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Anthropometric and biochemical markers to assess the risk factors for metabolic syndrome in south Indian non diabetic rural population

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Abstract

The present study was carried out at R L Jalappa Hospital attached to Sri Deva Raj Urs Medical College, Tamaka, Kolar, after a written consent from all the participants. The study includes 520 non diabetic rural subjects, in which 294 were males and 226 were females. The anthropometric and biochemical parameters were estimated by standard methods.The WHO (World Health Organization) criteria were used for diagnostic life style risk factors forestimating the metabolic risk factors. Higher mean WC (waist circumference) was observed in males than in females and it was statistically significant.Highly significant difference was found with respect to WHR (Waist hip Ratio) in males and females. Among the biochemical parameters, fasting blood sugar, triglycerides, low density lipoproteins and high density lipoproteins were significant. The lifestyle variables like smoking,alcohol and tobacco chewing were showed significant difference between males and females. Females had higher risk compared to males. Measurers such as educational programs, screening and prevention need to be taken at the peripheral level. Obesity is a positive risk factor in the development of type 2 Diabetes mellitus, dyslipidemia, insulin resistance and hypertension, which are linked more strongly to intra-abdominal and/or upper body fat than to overall adiposity.

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1. Introduction

The metabolic syndrome (MetS) has emerged as an important clinical entity over the last two decades following Reaven's description of a clustering of risk factors for coronary artery disease in 1988(Reavan et al., 1988).The global burden of disease is shifting from infectious diseases to non-communicable diseases (Goldwasser et al., 1993).As the infections and nutritional deficiencies are receding as leading contributors to death and disability, cardiovascular diseases (CVDs), cancers, diabetes, neuropsychiatric ailments, and other chronic diseases are becoming major contributors to the burden of the disease (Lowrie et al., 1994). This shift in the pattern of diseases from communicable to non-communicable is occurring at a faster rate in developing countries than in industrial nations (Owen et al., 1993).

According to National Health Profile 2007, the estimated number of cases of coronary heart disease in India in 2005 was approximately 36 million (Desky et al., 1984).It is also expected that the CVD burden of India Would double in the next two decades, making it the single largest cause of death and the second largest cause of disability by the year 2010(Baker et al., 1982). Most of this increase will occur on account of metabolic syndrome (Gupta e al., 2005, Rojratsirikul et al., 2004).

There are various external and internal factors affecting the preventive health behavior and health-seeking behavior undertaken by an individual(Kalantar- Zadesh et al., 1999),the external factors are resource availability(Asgarani et al., 2004) financial resources and accessibility to healthcare services, literacy status, socio-economic status(Painter et al., 2010) health awareness and knowledge, and cultural patterns. The internal factors include attitudes and beliefs. Indian population has better accessibility to healthcare facilities, proximity to healthcare professionals, and more exposure to public health. Therefore, the present study aimed to assess metabolic risk factors in non-diabetic rural population.

1.1 Objectives

To estimate and identify the metabolic risk factors in South Indian rural population.

2. Material and Methods

Study consists of Five twenty non -diabetic subjects with the age group of 35 to 60 years visiting Medicine outpatient department, R.L Jalappa Hospital, attached to Sri Devaraj Urs Medical College, tertiary health center included in this study. Type 1 and 2 diabetes mellitus, peripheral vascular disease, acute or chronic infection, cancer, hepatic disease; myocardial infarction was excluded from the study. Written informed consent was obtained from subjects. The following data was retrieved from the medical records between October 2011 to May 2012. Weight was measured (to the nearest 0.5 kg) with the participant standing motionless on a bathroom weighing scale without shoes or any heavy outer garments, and weight equally distributed over each leg. Height was measured(to the nearest 0.1cm) using a standards non-elastic tape measure with the participant standing erect against a wall, without shoes, and the head looking straight. Body Mass Index (BMI) was calculated as weight divided by height squared in meters (kg/m^2).Waist circumference (WC) was measured using a standard non-elastic tape measure (to the nearest 0.1cm). The participant will be asked to stand with the arms by the sides and to breathe out normally. Standing to the side of the participant, the inferior margin (lowest point) of the last rib and the crest of the ilium (top of the hip bone) will be located and marked with a fine pen. The midpoint between the two will be marked and measurement for waist circumference was taken at the level of this midpoint. The hip circumference (HC) was measured around the maximum circumference of the hips. Sitting blood pressure was measured using blood pressure apparatus (to the nearest 1mm Hg). Two readings were taken on left arm at an interval of 10 min. If difference between the two readings was more than10 mm Hg, a third reading of BP was recorded. The mean of 2 (or 3) readings will be taken as the final measurement and systolic blood pressure (SBP) and diastolic blood pressure (DBP) were noted.

Biochemical parameters were measured after an overnight fast, and the parameters were estimated byusing Johnson & Johnson vitros 250 dry chemistry Auto analyzer which works on the principle reflectancePhotometry. The blood glucose estimation was done by Glucose Oxidase Peroxidase method (GOD-POD), HbA_1C was estimated by HPLC, serum creatinine was estimated by Jaffes reaction, uric acid estimation byUricase method, total cholesterol was estimated by cholesterol oxidase method(Edmund et al., 1999), triglycerides estimationwas by Enzymatic colorimetric test- GPO PAP , High density lipoproteins (HDL) estimation was done byDirect Enzymatic colorimetric (Holewijn et al.,2010), spot urine albumin was done by dip stick method and urine creatinine by Jaffes reaction. LDL-C, Non-HDL-Cholesterol, eGfr was calculated (Levy et al., 1990, Waugh et al., 2003 and ADA, 2011).

For a person to be defined as having the MetS, they must have central obesity based on WC with cut-points specific to South Indians (WC ≥90 cm in men and ≥85 cm in women) (Ford 2006) plus any two of the following four factors:

(*1*) elevated TG, ≥150 mg/dL, or specific treatment for this lipid abnormality;
(*2*) reduced HDL-C, <40 mg/dL in men and <50 mg/dL in women, or specific treatment for this lipid abnormality;
(*3*) elevated BP, systolic BP ≥130 or diastolic BP ≥85 mmHg, or treatment of previously diagnosed hypertension; and
(*4*) elevated fasting plasma glucose, ≥100 mg/dL, or previously diagnosed type 2 diabetes.

The total number of these metabolic disturbances was calculated for each subject.

The life style risk factors and the diagnostic criteria will be used as follows: smoker: An adult who has smoked 100 cigarettes in his or her life time and who currently smokes cigarettes every day or some days (Jain et al., 2006).Alcohol: A person who consumes alcohol on a regular basis (every day) or occasionally (some days) (The WHO 2003) Tobacco use: Consumption of any form of tobacco other than smoked in the past 6 months. The type of tobacco consumption considered include oral (tobacco chewed, pan masala, any other form, etc.) and inhaled forms (snuff) (WHO2000).Diet: The dietary patterns will be classified as American Heart Association (Vegetarian diets, 2009) into total vegetarian/ vegan, lacto-vegetarian. Physical activity (physical activity, 1996): A pattern of physical activity is regular if activities are performed most days of the week-5 or more days of the week if moderate-intensity activities (at least 30 min per day); 3 or more days of the week if vigorous intensity activities (for at least 20 min per session).

2.1 Statistical analysis

The data was evaluated by SPSS statistical package version 16.0. Independent sample t-test (2-tailed) was used to compare means of different parameters. The results were considered significant with p-value < 0.05. In addition Pearson's correlation coefficient was used to observe significant changes between the variables measured.

3. Results

Table1: Mean and SD of Anthropometric and life style variables in males and female

Variables	Males (n=294) Mean±SD	Females (n=226) Mean±SD	*p-value*
Age	51.68±10.75	50.14±10.43	0.021
SBP	124.21±14.00	121.54±13.68	0.148
DBP	81.12±11.09	79.69±11.21	0.000**
Weight	68.68±11.81	58.01±11.87	0.000**
Height	165.57±15.33	152.61±11.97	0.003*
WC	92.88±9.67	89.67±14.44	0.002*
HC	95.96±9.67	95.06±14.99	0.960
BMI	24.72±4.06	24.69±5.41	0.551
WHR	0.96±0.09	0.95±0.16	0.000**
Smoking	1.79±0.43	2.00±0.00	0.002*
Alcohol	1.83±0.37	1.98±0.13	0.020*
Activity	2.69±0.53	2.79±0.44	0.620
Tobacco	1.90±0.28	1.81±0.38	0.020*
Diet	1.06±0.25	1.05±0.23	0.620

**p<0.05* considered as significant, ***p<0.005* considered as highly significa

The mean anthropometric and life style variables of the subjects in this study are shown in table 1. Of the 520 subjects 294 were males and 226 were females. The mean age for females were 50.14 and for males were51.68 years respectively. The mean height in males was 165 and in females was 152 cm. Male subjects had more weight (68.68kg) than females (58.08kg) and is statistically significant(*p<0.000*). The mean SBP in males was 124 mmHg and in females 122 mmHg highly significant (*p<0.000*) DBP was observed between males (82) and females (80). The higher mean WC was observed in males (92.88cm) than in females (89.67) and it was statistically significant (*p< 0.002*). The highly significant (*p<0.001*) difference was found with respect to WHR in males and females. The lifestyle variables like smoking (*p<0.002*), alcohol (*p<0.020*) and tobacco chewing (*p<0.020*) were showed significant difference between males and females.

Table 2: Mean and SD values of biochemical parameters in males and females

Variables	Males (n=294) Mean±SD	Females (n=226) Mean±SD	*p-value*
FBS	91.66±46.97	89.82±35.09	0.020*
PPBS	144.31±74.31	134.30±55.48	0.241
TC	177.63±39.92	181.83±42.04	0.051
TG	192.64±109.60	153.91±68.10	0.000**
HDL-c	41.01±42.73	42.75±21.80	0.012*
LDL-c	101.31±31.65	115.02±84.16	0.000**
VLDL-c	38.88±23.23	30.74±13.53	0.394
FI	11.06±11.34	10.22±10.64	0.203
HbA1c	6.33±1.63	6.16±1.28	0.039
SCr	1.25±4.64	0.68±0.17	0.000**
UA	5.17±1.25	4.12±1.19	0.880
Spalb	162.02±195.00	164.68±203.33	0.410
SUCr	82.06±85.01	75.64±91.66	0.321
ACR	3.23±5.68	4.37±18.58	0.373

*$p<0.05$ considered as significant, **$p<0.05$ considered as highly significant

Table 2 shows the observed biochemical parameters in the study. The mean significant difference ($p<0.020$) was found for FBS (91.66 mg/dl) in males and (89.82mg/dl) in females. The lipid variables like TG and LDL-c showed highly significant ($p<0.001$), whereas HDL-c

Table 3: Percentage of metabolic risk factors in males and females

Variables	Reference	Males (n=294)	Females (n=226)
BMI	≥30	23 (07.82)	32 (14.15)
	<30	271 (92.19)	194 (85.84)
WC	≥102	042 (14.20)	138 (61.06)
	<102	252 (85.71)	88 (38.93)
WHR	≥ 1.0	68 (23.12)	205 (90.70)
	<1.0	226 (76.87)	21 (09.29)
SBP	≥130	145 (49.31)	93 (41.15)
	<130	149 (50.68)	133 (58.84)
DBP	≥85	123 (41.83)	79 (34.95)
	<85	171 (58.16)	147 (68.04)

Note: Values in parenthesis indicate percentages

Table 4: Percentage of metabolic risk factors in males and females

Variables	Reference	Males (n=294)	Females (n=226)
FBS	≥ 100	57 (19.38)	46 (20.35)
	<100	237 (80.61)	180 (79.67)
HbA1c	≥ 6%	142 (48.29)	98 (43.36)
	<6%	152 (51.70)	128 (56.63)
TC	≥ 200	74 (25.17)	64 (28.31)
	<200	200 (68.02)	162 (71.68)
TG	≥150	164 (55.78)	105 (46.46)
	<150	130 (44.21)	121 (53.53)
HDL-c	≥40	104 (35.37)	37 (16.37)
	<40	190 (64.62)	189 (83.62)
LDL-c	≥100	167 (56.80)	133 (58.84)
	<100	127 (43.19)	93 (41.15)
Uric acid	≥5	162 (55.10)	52 (23.00)
	<5	132 (44.89)	174 (76.99)
Scr	≥1	85 (28.91)	16 (07.07)
	<1	209 (71.08)	210 (92.92)
MAU	≥30	257 (87.41)	186 (82.00)
	<30	37 (12.58)	40 (17.69)

Note: Values in parenthesis indicate percentages showed significant ($p<0.012$) but there was no significant difference found for TC and VLDL-c in males and females. Slightly higher mean FI values were observed in males (11.06) than in females (10.22) however there was no significant difference was observed for HbA1c. Mean values of renal function tests like SCr (1.25mg/dl), UA (5.17mg/dl) SUCr (82.06mg/dl) were found in males whereas, Spalb (164.68mg/dl) and ACR (4.37 mg/dl) was higher in females than males but no significant difference was observed and highly significant difference ($p<0.000$) were observed for SCr between males and females The most common metabolic risk factors are shown in table 3 and 14% males and 8% females were having BMI≥30kg/m2. 61.06 % females 14% males had WC≥102cm. The higher percent female subjects (91%) showed WHR ≥1.0 compared to male subjects (23%). 49% males had SBP≥130mmHg and 41% females had SBP≥ 130mmHg respectively. 41% males and 35% females showed DBP ≥85mmHg. However higher percentage females showed BMI, WC and WHR whereas SBP and DBP was higher in males.The 20% females had FBS≥ 100mg/dl and 48% males had HbA1c ≥6%. 25% males and 28% females had TC ≥200mg/dl. The males showed higher percentage (55.78%) for TG than females (46.46%). Only 35% males and 16% female subjects had HDL-c ≥40 mg/dl. More than 50% subjects had LDL-c ≥100mg/dl. The percentage values were more for UA, Scr and MAU for males than females.

Figure 1: Prevalence percentage of life style variables in males and females

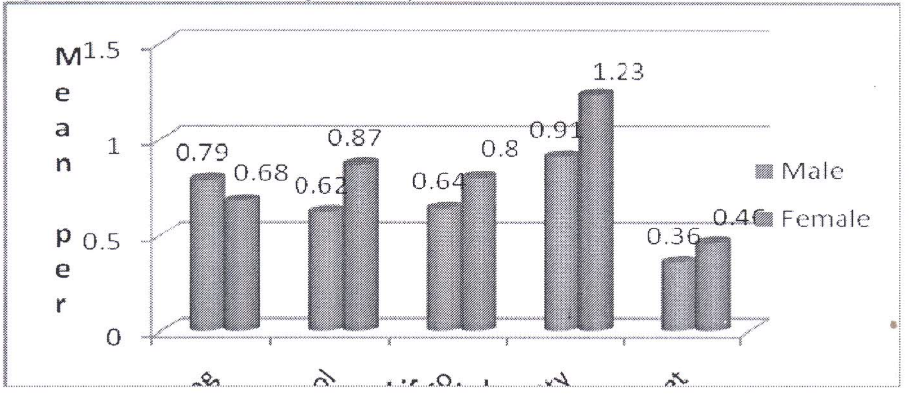
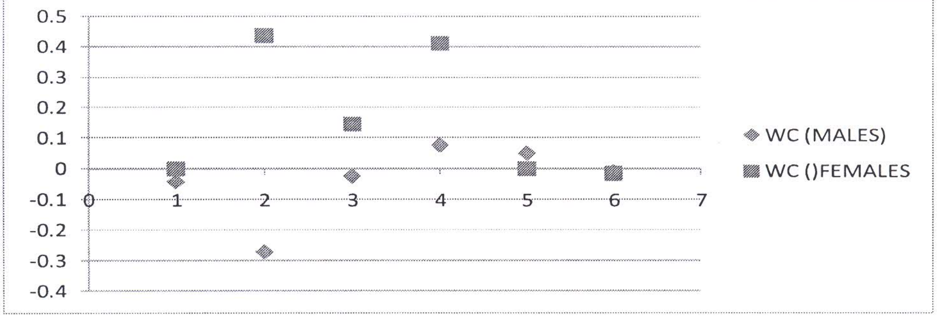


Figure 2: Pearson correlation of WC with age, BMI, HbA1c, Scr and mic alb in males and females



The mean percentage for lifestyle variables are presented in fig.1. 0.79% males showed smoking, more percentages females were observed for alcohol (0.87%), tobacco (0.8%) and activity (1.23%).

No significant correlation was observed with respect to waist circumference (fig2). Age, HbA1c, TG Scr and micro albumin in males whereas BMI (r= -0.272, p=0.000) was significantly correlated with WC in males. With respect to females WC was positively correlated with BMI (r=0.437, p=0.000) and HbA1c(r=0.144,p=0.031). Age, TG, Scr and Micro albumin were not significantly correlated with WC.

4. Discussion

In the present study, the mean values for WC was significant (0.002) between males and females (table1). 14% males and 61% females showed WC ≥102 cm. These results indicate that the risk of developing metabolic syndrome is certainly higher in females with the WC 10^2cm and above (Wannamethee et al., 2010).Studies conducted by Wannamethee et al showed WC and BMI are equal predictors of diabetes in men (Shah et al., 2009). The mean BMI of males (24.72) was slightly higher than females (24.69); however these results were not significant. Significantly higher WHR was observed in males than in females. Similar findings were observed by Shah et al that the risk of developing diabetes is higher with WHR≥1.0 (Park et al., 2005)and the results were statistically significant. Obesity is a positive risk factor in the development of type 2 Diabetes mellitus, dyslipidemia, insulin resistance and hypertension (Park 2005).Obesity is often expressed in terms of body mass index (BMI) (flier et al., 2005).The distribution of adipose tissue in different anatomic depots also has substantial implications for morbidity. Specifically, intra-abdominal and abdominal subcutaneous fat has more significance than subcutaneous fat present in the buttocks and lower extremities. Determining the waist-to-hip ratio (W/H ratio), most easily makes this distinction (Carey et al., 1997). The risk of diabetes increases progressively with increasing body mass index and waist-hip ratio. Weight gain is associated with an increase in insulin resistance and deterioration in glucose tolerance. Mainly the centrally located adipocytes have specific metabolic roles in the pathogenesis of insulin resistance and type 2 diabetes mellitus (Narasimha et al., 2012). Narasimha et al found that, as Waist-Hip (W/H) ratio increases, serum cholesterol and triglyceride levels increases in male type 2 diabetes mellitus patients. In this study we also found highly significant TG and LDL-c values in males and females. Haffner SM et al., in 1987 assessed diabetes and cardiovascular risk factors in Mexican-Americans and found that W/H ratio was associated with type 2 diabetes mellitus rates, low HDL-cholesterol levels and high triglyceride levels. Buynes C et al., studied the sex differences in fat distribution, W/H ratio, serum lipids, and blood pressure, in male and female patients with type 2 diabetes mellitus, and found that men had higher W/H ratio and lower HDL-cholesterol. The SBP observed in our study was not significant, even though it was more in males compared to females. These results are similar to the observations by wei-lian Phan et al. This showed that SBP helps to prevent several metabolic syndrome complications in males. BMI is one of the components which manifest the strongest independent contribution to elevated SBP (≥120mmhg) in males (Rosediani et al., 2006).

FI levels were elevated in both males and females, but the levels were found within physiological range. With reference to the mean HbA1c and FBS levels of males were more compared to females. A significant relation between HbA1c and FBS is in agreement with earlier reports (Bonora et al., 1996).Elevated uric acid is a consistent feature of the insulin resistance syndrome, which are characterized by high plasma insulin levels, blood glucose concentrations and serum triglyceride concentrations and raised BMI and WHR (Johnson et al., 2005). In our study we have observed slightly higher levels of uric acid in males than in females, which may suggest the presence of insulin resistance.

The higher values of micro albuminuria were observed in males than in females. Studies conducted by Broch. K et al., have reported an increased prevalence of micro albuminuria in men compared with women(Deckert et al., 1989).The casual risk factors for micro albuminuria are raised blood pressure, and older age, male sex and preexisting retinopathy. Micro albuminuria has also been reported to be associated with generalized vascular disease (Dunn et al., 1988). AER (urinary Albumin Excretion Rate) is most important and should be done frequently but there are gains to be made in predictive precision by considering family history, smoking habits, glycemia, B.P.,BMI and lipid levels. Early screening for insulin resistence and aggressive management of these risk factors is important in optimizing the risk for insulin resistence. We observed significant relation between BMI and WC in males and significantly positive correlation in females (figure 2). Several investigators have reported significant correlations between BMI and lipid profiles and suggested the importance for insulin resistence32.Along with other risk factors including hypertension, smoking and obesity, the other factors like physical activity, type of diet and alcohol consumption is also increasing importance has been given to secondary hyperlipidemia in the causation of accelerated atherosclerosis.

Conclusion

We found that MetS is becoming a common chronic disease among South Indian rural population. 14 % males and 61% females in this study had MetS. However females had higher risk of MetS compared to males. Multidimensional efforts are needed to deal with the growth of chronic diseases in South Indian rural population. MetS can serve as a good indicator of the health burden where the population is facing. Measurers such as educational programs, screening and prevention need to be taken at the peripheral level.

Limitations

In this study wide range of age group included, specific age and gender classification is required to compare the results.

Recommendations

This study has done on rural populations, to predict better results, urban population should be included.

Research Highlights

Females had highest metabolic risk compared to males.Lifestyle variables like smoking, alcohol and tobacco chewing and also biochemical variables such as fasting blood sugar, triglycerides, low density lipoproteins and high density lipoproteins were serves as good indicators for metabolic syndrome.

Funding and Policy Aspects
Nil

Authors' Contribution and competing interests

Dr. Madhavi Reddy: Concepts, design, literature search, experimental studies, data acquisition, data analysis, data acquisition, statistical analysis, manuscript preparation, manuscript editing, manuscript reviewand guarantor.

Dr. Raja Reddy P.: Literature search, experimental studies, manuscript preparation, manuscript editing, manuscript review.

Mrs. Munilakshmi U.: Data acquisition, data analysis, data acquisition, statistical analysis, manuscript preparation, manuscript editing, manuscript review.

Dr. Lakshmaiah V.: Concepts, manuscript preparation,manuscript editing,manuscript review.

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