery is located at the wrist of the subject. Air is pumped into cuff until no pulse sensation is felt. The reading on the scale is noted and the pressure is released completely. Then the diaphragm of the stethoscope is placed over the brachial at the elbow and slowly pressure is given into the cuff. When the pressure in the cuff is more than blood pressure in the artery no blood flow will be there through the artery, so no sound will be observed through the stethoscope. Now the pressure in the cuff is released slowly with a rate of 2 mm Hg/sec. when both pressures equalize there will be a sharp sound in the stethoscope which ensure the flow of the blood in the artery. This is the systolic blood pressure. On further release of pressure in the cuff, when the outer pressure has no effect on the arterial pressure the sound will give the diastolic pressure.

Subjects were identified as hypertensive recommended by the Seventh Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in children and adolescents (Chobanian et al., 2003). Three consecutive readings were taken and mean of these three were taken as final reading. The values were expressed as mmHg. Adolescents with raised blood pressure (Average systolic and/or diastolic blood pressure >95th percentile for gender and age) was considered as hypertension. The instruments were calibrated prior to their use.

The anthropometric measurements like height (m) and weight (kg), have recorded following the Lohman et al., (1988). The detailed procedures are given below.

Height (Stature): The height was measured in meters using an anthropometer. The subject has been made to stand on a horizontal platform with the heels together, stretching upward to the fullest extent, aided by the measures on the mastoid processes and by encouraging the subject to 'stand tall, take a deep breath and relax '. The subject’s back is seen as straight as possible with the head in Frankfort horizontal (F.H) plane while taking the measurement, which was achieved by rounding or relaxing the shoulders and manipulating the posture. The subject's heels have watched to make sure that they did not leave the ground.

Body Weight: The weight has been recorded in kilograms with the subject standing bear - foot and with minimum clothing on a weighing machine without any support.

By using above anthropometric measurements, Body Mass Index (BMI = weight (kg)/ height (m2) is calculated as per Tanphaichitr et al., (1990).

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Statistical analysis: Statistical package for social sciences (SPSS, 16.0) is used for analysis. Analysis includes the computation of descriptive statistics and Pearson's correlation co-efficient.

RESULTS

Descriptive statistics for the anthropometry and blood pressure in the study population are presented in Table 1 & Fig. 3. The mean values for age are 26.97, Height is 167.20, weight is 62.56, BMI is 22.39, SBP is 122.95, and DBP is 71.68.

Table 1: Descriptive Statistics for The Anthropometry and Blood Pressure in The Study Population

Variables	Mean ± S. D
Age	25.20±7.70
Height	154.69±5.27
Weight	52.25±10.42
BMI	21.85±4.30
SBP (Systolic Blood Pressure)	110.24±11.45
DBP (Diastolic Blood Pressure)	67.88±8.66

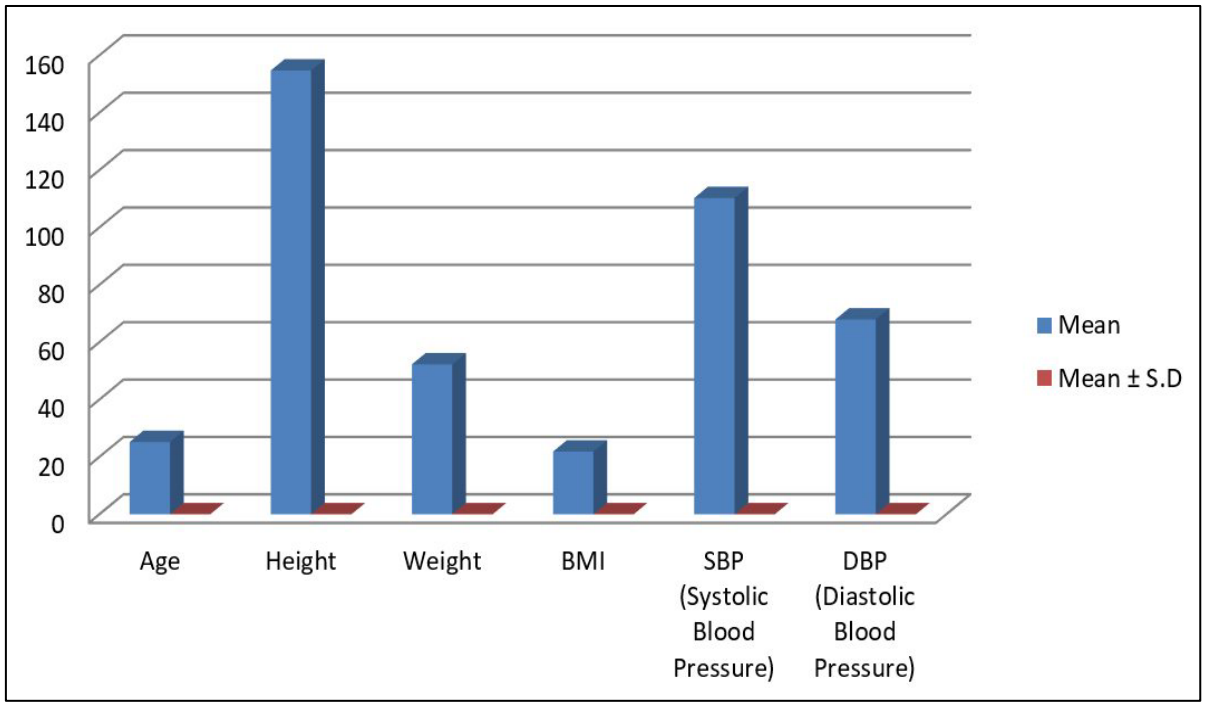

Figure 3: Descriptive Statistics for The Anthropometry and Blood Pressure in The Study Population

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The descriptive statistics for age, different anthropometric and blood pressure among the females is presented in Table 2 & Fig.4. Greater mean values have been observed for Age, Weight, BMI, and DBP for all age groups except Height and SBP. Significant values are observed for Age, weight, BMI, and DBP for all age groups except Height.

Table 2: Descriptive Statistics for The Anthropometry and Blood Pressure in The Study Population Age Group Wise

Variables	Age Group 20-24		Age Group 25-29		30 Years and Above		F	Sig
	N	Mean ± S. D	N	Mean ± S. D	N	Mean ± S. D		
Age	237	21.87±1.06	21	26.86±1.46	47	41.23±7.98	689.23	.000
Height	237	154.92±5.33	21	154.47±4.86	47	153.62±5.15	1.20	.302
Weight	237	49.43±8.61	21	57.30±7.60	47	64.21±10.68	57.73	.000
BMI	237	20.60±3.51	21	24.04±3.29	47	27.15±3.93	70.57	.000
SBP	237	108.87±10.31	21	108.14±9.39	47	18.06±14.43	14.13	.000
DBP	237	66.83±7.98	21	70.81±9.55	47	71.83±10.20	8.19	.000

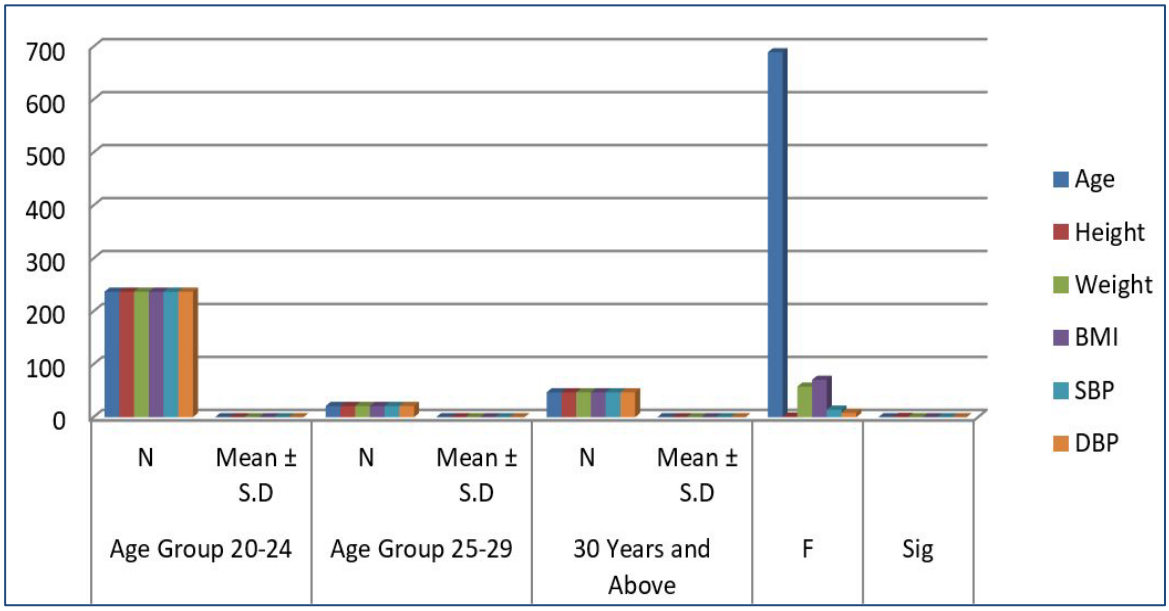

Figure 4: Descriptive Statistics for The Anthropometry and Blood Pressure In The Study Population Age Group Wise

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Prevalence of hypertension among the study population is presented in the Table 3 & Fig. 5. The subjects have been stratified according to the age groups of 20-24, 25-29 and ≥ 30 and above. The prevalence of hypertension is high in the 30 years and above age group (57.1%) and followed by 20-24 years age group (28.6%) and 25-29 years age group (14.3%).

Table 3: Prevalence Of Hypertension Among the Study Population

Age Group	Hypertension				Total	
	Normal		Risk			
	N	%	N	%	N	%
Age Group 20-24	235	78.9	2	28.6	237	77.7
Age Group 25-29	20	6.7	1	14.3	21	6.9
30 Years and Above	43	14.4	4	57.1	47	15.4
Total	298	100.0	7	100.0	305	100.0

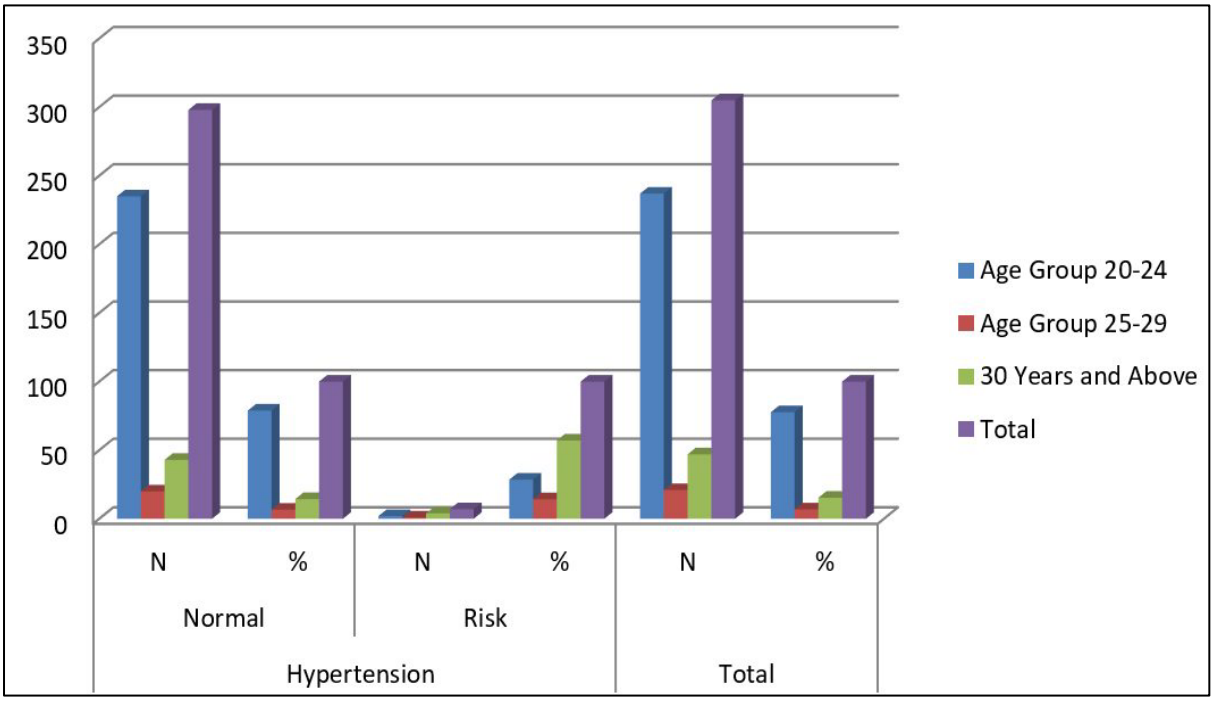

Figure 5: Prevalence Of Hypertension Among the Study Population

Table 4 & Fig.6. shows the Pearson's correlation coefficients between, Age, body composition measures and blood pressure among adult females. Age has positive association with Height, Weight, BMI, SBP and DBP, Height has positive association with weight, BMI. Weight has positive association with BMI, SBP and DBP, BMI has positive association with SBP and DBP, and SBP has positive association with DBP.

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Table 4: Pearson's Correlation Coefficients Between, Age, Body Composition Measures and Blood Pressure Among Adult Females

Variable	Age	Height	Weight	BMI	WC	HC	WHR	SBP	DBP
Age	-	-0.082	0.504**	0.543**	0.621**	0.550**	0.377**	0.359**	0.287**
Height	-0.082	-	0.225**	-0.123*	-0.032	0.099	-0.206**	0.013	0.083
Weight	0.504**	0.225**	-	0.937**	0.865**	0.899**	0.361**	0.377**	0.380**
BMI	0.543**	-0.123*	0.937**	-	0.892**	0.883**	0.436**	0.380**	0.361**
SBP	0.359**	0.013	0.377**	0.380**	0.379**	0.342**	0.232**	-	0.667**
DBP	0.287**	0.083	0.380**	0.361**	0.357**	0.339**	0.194**	0.667**	

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

* Correlation is significant at the 0.05 level (1-tailed)

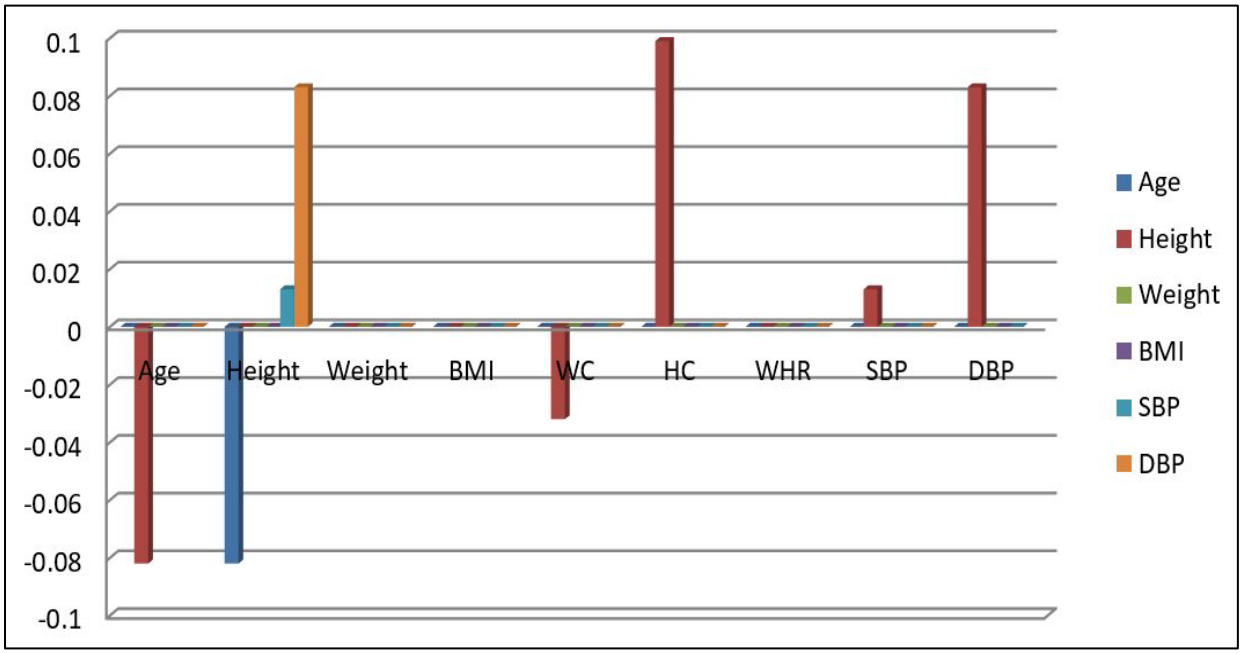

Figure 6: Pearson's Correlation Coefficients Between Age, Body Composition Measures and Blood Pressure Among Adult Females

DISCUSSION

The overall objective of the present study is to assess the prevalence of hypertension and its association with Anthropometric measures (Body mass indicators) in a group of adult females. Adult hypertension is an emerging epidemic in India and the complications of hypertension like stroke, retinopathy, and coronary artery disease (CAD).

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Adults with higher Body Mass Index (BMI) are at risk in developing high Blood Pressure (BP). Weight and Body Mass Index are showing strong positive correlation with Systolic and Diastolic Blood Pressure levels. Several prospective studies exhibited similar association between Weight gain and Blood Pressure (Kumar et al., 2012). The strong underlying association between Obesity and elevated Blood Pressure may corroborate that increasing prevalence of Obesity may likely elevates the Blood Pressure levels as supported by our data (Flynn, 2008). Blood Pressure elevation may lead to increased risk of end-organ damage such as Ventricular Hypertrophy and increased Carotid Intima-media thickness and risk of hypertension in adulthood (Markus et al., 2010; Miyaki et al., 2013).

The world epidemic of overweight and Obesity is well documented and shows no sign of diminishing (WHO, 2014). However, although rates are unacceptably high, there is recent evidence of a plateau effect in some high-income countries including the U.S (United States) (Ogden et al., 2010), Sweden (Lissner et al., 2011). Comparable data from Low- and middle-income countries are few, but a recent meta-analysis from China reports that the prevalence of overweight and Obesity increased from 1.8% in 1981–1985 to 13.1% in 2006–2010, (Yu et al., 2019) and studies from India show increases in Obesity from 9.8% to 11.7% during 2006–2009 (Gupta et al., 2012) with no sign of the flattening seen in high-income countries.

The evidence of the effect of obesity on blood pressure is contradictory and, despite strong evidence that BMI levels are positively associated with both Systolic and Diastolic Blood Pressure, there is some evidence from high-income countries that hypertension has not increased in parallel with Obesity, although this has not been reported in Low- and Middle-income countries (Din-Dzietham et al., 2007; Dong et al., 2013). The association between adult Obesity and hypertension is likely to have major impact on subsequent adult health, which in turn will have serious economic and health care implications (Sun et al., 2007; Park et al., 2012).

The association between Obesity and hypertension has been reported in numerous studies among a variety of ethnic and racial groups, with virtually all studies finding higher Blood Pressures and/or higher prevalence of hypertension in Obese compared with lean (Sorof et al., 2002). The most comprehensive study by Rosner et al. (2000) pooled data from 8 large US epidemiological studies described the Blood Pressure differences between black and whites in relation to body size. Irrespective of race, gender, or age, the risk of elevated Blood Pressure was significantly higher in the upper compared with the lower decile of BMI, with an odds ratio of Systolic hypertension ranging from 2.5 to 3.7 respectively. Freedman et al. (1999) reported that overweight adults in the Bogalusa Heart Study were 4.5 and 2.4 times as likely to have elevated Systolic Blood Pressure and Diastolic Blood Pressure. Sorof et al., (2002) reported a three times greater prevalence of hypertension in Obese compared with non-obese adults.

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The link between Obesity and hypertension may be mediated in part by Sympathetic Nervous System (SNS) hyperactivity. This state of hyperactivity may include Cardiovascular manifestations such as increased heart rate and Blood Pressure variability, neuro-humeral manifestations such as increased levels of plasma catecholamines, and neural manifestations such as increased peripheral sympathetic nerve traffic. Consistent with the SNS hyperactivity hypothesis, the Bogalusa Heart Study reported that, in a biracial group of children, resting heart rate was positively correlated with Blood Pressure and subscapular skinfold thickness (Voors et al., 1982) and a hyperdynamic cardiovascular state was positively associated with several measures of Obesity (Jiang et al.,2014).

In conclusion, Body Mass Index is the predominant risk factor in the elevation of adults Blood Pressure levels. The findings of the study strongly advocate the need to implement interventional measures for preventing adult's high Blood Pressure.

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