Original Article

Prevalence of Metabolic Syndrome and its Risk Factors among Adults in a Rural Area of Dakshina Kannada District

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Abstract

Background: Metabolic syndrome (MS) consists of interconnected factors responsible for increased risk of cardiovascular diseases and development of type 2 diabetes mellitus. Early identification and treatment of components of MS leads to improved cardiovascular outcomes. **Aims:** To determine the prevalence of metabolic syndrome among adults >18 years of age and to study the various socio-demographic and behavioral factors associated with MS. **Methods and Material:** This was a cross-sectional study conducted among 280 adults of >18 years in a rural area of Dakshina Kannada district. Probability proportional to size and random sampling was used to select the study participants. Data was collected by interviews, anthropometry, blood investigations. **Results:** Prevalence of MS was 33.9% and majority were females (71.8%). The mean age was 49.35 (±15.22) years. The prevalence (raised levels/on treatment) of hypertension, hyperlipidemia and hyperglycemia were 56.79% (systolic), 38.93% (diastolic), 38.57% (raised triglycerides), and 45% respectively. Majority of the subjects were obese (52.9%). Participants of 18–49 years age group had 2.30 times higher odds of having MS than ≥50 years age group (*P* value < 0.001). Female gender and low socio-economic status had 1.49- and 1.31-times higher odds of having MS respectively. Family history of diabetes and presence of co-morbidities had 1.20- and 1.02-times higher odds of developing MS. **Conclusion:** There is a high prevalence of MS in rural areas. Intervention based on lifestyle modifications needs to be developed.

Keywords: Adult population, metabolic syndrome, risk factors, rural area

Introduction

The Metabolic Syndrome (MS) is defined as a constellation of interconnected physiological, biochemical, clinical, and metabolic factors that directly increases the risk of cardiovascular diseases, type 2 diabetes mellitus and all-cause mortality.[1] It is clustering of hyperglycemia or insulin resistance, obesity, dyslipidemia, and hypertension. It is of tremendous importance as it identifies patients who are at high risk of developing atherosclerotic cardiovascular diseases (CVD) and type 2 diabetes (T2DM).[2] Metabolic Syndrome is estimated to double the risk of developing cardiovascular disease among affected compared to healthy individuals and to increase the risk of T2DM by five-fold, if not already diabetic.[3]

Obesity and physical inactivity are the driving forces behind the syndrome. MS is often associated with other medical conditions like fatty liver, cholesterol gallstones, obstructive sleep apnoea, gout, depression, musculoskeletal disease, and polycystic ovarian syndrome.[4] It has been estimated that approximately one in four to five adults develop MS. The incidence of MS has been estimated to increase with age especially after 50 years of age. Cardiovascular risks and development of T2DM if not already diabetic, are found to be the two major clinical outcomes of having metabolic syndrome.[3] Hence, this study was conducted to determine the prevalence of metabolic syndrome among adults >18 years of age in a rural area of Dakshina Kannada district and to study the various socio demographic and behavioral factors associated with metabolic syndrome.

Methods

We conducted a cross-sectional study in Kumpala village, a rural area of Dakshina Kannada district, Karnataka, India.

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Adults more than 18 years of age were included in the study. Pregnant women and seriously ill and terminally ill individuals were excluded. Sample size was calculated considering the prevalence of metabolic syndrome as 26% from a study conducted in Karnataka[5] and with the formula $n = 4pq/L^2$ (p = prevalence = 26; q = (1-p) = 74; L = absolute precision of 7%). Design effect of 1.5 and a non-response rate of 10% were considered and sample size of 280 was calculated for the study.

A village with approximately 4,500 population was chosen and multistage sampling was followed. The population under all the four anganwadi centres (AWCs) of the village were included. A line list was prepared from the voters list obtained from these anganwadis. Number of participants from each of the anganwadi area was elicited by probability proportional to size and simple random sampling was used to select participants from each anganwadi area. [Figure 1] The study was conducted from January 2018 till February 2019. Institutional ethics committee approval was obtained for the study and written informed consent was obtained by the participants. A mobile app 'Epicollect' was used for data capture.

Details of the data collection process

A pre-designed, pre-tested, semi structured, validated questionnaire was used for collecting details on socio-demographic profile, lifestyle related details like diet and physical activity, habits, and existing co-morbidities. Content validation of the questionnaire was done by three subject experts. Socio economic status was assessed using Modified BG Prasad classification (February 2019).

Details on alcohol and tobacco consumption were collected.[6] Details on diet were obtained regarding the type of diet they consumed and a number of servings of fruits and vegetables they consumed in a week. International Physical Activity Questionnaire (IPAQ) was used to assess the levels of physical activity.[7]

Height, waist, and hip circumference of the participants were measured using a non-stretchable fiber measuring tape. Body weight was recorded in kilograms using a digital weighing machine (Omron HN-283) with minimal clothing. Body Mass Index (BMI) was calculated and was classified according to Asian classification.[8,9] Blood pressure was recorded using mercury sphygmomanometer (Elkometer Delux model). Average of the two readings recorded at least 1 minute apart was considered. Fasting blood samples were collected post eight hours of fasting after the night meal. The blood samples were transported in cold chain system to the Central Lab of the tertiary care teaching hospital for analysis.

Fasting blood glucose level, high density lipoprotein (HDL), cholesterol level and triglyceride levels were estimated from the collected blood samples using Reflectance Spectrometer. Fasting blood glucose level was estimated by VITROS Glucose Micro slide method, using glucose oxidase-peroxidase enzymatic method. High density lipoprotein (HDL) cholesterol level was estimated by VITROS direct HDL Micro slide method using cholesterol ester hydrolase and peroxidise enzymatic method. Triglyceride level was estimated by VITROS triglyceride Micro slide method, using lipase and peroxidase enzymatic method.

NCEP ATP III (National Cholesterol Education Program Adult Treatment Panel III) criteria was used for diagnosing metabolic syndrome. Three of the following five criteria if positive indicated that the individual had metabolic syndrome.

1. Waist circumference of >40 inches (102 cm) in males and >35 inches (88 cm) in females.
2. Fasting glucose >/=100 mg/dl or on treatment.
3. Serum triglycerides >/=150 mg/dl or on treatment.
4. High density lipoprotein cholesterol <40 mg/dl in males and <50 mg/dl in females or on treatment.
5. Blood pressure >130 mmHg systolic or >85 mmHg diastolic or on treatment.

The data was analyzed using Statistical Package for Social Science (SPSS) (23.0 IBM, New York, USA). Normality was

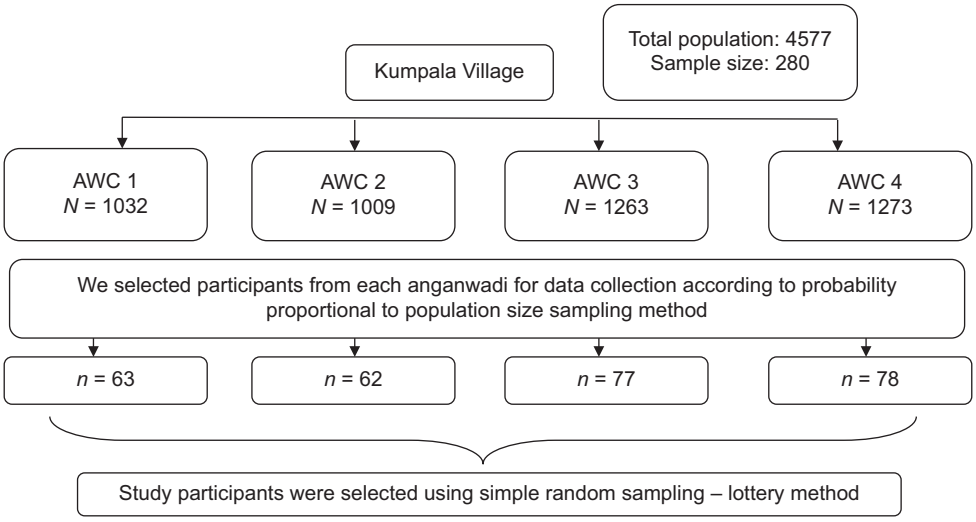

Figure 1: Flow chart depicting the sampling method

established using Kolmogrov Smirnov test (*P* value >0.05). Descriptive statistics were reported as mean (SD) for continuous variables following normal distribution, median (IQR) for skewed distribution and frequency (percentages) for categorical variables. Binary logistic regression was used to assess the risk factors of metabolic syndrome and results were presented as odds ratio. *P* value < 0.05 was considered as statistically significant.

Results

The results of this study are discussed under three headings:

Socio-demographic and anthropometric details

The mean age (±SD) of the study participants was 49.35 (±15.22) years. Most of the participants (28.9%) belonged to ≥60 years of age. Females constituted the majority (71.8%) of the study participants. One-fifth (22.9%) of the study participants had education up to middle school. About half of the participants (56.1%) belonged to nuclear family and the majority (70%) were unemployed. Individuals with clerical jobs/shop owners/farmers constituted 12.5%. According to Modified BG Prasad classification (February 2019 update), 37.9% belonged to upper class and 35.4% belonged to upper middle class Few (1.8%) belonged to lower class and rest belonged to lower middle and middle class (8.2% and 16.8% respectively).

Among 280 participants, 15.7% were tobacco users amongst whom 40.91% used it in smoking form and rest in smokeless form like betel nut chewing with tobacco leaves and gutka. Among the participants who used tobacco in smoking form, half of them were current smokers and the rest were former smokers. Among current smokers, the median numbers of cigarettes smoked were 10 (IQR = 10–20) cigarettes with median duration of smoking 30 years (IQR = 20–35) and pack years of 30 (IQR = 20–60) years. Among former smokers, the median number of cigarettes smoked was 10 (IQR = 9–20) cigarettes with median duration of smoking being 6.8 years (IQR = 2.9–20) and pack years of 20 (IQR = 10–44.5). Among former smokers, the median duration since quitting was 5 years (IQR = 2–17.5). Only 4.3% participants consumed alcohol currently. The median milliliters (ml) of alcohol consumed per day were 60 ml (IQR = 30–60).

The majority of study participants (94.3%) followed mixed diet. The mean number of days of vegetable consumption was found to be 2.26 ± 1.56 with mean number of serving of 0.91 ± 0.30. The mean number of days of fruit consumption was found to be 3.33 ± 1.48 with mean number of serving being 0.99 ± 0.06.

Majority of the study subjects (78.2%) were physically inactive. Participants who were minimally active were 21.1%. Only 0.7% of the participants were HEPA active. Among the study participants, 23.9% and 21.1% were hypertensive and diabetic respectively. Impaired lipid profile was known to 7.9% of the participants and most of them (86.36%) were on regular treatment. Family history of diabetes and hypertension was found in 46.4% and 40% of the participants respectively.

The mean waist circumference among males and females were 87.7 cm (±13.33) and 83.76 cm (±10.21) respectively. The mean WHR were 0.93 (±0.09) and 0.86 (±0.08) among males and females respectively. The mean systolic BP was 126.34 mmHg ± 11.51 mmHg. The mean diastolic BP was 80.64 mmHg ± 6.23 mmHg. Majority of the study participants (52.9%) were obese and 17.9% were overweight and the association between BMI and presence of metabolic syndrome was found to be statistically significant (*P* value < 0.001, Chi-squared test).

Prevalence of metabolic syndrome

According to ATP III criteria; 95 (33.9%) of the 280 study participants had metabolic syndrome. Out of these, 32 were males (40.52% of male participants) and 63 were females (31.34% of female participants). The distribution of components of MS is described in Table 1.

Risk factors associated with metabolic syndrome

Relationship between various socio-demographic factors and prevalence of metabolic syndrome is provided in Table 2.

Discussion

The prevalence of metabolic syndrome was found to be 33.9%. The prevalence has ranged from 11%–45% in different studies conducted in India.[10-12] A systematic review and meta-analysis found that the pooled prevalence of MS among adult population in India was 30%.[13] The surge in prevalence compared to the previous statistics can be attributed to changes in nutrition and lifestyle associated with economic development of the country. Similar findings are observed in low and middle income countries primarily due to changes in the lifestyle and diet.[14,15]

The mean age of the study participants was 49.35 years (±15.22). Our study observed higher prevalence of MS among

Table 1: Distribution of components of metabolic syndrome among the study participants, *n*=280

Components of metabolic syndrome	*n* (%)
Abdominal obesity (waist circumference in cm)	
Males (≥ 102 cm)	37 (13.21)
Females (≥ 88 cm)	144 (51.4)
Raised blood pressure or on anti-hypertensive drugs*	
Systolic (≥ 130 mmHg)	159 (56.79)
Diastolic (≥ 85 mmHg)	109 (38.93)
Low HDL levels or on treatment for hyperlipidemia	
Males (<40 mg/dl)	48 (17.14)
Females (<50 mg/dl)	165 (58.92)
High triglyceride levels (≥150 mg/dl) or on treatment for hyperlipidemia	108 (38.57)
Raised plasma glucose (≥100 mg/dl) or on anti-diabetic drugs	126 (45)

*Multiple responses

Table 2: Relationship between various socio-demographic factors with prevalence of metabolic syndrome, *n*=280

Variable	Metabolic syndrome		Unadjusted OR (95% CI)	*P*	aOR[$] (95% CI)	*P*
	Yes=95 *n* (%)	No=185 *n* (%)				
Gender						
Female	63 (66.3)	138 (74.6)	1.49 (0.87 – 2.56)	0.146	1.34 (0.73 – 2.45)	0.341
Male	32 (33.7)	47 (25.4)	1		1	
Age						
≥50 years	61 (64.2)	81 (43.8)	2.30 (1.38 – 3.83)	<0.001*	2.32 (1.36 – 3.96)	0.002*
18-49 years	34 (35.8)	104 (56.2)	1		1	
Socio-economic status (According to modified BG Prasad classification)						
Lower and middle class	63 (66.3)	111 (60.0)	1.31 (0.78 – 2.20)	0.303	0.72 (0.42 – 1.24)	0.234
Upper class	32 (33.7)	74 (40.0)	1		1	
Physical activity						
Inactive	74 (77.9)	145 (78.4)	0.97 (0.53 – 1.76)	0.926	1.01 (0.53 – 1.92)	0.985
Active	21 (22.1)	40 (21.6)	1		1	
Current smoker						
Yes	4 (4.2)	5 (2.7)	1.58 (0.41 – 6.04)	0.502	1.02 (0.24 – 4.21)	0.994
No	91 (95.8)	180 (97.3)	1		1	
Alcohol consumption						
Yes	4 (4.2)	8 (4.3)	0.97 (0.28 – 3.31)	0.964	1.17 (0.31 – 4.48)	0.814
No	91 (95.8)	177 (95.7)	1		1	
Family history of diabetes mellitus						
Yes	47 (49.5)	83 (44.9)	1.20 (0.73 – 1.97)	0.464	0.72 (0.41 – 1.27)	0.263
No	48 (50.5)	102 (55.1)	1		1	
Family history of hypertension						
Yes	36 (37.9)	76 (41.1)	0.87 (0.52 – 1.45)	0.606	1.03 (0.57 – 1.85)	0.928
No	59 (62.1)	109 (58.9)	1		1	
Educational status						
Till middle school	48 (50.5)	80 (43.2)	1.34 (0.81 – 2.2)	0.247	-	-
High school and above	47 (49.5)	105 (56.8)	1			
Occupational status						
Unemployed	66 (69.5)	130 (70.3)	0.963 (0.56 – 1.65)	0.890	-	-
Employed	29 (30.5)	55 (29.7)	1			
Former smoker						
Yes	5 (5.5)	4 (2.2)	2.56 (0.67 – 9.76)	0.169	-	-
No	86 (94.5)	176 (97.8)	1			
Presence of co-morbidities[#]						
Yes	13 (13.7)	25 (13.5)	1.02 (0.49 – 2.08)	0.969	-	-
No	82 (86.3)	160 (86.5)	1			

Binary logistic regression is employed for obtaining the odds ratio. *Statistically significant association. [#]Co-morbidities included cardiovascular diseases, thyroid abnormalities, COPD and epilepsy. OR – Odds ratio. aOR – adjusted odds ratioCI – Confidence interval. [$]aORs are provided only for select variables which were considered for binary logistic regression

higher age groups and this was found to be statistically significant ($P < 0.001$). Similar findings were found among the studies conducted across India. This reflects the need to identify the risk factors at an earlier age to prevent the onset of metabolic syndrome in later life. This primary mode of prevention helps to decrease the prevalence of the components of MS as well.[13,16]

Among the study participants, 33.7% of the male participants and 66.3% of the female participants had MS. This finding can be compared with most of the studies conducted on MS, which showed higher prevalence of MS among females.[10,17,18] A systematic review of MS in Asia-pacific region also found that women have higher prevalence of MS.[19] This can be due to various factors like history of gestational diabetes mellitus, polycystic ovary syndrome, intake of hormonal contraceptives and/or menopausal state, all or any of these contributing to metabolic syndrome. Further, another study noted that Indian women were less physically active apart from daily household chores and thus at a risk of development of central obesity.[20,21] Thereby, our study recommends specific gender- based risk reduction strategies along with treatment of the underlying conditions.

Higher prevalence of metabolic syndrome was observed among those with lower educational status. Similar findings

were obtained in various other studies.[11,12,22] Poor level of knowledge about the risk factors and prevention measures may have contributed to higher estimates of MS among those with low educational levels. Association between the occupational status and presence of MS was analyzed and 69.5% of the individuals who had MS were unemployed. Few other studies also reported higher odds of MS among individuals who were unemployed.[10,23,24] This may probably be due to relatively less physical activity among unemployed individuals.

In the present study, it was found that 66.3% of the individuals who had MS belonged to lower and middle class of socio-economic status. However, few other studies conducted across India showed increased prevalence in higher socio-economic statuses. These variations can be attributed to the difference in the socio-economic scale employed by these studies.[10,11,25] A meta-analysis conducted on the association between socio-economic vulnerability and metabolic syndrome found that, increased risk of metabolic syndrome was found among the individuals belonging to lower socio-economic groups. The study also highlighted that need for targeted interventions and interventions provided for general population might not be applicable to all.[26]

The study results showed a lower proportion of individuals consuming tobacco (15.7%) and alcohol (4.3%). The study participants predominantly belonged to Muslim religion and religious beliefs practiced by the community of not using tobacco or alcohol may be the reason for the lower proportions. Current smokers had 1.58 higher odds of having MS when compared to non-smokers in this study. People who were former smokers had 2.56 times higher odds of having MS. These findings are consistent with the results obtained from a South Indian study, which reported significant association between smoking and MS.[27] This reinforces the need to implement a multi-faceted activity to curb smoking among the adults.

Physical activity of the study participants was analyzed with prevalence of MS. Almost three-fourths of the individuals who had MS were physically inactive. The studies conducted in various parts of India reported that, there was a significant association between physical inactivity and presence of MS.[10,28,29] This highlights the need to motivate the community to have regular physical activity. A review article on the facilitators and barriers in exercising highlighted that, though regular physical activity is recommended for chronic diseases, physical activities need to be advised considering the underlying health conditions of the individuals.[30] Another systematic review regarding physical activity in obese individuals found that lack of time and social support also acted as barriers for physical activity.[31] Making the activity more enjoyable would help the individuals to have more adherence to the physical activity. The advice thus should be tailor-made, according to the baseline health status of the individual.

Higher prevalence of MS was observed among the participants belonging to obese category based on BMI classification and this was statistically significant (P value < 0.001). This can be attributed to the basic patho-physiology of occurrence of metabolic syndrome with hyperplasia of adipocytes.

It was found that the odds of having MS in presence of family history of diabetes was 1.20 times higher than the individuals without family history of diabetes. The genetic predisposition of developing diabetes and hypertension with positive family history can be a reason for this finding. Similar findings were obtained by other studies as well.[25,32] It was found that 56.79% of the study participants had raised systolic BP, 38.93% had raised diastolic BP or were on antihypertensive medications. The study thus highlights the need to screen the population for hypertension and undertake appropriate control measures. Primordial prevention will play a major role in prevention of hypertension in the community.

Among the study participants, 76.06% of the study participants had low HDL levels or were on treatment for hyperlipidemia. High triglyceride levels were observed in 38.57% participants. Similar findings were reflected in many other Indian studies.[11,18,33]

The strengths of our study are that, the sampling was done using probability proportional to size method and simple random sampling hence, sample is representative of the population. Blood samples were collected from all the participants and were processed in NABL accredited laboratory. Participants who were diagnosed with MS or its components were referred to the sub-center of Rural Health Care and Development Center or to the teaching hospital with which the center is affiliated to for further evaluation and management. Limitation of the study is that, the tobacco and alcohol consumption were less prevalent in the study population as the participants belonged to minority ethnic group with religious beliefs and consumption of tobacco and alcohol was a taboo. These findings may thereby not be the same as the general population.

Conclusion and Recommendations

One out of three participants were diagnosed with metabolic syndrome in our study. Female gender, belonging to lower socio-economic status and lower educational status had higher odds of metabolic syndrome. Odds of having metabolic syndrome was higher among physically inactive individuals, among smokers and among individuals with family history of hypertension.

A population based comprehensive strategy needs to be formulated to address the increasing burden of metabolic syndrome. Delivering the behavioral change communication sessions addressing the risk factors, risk assessment in early years of life and suitable lifestyle modifications are required to reduce the prevalence of metabolic syndrome.

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Conflicts of interest

There are no conflicts of interest.

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