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Assessment of Metabolic Profile in Type 2 Diabetic Patients of Chittoor District, Andhra Pradesh

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ABSTRACT

Present study has been undertaken to assess the metabolic profile of 918 adult type-2 diabetic patients attending the different clinics in Tirupati town of Andhra Pradesh state. Data on demography, socioeconomic status, physical activity, anthropometry, blood pressure and lipid profile are procured. BMI is greater in women and WHR is greater in men than to their counterparts. 38 percent of males and 42 percent of females are classified as hypertensives. Hyperglycemia is 16 percent in males and 20 percent in females. Hypercholesterolaemia is 42 percent. Low HDLC is observed to an extent of 55 percent in males and 50 percent in females. 46 percent of the males and 50 percent of the females are documented with a cluster of risk factors termed as metabolic syndrome. Multinominal regression model reveals that overweight/obese subjects pose greater burden of MetS than normal weight subjects. In conclusion, obese adults are particularly at risk of developing MetS, with significant implications for their health. Hence, promotion of healthy lifestyles, increased physical activity may reduce the burden of developing MetS mediated diseases.

Keywords: BMI. Hypertension. Hyperglycemia. Metabolic syndrome. Type-2 diabetes.

I. INTRODUCTION

The metabolic syndrome (MetS) is a multiplex risk factor for cardiovascular diseases (CVD) [1]. Several prospective studies reveal that the presence of MetS affects quality of individual life. Even though the influence of environmental factors on MetS is proven hypothesis [2, 3], but it varies across the cultures as evinced by the diverse prevalence rates [4, 5]. The environmental risk factors are collectively under the influence of nutrition, lifestyle and socioeconomic transitions, consequent to increasing affluence, urbanization, industrialization, mechanization, rural-to-urban migration and habits of smoking, alcoholic consumption, diet etc [6, 7].

Metabolic syndrome has been described as a global time bomb, with a quarter of the world's adults estimated to be having the condition. People with MetS are twice at risk towards CVD and fivefold risk in developing type-2 diabetes (T2D). Global statistics indicates that 80 percent of the people with T2D die with various CVDs [8]. The worldwide prevalence of MetS varies from 14 to 46 percent [9]. It is estimated that 20 to 25 percent of South Asians have developed MetS and many more may be prone to it [10].

Prevalence of MetS is high among Asians including Indians, and is rising, particularly with the adoption of modernized lifestyle. Many studies in India have reported high prevalence of MetS and are varying between 10 to 50 percent depending on age and sex [11]. The ICMR-InDIaB national study reported that there are 62.4 million people with T2D and 77 million people with pre-diabetes in India [12]. These numbers are projected to increase to 101 million by the year 2030 [13]. India has the largest number of diabetics in the world with a 3.8 percent in rural and 11.8 percent in urban adults [14].

Andhra Pradesh is no exception to the above statistics and it harbours a substantial number of people with T2D. The populations of Andhra Pradesh also show a wide variation in the lifestyle patterns due to economic shift and urbanization. Therefore, assessing MetS among the T2D is significant to understand the magnitude of the burden. Hence, present study has been undertaken to assess the metabolic profile of adult type-2 diabetic subjects.

II. MATERIALS AND METHODS

The material selected for the present study is T2D patients attending the Outpatient Department at SVRR Medical College Hospital and four other prominent diabetic clinics in Tirupati town of Andhra Pradesh state. The data collection took place during the period of December 2011 to March 2013. A total of 1320 T2D patients attended in the defined Hospital/ Clinics. 270 patients (20.45%) are dropped from the study as they do come under exclusion criteria. Further, 132 patients (10%) could not give consent and hence dropped from the study. Finally, 918 T2D (males: 500; females: 418) sample in the age range of 30 to above 60 years who are screened for clinical profile are selected upon their written consent. The objectives of the study have been explained before taking the written consent. The exclusion criteria include subjects with suffering from any chronic disease or pregnant/ lactating women. The protocol, case report forms and consent forms are duly approved by SVU Ethics Committee on Human Subject Research, Sri Venkateswara University, Tirupati, Andhra Pradesh.

A structured and standardized questionnaire is used to collect the data on demography, socioeconomic status, physical activity, habit of smoking and alcohol consumption via face-to-face in-depth interviews. For the purpose of comparison, the subjects are divided into four age groups, like, 30-39 years, 40-49 years, 50-59 years, ≥60 years. SES is classified into five groups (i.e. SES-I to SES-V) based on scores of education, occupation, housing condition, ownership of durables and per capita income of the family [15]. SES-I is the highest and SES-V is the lowest class. Physical activity is assessed from occupational and spare time activities and subjects are graded as sedentary, mild, moderate or heavy, based on scores of activities according to Indian criteria [16].

The physical assessment included height, weight and circumferences of waist and hip as per the procedure specified by Lohman et al. [17]. Subject's blood pressure (BP) is recorded as per the standard procedure. The instruments are calibrated prior to take the measurements. Fasting blood sample is collected for biochemical investigation after an overnight fast of at least 10 hours. Serum is separated by centrifugation at 2500 rpm for 20 minutes into pre-labeled sterile tubes and used for biochemical analysis for fasting blood glucose (FBG), triglycerides (TG), total cholesterol (TC), HDL cholesterol (HDLC), LDL cholesterol (LDLC), and VLDL cholesterol (VLDLC). MetS is defined according to the census definition of IDF/ NHLBI/ AHA/ WHF/ IAS/ IASO by Alberti et al. [18]. Participants are defined as having MetS if they met, or exceeded, the criteria for three or more of the following five variables: – a) WC ≥90 cm in men and ≥85 cm in women; b) BP ≥140/90 mmHg; c) FBG level ≥120 mg%; d) TG ≥200 mg%; and e) HDLC ≥40 mg% .

Statistical Analysis

Statistical analysis is carried out via SPSS-16.0 and alpha levels are set at $p<0.05$. The sample size varies from variable to variable due to non availability of data. Univariate analysis is carried out to calculate the descriptive statistics after adjusting for age. Discontinuous variables are provided with percentages. Student's *'t'* test is applied to see the differences between groups and one way analysis of variance among the groups. *Chi square* (χ^2) test is applied to see the association of overweight/obesity with BP, FBG, TG, TC and HDLC. Further a simple linear regression model is fitted to see the variation exerted by the body mass index (BMI) on BP and metabolic profile after adjusting for sex, age and physical activity.

III. RESULTS

Age, sex and lifestyle characteristics of the study population are shown in table 1. More than 50 percent of the study population falls in the age groups of 40-49 and 50-59 yrs in both genders. Illiteracy is noticed to an extent of 12 percent in males and 34 percent in females. In the present study 10 percent of the females and 20 percent of males do come under SES-I category. Only 10 percent of males and 20 percent of females are in SES-IV category. Sedentary physical activity is recorded to an extent of 16 percent in females and 8 percent in males. Habit of smoking and alcoholism is recorded only in males. 39 percent are smokers and 30 percent are habituated to consumption of alcoholic beverages.

Table 1: Age, sex and lifestyle characteristics of the study population

Variable	Male (n=500)		Female (n=418)	
	n	%	n	%
Age Group				
30-39 yrs	53	10.60	56	13.39
40-49 yrs	137	27.40	105	25.12
50-59 yrs	171	34.20	133	31.82
≥60 yrs	139	27.80	124	29.66
Education				
Illiterate	58	11.60	142	33.97
Primary	138	27.60	140	33.49
Secondary	179	35.80	100	23.92
Higher	125	25.00	36	8.61
Socioeconomic Status (SES)				
SES-I	101	20.20	42	10.05
SES-II	200	40.00	124	29.67
SES-III	145	29.00	167	39.95
SES-IV	54	10.80	85	20.33
Physical Activity				
Sedentary	42	8.40	65	15.55
Mild	186	37.20	209	50.01
Moderate	237	47.40	116	27.75
Heavy	35	7.00	28	6.69
Habit of Smoking				
Yes	195	39.00	-	-
No	305	61.00	418	100.00
Habit of Alcoholism				
Yes	147	29.40	-	-
No	353	70.60	418	100.00

Age adjusted descriptive statistics for anthropometry, BP, blood glucose and lipid levels in the study population are carried out through univariate analysis and the results are shown in table 2. Men are taller ($p<0.05$) and heavier ($p<0.05$) than women. However, the resulting BMI is greater in females than males ($p<0.05$). Women are characterized by elevation in hip circumference than men. Waist-hip ratio is significantly higher in males than females ($p<0.05$). Both systolic and diastolic BP, pulse rate, FBG, triglycerides, total cholesterol, HDLC, LDLC and VLDLC do not show significant difference between genders.

Percent prevalence of overweigh/obesity, hypertension (HTN), hyperglycemia and dyslipidaemia are shown in table 3. In the sample a maximum of 70 percent of the study population comes under overweight and obesity category. 38 percent of males and 42 percent of females are classified as hypertensives. Hyperglycemia is 16 percent in males and 20 percent in females. Hypercholesterolaemia

is 42 percent. Low HDLC is observed to an extent of 55 percent in males and 50 percent in females. Hypertriglyceridemia is 16 percent in males and 20 percent in females. 46 percent of the males and 50 percent of the females are documented with a cluster of risk factors termed as metabolic syndrome.

Table 2: Age adjusted descriptive statistics for anthropometry, blood pressure, blood glucose and lipid levels in the study population

Variable	Male		Female		*t-value*
	Mean	SD	Mean	SD	
Height (cm)	165.62	10.67	156.18	10.28	13.61*
Weight (Kg)	74.14	16.59	68.95	14.70	5.02*
Body Mass Index (kg/m^2)	27.06	5.93	28.34	6.32	3.13*
Waist Circumference (cm)	89.87	12.21	89.99	11.45	0.15
Hip Circumference (cm)	97.93	13.93	101.60	13.72	4.01*
Waist-Hip Ratio	0.92	0.07	0.89	0.08	6.20*
Pulse Rate	78.75	12.81	80.62	13.80	2.10
Systolic Blood Pressure (mmHg)	133.57	18.18	133.99	19.22	0.35
Diastolic Blood Pressure (mmHg)	85.21	11.20	85.35	10.28	0.20
Fasting Blood Glucose (mg%)	162.65	58.03	157.57	70.17	1.18
Postprandial Blood Glucose (mg%)	224.19	101.30	233.47	116.30	1.28
Triglycerides (mg%)	156.72	96.46	152.68	95.38	0.64
Total Cholesterol (mg%)	196.89	49.13	197.97	49.01	0.33
HDL cholesterol (mg%)	39.02	9.46	39.77	11.80	1.04
LDL cholesterol (mg%)	127.90	44.27	127.74	49.01	0.05
VLDL cholesterol (mg%)	31.13	19.14	30.35	18.56	0.63

** p<0.05*

Table 3: Percent prevalence of BMI, blood pressure, blood glucose and lipid levels in the study population

Variable	Male		Female		χ^2 *value*
	n	%	n	%	
Body Mass Index (kg/m^2)					
Normal weight	135	28.60	97	24.49	3.20*
Overweight	189	40.04	154	38.89	
Obese	148	31.36	145	36.62	
Blood Pressure (mmHg)					
Normotensive (≤140/90)	309	61.80	241	57.66	1.63
Hypertensive (≥140/90)	191	38.20	177	42.34	
Triglyceride (mg%)					
Normotriglyceridaemia (≤199)	412	83.91	332	80.19	2.12
Hypertriglyceridaemia (≥200)	79	16.09	82	19.81	
Total Cholesterol (mg%)					
Normocholesterolaemia (≤199)	286	57.55	240	57.69	0.02
Hypercholesterolaemia (≥200)	211	42.45	176	42.31	
HDL cholesterol (mg%)					
Low HDL cholesterol (≤39)	270	54.66	205	49.76	2.16
Normal HDL cholesterol (≥40)	224	45.34	207	50.24	
Metabolic Syndrome (MetS)					
without MetS	269	53.80	208	49.76	1.49
With MetS	231	46.20	210	50.24	

**p<0.05*

Descriptive statistics for FBG, lipid levels across BMI quartiles are shown in table 4. Both FBG and lipid levels increases from normal weight to obese in both genders ($p<0.05$). Percent prevalence of BP, blood glucose and lipid status according to BMI quartiles are shown in table 5. In both males and females the prevalence of HTN is elevated in overweight/obese ($p<0.05$). Hyperglycemia elevated in overweight and obesity ($p<0.05$). Similarly the prevalence of hypercholesterolemia, low HDLC, hypertriglyceridemia and MetS elevated among obese ($p<0.05$).

Table 4: Descriptive statistics for blood glucose and lipid levels according to BMI quartiles in the study population

Variable	BMI (Kg/m^2)	Males		Females		*t*-value^
		Mean	SD	Mean	SD	
FBG (mg%)	Normal Weight	137.30	27.23	147.39	41.83	2.22*
	Overweight	169.08	41.06	165.73	49.88	0.68
	Obese	183.19	29.31	172.14	41.93	2.35*
	F-value$^{\#}$		59.10*		9.00*	
Triglycerides (mg%)	Normal Weight	137.22	58.02	144.78	55.45	1.00
	Overweight	156.52	68.56	142.22	57.86	2.04*
	Obese	156.13	60.56	169.30	57.90	1.89
	F-value$^{\#}$		4.39*		9.44*	
Total Cholesterol (mg%)	Normal Weight	183.90	35.91	192.10	35.66	1.71
	Overweight	204.82	32.73	196.71	30.32	2.36*
	Obese	197.95	26.36	203.90	23.07	2.06*
	F-value$^{\#}$		17.00*		5.00*	
HDL cholesterol (mg%)	Normal Weight	40.71	5.92	42.46	6.97	2.04*
	Overweight	39.51	5.90	39.93	7.30	0.58
	Obese	38.13	6.10	38.67	6.77	0.72
	F-value$^{\#}$		6.50*		8.40*	
LDL cholesterol (mg%)	Normal Weight	113.55	39.33	119.12	38.65	1.07
	Overweight	130.44	28.84	127.34	32.64	0.92
	Obese	132.39	25.04	133.98	22.33	0.57
	F-value$^{\#}$		15.63*		6.61*	
VLDL cholesterol (mg%)	Normal Weight	27.44	11.60	28.96	11.09	1.00
	Overweight	31.30	13.71	28.31	11.60	2.18*
	Obese	30.37	11.95	31.74	10.91	1.02
	F-value$^{\#}$		3.80*		3.72*	

* $p<0.05$; ^ t-test between the genders; $^{\#}$ ANOVA between the groups

Multinominal regression model is fitted to see the effect of the BMI on HTN, FBG, triglycerides, total cholesterol, HDLC and MetS after adjusting for sex, age and physical activity and the consequences are shown in table 6. The OR of being hypertensive among overweight subjects are 1.791 times (95% CI: 1.232-2.602), and increased to 2.800 times (95% CI: 1.900-4.125) among obese subjects. The OR of FBG are 4.223 times (95% CI: 2.673-6.673) more among overweight subjects compared to normal weight subjects and increased to 64.632 times (95% CI: 15.527-269.036) in obese subjects. The risk of elevation in TG among overweight subjects is 1.596 times (95% CI: 0.976-2.607) and among obese subjects the risk is 2.160 times (95% CI: 1.326-3.518). Overweight subjects are 2.045 times (95% CI: 1.433-2.918) at risk in the elevation of cholesterol levels. The risk in obese subjects for the elevated cholesterol levels decreased to 1.890 times (95% CI: 1.310-2.728). Overweight subjects are 1.376 times (95% CI: 0.970-1.952) at risk in the depletion of HDLC levels. The risk of depletion in HDLC levels increased to 2.400 times (95% CI: 1.653-3.484) among obese subjects. The odds of MetS in overweight and obese are 3.223 times (95% CI: 2.162-4.805) and 9.012 (95% CI: 5.899-13.768) respectively.

Table 5: Percent frequency distribution of BP, FBG, TG, TC and HDLC levels according to BMI quartiles in the study population

Variable	Male								Female							
	N	Normal weight		Overweight		Obese		χ^2 value	N	Normal weight		Overweight		Obese		χ^2 value
		N	%	n	%	n	%			n	%	n	%	n	%	
Blood Pressure (mmHg)																
≤139/89	309	96	71.11	118	62.43	73	49.32	14.41*	241	68	70.10	90	58.44	73	50.34	9.34*
≥140/90	191	39	28.89	71	37.57	75	50.68		177	29	29.90	64	41.56	72	49.66	
Fasting Blood Glucose (mg%)																
≤119	56	42	31.34	12	6.59	2	1.85	87.92*	60	35	36.08	23	14.94	-	-	62.66*
120-199	319	92	68.66	127	69.78	72	66.67		284	53	54.64	99	64.29	115	79.31	
≥200	77	-	-	43	23.63	34	31.48		72	9	9.28	32	20.77	30	20.69	
Triglycerides (mg%)																
≤199	412	121	89.63	146	80.66	120	81.63	5.13	332	84	86.60	130	84.97	105	73.94	8.22*
≥200	79	14	10.37	35	19.34	27	18.37		82	13	13.40	23	15.03	37	26.06	
Total Cholesterol (mg%)																
≤199	286	96	72.73	94	49.74	83	56.08	17.29*	240	62	64.58	86	56.21	77	53.10	3.19
≥200	211	36	27.27	95	50.26	65	43.92		176	34	35.42	67	43.79	68	46.90	
HDL cholesterol (mg%)																
≤39	270	62	47.69	101	53.72	107	72.30	19.49*	205	31	32.63	76	50.33	87	60.00	17.25*
≥40	224	68	52.31	87	46.28	41	27.70		207	64	67.37	75	49.67	58	40.00	
Metabolic Syndrome (MetS)																
Without MetS	249	103	41.4	96	38.6	50	20.1	51.68*	200	78	39.0	85	42.5	37	18.5	72.28*
With MetS	223	32	14.3	93	41.7	98	43.9		196	19	9.7	69	35.2	108	55.1	

**p<0.05*

Table 6: OR and 95% CI for the prevalence of overweight and obesity according to hypertension, fasting blood glucose, triglycerides, total cholesterol, HDLC and Mets

Variable[@]	n (%)	OR	95% CI	*p-value*
Hypertension (≥140/90 mmHg)				
Normal weight	232 (26.7)	Ref.		
Overweight	343 (39.5)	1.791	1.232-2.602	0.002
Obese	293 (33.8)	2.800	1.900-4.125	0.000
Fasting blood glucose (mg%)				
Normal weight	231 (28.2)	Ref.		
Overweight	336 (41.0)	4.223	2.673-6.673	0.000
Obese	253 (30.9)	64.632	15.527-269.036	0.000
Triglycerides (mg%)				
Normal weight	232 (27.1)	Ref.		
Overweight	334 (39.1)	1.596	0.976-2.607	0.062
Obese	289 (33.8)	2.160	1.326-3.518	0.002
Total cholesterol (mg%)				
Normal weight	228 (26.4)	Ref.		
Overweight	342 (39.6)	2.045	1.433-2.918	0.000
Obese	293 (34.0)	1.890	1.310-2.728	0.001
HDL cholesterol (mg%)				
Normal weight	225 (26.3)	Ref.		
Overweight	339 (39.6)	1.376	0.970-1.952	0.074
Obese	293 (34.2)	2.400	1.653-3.484	0.000
Metabolic syndrome				
Normal weight	232 (26.7)	Ref.		
Overweight	343 (39.5)	3.223	2.162-4.805	0.000
Obese	293 (33.8)	9.012	5.899-13.768	0.000

[@]adjusted for sex, age and physical activity

IV. DISCUSSION

The outcome of the present research clearly indicates the association of overweight/obesity with clinical profile of T2D. Prospective studies highlighted that altered metabolic risk factors are likely to contribute to the cardiovascular risk in diabetic patients [19]. Hence, assessing the risk factor profile is now considered as a standard of the diabetes care. A clear cut examination of the results indicates that the metabolic risk factors are increased in T2D subjects. An interesting variable to highlight in the present study is the high incidence of low HDLC. Further twenty percent of the subjects have elevated triglyceride levels, a fact that might be inversely associated with HDLC. Our results are in best agreement with other studies indicating the low HDLC and elevated TG are the predominant risk factors in developing CVDs among the T2D.

Hypertriglyceridaemia and low HDLC are the most frequent dyslipidaemia as observed in the present study. Increased triglyceride levels under reduced HDLC are risk factors in developing coronary events [20]. Further overweight/obesity has shown strong association with hypertriglyceridemia, low HDLC and other risk factors. The logistic regression model offers to establish a pathogenic link between BMI, HTN, T2D and dyslipidaemia in MetS.

The prevalence of MetS in India varies between 10 to 50 percent depending on age and sex [21]. The prevalence of various risk factors in the study is in line with other studies [22, 23]. Prevalence of

abdominal obesity, low HDLC and HTN are the commonest of the diagnostic criteria of MetS. The outcome of the present work affirms that MetS is common in Indian patients [24]. A comparison of the data with other data from western communities, it is observed that the prevalence rates in Indian population are higher than Europe and USA [25]. The prevalence of MetS in seven European countries is approximately 23 percent. The age adjusted prevalence of MetS in the US, as reported in the US Third National Health and Nutrition Survey (NHANES-3) is 24 percent for men and 23 percent for women [26]. The worldwide prevalence of MetS varies from 14 to 46 percent [9]. Prevalence of metabolic risk factors differ from region to region and population to population [27]. The differences could be attributed to changes in lifestyles, characterized by intake of higher energy food and low physical activity, as well as by colossal migrations from rural to urban areas.

Metabolic risk factors or MetS is a disorder characterized by the presence of multiple risk factors, including central obesity, hyperglycemia, hypertriglyceridaemia, low HDLC and HTN. Concurrence of at least three of these factors means that an individual has MetS [28]. The relation of MetS with the risk of developing several chronic diseases, such as CVD is well established, and it is also associated with a high mortality risk [29]. The aetiology of MetS, although largely unknown, is considered to reside in a complex interaction between genetic predisposition and metabolic and environmental factors [30, 31].

V. CONCLUSION

The present analysis conferred that the association of BMI with clinical profile of T2D patients. Obese adults are particularly at risk of developing MetS, with significant implications for their health. These results highlight the importance of weight loss to reduce morbidities associated with MetS. Further, the strength of association of BMI and clinical profile indicates that overweight/obese subjects are at risk in the elevation of levels of TC, TG and a reduced HDLC levels. Hence, promotion of healthy lifestyles, increased physical activity may reduce the burden of developing MetS mediated diseases.

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