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A Study of Clinico-Demographic Associates and Anthropometric Predictor of Hypertension in Urban Central India

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ABSTRACT

Objectives: The present study of hypertension and its association with demographic variables, physical activity, family history, co-morbidities namely diabetes mellitus and stroke, was conducted utilizing most appropriate methods of survey and analysis as per the scientific requirement for the study. **Methodology:** Community Based- Cross-Sectional survey in urban agglomeration of a central Indian city conducted for the period of 1 year. The adult population (20 years and above) who were residing under the premises of Municipal Corporation was considered as Target Population. Multistage Cluster sampling method supplemented by PPS (Probability Proportion to Size) sampling. The final sample calculated was size = 1350; 30 person per cluster in a total of 45 clusters. **Results:** The mean age of study participants was 43.8 (42.8-44.8 at 95% CI) years and mean age of Hypertensive participants was 53.9 (52.6-55.3) years at 95% CI. 11.04% (9.47-12.82 at 95% CI) of study participants were suffering from Diabetes Mellitus and proportion of person with stroke and hypertension as co-morbidity at 5.48% (3.97-7.51 at 95% CI). **Conclusions:** Multivariate analysis using Logistic Regression; Age, Family history, Physical Activity, Diabetes and stroke as they were the significant variable from the uni-variate analysis associate in the hypertension.

Key-words: Hypertension, Anthropometric predictor, co-morbidity, Urban, Demographic variables, India.

INTRODUCTION

I feel my head throbbing when I wake up in the morning; sometimes I feel my heart running race with my breath. The above words represent one of the way by which a patient may describes suffering from hypertension. However, there are evidences that elevated blood pressure produces structural changes causing damage to the arteries that supply blood to the brain, heart, kidneys and other organ without any warning symptoms! [1].

Though there are no unchallenged perspectives; clinical or epidemiological which defines Hypertension at a given level of blood pressure. Still there is some degree of accord among professional communities about continuous, incremental risk of cardiovascular disease, stroke, and renal disease across levels of both systolic and diastolic blood pressure [2].

Worldwide prevalence estimates for hypertension may be as much as 1 billion individuals. The World Health Organization reports that Systolic Blood Pressure (SBP) >115 mmHg is responsible for 62 percent of cerebrovascular disease and 49 percent of ischemic heart disease (IHD), with little variation by sex [3].

Prevalence in developing countries is almost found to be similar to developed societies ranging from 10 percent to as much as 20 percent among adults [4].

A number of studies have been conducted on prevalence of hypertension in India. These studies have been carried out in different geographic areas and in urban as well as rural area populations. Many of these studies have used the criterion for hypertension as systolic BP > 140 mm Hg and / or diastolic BP > 90 mmHg, shown a high prevalence of hypertension among urban adults ranging from 20 to 40% approximately [5].

Hypertension usually occurs in conjunction with other metabolically linked risk factors. The risks of cardiovascular disorders are proportional to the levels of BP for any age or either sex. The metabolically linked disorders are the key factor causing mortality which may be attributed to the hypertension.

Among the metabolic linked disorders, the growing prevalence of obesity is increasingly recognized as one of the most important risk factors for the development of hypertension. Obesity and in particular central obesity have been consistently associated with hypertension and increased cardiovascular risk. The risk of hypertension is 5 times higher in the obese as compared to non-obese person. Obesity attributes >85% to all hypertension cases [6, 7].

There is a scope to learn and apply about hypertension and its association with demographic variables, physical activity, family history, co morbidities namely diabetes mellitus and stroke. The present study with this rational was conducted

utilizing most appropriate methods of survey and analysis as per the scientific requirement for the study.

METHODS

Present study was a Community Based- Cross-Sectional survey in urban agglomeration of a central Indian city in which wards were labeled as delineated clusters. Study was undertaken from the month of November 2012 to the month of October 2013 for a period of 1 year. The adult population (20 years and above) who were residing under the premises of Municipal Corporation was considered as Target Population. Further the informed consent was obtained from sampled population. Also, Participants with known secondary hypertension, pregnancy, ascites and severely debilitated as of unable to be interviewed e.g.: profound dementia etc. were excluded from study.

Sampling Method: Multistage Cluster sampling method involving following stages was used. This sample strategy was supplemented by PPS (Probability Proportion to Size): [8]

Stage I: The 66 wards of Municipal Corporation were considered as primary sampling units (PSUs) out of which 45 clusters were selected randomly using the simple random sampling by random number tables. In Stage II In each of the selected clusters, households were randomly selected using a random strategy- First household was selected randomly as given by WHO EPI recommendation [9]- some central point in the community, the market in the case of this study, was chosen. A random direction is chosen from the chosen central point, the number of household are counted from that point to the edge of the area and one household is chosen at random from that as starting point of survey then every 5th house hold is chosen. In continuation of Stage III: All the Eligible persons of the households were selected till the desired sample size is reached.

PPS sampling: The relevance to include PPS in the study is embedded in its two stage methods:-

In First stage: Selected larger clusters have bigger probability of being sampled. In Second stage: Sampling exactly the same number of individuals per cluster -individuals in large clusters have smaller probability of being sampled than Overall Second stage compensates first stage, so that each individual in the population has the same probability of being sampled.

Steps in applying Probability Proportional to Size (PPS): A List of primary sampling units (all 66 wards of Municipal Corporation) and their population sizes was prepared, and cumulative sum of the population sizes was also calculated, the final sample calculated was size = 1350; 30 person per cluster in a total of 45 clusters.

Survey Performa and its elements:-

A semi-structured questionnaire was prepared while taking account of Clinico-demograph ic Variables namely age and sex, Family History of Hypertension, Physical Activity, Co-morbidities namely Diabetes Mellitus and CVA was prepared. Also Anthrometric Indicators viz Body Mass Index (BMI), Waist Circumference (WC) and Hip circumference, were also measured and recorded. After the informed consent from each individual, using the preformed semi-structured perform, A pilot study was carried out and necessary corrections had been made.

Ethical Approval: The study protocol was approved by the Institutional Ethical Committee (IEC) of Gandhi Medical College and associate Hospital, Bhopal, MP, India. Informed consent was taken from each individual study subject and ensuring that this information will use only in research purposes.

Methods of Statistical Analysis:-

For Uni-variate analysis, Chi (χ^2) square test with Yates correction was used, P value with <0.05 was considered as significant. For Multivariate analysis, Logistic Regression Model constructed using significant variables from uni-variate analysis. Wald Chi square, standard error of mean and odd ratios was determined using this model. A value of <0.05 for P was considered significant.

Receiver operating Characteristic (ROC) curve:

Sensitivity, specificity, positive/negative predictive value and likelihood ratio for each measurement tools (BMI/WC/WHR) were separately calculated for male and female. ROC curves for each tool were drawn to check the discriminating capacity among diseased and non diseased assuming measures as continuous variable. This study examines the performance of tools over a range of decision levels through D'long-D'long non-parametric.

RESULTS

Table-1.Measures of performance of hypertension associated factors with associated morbidity factors under study.

Characters/ Variables	Research subject No. (%) N=1350	No.(%) with associate Morbidities in hypertension N=657	P valve
Age group in years			<0.0001
20-29	407(30.15)	51(7.63)	
30-39	310(22.96)	126(19.18)	
40-49	153(11.33)	82(12.48)	
50 and above	480(35.56)	398(60.58)	
Gender			0.6891
Male	688(50.96)	339(51.6)	
Female	662(49.04)	318(48.4)	
Family History			0.0077
Present	180(25.97)	215(32.72)	
Absent	513(74.03)	442(67.28)	
Level of Physical activity			0.0001
Sedentary	241(34.8)	271(41.2%)	
Moderate	252(36.4)	312(47.5)	
Heavy	200(28.9)	74(11.3)	
Diabetes Mellitus			<0.0001
Present	05(0.72)	144(21.9)	
Absent	688(99.28)	513(78.1)	
Stroke			<0.0001
Present	02(0.29)	36(5.48)	
Absent	691(99.71)	621(94.52)	

Uni-variate Analysis: The findings are summarized in the Table-3. The results thus obtained provides basis for eligibility to multivariate analysis. The various observation pertaining to the associated variables in this analysis are given below:-

The mean age of study participants was 43.8 (42.8-44.8 at 95% CI) years. The maximum numbers of participants contributing to study belong to the age group 50 years and above (35.56%) followed by 20-29 year age group (30.15%). On further segregation, the occurrence of hypertension was mostly in 50 year and above age group (60.58%) followed by 30-39 year age group (19.18%). The mean age of Hypertensive participants was 53.9 (52.6-55.3) years at 95% CI. (Table-1)

Out of total, 50.96 %(48.3-53.6 at 95% CI) of study participants were male against 49.04 %(46.4-51.7 at 95% CI) Female. On further segregation, the occurrence of hypertensive in male was more i.e. 51.6 %(47.8-55.4 at 95%CI) as compared to female i.e. 48.4 %(44.6-52.2 at 95% CI). 26% (26.89-31.74) of total participants were having a family history of hypertension. Out of total 657 hypertensive 32.72 % (29.24-36.41) at 95% CI, have family history of hypertension. (Table-1)

Out of the total 657 hypertensive patients only 11.3% (9.48-13.42) at 95% CI, were having heavy level of physical activity against 28.9% (26.17-31.79) at 95% CI, among the non-

hypertensive population. The percentage of person with sedentary level of physical activity among hypertensive participants was 41.2% (38.19-44.28) at 95% CI, compared to 34.8 %(31.91-37.81) at 95% CI, among non-hypertensive participants. The less percentage of people with heavy level of physical activity among hypertensive compared to non-hypertensive is most noticeable finding. (Table-1)

Out of total, 11.04% (9.47-12.82 at 95% CI) of study participants were suffering from Diabetes Mellitus. 21.9% (18.92-25.24 at 95%CI), among hypertensive individual were also having Diabetes mellitus as co-morbidity. The percentage of person without hypertension having diabetes was only 0.72 (0.262-1.73) at 95%CI.

A total of 2.8% (2.05-3.85) at 95%CI, of stroke affected person were among the studied population. The most noticeable finding was the proportion of person with stroke and hypertension as co-morbidity at 5.48% (3.97-7.51 at 95% CI). (Table-1)

Multivariate Analysis: Following Variables were used for multivariate analysis using Logistic Regression: Age, Family history, Physical Activity, Diabetes and stroke as they were the significant variable from the uni-variate analysis. Sex was not used for multivariate as it didn't turn out to be statistically significant in uni-variate analysis (P value =0.6891). The Overall Performance of Multivariate Regression model is shown in Table 2a with explanatory notes following it.

Table.2a: Overall Performance of the Regression Model in term of gain in predicting hypertension.

Predictor Variables	I (predictor coefficient)	S.E	Wald Chi-square	P value	ODD Ratios
Age	-0.077	0.005	227.330(df=1)	0	.926(.908-.941)
Fam_Hist	0.991	0.158	39.600(df=1)	0	2.694(2.59-2.79)
Phy_Activit			40.507(df=2)	0	
Phy_activit_1@	0.562	0.229	6.038(df=1)	0.014	1.754(1.67-1.84)
Phy_activit_2#	-0.538	0.188	8.169(df=1)	0.004	0.584(0.538-0.633)
Diab_mellit	2.499	0.427	27.998(df=1)	0	12.164(11.495-12.863
Stroke	2.143	0.757	8.016(df=1)	0.005	8.525(8.346-8.710)
Constant	-1.746	0.937	3.475(df=1)	0.062	0.174(0.149-0.202)

Table.2b: Predictors with their relative contribution in models with statistical certainty & odd ratios

Predictor Variables	I (predictor coefficient)	S.E	Wald Chi-square	P value	ODD Ratios
Age	-0.077	0.005	227.330(df=1)	0	.926(.908-.941)
Fam_Hist	0.991	0.158	39.600(df=1)	0	2.694(2.59-2.79)
Phy_Activit			40.507(df=2)	0	
Phy_activit_1@	0.562	0.229	6.038(df=1)	0.014	1.754(1.67-1.84)
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@ Phy_activit_1 represents difference between Level 1 and 3 of physical activity (i.e. sedentary and heavy) #Phy_activit_2 represents difference between Level 2 and 3 of physical activity (i.e. moderate and heavy)

The Step 0, or the null model, includes no predictors and just the intercept, in the model summary. The "Observed in the study population" indicates the number of present and absent that are observed in the dependent variable. i.e. hypertension. This model predicts all the cases are 0 on dependent variable and the overall Percentage gives the percent of cases for which the dependent variables was correctly predicted given the model.

In Step1 model, The "Observed in the study population" indicates the number of present and absent that are observed in the dependent variable. i.e. Hypertension. This model predicts the values of the dependent variable i.e. Hypertension based on the full logistic regression model. 484 cases are observed to be hypertensive and are correctly predicted to be hypertensive; 544 cases are observed to be normotensive and are correctly predicted to be normotensive and 173 cases are observed to be hypertensive but are predicted to be normotensive; 149 cases are observed to be normotensive but are predicted to be hypertensive).

The overall percent of cases that are correctly predicted by the model percentage has increased from 51.3 for the null model to 76.1 for the full model.

The Analytical finding and results of Multivariate Regression Model are summarizing in Table 2b with formulation of Predictor Equation based on findings of analysis.

The Predictor Coefficients (I) are the values for the logistic regression equation for predicting the dependent variable (hypertension in this study) from the independent variable (all significant variables listed above). They are in log-odds units. S.E, the standard errors associated with the coefficients. The standard error is used for testing whether the parameter is significantly different from 0 and to form a confidence interval for the parameter. Constant-This is the expected value of the log-odds of proportion of hypertension when all of the predictor variables equal zero.

Regression Model or Predictor Equation for Hypertension is:-

$$\text{Log}(p/1-p) = \text{Constant} + I_{age} + I_{Fam\_Hist} + I_{Phy\_activit\_1} + I_{Phy\_activit\_2} + I_{diabet\_mellit} + I_{stroke}$$

Where, p is the probability of having hypertension. Expressed in terms of the variables used in this Logistic Regression model:-

$$\text{Log}(p/1-p) = -1.746 + (-0.077) + 0.991 + 0.562 + (-0.538) + 2.499 + 2.143$$

These estimates tell the amount of increase (or decrease, if the sign of the coefficient is negative) in the predicted log odds of hypertension= 1 that would be predicted by a 1 unit increase (or decrease) in the predictor, holding all other predictors constant.

C. ROC Curves: There were 688 males and 682 females in the study out of which 339 males and 328 females were hypertensive (sample prevalence=48.7%). The demographic and anthropometric characteristics of studied normotensive and hypertensive population are shown in the table.3a.

Table .3a: Demographic and Anthropometric Characteristics of Population under study

Sex	Disease Status	Age(Years)	Mean BMI(kg/m2)	Mean WC (In c.m.)	Mean WHR
Male	Hypertensive(339)	50.18(±17.85)	23.04(±4.41)	89.12(±8.64)	0.952(±0.065)
-688	Normotensive(349)	39.40(±16.81)	20.60(±1.92)	87.19(±6.89)	0.953(±0.056)
Female	Hypertensive(318)	57.04(±16.84)	30.17(±7.06)	100.14(±13.90)	0.916(±0.053)
-682	Normotensive(344)	29.03(±7.55)	24.96(±3.80)	86.27(±8.02)	0.884(±0.052)

Table.3b: Validity and Predictive Accuracy of Body Mass Index, Waist Circumference and Waist Hip Ratio to predict Hypertension

Sex	Obesity Measurement Tool	Sensitivity	Specificity	Predictive Value		Likelihood Ratio	
				Positive	Negative	Positive	Negative
Male	Body Mass Index	0.954(0.927-0.974)	0.357(0.306-0.410)	0.883(0.817-0.932)	0.604(0.562-0.645)	7.79(4.7-12.8)	0.67(0.6-0.7)
	Waist Circumference	0.472 (0.418-0.527)	0.553 (0.499-0.606)	0.506 (0.450-0.563)	0.519 (0.467-0.571)	1.06(0.9-1.2)	0.95(0.8-1.1)
	Waist-Hip Ratio	0.829 (0.785-0.867)	0.198 (0.157-0.243)	0.501 (0.459-0.543)	0.543 (0.452-0.632)	1.03(1.0-1.1)	0.87(0.6-1.2)
Female	Body Mass Index	0.695 (0.641-0.745)	0.611 (0.557-0.662)	0.623(0.570-0.673)	0.684(0.629-0.736)	1.78(1.5-2.1)	0.5(0.4-0.6)
	Waist Circumference	1 (0.988-1.000)	0.258 (0.213-0.308)	0.555 (0.515-0.596)	1 (0.959-1.000)	1.35(1.3-1.4)	0
	Waist-Hip Ratio	0.893 (0.854-0.925)	0.256 (0.211-0.305)	0.526 (0.483-0.569)	0.721 (0.633-0.799)	1.2(1.1-1.3)	0.42(0.3-0.6)

WC-Waist Circumference, WHR- Waist –Hip Ratio

The table.3b shows performance of the studied obesity measures to envisage hypertension. BMI was detected most sensitive obesity measures tool allied with hypertension in males, but less specific than Waist Circumference. (Fig.1a) Waist circumference was detected most sensitive obesity measures tool allied with hypertension in females but less specific than BMI.(Fig.1b) Positive predictive value (PPV) was highest for BMI in both sexes and Negative Predictive Value (NPV) was highest for WC in Female, though in male it was BMI which has the highest NPV.

Fig.1a: ***Receiver-operating characteristic*** (***ROC***) plots for Obesity Measures in Males Showing the trade-off trend between sensitivity and specificity for alternative tests (WC/BMI/WHR) for male sex.

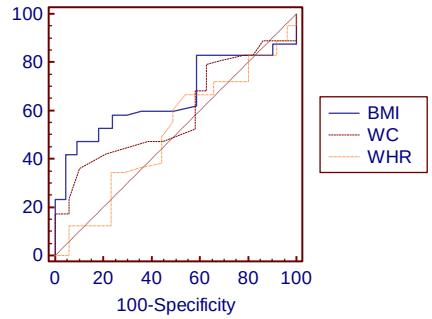
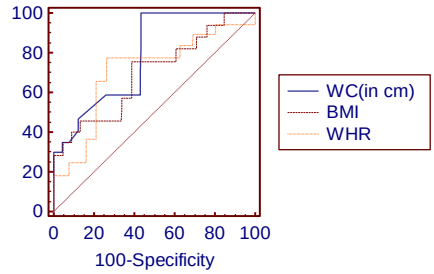


Fig.1b: ***Receiver-operating characteristic*** (***ROC***) plots for Obesity Measures in Females.: Showing the trade-off trend between sensitivity and specificity for alternative tests (WC/BMI/WHR) for female sex.



The results of the paired comparisons for Area under Curve for WC/BMI/WHR are as shown in Table6. BMI occupied the maximum Area under Curve (AUC) in male sex while, Waist circumference occupied the maximum Area under Curve (AUC) in female sex. The paired comparison difference was significantly higher for Waist circumference with other two studied variable in female and all pair comparison difference were significant in male. The paired comparison difference was not significant for WHR and BMI in female.

DISCUSSION:-

The current study with its community based survey approach followed by rigourous analysis sought to answer various impending questions woven around Hypertension and its clinico-metabolic milieu. Further it derives the benefits from studies and evidences already generated indicating obesity as greatest associate to such an extent that the anthrometric tools for measuring it leading to prediction of the hypertension itself.

The findings indicated that out of total number of hypertensive patients 82.9% were above 50 years indicating a clear predilection of increasing age as a major risk factor for hypertension. Generally the risk increases in stages as the person gets older. The reasons include hardening, less activity & elasticity of arteries which interferes with the circulation & hence alters the peripheral resistance. The advancing age has also found to be associated with decreasing kidney functions, more sensitivity of body towards salt & hormonal changes such as menopause in females [10].

Table 4: Paired Comparisons of Area under Curve (AUC) for Body Mass Index, Waist Circumference and Waist-Hip Ratio

Sex	Obesity Measurement Tool	Area Under Curve(AUC)	D'long-D'long Paired Comparison		
			Contrast	Difference in curve area	p-value
Male	Body Mass Index	0.657±0.0218(0.621-0.693)	WC Vs BMI	0.0705±0.0151(0.0408-0.100)	<0.0001
	Waist Circumference	0.587±0.0222(0.549-0.624)	WC vs WHR	0.0794±0.0184(0.0433-0.116)	<0.0001
	Waist-Hip Ratio	0.507±0.0223(0.469-0.545)	WHR vs BMI	0.150±0.0221(0.107-0.193)	<0.0001
Female	Body Mass Index	0.696±0.0203(0.659-0.731)	WC Vs BMI	0.0880±0.0178(0.0530-0.123)	<0.0001
	Waist Circumference	0.784±0.0175(0.750-0.814)	WC vs WHR	0.0752±0.0210(0.0340- 0.116)	0.0003
	Waist-Hip Ratio	0.708±0.0209(0.672-0.743)	WHR vs BMI	0.0128±0.0298(-0.0454- 0.071)	0.6669

This study also revealed that 49.2% (46.11-52.30) of males have hypertension while the females with hypertension were 48.04(44.92-51.10). The association of hypertension with sex was found to be insignificant.

Men are at greater risk of developing Hypertension than the age-matched, premenopausal women. After menopause, however, BP increases in women to levels even higher than in men suggesting that ovarian hormones may modulate blood pressure [11, 12] this variation may account for the resultant insignificance.

As for association with family history; the study finds that out of total hypertensive, 32.72 % (29.24-36.41) have family history of hypertension & thus the association between hypertension and Family History is considered to be very statistically significant. Family history of hypertension would be related to the increased renal proximal sodium re-absorption, impaired arterial compliance & a positive relationship of norepinephrine, insulin resistance and lipids to family history of hypertension, these mechanisms could explain the higher prevalence of hypertension in the off springs of hypertensive parents [13, 14,15].

Hypertension and physical activity were found to be inversely related in the finding of analysis.
Out of total; 11.3 %(9.48-13.42) were having heavy level of physical activity against 28.9% (26.17-31.79), among the non-hypertensive population. Conversely, the percentage of person with sedentary level of physical activity among hypertensive participants was 41.2% (38.19-44.28) compared to 34.8 %(31.91-37.81), among non-hypertensive participants. The less percentage of people with heavy level of physical activity among hypertensive compared to non-hypertensive is most noticeable finding.
A regular exercising individual i.e. a physically active individual is at a lower risk of developing hypertension as compared to an individual with a sedentary life style. Daily exercise is a remedy or preventive measure for cardiovascular problems. By increasing blood flow and promoting cardiovascular efficiency, exercise provides benefits to the entire circulatory system.

Regular exercise trains the heart to respond quickly and efficiently to external physical stresses. Additionally, regular physical activity can modestly lower blood pressure by reducing total peripheral resistance & it would also help to curb the growing menace of obesity and co morbidities of metabolic syndrome including Hypertension [16, 17].

The findings showed that total 11.04% (9.47-12.82) of total study participants were suffering from Diabetes Mellitus. 21.9% (18.92-25.24) among hypertensive individual were also having Diabetes mellitus as co-morbidity. The percentage of person without hypertension having diabetes was only 0.72 (0.262-1.73) this represents a strong association of both the conditions as a twin epidemic.

It has been found that Diabetes and Hypertension share common pathways such as Sympathetic Nervous System, Renin Angiotensinogen Aldosteron System, oxidative stress, adipokines, insulin resistance and Peroxisome Proliferator Activated Receptors. These pathways interact and influence each other and may even cause a vicious cycle. Hypertension and diabetes are both end results of the metabolic syndrome. They may, therefore, develop one after the other in the same individual. Another possible mechanism may be related with diabetic nephropathy as it increases the total amount of fluid in the body, which tends to raise blood pressure. Diabetes can also decrease the ability of the blood vessels to stretch, increasing average blood pressure [18, 19].

The related findings showed a total of 2.8% (2.05-3.85), of stroke affected person were among the studied population. The most noticeable finding was the proportion of persons with stroke and hypertension as co-morbidity that was found to be 5.48% (3.97-7.51) the pathological effects of Hypertension on blood vessels increases risk for both ischemic as well as hemorrhagic stroke. A high intra-luminal pressure will lead to extensive alteration in endothelium and smooth muscle function in intra-cerebral arteries. The increased stress on the endothelium can increase permeability over the blood–brain barrier and local or multifocal brain edema. Endothelial damage and altered blood cell–endothelium interaction can lead to local thrombi formation and ischaemic lesions. Fibrinoid necrosis can cause lacunar infarcts through focal stenosis and occlusions. Degenerative changes in smooth muscle cells and endothelium predisposes for intracerebral haemorrhages. Furthermore, hypertension accelerates the arteriosclerotic process, thus increasing the likelihood for cerebral lesions related to stenosis and embolism originating from large extracranial vessels, the aortic arch and from the heart [20].

In Multivariate Analysis of Significant Variables using Logistic Regression it was concluded in a nutshell that the Diabetes mellitus is most significant predictor of hypertension followed by stroke (CVD) and Family history respectively.

Waist circumference was found to be better predictor of hypertension in female owing to more abdominal obesity with less stature, while BMI was found to be better predictor in studied male participants owing to less visceral fat and larger stature compared to female counter part.

BMI values are age-independent and the same for both sexes. However, BMI may not correspond to the same degree of fatness in different populations due, in part, to different body proportions. The health risks associated with increasing BMI are continuous and the interpretation of BMI grading in relation to risk may differ for different populations.

The current study aimed at detecting the association of hypertension with certain variables also finds as byproduct that the prevalence of hypertension in the urban agglomeration of central India is alarmingly high (48.7%). A comprehensive strategy to prevent the complications associated with Hypertension making provision for both early identification & effective management of individuals with hypertension as well as prevention of hypertension by measures aimed at reducing the BP levels in the population as a whole is required. Research into the genetic basis of hypertension should be encouraged as the information gained from specific genes and positional cloning may identify new genetic polymorphisms that possibly influence blood levels, cardiovascular risk and response to therapy. The findings of this research have the potential to improve the quality and methods of decision-making in the prevention of hypertension and be harnessed to assist the health professional to control hypertension and associated risk factors in patients and population. Lifestyle measures to reduce obesity, increasing physical activity should be instituted in all patients ranging from normotensive to moderate and severe hypertensive.

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