International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Original Research Article

Prevalence of Metabolic Syndrome and Its Association with Lifestyle Factors In Type-2 Diabetics in Southern Tamilnadu

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ABSTRACT

Aim: To evaluate the prevalence of metabolic syndrome according to modified NCEP ATP III definition and its association with lifestyle factors among adult type-2 diabetics in southern Tamilnadu, India.
Methods: 1126 adult type-2 diabetics (663 male, 463 female) from a diabetic clinic were enrolled in the study based on purposive sampling. Baseline characteristics, clinical data, lifestyle habits and food frequency pattern were elicited through a validated questionnaire. Study parameters included anthropometric indices and blood pressure, measured by standard techniques, and the biochemical profile obtained from the hospital records. The data obtained were analysed statistically. The modified NCEP ATP III definition was used to identify MS.
Results: Mean age of the subjects was 52.31 years. Prevalence of metabolic syndrome was three fourth (77.44%), higher among women (84.67%) as compared to men (72.40%), and it was highest among the age group of 60 to 70 years (81.77%). Women had higher prevalence of low HDL and central obesity. No strong association of independent variables in predicting MS was observed.
Conclusion: The prevalence of MS is high among type-2 diabetics. This highlights the significance of routine screening and preventive strategies in type-2 diabetics to identify and treat the cardiovascular risk factors.
Key words: type-2 diabetes, metabolic syndrome, prevalence, food frequency, lifestyle

INTRODUCTION

Diabetes Mellitus is increasing rapidly, particularly in developing countries of the world resulting in a substantial burden on the healthcare services. Globally, the prevalence of type-2 diabetes mellitus is expected to rise from 6.4% in 2010 to 7.7% in 2030. [1] In Tamil Nadu, the prevalence of diabetes in urban areas (13.7%) is almost double the rate found in rural areas (7.8%) and the overall weighted prevalence of prediabetes is 8.3%. [2] A survey carried out in 2011-12, in all pin code areas of Madurai city revealed 13 per cent to be suffering from diabetes and another 12 per cent in the pre-diabetic stage. The data collated from these surveys indicate that a quarter of Madurai's population has diabetes. [3]

The metabolic syndrome characterized by abdominal obesity, dyslipidemia, hyperglycemia and hypertension, has become one of the major public health challenges worldwide. It is a concurrence of several closely associated cardiovascular risk factors and has become a subject of great interest because of its

association with type-2 diabetes and atherosclerotic cardiovascular disease. [4] The prevalence of metabolic syndrome (MS) depends on the definitions used as well as the population being studied. [5] The number of people with MS differs by gender, age, ethnicity and environment of the population. [6] Type-2 diabetes mellitus (T2DM) is a significant risk factor for coronary heart disease (CHD) and stroke. Moreover, the prevalence of CHD in patients with T2DM increases significantly with the addition of MS components.

Majority of the patients with T2DM also have MS and are predisposed to higher risk of cardiovascular diseases, stroke and premature death compared to both non-diabetic individuals and diabetic individuals without MS. Presence of MS in T2DM has been shown to decrease the survival rate at least by 10 years. [7] Lifestyle factors such as dietary habits influenced by region and culture, smoking and physical inactivity appear to play an important role in increasing the risk of CVD. [8] A study conducted in an urban Indian population stated a MS prevalence of 77.2% among T2DM. [9] Prevalence of MS, especially among T2DM, in southern Tamilnadu has not been reported so far. Hence this study aims to identify prevalence of MS and its association with lifestyle factors in a diabetic population in Madurai, a southern district in Tamilnadu, India.

With type-2 diabetes growing as a pandemic in India, especially Tamilnadu, the risk of CVD is an alarming burden on the individual. Estimating the prevalence of metabolic syndrome in type-2 diabetics predicts the risk of CVD and can be used as a screening measure for initiating preventive strategies.

MATERIALS AND METHODS

The observational study was based on a cross-sectional representative sample of 1126 adult type-2 diabetics attending outpatient diabetic clinic of Arthur Asirvatham Hospital, Madurai, during the period, April 2016 to January 2017. A questionnaire was developed to elicit information on the demographic and socio-economic profile, lifestyle habits - smoking, alcohol consumption, physical activity and food consumption pattern. Institutional Ethical Committee approval was obtained for the conduct of the study in April 2016.

Study Design:

1126 adults receiving treatment at the diabetic clinic were selected for the study by purposive sampling based on the inclusion criteria of being able to read the questionnaire and provide informed consent, above 18 years of age, diagnosed as type-2 diabetic for at least one year and the exclusion criteria of having no severe co-morbidities, pregnancy or psychiatric disorder.

Information about the diabetic subjects on the socio-demographic variables and current biomedical indicators of metabolic control of their disease were collected, using a pretested questionnaire in Tamil language, in a room near the out-patient department. The researcher was present to offer assistance, while the patients were answering the questionnaire. The disease status and metabolic control indicators were double checked either with patient information obtained from the questionnaire or the patients' data available in the computer present in the outpatient department.

Anthropometric measurements and Biochemical tests:

The researcher measured the anthropometry of each participant of the study which includes height, weight, waist and hip circumferences. The participants were measured for weight and height using a digital Omron weighing scale and Omron body meter, respectively. Body mass index (BMI) was calculated as kg/m^2. Waist and hip circumferences were measured using a tape when the participant stood in abduction and the tape was placed just above the umbilicus and the widest part around the hip, respectively. Blood pressure was measured using sphygmomanometer and

stethoscope when the subject was at restful conditions. Data on fasting plasma glucose and lipid profile were obtained from the patients' records maintained in the out-patient department. Standard laboratory procedures have been followed to assess the biochemical profile which included Fasting Plasma Glucose, Serum Triglyceride, Total Cholesterol and HDL Cholesterol. LDL Cholesterol was calculated using Friedewald formula.

Criteria for Metabolic Syndrome (modified NCEP ATP III definition): [10]

Presence of any three of the following five factors is required for diagnosis of metabolic syndrome.

- Central Obesity (modified for Indians): Waist Circumference: Men>90cm,
- Women>80cm
- Fasting Plasma Glucose ≥100 mg/dl or diagnosed with type-2 diabetes
- Fasting Plasma Triglyceride >150 mg/dl
- Fasting Plasma HDL cholesterol: Men <40mg/dl, Women <50 mg/dl
- Blood Pressure ≥ 130/85 mmHg or on anti-hypertensive drugs

Data Analysis

Data were computed using Excel database and analyzed using SPSS version 22.0 for Windows (SPSS Inc., Chicago, USA). Based on normality test, all continuous data were found to be normally distributed and were presented as descriptive statistics i.e., mean and standard deviation, and gender comparisons using unpaired 't' test. The categorical data were expressed as frequencies and percentages. The statistical significance was assumed at a p-value of <0.05. Prevalence of Metabolic syndrome was calculated based on age and gender. Variables such as age, gender, socio-economic status, lifestyle habits, dietary habits, BMI, waist circumference, systolic and diastolic blood pressure, family history of diabetes and duration of diabetes were used as independent variables. Association of independent variables with MS was identified using multinomial logistic regression analysis.

RESULTS

The findings of the observational study are presented below:

Study sample

The study population (N=1126) consisted of 463 female (41.12%) and 663 male (58.88%) eligible type-2 diabetics visiting the out-patient department of the diabetic clinic who volunteered to enrollin the study with informed consent. Description of the baseline characteristics of the study sample is presented in **Table 1**.

Baseline characteristics

Mean age of the male and female subjects was 53.41 and 51.21 years respectively. More than half of the study population were graduates (66.21% and 61.99% male and female subjects respectively), only 28.08% of the women participants were unemployed, a majority (53.09% men and 44.28% women subjects) of them belonged to upper middle and upper classes respectively as per Kuppuswamy's [11,12] classification of SES adapted to the current year of study. The subjects had a mean duration of ten years since diagnosis of type-2 diabetes. Parental history of diabetes was as high as 45% in both male and female subjects while the family history of CVD or HT was negligible.

Lifestyle habits

Lifestyle has a direct effect on metabolic syndrome. [13] **Table 1** depicts the frequency distribution of lifestyle habits of the diabetic subjects. Tobacco consumption was more prevalent (23.83%) as smoking cigar among male type-2 diabetics and only one fourth (27.45%) of the male subjects had the habit of alcohol consumption. Most of the subjects, (89.44% men and 92.01% women) had no routine physical exercise, and among the rest, majority of them followed walking as a routine exercise. Among those who had an exercise schedule, most of them preferred duration of 45 minutes for exercising. Three-fourth of the diabetics were non-vegetarians (75.11% male and 77.32% female subjects), a maximum (91.1% male and 89.2% female) percentage of the subjects preferred a

frequency of 3 meals per day and 3/4th of male and one half of female subjects had the habit of snacking between meals.

Table 1: Baseline characteristics of the study sample (N = 1126)

Variable	Male (n=663) Mean ±SD or n(%)		Female (n-463) Mean ±SD or n(%)	
Mean Age (yrs)	53.41 ±11.05		51.21 ±12.71	
Marital Status				
Married	608 (91.7)		417 (90.06)	
Single	55 (8.3)		46 (9.93)	
Type of family				
Joint	477 (71.95)		326 (70.41)	
Nuclear	186 (28.05)		137 (29.58)	
Education				
Middle school	60(9.05)		48 (10.37)	
SSLC	47 (7.09)		51 (11.02)	
Higher secondary/Diploma	117 (17.65)		77 (16.63)	
UG/PG	439 (66.21)		287 (61.99)	
Socio-economic status*				
Lower class	-		-	
Upper lower	98 (14.78)		122 (26.35)	
Lower middle	213 (32.13)		136 (29.37)	
Upper middle	301 (45.4)		173 (37.37)	
Upper class	51 (7.69)		32 (6.91)	
Duration of diabetes	10.91 ±7.04		10.15 ±6.9	
Family history of disease	Diabetes	CVD/HT	Diabetes	CVD/HT
Parent	302(45.55)	7 (1.00)	210(45.26)	9 (1.94)
Sibling	144(21.72)	22 (3.32)	70(15.09)	28 (6.03)
Grand parent	13 (1.96)	-	17 (3.66)	-
Lifestyle habits				
Cigar	158 (23.83)		-	
Snuff	6 (0.90)		-	
Tobacco	2 (0.30)		1 (0.21)	
Alcohol	182 (27.45)		-	
Type of exercise				
Walking	53 (7.99)		33 (7.12)	
Yoga	16 (2.41)		4 (0.88)	
Duration of exercise				
>=45 min	57(81.43)		31 (83.78)	
<45 min	13(18.57)		6(16.21)	
Food habits				
Veg	77(11.61)		59(12.74)	
Veg with egg	88(13.27)		46(9.94)	
Non Veg	498(75.11)		358(77.32)	
3 meals/day	604(91.1)		413(89.2)	
>3 meals/day	59(84.90)		50(10.80)	
Snacking between meals				
No	165(24.89)		123(26.57)	
Yes	498(75.11)		340(51.28)	
Food frequency				
Consumption of greens &vegetables				
One serving daily	286(43.14)		199(42.98)	
>1 serving daily	237(35.75)		156(33.69)	
Consumption of fruits				
Occasionally	321(48.42)		219(47.3)	
Never	231(34.84)		150(32.4)	
Consumption of roots & tubers				
Occasionally	288(43.44)		185(39.96)	
Never	334(50.38)		251(54.21)	
Consumption of sea foods				
Never	302(45.55)		226(48.81)	
Occasional	350(52.79)		226(48.81)	
Consumption of sugars				
Never	291(43.89)		205(44.28)	
Occasional	342(51.58)		238(51.4)	

*As per Kuppuswamy's SES classification for 2016 **[11,12]**

Food frequency pattern

Dietary behaviour is an important factor in the maintenance of good health especially in chronic metabolic disorders. Food frequency pattern of the participants was derived through the pre-tested

questionnaire and the findings are provided in Table 1. Nearly one third and more than 40% of the subjects consumed cereals and pulses respectively, at least once a day, 42% consumed roots and tubers occasionally while 50% never included it in their meal. Greens and vegetables were included once a day by a majority (>42%) of the subjects. Fruits were included occasionally by almost half (47.97%) the number of subjects. More than 45% of them never or occasionally consumed sea foods. Dairy products were consumed once a day (47.87%) or 2 to 3 servings a day (30.28%). Only 44% of the subjects avoided sugar/ jaggery completely in their routine diet. Oils and spices formed part of their daily meal pattern. Restricted servings of cereals and consumption of 3 to 4 servings of fruits and vegetables every day are proven to improve the metabolic state in type-2 diabetes.

Data on the anthropometric and biochemical parameters is presented in Table 2.

The mean anthropometric and biochemical parameters (waist circumference, blood pressure, fasting glucose and triglycerides) were comparable between the male and female diabetics, except for BMI, Total cholesterol, LDL and HDL cholesterol which showed significant (P<0.001) differences. Women diabetics exhibited higher occurrence of individual parameters above the given cut-off limits as defined by modified NCEP ATP III except hyperglycemia, which was observed in higher proportion in male diabetics. A greater proportion of women subjects had central obesity (91.14%) and low HDL (71.06%) levels. This striking difference observed between male and female subjects could partially be attributed to the lower cut-off for waist circumference and higher cut-off for HDL for women as compared to men.

Table 2: Mean values and frequency distribution of anthropometric measures and biochemical parameters

Parameter	Male	Female	't'-value	No. of subjects above cut- off values	
	n=663	n=463	P value	Male	Female
BMI (kg/m^2)	25.25 ±4.45	27.62 ±4.92	8.42 P<0.001***	-	-
Waist Circumference(cm)	95.4 ±11.49	94.5 ±12.41	1.25 0.211	485 (73.15%)	422 (91.14%)
Blood Pressure Systolic (mmHg)	130.94 ±19.85	133.39 ±20.41	2.01 0.044	406 (61.24%)	296 (63.93%)
Blood Pressure Diastolic (mmHg)	81.3 ±11.07	80.88 ±11.33	0.62 0.535		
Fasting Plasma Glucose (mg/dl)	177.31 ±75.08	172.36 ±72.52	1.103 0.270	596 (89.89%)	403 (87.04%)
Total Cholesterol (mg/dl)	180.17 ±47.83	190.24 ±45.5	3.55 0.0004***	-	-
Triglycerides (md/dl)	175.07 ±100.33	176.17 ±95.78	0.184 0.853	308 (46.46%)	217 (46.87%)
LDL Cholesterol (mg/dl)	115.45 ±38.88	121.82 ±37.51	2.74 0.006**	-	-
HDL Cholesterol (mg/dl)	41.6 ±9.53	44.46 ±15.21	3.87 0.0001***	305 (46.00%)	329 (71.06%)
Parameter	Male	Female	't'-value	No. of subjects above cut- off values	
	n=663	n=463	P value	Male	Female
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Blood Pressure Systolic (mmHg)	130.94 ±19.85	133.39 ±20.41	2.01 0.044	406 (61.24%)	296 (63.93%)
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HDL Cholesterol (mg/dl)	41.6 ±9.53	44.46 ±15.21	3.87 0.0001***	305 (46.00%)	329 (71.06%)

Table 3: Prevalence of metabolic syndrome according to modified NCEP ATP III definition

Age groups	Men n=663 (f %)	Women n=463 (f %)	Total N=1126 (f %)
< = 30	3 (30.00)	14 (53.85)	17 (47.22)
>30 to < = 40	50 (71.43)	55 (85.94)	105 (78.35)
>40 to <=50	142 (71.72)	124 (84.93)	266 (77.32)
>50 to <=60	154 (72.99)	107 (88.43)	261 (78.61)
>60 to <=70	107 (77.54)	68 (89.47)	175 (81.77)
>70	24 (66.67)	24 (80.00)	48 (72.72)
Total	480 (72.40)	392 (84.67)	872 (77.44)

The study identifies (Table 3) the overall prevalence of metabolic syndrome to be above three fourth (77.44%) of the diabetic sample in an urban southern district of India. Prevalence of metabolic syndrome was higher among women (84.67%) as compared to men (72.40%). The difference may be owing to the gender based difference in the cut-off points for individual markers of metabolic syndrome. It is also derived that the prevalence of MS is higher in the age group of 60 to 70 years in both male (77.54%) and female (89.47%) diabetics and less (47.22%) among those below 30 years as shown in Table 3.

There also exists a significant difference in the mean values of almost all the parameters among the diabetic subjects with and without metabolic syndrome both in men and women except LDL-C in men (Table 4).

Table 4: Comparison of mean anthropometric and biochemical determinants between subjects with and without metabolic syndrome

Parameters	Female(n=463)		P-Value	Male(n=663)		P-Value
	Without MS(n=71)	With MS (n=392)		Without MS(n=183)	With MS (n=480)	
	Mean±SD	Mean±SD		Mean±SD	Mean±SD	
BMI (kg/m^2)	26.11 ±4.92	27.89 ±4.87	0.005**	23.13 ±4.85	26.06 ±4.004	P<0.001***
Waist Circumference (cm)	89.57 ±11.87	97.63 ±10.53	P<0.001***	89.20 ±14.05	95.49 ±11.88	P<0.001***
Blood Pressure Systolic (mmHg)	118.7 ±17.06	136.04 ±19.85	P<0.001***	118.7 ±14.03	135.63 ±19.77	P<0.001***
Blood Pressure Diastolic(mmHg)	74.08 ±7.85	82.11 ±11.44	P<0.001***	75.05 ±8.17	83.68 ±11.09	P<0.001***
Fasting Plasma Glucose (mg/dl)	137.39 ±65.18	178.69 ±72.05	P<0.001***	159.79 ±79.22	184.07 ±72.02	P<0.001***
LDL Cholesterol (mg/dl)	109.49 ±32.76	124.05 ±37.92	0.003**	111.9 ±34.3	116.89 ±40.45	0.140
HDL Cholesterol (mg/dl)	48.45 ±10.39	43.74 ±15.83	0.016*	45.51 ±8.62	40.09 ±9.43	P<0.001***
Triglycerides (mg/dl)	111.46 ±20.5	187.90 ±99.33	P<0.001***	123.1 ±50.81	194.7 ±107.24	P<0.001***

The mean BMI and waist circumference of the female diabetics and fasting glucose of both men and women subjects without MS were also above the cut-off values and HDL level was lower than the minimum limit among women. This indicates that central obesity is the forerunner of metabolic syndrome in type-2 diabetics, especially in women, followed by low HDL levels.

Positive correlations existed between BMI, waist circumference, blood pressure, fasting and post-prandial glucose levels at 0.01 level of significance (2-tailed). Triglyceride levels were also positively correlated with FPG, PPG, TC and LDL but negatively associated with HDL at 0.01 level of significance (2-tailed).

Even though metabolic syndrome was highly prevalent and positive correlations existed between dependent variables, the association of independent variables namely, age and socio-economic status, lifestyle factors such as smoking and food habits, anthropometric measures such as BMI, and biochemical parameters were found to be statistically non-significant (P>0.001) in predicting MS in multinomial logistic regression model as depicted in Table 5. This may be attributed to the setting of the study sample. However, the odds ratio for presence of hypertension had a significant level of prediction (P<0.005) of MS in male subjects. Similarly, the odds ratio for lack of exercise and longer duration of disease had a marginal significance (P<0.05) in female subjects.

Table 5: Multinomial logistic regression of independent variables affecting Metabolic syndrome

Independent variable	Female subjects		Male subjects	
	OR(95% CI)	P value	OR(95% CI)	P value
Age (>60 yrs) Yes/No	16.3(0.86-308.65)	0.063	1	-
Duration of diabetes > 5 yrs Yes/No	1.28(1.02-1.60)	0.028*	1.04(0.91-1.18)	0.529
SES(upper class) Yes/No	2.4(0.32-18.58)	0.384	1.381(0.50-3.78)	0.531
Smoking (Yes/No)	-	-	2.845 (0.16-49.87)	0.474
Exercise (Yes/No)	0.45(0.22-0.91)	0.028*	1.00(0.65-1.54)	0.979
Food habit Non-veg Yes/No	1.15(0.79-1.67)	0.449	0.91(0.69-1.20)	0.527
BMI >23kg/m^2 Yes/No	1.01(0.90-1.13)	0.823	1.09(0.99-1.20)	0.054
Hypertension Yes/No	1.03(0.98-1.08)	0.208	1.04(1.01-1.08)	0.005**
Hypertriglyceridemia Yes/No	1.03 (1.01-1.04)	0	1.01 (1.01-1.02)	0
Abnormal HDL Yes/No	0.95 (0.94-0.97)	0	0.89 (0.86-0.92)	0

DISCUSSION

The overall prevalence of metabolic syndrome in the study population of type-2 diabetics was as high as 77.44%. Similar high prevalence rate of 66.2% was reported by [13] in newly detected diabetic individuals in Kerala [9,14] also stated a high prevalence rate of 77.2% and 71.7% respectively in type-2 diabetics. However, studies conducted in the general population of the Southern Indian state of Tamilnadu, [15] the Eastern Indian state of Orissa [16] and the Northern state of Uttar Pradesh [17] observed a prevalence rate of 41%, 43.2% and 11.7% respectively. This evidences the fact that diabetes increases the risk for MS, irrespective of the region studied, when compared to the general population whichshowed comparatively lower risk and also significant regional differences.

The higher prevalence of MS in female diabetics observed in our study is well supported by the findings of. [18,19,16,20,21,22,13] This calls for an urgent need to focus on the high risk woman population with target screening so as to reduce the individual components of MS and thereby minimize the risk of CVD. [23]

The prevalence rate increases with increasing age across the genders, with a peak prevalence in the age range of 60-70 years, in agreement with the findings of Sawant *et al.* [24] This may be attributed to the addition of MS components with increasing age. However, there is a marginal decline in the prevalence rate beyond the age of 70, possibly due to loss of body mass which may have resulted in decreased likelihood of MS components.

Central obesity and reduced HDL cholesterol are the predominant components of MS in our study subjects as evidenced by. [19] The above observation is not surprising, with waist circumference being the principal parameter for defining metabolic syndrome along with lower cut-off for women. Raman *et al.* [23] report that central obesity is the single most contributing factor to metabolic syndrome in type-2 diabetes, followed by low HDL levels, both being predominant factors even in women without metabolic syndrome.

Low HDL is very common among Asian Indians as evidenced by various studies. [25,16,13] It is noted in our study that a higher percentage of women diabetics (71.06%) had HDL levels below the minimum cut-off value when compared to men (46%) which may be due to their post-menopausal age and partly due to more stringent cut-off criteria for women. Many studies have confirmed the existence of correlation of central obesity with insulin resistance, dyslipidemia, hypertension and cardiovascular disorders. [26]

Hyperglycemia is another highly prevalent component (88.72%) of metabolic syndrome in the study group denoting uncontrolled diabetes. Bonora *et al.*, [27] reported the prevalence of higher waist

circumference, blood pressure and low HDL according to IDF definition for metabolic syndrome in diabetic subjects to be 87% 69%, and 59% respectively. The findings are a cause of great concern as it evidences a greater risk of developing micro and macro-vascular complications of diabetes. [23] Lifestyle factors such as socio-economic status, food habits and smoking had no statistically significant association with MS. Jacob *et al.,* [13] report similar results through multinomial logistic regression model. However, longer duration of disease, lack of exercise and being hypertensive showed a marginal prediction of MS in the study sample. In adults who have type 2 diabetes, the presence of metabolic syndrome is associated with a fivefold increase in CV risk independent of age, sex, smoking status, and glycated hemoglobin (HbAlc). [27] Management of parameters by lifestyle modification is necessitated to prevent and treat the increased cardiovascular risk. Further, long term studies are needed to identify the association of the lifestyle variables in contributing to metabolic syndrome in type-2 diabetes.

In the present study, all the anthropometric and biochemical parameters of MS were significantly higher in both male and female diabetics with MS than the subjects without MS. Nahar *et al.,* [28] also stated significant differences between type-2 diabetics patients with and without MS according to modified NCEP ATP III criteria.

Identifying the prevalence of Metabolic Syndrome and associated risk factors in people with diabetes are important for prevention or delaying of complications including macro and microvascular disease. This study elucidates the interaction between the variables in metabolic syndrome in type-2 diabetes patients in Madurai, Southern Tamilnadu, India. In a developing country like India, increasing urbanization and lifestyle changes have led to an increased incidence of diabetes. [15] Hence it is imperative that health care system encourages dietary adherence and healthier lifestyle to prevent or treat markers of metabolic syndrome among the increasing population of type-2 diabetics.

Limitations

The cross-sectional study cannot evaluate the prospective effect of lifestyle on the incidence of metabolic syndrome. Therefore, longitudinal cohort studies to assess the association of independent variables in metabolic syndrome among type-2 diabetics are recommended. Further, gender imbalance was observed with a predominantly male population in the study group. However, the findings demonstrate the important aspects of metabolic syndrome among type-2 diabetics in the unexplored region of Madurai district.

CONCLUSION

Prevalence of metabolic syndrome was high among the type-2 diabetic study population, higher among women and in increasing proportions with increasing age across genders. A high proportion of abdominal obesity was observed. Uncontrolled diabetes was a common feature.

The high risk of metabolic syndrome observed in the study necessitates the healthcare system to monitor the trends of MS over a period of time in different regions and to practice preventive strategies. Early intervention with lifestyle modification such as regular exercise, abstinence from tobacco and alcohol, dietary adherence by carbohydrate restriction, avoidance of trans-fats in the form of fried/processed foods and increased intake of locally grown fruits and vegetables form the cornerstone to prevent complications of type-2 diabetes and reduce the risk of CVD.

Funding: No funding sources supported the study

Ethical Approval: The study was approved by the Institutional Ethical Committee

ACKNOWLEDGEMENT

The authors acknowledge the support received from the staff and visiting patients of the outpatient and dietary departments of the diabetic clinic. They also acknowledge Mr. V. Mani, (Biostatistician) for the statistical analyses.

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How to cite this article: Sharmila JB, ThahiraBanu A, MaryAnn GJ et al. Prevalence of metabolic syndrome and its association with lifestyle factors in type-2 diabetics in southern Tamilnadu. Int J Health Sci Res. 2018; 8(5):277-286.

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