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Metabolic Profile and Body Fat Distribution in Diabetic Hypertensives and Normotensives

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ABSTRACT The aim of the present study is to assess the metabolic profile and body fat distribution in diabetic hypertensives and normotensives. Information on subject's demographics, life styles, disease history, anthropometry, blood pressure, blood glucose and lipids were assessed among 91 hypertensives and 179 normotensives. In the present sample, overweight and obesity recorded to an extent of 80 percent in hypertensives and 68 percent in normotensives. Hypertensives possess higher levels of blood pressure, pulse rate, fasting and post prandial blood sugar and triglycerides. Thirty- eight percent of the variance in SBP and thirty- six percent of the variance in DBP levels were explained by independent variables like age, body mass index and post prandial blood sugar. The ODD's of hypertension were: obesity, 2.83; 95% CI: 1.29-6.19, fasting blood glucose, 5.78; 95% CI: 1.96-17.09, Post prandial blood glucose, 5.11; 95% CI: 1.14-22.85, triglycerides, 5.73; 95% CI: 2.22-14.83. In conclusion the results indicate that age, body mass index and post prandial blood sugar levels are significant risk factors in developing hypertension. Hence preventive strategies warranted towards the management of hypertension.

INTRODUCTION

Hypertension is a metabolic disorder and its prevalence is an important global health problem (King et al. 1998). Hypertension is the commonest risk factor affecting 20% adult population worldwide leading to the development of cardiovascular diseases (WHO 1996). Research reports suggest that the prevalence of hypertension is increasing in developing countries and important cause of death and disability (Kearney et al. 2005). In India, the prevalence of hypertension is reported as ranging from 10 to 30.9 % (Padmavathi 2002). The average prevalence of hypertension in India is 25% in urban and 10% in rural inhabitants and this trend is likely to continue (Gupta 2004). Increased urbanization, economic development and job related sedentary habits in developing countries are likely the contributory factors for the expected rise in hypertension (Reddy et al. 2002). With its present rate of increase, hypertension is poised to become one of the world's major diseases which are a chief concern of public health (WHO 2009).

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Some studies have indicated that obesity is a significant contributor for the development of hypertension routed through reduction in physical activity and change in diet (Mahanta and Mahanta 2009). Lipid abnormalities in hypertension are characterized by high triglyceride and low high density lipoprotein-cholesterol concentrations (Ginseng 2011). Published reports support an aggressive approach to the diagnosis and treatment of hypertension in patients with diabetes in order to substantially reduce the incidence of both macrovascular and microvascular complications. Epidemiological studies to assess the prevalence of hypertension are essential to plan preventive strategies and promote the health of these populations. Since the prevalence of hypertension is a multi-factorial one, there is every need to assess the magnitude of the risk exerted by independent variables in the progression of the disease. In the light of this background, an attempt has been made in the present study to assess the metabolic risk factor prevalence and its association with hypertension in subjects with type-2 diabetes.

MATERIAL AND METHODS

Subjects with complaint of diabetes attending the outpatient department at SVRR Medical College Hospital and four other prominent clinics in Tirupati town of Andhra Pradesh were screened to assess metabolic profile. The data collection took place during the period of January 2011 to July 2011. The inclusion criteria for the study were subjects with a history of both diabetes and hypertension, willing to provide written informed consent. The exclusion criteria were pregnant women and chronic bedridden patients. The protocol, case report forms and consent forms were approved by Sri Venkateswara University Ethics Committee on Human Subject Research.

A total of 179 diabetic normotensives and 91 hypertensives in the age range of 28 to 79 yrs were enrolled in the study. All the subjects gave written informed consent. Subject's demographics (age, sex, education, occupation and income), clinical history and family history were recorded. For the purpose of comparison, the subjects were divided into three age groups like <39 yrs, 40-54 yrs and >55 yrs. Socio-economic status was assessed by taking the individuals education, occupation, income and durables as per the procedure specified by Singh et al. (1997), and classified them into SES 1 to V (SES-1 is the highest and SES-5 is lowest class). Selection of one Government Clinic and 4 private clinics allowed us to secure the sample representing all sections of the people. Physical activity is assessed based on subjects occupational and leisure time activities (Singh et al. 1997).

Subject's physical assessment included height, weight, waist and hip circumference. Weight was recorded with the subjects wearing light clothing without shoes. Height was measured and rounded off to the nearest centimetre, with the subjects standing in erect posture. Body Mass Index (BMI) was calculated as weight in kg divided by the height in meter square. Based on the BMI, subjects were categorized as normal weight (17.9-24.99), over weight (25.0-29.9) and obese (>30.0). Waist girth was measured at the level of umbilicus with person breathing silently and hip girth measured at inter-trochanteric girth while standing according to the method specified by Weiner and Lourie (1981). Waist Hip Ratio (WHR) was calculated as waist circumference/hip circumference and categorized the subjects into 0.7-0.79, 0.8-0.89, 0.9-0.99 and >1. Blood pressure was recorded with sphygmomanometer as per the procedure of Rose et al. (1982). Systolic hypertension (>140 mmHg) and Diastolic hypertension (>90 mmHg) was calculated as per JNC VII Committee Recommendations (2004).

All subjects were requested to come for Out Patient Unit with 11 hr fasted condition. 5 ml of intravenous blood sample was drawn from each subject and serum was separated upon blood collection and processed for various biochemical parameters like blood glucose, cholesterol, HDL cholesterol and triglycerides. Subject's second blood sample was taken after 2 hr and the serum is used for the estimation of post prandial blood sugar. Blood glucose was determined by the glucose-oxidase method with an intra- and inter-assay coefficient of variation of <1%. Serum lipid levels (total cholesterol, HDL cholesterol and triglycerides) were measured by enzymatic methods with an intra- and inter assay coefficient of variation of <3%. The HDL cholesterol was estimated after selective precipitation of non-HDL fractions.

Statistical analysis was carried out by SPSS 16.0 version and p values were set at 0.05 as significant. Percentages were calculated for discontinuous variables. Descriptive statistics were provided for continuous variables and test of significance was seen with t-test. To assess the variation explained by the independent variables in SBP and DBP, a linear regression model was fitted with an entry at 0.05 and removal at 0.10. Further logistic regression model was fitted with hypertension as dependent variable and other factors served as independent variables.

RESULTS

A cross sectional survey was conducted among 91 hypertensives and 179 normotensives with a history of type-2 diabetes to assess the metabolic profile. Information on demographics and risk factor prevalence rates were presented in Table 1. Around 2 to 19 percent of the sample falls in >39 yrs age group, 37 percent to 44 percent fall in 40-54 yrs age group and 37 percent to 60 percent fall in >55 yrs age group. Illiteracy accounted to an extent of 40 percent in both the groups. 17 to 19 percent of the sample comes under SES-V category, 23 to 30 percent in SES-IV category, 35 to 48 percent in SES-III category and 12 to 16 percent in SES-II category. In the present sample obesity was recorded to an extent of 28 percent in hypertensives and 24 percent in normotensives.

Table 1: Demographics and anthropometric characters for the hypertensives and normotensives

Variable	*Hypertensive (n=91)*		*Normotensive (n=179)*	
	No.	*%*	*No.*	*%*
Age (years)				
<39	02	2.20	34	18.99
40-54	34	37.36	78	43.58
>55	55	60.44	67	37.43
Education (EDU)				
Illiterate	38	41.76	68	37.99
Up to 10th class	27	29.67	54	30.17
>Degree	26	28.57	57	31.84
Socio-economic Status (SES)				
SES-V	17	18.68	30	16.76
SES-IV	27	29.67	42	23.46
SES-III	32	35.16	86	48.04
SES-II	15	16.48	21	11.73
Body Mass Index				
Normal weight	17	18.68	56	31.28
Overweight	49	53.85	80	44.69
Obese	25	27.47	43	24.02

Descriptive statistics for anthropometry, blood pressure and biochemistries are shown in Table 2. Anthropometric indicators do not show significant difference between normotensives and hypertensives except in weight height ratio, wherein hypertensives possess higher values than normotensives. A significant elevation in pulse rate, systolic blood pressure and diastolic blood pressure was noticed in hypertensives than normotensives ($p<0.05$). Both fasting and post prandial blood glucose and triglyceride levels were significantly higher in hypertensives than normotensives.

In order to assess the effect of variation exerted by the independent variables on dependent variables like SBP and DBP, a linear regression analysis was carried out with a probability of entry of variables at 0.05 and removal at 0.10, and the results were shown in Tables 3 and 4. Out of the total variables entered into the model independent variables like age, sex, educational status, SES, BMI, WHR, Fasting and post prandial blood sugar and lipid levels fitted in the model. 38 percent of the variance in SBP is explained by the independent variables. Age and body mass index were positively associated towards the elevation of SBP levels. Similarly 36 percent of the variance in DBP is explained by the independent variables. Body mass index and post prandial blood sugar levels were shown positive impact on DBP.

Logistic regression analysis provided the odds ratios to explain the relative risk of independent variables in developing hypertension (Table 5). We have provided odd ratios for the independent variables after adjusting for age in the model. Overweight and obesity is exerting 2.80 times at risk in developing hypertension when compared to normotensives. Adjustment for education, SES and physical activity did not alter the risk in hypertensives. Fasting blood glucose was exerting 5.78 times risk in developing hypertension and the risk was being increased with further adjustment of EDU, SES and PA. Similarly the risk in elevation with post prandial blood glucose is 5.11. Triglycerides also exerted 5.73 times risk in hypertensives when

Table 2: Descriptive statistics for anthropometry and metabolic profiles for the hypertensives and normotensives

Variable	*Hypertensive (n=91)*		*Normotensive (n=179)*		*t-value*
	Mean	*SD*	*Mean*	*SD*	
Height (cm)	155.78	8.58	156.72	9.87	0.77
Weight (kg)	68.16	10.73	66.53	10.81	1.17
Body mass index (kg/m^2)	28.14	4.31	27.15	4.10	1.86
Waist circumference (cm)	91.01	10.51	88.64	9.65	1.85
Hip circumference (cm)	101.32	9.87	99.37	8.59	1.68
Waist height ratio	0.59	0.07	0.57	0.07	1.96*
Waist hip ratio	0.90	0.06	0.89	0.05	0.94
Pulse rate	81.03	11.92	77.83	9.56	2.39*
Systolic blood pressure (mmHg)	146.18	6.21	130.16	9.35	14.76*
Diastolic blood pressure (mmHg)	96.43	5.07	88.40	7.93	8.80*
Fasting blood sugar mg%	198.54	50.91	150.21	36.51	8.95*
Post prandial blood sugar mg%	274.64	63.03	218.62	58.76	7.22*
Triglycerides mg%	179.33	84.47	139.32	72.22	2.73*
Cholesterol mg%	197.28	38.35	181.33	44.53	1.93
HDL-Cholesterol mg%	45.97	2.89	46.92	3.48	1.48
LDL-Cholesterol mg%	96.42	55.93	104.32	44.61	0.84

*$p<0.05$

Table 3: Linear regression analysis for systolic blood pressure

Variable	*Unstandardized coefficients*		*t-value*	*P value*	*95% Confidence interval for B*	
	B	*Std. error*			*Lower bound*	*Upper bound*
Age	0.47	0.11	4.40	0.00	0.26	0.69
Sex	2.39	2.28	1.05	0.29	-2.11	6.91
Educational status	-1.48	1.17	-1.27	0.21	-3.80	0.84
Income	-0.45	1.52	-0.30	0.76	-3.50	2.56
Body mass index	0.90	0.35	2.58	0.01	0.21	1.60
Waist hip ratio	15.23	21.22	0.72	0.47	-26.84	57.31
Fasting blood sugar mg%	0.05	0.03	1.71	0.10	-0.01	0.12
Post prandial blood sugar mg%	0.03	0.02	1.53	0.13	-0.01	0.07
Triglycerides mg%	-0.01	0.02	-0.28	0.78	-0.04	0.03
Cholesterol mg%	0.05	0.03	1.41	0.16	-0.02	0.11
HDL- cholesterol mg%	-0.16	0.34	-0.47	0.64	-0.82	0.51
LDL- cholesterol mg%	-0.06	0.03	-1.92	0.06	-0.12	0.002

Table 4: Linear regression analysis for diastolic blood pressure

Variable	*Unstandardized coefficients*		*t value*	*P value*	*95% Confidence interval for B*	
	Lower bound	*Std. error*			*Lower bound*	*Upper bound*
Age	0.12	0.08	1.59	0.12	-0.03	0.28
Sex	2.66	1.62	1.64	0.10	-0.56	5.88
Educational status	-0.40	0.83	-0.50	0.63	-2.06	1.25
Income	0.56	1.09	0.52	0.61	-1.59	2.72
Body mass index	0.63	0.25	2.50	0.01	0.129	1.12
Waist hip ratio	14.20	15.10	0.94	0.35	-15.90	44.20
Fasting blood sugar mg%	0.02	0.02	0.73	0.47	-0.03	0.06
Post prandial blood sugar mg%	0.06	0.01	4.00	0.00	0.03	0.09
Triglycerides mg%	0.01	0.01	0.30	0.77	-0.02	0.03
Cholesterol mg%	0.01	0.02	0.26	0.80	-0.04	0.05
HDL-Cholesterol mg%	-0.16	0.24	-0.70	0.52	-0.63	0.32
LDL-Cholesterol mg%	-0.01	0.02	-0.30	0.74	-0.05	0.04

compared to normotensives and the risk was slightly decreased after adjustment for EDU, SES and PA. The risk exerted by WHR, Cholesterol and HDL Cholesterol was insignificant.

DISCUSSION

Hypertension is common metabolic disorder and preventable non-communicable disease. This cross sectional study clearly indicates that age, body mass index and post prandial blood sugar are the predominant risk factors in developing hypertension. Several studies have indicated that age is a confounder when using anthropometric and metabolic indicators to predict the risk of hypertension (Woo et al. 2002; Molarius et al. 2000). Age has been differently categorized by different scientists; however, relationships between anthropometric indicators, metabolic profile and hypertension were consistent across the age groups (Daniel et al. 1999; Cheng et al. 2010; Reddy et al. 2010). In contrary some studies have shown that age is not a confounder when assessing the relationship between anthropometric indicators, metabolic profile and hypertension (Zaimin et al. 2007; Mato Grosso 2009; Xiaolin Dong et al. 2010). It is assumed that a larger sample size in each age group might increase the statistical power to eliminate age as the confounder.

Earlier it is assumed that hypertension is more prevalent among affluent communities due to practice of sedentary life styles and energy dense foods (Singh et al. 1999). The distribution of socio-economic grading in the present study emphasizes that hypertension is no longer confined to affluent communities in Indian setting, and low SES people are also likely to be affected in the changing nutritional and life style transition. Elevation in blood pressure or uncontrolled hypertension may lead to accumulation of multiple complications. Increase in the

Table 5: The OR (95%CI) for hypertension in relation to anthropometric and metabolic indicators after adjustment for potential confounders

Category	*Age adjusted*		*Age, EDU, INC adjusted*		*Age, EDU, INC,PA adjusted*	
	OR	*95%CI*	*OR*	*95%CI*	*OR*	*95%CI*
Body Mass Index (kg/m²)						
<24.9	1.00		1.00		1.00	
25.0-29.9	2.89	1.44-5.79	2.88	1.43-5.78	2.83	1.39-5.77
>30.0	2.83	1.29-6.19	2.80	1.23-6.20	2.81	1.24-6.38
Waist Hip Ratio						
<0.79	1.00		1.00		1.00	
0.80-0.99	1.28	0.31-5.20	1.35	0.32-5.68	1.49	0.35-6.37
0.99-1.00	1.27	0.31-5.19	1.27	0.30-5.31	1.40	0.33-5.96
>1.0	1.04	0.07-16.62	1.09	0.07-18.49	1.07	0.06-18.35
Fasting Blood Sugar						
<120	1.00		1.00		1.00	
>120	5.78	1.96-17.09	6.57	2.17-19.97	6.87	2.24-21.06
Post Prandial Blood Sugar						
<150	1.00		1.00		1.00	
>150	5.11	1.14-22.85	5.18	1.85-23.36	5.32	1.17-24.20
Triglycerides mg%						
<120	1.00		1.00		1.00	
>120	5.73	2.22-14.83	5.05	1.83-13.90	5.15	1.84-14.39
Cholesterol mg%						
<200	1.00		1.00		1.00	
>200	1.66	0.73-3.75	1.63	0.67-3.96	1.75	0.70-4.37
HDL-Cholesterol mg%						
<35	1.00		1.00		1.00	
>35	0.69	0.28-1.66	0.46	0.18-1.21	0.49	0.18-1.33

EDU=Education, INC= Income, PA= Physical activity

blood glucose levels upon exposure to the hypertension is a serious concern. Poor glycemic control is noticed in the present study, even under medication. This may be due to lack of awareness and managerial attitude over the condition. Personal interviews with all the subjects indicated that the sense of restriction in food habits is meager.

Overall and abdominal adiposity is a risk factor in the development of hypertension (Shills et al. 1994). Many studies have emphasized the positive role of BMI and WHR in hypertension. In general generalized obesity appeared to ensure hypertension and the results of the present study show such an association. Around 80 percent of the hypertensive subjects of the present study found to be overweight and obesity. The precipitation of huge overweight/obese in the study sample may explain the positive role towards the disease. In the present study the association of WHR and hypertension is insignificant.

The blood pressure levels are higher in obese and overweight than normal weight subjects in both groups and the magnitude of elevation is higher in hypertensives. Similarly as the BMI increased the levels of total cholesterol, triglycerides were also increased in both the groups but the magnitude is higher in hypertensives than normotensives. Weight gain tends to associate with developing increased risk towards cardiovascular and metabolic disorders (Rosenbaum et al. 1997). The results of the present study support the above hypothesis. Prospective studies have shown a direct relationship between BMI and cardiovascular events (Kopelman 2000). Some studies have shown positive association between body weight and blood pressure even in normotensive subjects with normal BMI (Mikhail and Tuck 2000). Clinical studies have shown that weight loss reduces arterial pressure and corrects metabolic disorders associated with obesity (Richards et al. 1996).

Although the association of obesity and hypertension is well recognized, the mechanisms involved in the pathogenesis of increased blood pressure in the obese are poorly understood, and most likely represents the interaction of demographic, genetic, hormonal, renal, and hemodynamic factors (Mikhail and Tuck 2000). The mechanisms that may lead to hypertension in obese individuals include increased SNS activity, insulin resistance and hyperinsulinemia, sodium retention, and enhanced vascular reactivity. These abnormalities are interrelated in a complex fashion. Clinically, hypertensive obese subjects are more likely to develop left ventricular hypertrophy and kidney damage than their lean counterparts (Hsueh and Buchanan 1994).

CONCLUSION

This study provides a baseline data regarding the metabolic risk factor prevalence in hypertensives. Body mass index and post prandial blood sugar and age are the most commonly observed risk factors. Our data will be helpful to sensitize health care practitioners and hypertensive subjects towards the management of the condition.

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