ejpmr, 2023,10(7), 467-473

SJIF Impact Factor 6.222

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Research Article

ISSN 2394-3211

EJPMR

A CROSS-SECTIONAL STUDY ON METABOLIC SYNDROME (NCEP ATP III) AND IDENTIFYING THE INFLUENCE OF DIET USING FOOD FREQUENCY QUESTIONNAIRE

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Article Received on 22/05/2023 **Article Revised on 12/06/2023** **Article Accepted on 02/07/2023**

ABSTRACT

Objective: The objectives of the study were to screen the patients for MetS using NCEP ATP- III criteria, to predict the prevalence of CVD risk using FRS, to assess the impact of dietary pattern using food frequency questionnaire (FFQ), to find out various risk factors. **Methodology:** A cross sectional study was conducted for a period of 6 months on an estimated sample size of 278. Patients were screened for MetS and CVD risk assessment was done using non-laboratory-based FRS. Patient's dietary habits were analysed and calculated with diet Cal software and Indian Food Composition Table (IFCT). Categorical data and quantitative variables were analysed using Chi-square test, unpaired t-test and one-way ANOVA respectively. **Results:** Out of 278 participants,71.9% had MetS and 28.05% did not have MetS. Factors like BMI (25-29.9kg/m2), waist circumference (Male:100-20cm; Female: 90-109 cms), SBP (140-150mmHg), DBP (90-99 mmHg), FBS (>126mg/dl), patients with HTN &T2DM and patients taking treatment for HTN was associated with MetS ($p<0.0001$). MetS was associated with increased carbohydrate intake in females ($p=0.27$), total fat intake in both males and females($p=0.0219$), total protein ($p=0.042$) and monounsaturated fatty acid ($p<0.0001$) intake in males. The increased dietary carbohydrates intake($p=0.027$) showed a positive correlation with intermediate 10year CVD risk. **Conclusion:** Male subjects in the age group of 51-70 years were more at risk of MetS. participants with increased carbohydrate, total protein, fat and total monounsaturated fatty acid intake had a significance association with MetS. The increased carbohydrates intake showed a positive correlation with intermediate 10-year CVD risk.

KEYWORDS: Metabolic Syndrome, Cardiovascular Disease, Framingham Risk Score, Food Frequency Questionnaire.

INTRODUCTION

As per National Policy 2017, the estimated death rate in India due to NCDs were approximately 20.7 million, out of which cardiovascular disease counted for 17.9 million (23%).[1] Key elements contributing to the development of these NCDs have been identified and are studied together under the heading of Metabolic Syndrome (MetS).[2] According to World Health Organization (WHO), MetS can be defined as the cluster of cardiometabolic dysfunction.[3] In the year 2001, the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) proposed a definition and a simple set of diagnostic criteria for metabolic syndrome. It has five components, the presence of any three or more of the five components indicate the presence of MetS.

The components and criteria are listed below:

1. Fasting plasma glucose level at least 110 mg/dl (6.1mmol/l)
2. At least 150 mg/dl (1.7 mmol/l) of serum triglycerides
3. Serum high density lipoprotein cholesterol level less than 40 mg/dl (1.04 mmol/l)
4. BP of at least 130/85 mmHg or controlled with any antihypertensive treatment and or
5. Waist circumference of more than 102 cm.[4]

Therefore, aim of the study was to screen patients for MetS using NCEP ATP III criteria.

Around 59% of the premature mortality is due to CVD in India over two decades highlighting the continuing threat to the population.[5] CVDs are one of the major causes of

disability and premature death worldwide and contribute substantially to the escalating cost of healthcare.[6]

Since the Indian population has the highest prevalence of metabolic profiles at younger ages. There exists a positive association between the nutrient intake and MetS. This study focuses on the food intake of the study participants for the past one month using FFQ which consist of a finite list of foods and beverages as per Indian Food Composition Tables (IFCT) with response categories to indicate usual frequency of consumption over the time period queried.[7] Along with the food pattern another major contribution to obesity is physical inactivity.[8] The best intervention for metabolic syndrome is regular exercise and a balanced diet according to the nutritional guidelines as they modulate insulin sensitivity and influences cardiovascular risk factors.[9] Physical activity on daily basis has a greater impact on the concentration of LDL, HDL and triglyceride levels. There will be a spontaneous decrease in the triglyceride levels and increase in HDL concentration, which has a protective action on patients who are prone to develop CVD.[10]

METHODOLOGY

A cross sectional study was conducted at S.S. Institute of Medical Science and Research Centre, Davangere for a period of six months on an estimated sample size of 278 subjects. This study included male and female participants between 30-80 years of age with social habits like smoking, alcohol consumption and other comorbidities like hypertension, type 2 diabetes mellitus, thyroid disorders, dyslipidaemia, asthma, COPD. Patients with Type I DM, history of CVD or newly diagnosed CVD's, critically ill patients who are at risk of CVD or stroke, patients with mental disabilities, pregnant and lactating women were excluded from the study. Data was collected from inpatient and outpatient of SSIMS hospital using data collection form which included demographics and clinical status, anthropometric measurements, NCEP-ATP III criteria and Food Frequency Questionnaire Participants were divided into two groups with MetS and without MetS according to NCEP- ATP III Criteria and 10-year cardiovascular risk was predicted according to Framingham risk score (FRS). Daily food intake was measured using a 24- hour recall. The food intake frequency was divided into 10 categories and 79 food items. Each food item had a food code linkage corresponding to the code number listed in the Indian food composition table (IFCT, 2017). Nutrient intake for each participant was calculated using Diet Cal software and IFCT. The daily intake of calories, carbohydrates, protein, total fat, total saturated fatty acids, total monounsaturated fatty acids, total polyunsaturated fatty acids was done using diet Cal software. Statistical analysis was performed using Microsoft Excel and SPSS, 18 for windows. The collected data was summarized as frequency and percentage for categorical variables and compared using the chi-square test, unpaired 't' test and one-way ANOVA was used.

RESULTS

The study participants were divided into patients with MetS and without MetS and the mean age± standard deviation of study participants in Mets and non-MetS groups were 58.83±10.76 years and 55±10.95 years respectively. The majority of the participants belonged to male gender in the MetS category. Out of 200 MetS participants, 14(7%) had low risk (FRS<10%), 32 (16%) had intermediate risk (FRS 10-20%) and 154 (77%) had high risk (FRS≥20%).

Table 1: Comparison of Demographic details in patients with or without MetS.

Parameters	With MetS N=200	Without MetS N=78	χ^2 value	P value
Gender				
Male	114(5)	46 (58.97)	0.089	0.764
Female	86(43)	32 (41.02)		
Age (Years)				
30-40	17(8.5)	9 (11.53)	3.483	0.480
41-50	39(19.5)	20(25.4)		
51-60	59(29.5)	24 (30.76)		
61-70	59(29.5)	19 (24.35)		
71-80	26 (13)	6 (7.69)		
Education				
No formal education	34(17)	19(24.35)	3.662	3.003
Primary school	52(26)	16(20.51)		
High school	46(23)	13(16.66)		
Diploma	68(34)	30(38.46)		
Income				
Low income	26(13)	27(34.61)	19.218	<0.0001**
Middle income	141(70.5)	36(46.15)		
High income	33(16.5)	15(19.28)		
Medical history				
HTN	7(3.5)	15(19.23)	75.327	<0.0001**

T2DM HTN &T2DM Hypothyroidism Others	46(23) 89(44.5) 11(5.5) 47 (23.5)	12(15.38) 2(2.56) 1(1.28) 48(61.5)		
Social history Smoker Alcoholic Both None	 58 (29) 9 (4.5) 7 (3.5) 126 (63)	 18 (23.07) 5 (6.41) 5 (6.41) 50 (64.10)	2.238	0.524
Physical activity Sedentary Less active Moderate active Highly active	 1 (0.5) 79(39.5) 111(55.5) 9 (4.5)	 1(1.28) 11(14.10) 57 (73.07) 9 (11.53)	18.819	<0.0001**

As show in table 1, There was no significant association between MetS and demographic factors such as gender (p=0.764), age group (p = 0.480), education (p=3.003) and social history (p=0.524) whereas high significant association was found between MetS and Middle-income group, medical history and physical activity (p <0.001). p <0.05, **<0.001 is considered statistically significant*

Table 2: Comparison of Anthropometric details in patients with or without MetS.

Parameters	With MetS N=200	Without MetS N=78	χ^2 value	P value
BMI (kg/m2) <18.5 18.5-24.9 25-29.9 ≥30	 1 (0.5) 10 (5) 148(74) 41 (20.5)	 1(1.28) 40(51.28) 34 (43.58) 3 (3.84)	85.068	< 0.0001**
Waist circumference in cms (Male) ≤94.9 95-100 100-120 >120	 0 (0) 0 (0) 107 (93.8) 7 (3.5)	 1(1.28) 16 (34.78) 28 (35.89) 1(1.28)	47.389	<0.0001**
Waist circumference in cms (Female) <70 70-89 90-109 >110	 0 (0) 4 (4.65) 69 (80.23) 13 (15.11)	 1(1.28) 14 (43.75) 14 (43.75) 3 (9.37)	31.039	<0.0001**

As shown in table 2, Anthropometric factors such as BMI of 25-29.9 kg/m² and waist circumference of 100-120 cm in males and 90-109 cm in females was found statistically significant with MetS.

Table 3: Comparison of Risk Factors in patients with or without MetS.

Parameters	With MetS N=200	Without MetS N=78	χ^2 value	P value
Systolic BP (mmHg) <120 120-139 140-150 ≥160 ≥180	 0 (0) 40 (20) 99 (49.5) 36 (18) 25 (12.5)	 17 (21.79) 30 (38.46) 18 (23.07) 11 (14.10) 2 (2.56)	66.705	0.000**
Diastolic BP (mmHg) <80 80-89 90-99 ≥100 ≥110	 0 (0) 49 (24.5) 117 (58.5) 31 (15.5) 3 (1.5)	 18 (23.07) 34 (43.58) 13 (16.66) 10 (12.82) 3 (3.84)	75.707	0.000**

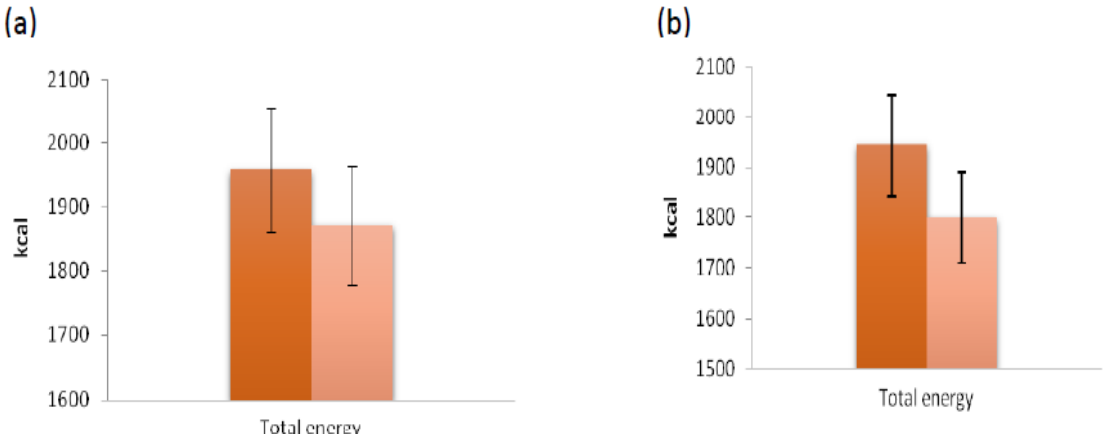
Rx HTN Yes No	 134 (67) 66 (33)	 33 (42.30) 45 (57.69)	14.264	<0.0001**
Fasting Blood Sugar (mg/dl) 70-100 101-125 >126	 02(1) 09(4.5) 189(94.5)	 43(55.1) 06(7.69) 29(37.17)	126.140	<0.0001**

As shown in table 3, There was high degree of statistically significant association between MetS and risk factors such as systolic blood pressure of 140-150 mmHg, diastolic blood pressure of 90-99 mmHg and fasting blood sugar levels of >125 mg/dl and also for the participants who were under treatment for hypertension

Table 4: Dietary pattern analysis using food frequency questionnaire between gender subgroups of with and without MetS

Variables	Men		P-Value	Women		P-Value
	MetS	Non-MetS		MetS	Non-MetS	
Energy (Kcal)	1944.65±431.02	1799.59±409.50	0.0640	1958.63±460.07	1870.45±685.31	0.4231
Carbohydrates (gm)	375.82±165.94	411.14±179.51	0.2843	371.88±143.19*	338.65±171.33	0.019*
Proteins (gm)	58.69±15.01*	54.42±9.59	0.042*	57.95±15.70	55.43±9.29	0.395
Total Fat (gm)	60.04±43.44*	79.33±37.38	0.0219*	57.10±34.77*	73.35±36.16	0.0275*
Total Saturated Fatty Acid (mg)	19780.33±7545.96	18283.32±5842.34	0.2503	19791.81±11453.35	18402.85±6841.22	0.5211
Total Monounsaturated Fatty Acid (mg)	13158.31±4953.89**	33466.69±20482.28	<0.0001**	14076.16±13496.90	15738.97±8638.60	0.629
Total Polyunsaturated Fatty Acid (mg)	9715.18±4009.69	9407.44±3988.71	0.908	9999.74±4032.37	11606.80±7025.65	0.124

As shown in table:4 Dietary quality assessment, the male participants with increased carbohydrate intake had a significant association with MetS than in females (p= 0.019). There was a positive association between the total protein intake and MetS among male participants (p=0.042), similarly increased dietary fat intake in both male(p=0.0219) and female(p=0.0275) participants showed significant association with MetS. The participants who had an increased total Monounsaturated Fatty Acid consumption had a high significant association with MetS.



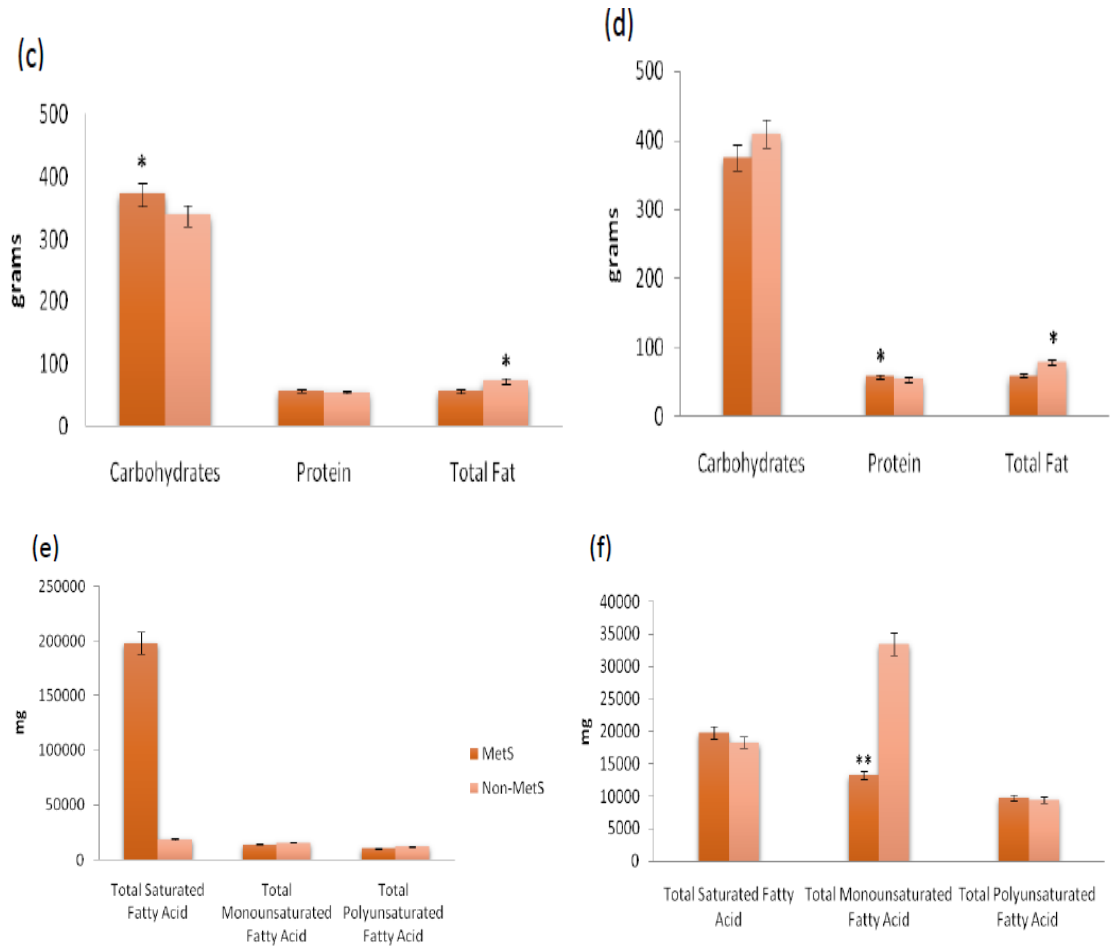


Fig. 1: Dietary pattern analysis using food frequency questionnaire between gender subgroups of with and without MetS *(a)Dietary difference in total energy in MetS and non-MetS female participants, (b)Dietary difference in the total energy in MetS and non-MetS male participants, (c) Dietary difference in the carbohydrates, protein and total fat in MetS and non-MetS male participants, (d)Dietary difference in the carbohydrates, protein and total fat in MetS and non-MetS female participants, (e)Dietary difference in the Total saturated fatty acid, total monounsaturated fatty acid and total polyunsaturated fatty acid in MetS and non-MetS male participants, (f)Dietary difference in the Total saturated fatty acid , total monounsaturated fatty acid and total polyunsaturated fatty acid in MetS and non-MetS female participants.*

Table 5: Dietary pattern analysis in MetS participants with subgroups of FRS using food frequency questionnaire.

Variables	Low-risk	Intermediate-risk	High-risk	P-Value
Energy (Kcal)	1877.62±296.02	2022.98±4761.71	1936.85±446.63	0.4998
Carbohydrates (gm)	368.78±126.61	442.39±211.03	362.45±141.64	0.027*
Proteins (gm)	57.33±17.34	60.09±16.82	58.57±14.84	0.8219
Total Fat (gm)	57.48±34.18	74.18±55.09	57.32±36.29	0.092
Total Saturated Fatty Acid (mg)	19514.69±5051.52	19025.36±7983.83	19925.01±9996.93	0.880
Total Monounsaturated Fatty Acid (mg)	10995.20±4800	16269.26±20840.24	12702.27±4977.85	0.104
Total Polyunsaturated Fatty Acid (mg)	9248.17±5494.69	10274.78±3973.56	9627.75±3889.44	0.639

As shown in table 5, There was a high statistically significant association between intermediate 10 - year CVD risk and dietary carbohydrate intake (p=0.027)

DISCUSSION

The present study was aimed and distinctly designed to determine prevalence of metabolic syndrome (MetS) and CVD risk and to assess the impact of dietary patterns among the Indian population. Socioeconomic status has long been known to predict higher rates of many chronic diseases but according to our results MetS was more prevalent in participants belonging to middle income

group (p <0.0001). The prevalence rate of MetS and moderate levels of physical activity was found to be significant (p<0.0001). In a study by K. Hajian-Tilaki[11] et al states that vigorous physical activity decreased the risk of MetS by 65%. There was a high degree of statistically significant association between MetS and BMI of 25-29.9 kg/m² (p<0.0001). In a previously conducted study in India by Apurva Sawant et al[12] where about three fourth of the subject participated in the study were overweight/obese, being a prime determinant of MetS prevalence. According to our results MetS and waist circumference of 100-120 cm in males and 90-109 cm in females showed a high degree of statistically significant association (p<0.0001). Some studies propose that waist circumference is a more advantageous index of adiposity. According to Angelo Scruteri et al [13] waist circumference is a strong predictor of the incidence of MetS in both men and women. Among the MetS participants, medical history and MetS was found to be significant (p <0.0001). Various study states that there was a marked tendency for hypertensive patients with MetS to develop early signs of end organ damage that may account for a considerable portion of the elevated risk of cardiovascular morbidity. Also, participants who were under treatment for hypertension were found to have statistically significant association with MetS (p < 0.001). There was significant association between MetS and systolic blood pressure of 140-150 mmHg, diastolic blood pressure of 90-99 mmHg (p < 0.001) and the fasting blood sugar levels of >125 mg/dl (p< 0.001). These findings were in accordance with the previous study by Leila Jahangir et al [14] where SBP 131.78±11.03, DBP 88.33±6.45 was found to be prevalent in MetS and high FBS levels were more susceptible to higher CVD risk.

On analysing dietary patterns, results showed that there was a high degree of statistically significant association between MetS and carbohydrate intake in females (p= 0.019). Protein intake in male participants (p=0.042) was also found to be significant with MetS. In a previous study by JaeoukAhn[15] the prevalence of MetS increased 1.089-fold by 5% increase in carbohydrate and moreover there was a significant gender difference: positive association with carbohydrate intakes only in women. However, there was no gender specific significant relation between protein intake and MetS which was contrary to our findings. There was a significant relation between total fat in both males (p=0.0219) and females (p=0.0275), according to a study in Japan by Reneta D Freire et al[16] where a positive association between MetS and total fat was detected that is similar to our results. In our study the total monounsaturated fatty acid in males (p<0.0001) was found significant with MetS but in a study on Korean men by CheongminSohn et al [17] monounsaturated fatty acid was not found significant with FRS. According to our study there was a high degree statistically significant association between intermediate 10 - year CVD risk and dietary carbohydrate intake(p=0.027). In a study by Jeongseon Kim et al [18] high carbohydrate intake was linked to a higher chance of having elevated TG, which is a significant risk factor for CVD. Lower carbohydrate diet score was consistently related to 25% CVD risk reduction.

CONCLUSION

A universal deficiency of awareness, ineffectual screening programs and inadequate interest given to the associated risk factors, all together influence alarmingly high MetS rates. It is noted that the prevalence of CVD among the MetS patients is increasing on a rapid scale. The association of medications and dietary habits play a major role in development of MetS. Male participants had a higher chance of developing MetS than the female counterparts. The subjects in the age group of 51-70 years were more at risk of MetS. Participants with Middle income, who had completed Diploma/ masters, who were moderately active and with both HTN and T2DM higher probability to develop MetS. All the anthropometric parameters like BMI and WC showed a positive association with Mets. Our study analysed the dietary pattern of the participants and it was concluded that participants with increased carbohydrate, total protein, fat and total monounsaturated fatty acid intake had a significance association with MetS. The increased dietary carbohydrates intake showed a positive correlation with intermediate 10-year CVD risk.

Hence, these results suggest that there is a need for more effective awareness programs about MetS and the risk of developing CVD associated with it. From this study it was concluded that the patient's dietary pattern can also influence the development of MetS. Therefore, promotion of free regular check-ups as well as educating and encouraging the people to adopt a healthier lifestyle will increase the awareness and thereby decrease the disease burden.

AKNOWLEDGEMENT

The authors wish to acknowledge Dr. A. P. Basavarajappa (Bapuji Pharmacy College, Davangere), Dr. G.L Prabhushankar (HOD, Department of Pharmacy Practice, Bapuji Pharmacy College, Davangere) and Dr. Arlynn Aby George (Dietician) for their assistance in the study.

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