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Original Research Article

Metabolic syndrome in rural Kerala: a hospital based study

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ABSTRACT

Background: Metabolic syndrome refers to a cluster of various interrelated cardio-metabolic risk factors that promote the development of atherosclerotic cardiovascular disease (CVD) and type 2 diabetes mellitus (T2DM). Identifying at risk individuals is necessary for early medical management, thereby reducing the economic burden on the patient and the society. The objective of this study was to assess the prevalence of metabolic syndrome in patients presenting to medicine clinics of our institute.
Methods: This cross-sectional hospital based study was carried out at department of medicine, DM Wayanad institute of medical sciences, Wayanad, Kerala and included 432 patients attending the general medicine outpatient department. Patients' demographic details and anthropometric measurements including height, weight, waist and hip measurements were taken. Clinical data including blood pressure, blood sugars and fasting lipid profile was also collected. The NCEP ATP III (National cholesterol education program - adult treatment panel III) criteria for diagnosis of metabolic syndrome were used to make a diagnosis of metabolic syndrome.
Results: On applying the modified NCEP ATP III guidelines with the waist circumference specific to Asian population, we found that the prevalence of metabolic syndrome in our study population was 60.9%. The prevalence was more in females than in males and the difference was statistically significant ($p = 0.049$). Abdominal obesity and decreased HDL was more in females as compared to males and the difference was also found to be statistically significant. 27% of the study population with metabolic syndrome was normal or underweight.
Conclusions: The prevalence of metabolic syndrome in the present studied population was high as they represent patients presenting to hospital. This data is more like the tip of an iceberg. Larger population based studies and intervention in the form of aggressive lifestyle modification is the need of the hour to prevent the cardio-metabolic complications of metabolic syndrome.

Keywords: Central obesity, Hospital, Metabolic syndrome, NCEP ATPIII, Rural

INTRODUCTION

The rapid rise of non-communicable diseases (NCDs), particularly related to metabolic syndrome is presenting a formidable challenge in the 20th century threatening to derail the economic and social development of the world, as well as the lives and health of millions across the globe. NCDs comprised 36 million of the 57 million deaths that occurred globally in 2008; the important ones being cardiovascular diseases, cancers, diabetes and

chronic lung diseases. In a developing country like ours, rapidly increasing burden of chronic diseases, particularly due to metabolic syndrome, will have significant social, economic, and health consequences. Kerala is supposed to be the most advanced state in terms of epidemiological transition and also has the dubious distinction of being the diabetic capital of India. It also has the highest prevalence of NCDs and this could be a trendsetter for the rest of the country.[1,2]

Metabolic syndrome is a well-known risk factor for increased cardiovascular morbidity and mortality and it is also an important predictor of increased risk of all causes of mortality. These cardio-metabolic risk factors are known to promote the development of atherosclerotic cardiovascular disease (CVD) and type 2 diabetes mellitus (T2DM).[3,4] Metabolic syndrome is estimated to be prevalent in one fourth of the world's adults and is noticed in many ethnic groups. Amongst South Asians, evidence suggests that one third of the population is affected by metabolic syndrome and Asian Indians are particularly at high risk of diabetes and CVD with the numbers increasing at an alarming rate.[3-5] Early identification and effective prevention of metabolic syndrome will alter the life course of various chronic conditions reducing morbidity and hence mortality.[3] Factors affecting metabolic syndrome includes regional variation, urbanization, lifestyle patterns, socio-economic and cultural factors.[6]

Kerala has a diabetes prevalence of 14.8% in the age group of 15-64 years and compared to United States of America has twice the cardiovascular mortality. Females, particularly in reproductive age group can affect the future generation due to possible in-utero programming. This makes it more important to understand metabolic syndrome and its associated risk factors from the state of Kerala.[1] This study was done to address two important issues; first, to assess the prevalence of metabolic syndrome in patients presenting to our hospital, which predominantly caters to rural population and second, the prevalence of various components contributing to metabolic syndrome.

METHODS

This cross-sectional study was conducted in a medical college located in rural north Kerala. Study consisted of 432 patients, who attended the outpatient clinics of DM Wayanad Institute of medical sciences hospital for various conditions. Patients of age 20years and above were included in the study and patients with pre-existing CVD or patients not consenting for study were excluded.

Along with demographic details, objective anthropometric measurements like height, weight, waist and hip measurements, blood pressure (BP), and biochemical details [Fasting blood glucose (FBS) and lipid profile - triglycerides (TG) and High density lipoproteins (HDL)] were recorded in the out-patient department according to standard prescribed guidelines.

The authors believe that all criteria are significant in the diagnosis of metabolic syndrome and hence modified NCEP ATP III (National cholesterol education program - Adult treatment panel III) criteria were preferred over IDF criteria. The modified NCEP ATP III criteria for the diagnosis of metabolic syndrome with ethnicity specific waist circumference was applied to the collected data and analyzed.[4] The NCEP ATP III guidelines state that 3 of the following 5 criteria is required to make a diagnosis of metabolic syndrome -

- Waist circumference ≥ 80cms in women and ≥ 90cms in men
- BP ≥ 130 mm Hg systolic or ≥ 85 mm Hg diastolic
- FBS ≥ 100 mg/dl or drug treatment for diabetes mellitus
- Serum TG ≥ 150mg/dl
- Serum HDL ≤ 40mg/dl in men and ≤ 50mg/dl in women.

Statistical analysis

The continuous variables were reported as mean±standard deviation (SD) and categorical variables were reported as number and percentages. Associations of categorical variables were examined using Pearson's chi-square test. A p value (significance) of <0.05 was deemed statistically significant. The statistical analysis was performed using SPSS 17.

RESULTS

The study consisted of 432 patients. On applying modified NCEP ATP III criteria with ethnicity specific waist circumference cut offs, 96.5% of patients had at least one abnormal parameter. The general characteristics of the study population are as given in Table 1.

Demographic characteristics

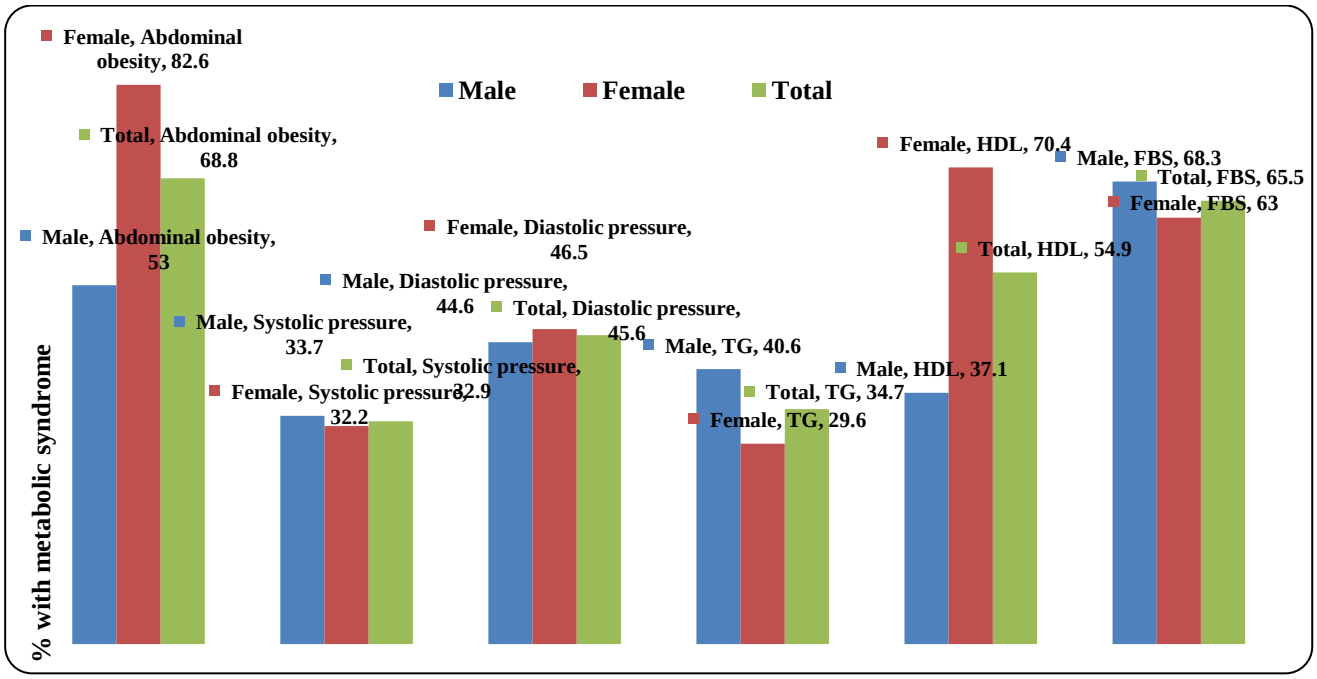
In this study, females (53.2%) were more compared to males (48.5%). Age range was between 20-75 years with a mean of 46.10years (SD = 11.68). 54.2% of the patients were in 41-60 years age group; 34.7% of patients were in the 20-40 years age group and only 10.6% were above the age of 60 years.

Anthropometric profile

21.8% of the study population was overweight and 32.6% were obese. BMI varied between 14.69- 40.27 kg/m^2 with a mean of 23.69 kg/m^2 (SD = 3.96). Among patients with metabolic syndrome, 46% were obese and 27% were overweight (Table 2). The average BMI of patients with metabolic syndrome was 25.1±3.8.

Central obesity was seen in 82.6% females and 53% males and this gender difference was found to be statistically significant (p<0.001). The average waist circumference of patients with metabolic syndrome was 93.2±8.2.

Figure 1: Graphical representation of various components of metabolic syndrome.



TG - Triglycerides, HDL - High density lipoproteins, FBS - Fasting blood sugar.

Table 1: Descriptive characteristics of the study population.

Characteristics	N	Minimum	Maximum	Mean	Std. deviation
Age (years)	432	20.0	75.0	46.176	11.7167
Systolic blood pressure (mm Hg)	432	100.0	180.0	128.815	16.9685
Diastolic blood pressure (mm Hg)	432	60.0	110.0	83.819	9.9649
Weight (kgs)	432	36.0	104.0	62.414	11.3959
Height (cms)	432	136.0	187.0	162.292	9.0691
Hip circumference (cms)	432	68.0	126.0	94.032	8.5215
Waist circumference (cms)	432	55.0	120.0	89.252	9.6382
Waist/hip ratio (cms)	432	.76	1.13	.9488	.05137
Fasting blood sugar (mg/dL)	432	62.0	341.0	120.719	43.6197
Triglycerides (mg/dL)	432	23.0	535.0	142.765	62.3192
High density lipoproteins (mg/dL)	432	8.0	102.0	45.595	11.8324

Table 2: BMI with metabolic syndrome.

BMI	Metabolic syndrome no.	Percentage
<18.5-Underweight	6	2.3%
18.5-22.9-Normal	65	24.7%
23-24.9-Overweight	71	27%
>=25-Obese	121	46%
Total	**263**	**100%**

Blood pressure (Table 3, Figure 1)

32.9% of the study population had a systolic BP greater than 130 mmHg and it was comparatively more common in males (33.7%) than females (32.2%). This difference was not statistically significant. The average systolic BP of patients with metabolic syndrome was 136.2±15.9 mmHg.

It was also found that 45.6% of the subjects had a diastolic blood pressure greater than 85 mm Hg and

contrastingly more in females (46.5%) compared to males (44.6%) and this gender difference was also not statistically significant. The average diastolic BP of patients with metabolic syndrome was 88.2±9.3.

Table 3: Male to female variation of components of metabolic syndrome.

Variables	Male, n (%)	Female, n (%)	Total, n (%)
Abdominal obesity	53	82.6	68.8
High systolic pressure	33.7	32.2	32.9
High diastolic pressure	44.6	46.5	45.6
High triglycerides	40.6	29.6	34.7
Low high density lipoproteins	37.1	70.4	54.9
Fasting blood sugar	68.3	63	65.5

Biochemical analysis (Table 3, Figure 1)

Increased TGs was seen in 34.7% of the study population and it was more in males than in females, 40.6% versus 29.6% and this difference was statistically significant (p = 0.016). Amongst patients with metabolic syndrome the average TGs levels were 158.8±62.5 mg/dl.

Low HDL levels were seen in 54.9% and it was more in females than males, 70.4% versus 37.1% and this difference was statistically significant (p<0.001). The average HDL of patients with metabolic syndrome was 42.6±11 mg/dl.

High FBS was seen in 65.5% of the study group with 68.3% of males and 63% of females having high values. This gender difference was not statistically significant.

Metabolic syndrome

The overall prevalence of metabolic syndrome as per the modified NCEP ATP III criteria was 60.9% with 55.9% males and 65.2% females fitting into the criteria. The gender difference was statistically significant (p = 0.49). The various clinical parameters in patients with and without metabolic syndrome are as shown in Table 4.

Table 4: Clinical parameters and its correlation to patients with and without metabolic syndrome.

Clinical parameters	Overall population	Metabolic syndrome	No metabolic syndrome
Outpatients (n %)	432 (100)	263 (60.9)	169 (39.1)
Female individuals (n %)	230 (53.2)	150 (65.2)	80 (34.8)
Male individuals (n %)	202 (46.8)	111 (55.5)	89 (44.5)
Age (years)	46.18±11.7	48.5±10.4	42.6±12.7
Systolic BP (mmHg)	128.8±17.0	136.2±15.9	117.3±11.1
Diastolic BP (mmHg)	83.8±10.0	88.2±9.3	77.0±6.5
Weight (Kg)	62.4±11.4	65.9±11.1	57.0±9.6
Height (cm)	162.3±9.1	161.9±9.3	162.8±8.7
Hip circumference (cm)	94.0±8.5	97.0±7.7	89.4±7.6
Waist circumference (cm)	89.2±9.6	93.2±8.2	83.0±8.3
Waist / hip ratio (cm)	0.95±0.05	0.96±0.04	0.9±0.05
Fasting blood sugar (mg/dL)	120.7±43.6	129.6±45.9	106.9±35.8
Triglycerides (mg/ dL)	142.8±62.3	158.8±62.5	117.7±53.2
High density lipoproteins (mg/dL)	45.6±11.8	42.6±11.0	50.3±11.7
Body mass index (kg/m^2)	23.7±4.0	25.1±3.8	21.5±3.1

Table 5: Age-wise incidence of patients with metabolic syndrome.

Age (years)	Total males in study	Total no. (%) of males with metabolic syndrome	Total females in study	Total no. (%) of females with metabolic syndrome
20-30	19	4 (21.1%)	33	10 (30.3%)
31-40	48	27 (56.3%)	50	27 (54%)
41-50	52	30 (57.7%)	62	47 (75.8%)
51-60	55	37 (67.3%)	65	50 (76.9%)
>60	26	13 (50%)	20	16 (80%)
Total	**202**	**111 (55.5%)**	**230**	**150 (65.2%)**

Among males, the prevalence across age groups did not vary much beyond the 30years of age. However, in females, with each decade, the metabolic syndrome prevalence kept increasing as shown in Table 5.

When BMI was compared with metabolic syndrome, 27% of the study population with metabolic syndrome was normal or underweight (Table 2). The remaining cases were overweight (27%) or obese (46%). 13.7% of patients without central obesity were also found to have metabolic syndrome.

DISCUSSION

Metabolic syndrome, a life style disease, is now a major health challenge due to increasing urbanization, sedentary life style, reduced physical activity, and surplus energy intake.[6] Just as the prevalence of the individual components of the syndrome varies among populations, so does the prevalence of the metabolic syndrome itself. Differences in genetic background, diet, levels of physical activity, population age and sex structure, levels of over- and under-nutrition, and body habitus all influence the prevalence of both metabolic syndrome and its components. Regardless of the underlying genetic and environmental influences that mediate the prevalence of the metabolic syndrome, a higher prevalence will undoubtedly lead to undesirable outcomes such as cardiovascular disease.[6,7]

In India, metabolic syndrome is rapidly raising leading to increased mortality and morbidity due to type 2 diabetes mellitus and CVD. Asian Indians are particularly known to be physically non-obese and metabolically obese and are also known to have lower BMIs and hence, lower levels of obesity compared to the Europeans. Additionally, Asian Indians, for any given BMI have greater waist-to-hip ratios and abdominal fat than Europeans. Rural to urban migration and decreasing physical activity levels have been identified as one of the most important reason for increasing metabolic syndrome and this study was conducted to assess the prevalence of metabolic syndrome in rural population in a hospital setup.[3,8,9]

Table 6: Comparison with other studies: references with year.

Study	Associated condition under study	Hospital based study prevalence	Control/general population prevalence	Country
Thappa DM et al[15]	Psoriasis vulgaris case	44%	30%	India
Moini A et al[16]	Polycystic ovarian syndrome	22.7%	6-10%	Iran
de Oliveira BM et al[17]	Rheumatoid arthritis	50%	29.6%	Brazil
Lin CH et al[18]	Routine checkup/ preventive services	12.9%	9.5%	Taiwan
Zeller M et al[19]	Myocardial infarction	46%	25-44%	France
Gisondi P et al[20]	Psoriatric arthritis	35.2%	15-18%	Italy
Salvi V et al[21]	Bipolar disorder	26.5%	15-18%	Italy
Jacob B et al[13]	First time detected Type 2 diabetes mellitus	66.2%	11-41%	Kerala, India
Shuba S et al	Present study	60.9%	10-50%	Kerala, India

The prevalence of metabolic syndrome ranges from 10-50% and this wide variation could be attributed to different criteria's, age groups and individual components in different individuals. The prevalence of metabolic syndrome is 1.5-2 times higher in females than in males. In our study, metabolic syndrome was more common in females (female to male - 1.16:1). Studies have shown similar prevalence of metabolic syndrome in the age group of 20-40 and 41-60 age groups with a marginal increase in >60 years age group. In our study too, 3rd, 4th and 5th decade had almost similar values, and there was 20% increased prevalence in >60 years age group particularly in females. Enas EA et al, in their study on metabolic syndrome and dyslipidemia among Asian Indians, found that the prevalence of metabolic syndrome increases from 10% at age 20 to 29 years to 53% by the age of 60 years. This correlates well with our findings especially in women. Even amongst patients in the 3rd decade in our study, metabolic syndrome incidence is more common in females, which is similar to other studies.[3,4,7,10-12]

Kerala, the diabetic capital of India, has a high obesogenic environment. This is evident from the fact that 73% of the study population with metabolic syndrome has obesity. Similar study in Kerala amongst first time diabetics showed a prevalence of 89.7% obesity among patients with metabolic syndrome. Possible etiological factors include sedentary lifestyle, high living standards, and unhealthy eating habits amongst Keralites.[1,13]

The wide variation in prevalence of metabolic syndrome in Asian Indians is highly troublesome. Ramachandran A et al, in their study on urban Asian Indians found that 41.1% of Indians had metabolic syndrome. However one has to note that in this study they used the waist circumference cut off for women as 85 cms rather than 80cms that has been recommended for Asian Indians. Our study showed a prevalence of 60.9% but the point to note is that we used the recommended 80cms as cut off for women. This could account to some extent for the increased prevalence in our study. The other difference between the two studies is that theirs was a community based study and ours is a hospital based study.[14]

A hospital based study done in Kerala by Jacob B et al showed a prevalence of 66.2% in their study group using the same criteria as ours. The prevalence in this study was much higher than ours probably because they studied newly detected diabetics. Our study group had 22.7% diabetics on treatment. Their study also showed a higher prevalence amongst women very similar to ours. Various studies for different conditions have shown increased prevalence in hospital based studies compared to the general population studies (Table 6).[13,15-21]

Enas EA et al, in their study on Asian Indians reported that only 4% of men and 5% of women had optimal HDL levels.[22] Our study showed that 70.4% of women and 37% of men had low HDL levels. Similar findings have been noticed in other studies across South Asia and are attributed to higher prevalence of central obesity in females compared to males.[3] This study also showed that 40.6% of men and 29.6% of women had elevated TG levels. This can be explained by the low intake of vegetables, predominantly non vegetarian diet and lack of exercise seen among Keralites. This is more so in rural areas, where being a predominantly conservative community, the awareness regarding exercise and weight control is abysmally low. Studies have shown that physically active women have lower prevalence of metabolic syndrome (27.4%) when compared with inactive women (34.8%) and are at 1.4 times higher risk compared to physically active women. Mohan et al., observed similar correlations of physically inactivity with increased risk metabolic syndrome.[1,10,23] As a consequence of inactivity, weight gain and dyslipidemia tends to be rampant in this community.

Unfortunately, review of literature does not show many studies from rural Kerala. Extensive search showed one study, done in Kannur on prevalence of metabolic syndrome in a tribal community, which cannot be considered as representative of the larger rural community of Kerala.[24] Ours was a hospital based study and like in all hospital based studies the prevalence is found to be a little more than the general population (Table 6). However, we must realize that this could reflect the trend in the general community in the near future.

If our results do reflect the trend in rural Kerala, then it is cause for alarm since the prevalence is much higher than what has been reported earlier. Metabolic syndrome was thought to be a disease of urbanization and inactivity. But the trend is changing with people in rural areas having access to high calorie food and reduced levels of physical activity coupled with poor awareness. This study highlights this changing trend even though it was conducted on a small population presenting to the hospital. However, this study also emphasizes the importance of a pressing need for a large community based survey to assess the prevalence in the community. Community based education programmes to promote a healthy lifestyle is the need of the hour, especially in the rural community.

CONCLUSION

The present study has shown that the prevalence of metabolic syndrome in rural Kerala is high. This goes to prove that metabolic syndrome is no longer an urban disease.

Hence the take home message of this study is

The prevalence of metabolic syndrome is on the rise in rural India. The urban rural divide is getting blurred with time probably due to increasing affluence, decreasing physical activity, easy access to high calorie food coupled with lack of awareness especially in this part of Kerala. The basic healthcare system in a state like Kerala has reduced the incidence and prevalence of communicable diseases; but life style diseases are on the rise due to inappropriate diet and lack of physical activity. Hence, larger community based studies needs to be conducted in order to get a clearer picture of the extent of the problem in the community. Patient education regarding healthy diet and regular, optimal exercise is the need of the hour in order to reduce the menace of Type II DM and Cardiovascular disease which is a natural consequence of metabolic syndrome. Patient education is a social responsibility and educating patients at the hospital and at the community level are both essential in order to stem the tide and reduce the financial burden on the individual and the nation at large.

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REFERENCES

1. Sivasankaran S, Thankappan KR. Prevention of non-communicable diseases requires a life course approach: A case study from Kerala. Indian J Med Res. 2013;137:874-7.
2. Pathania D, Bunger R, Mishra P, Pathak R, Arora A. A study to assess prevalence of metabolic syndrome and its socio demographic risk factors in rural area

of district Ambala, Haryana. J Community Med Health Educ. 2013;3(5):226.
3. Prasad DS, Kabir Z, Dash AK, Das BC. Prevalence and risk factors for metabolic syndrome in asian Indians: a community study from urban eastern India. J Cardio Dis Res. 2012;3(3):204-11.
4. Surana SP, Shah DB, Gala K, Susheja S, Hoskote SS, Gill N, et al. Prevalence of metabolic syndrome in an Urban Indian Diabetic population using the NCEP ATP III guidelines. J Assoc Physic India. 2008;56:865-8.
5. Misra A, Misra R, Wijesuriya M, Banerjee D. The metabolic syndrome in South Asians: continuing escalation and possible solutions. Indian J Med Res. 2007;125(3):345-54.
6. Kaur J. A comprehensive review on Metabolic syndrome. Cardiology research and practice. Cardiol Res Pract. 2014;2014:943162.
7. Cameron AJ, Shaw JE, Zimmet PZ. The metabolic syndrome: prevalence in worldwide populations. Endocrinol Metab Clin North Am. 2004;33(2):351-75.
8. Anjana M, Sandeep S, Deepa R, Vimaleswaran KS, Farooq S, Mohan V. Visceral and central abdominal fat and anthropometry in relation to diabetes in Asian Indians. Diabetes Care. 2004;27(12):2948-53.
9. Maumus S, Marie B, Siest G, Visvikis-Siest S. A prospective study on the prevalence of metabolic syndrome among healthy French families: two cardiovascular risk factors (HDL cholesterol and tumor necrosis factor- alpha) are revealed in the offspring of parents with metabolic syndrome. Diabetes care. 2005;28(3):675-82.
10. Selvaraj I, Gopalakrishnan S, Lograj M. Prevalence of metabolic syndrome among rural women in a primary health centre area in Tamil Nadu. Indian J Public Health. 2012;56(4):314-7.
11. Bentley-Lewis R, Koruda K, Seely EW. The metabolic syndrome in women. Nat Clin Pract Endocrinol Metab. 2007;3(10):696-704.
12. Enas EA, Mohan V, Deepa M, Farooq S, Pazhoor S, Chennikara H. The metabolic syndrome and dyslipidemia among Asian Indians: a population with high rates of diabetes and premature coronary artery disease. J Cardiometab Syndr. 2007;2(4):267-75.
13. Jacob B, George AT, Antony TP, Jose R, Sebastian SR. Prevalence of metabolic syndrome in newly detected type 2 diabetes mellitus. Academia Medical Journal of India 2015;3(1). Available at http://medicaljournal.in/prevalence-metabolic-syndrome-newly-detected-type-2-diabetes-mellitus/ Accessed on 24 September 2016.
14. Ramachandran A, Snehalatha C, Satyavani K, Sivasankari S, Vijay V. Metabolic syndrome in urban Asian adults a population study using modified ATP III criteria. Diabetes Res Clin Pract. 2003;60(3):199-204.
15. Thappa DM, Gupta D. Prevalence of metabolic syndrome in South Indian patients with psoriasis vulgaris and the relation between disease severity and metabolic syndrome: a hospital-based case-control study or cross-sectional study? Indian J Dermatol. 2013;58(4):315.
16. Moini A, Javanmard F, Eslami B, Aletaha N. Prevalence of metabolic syndrome in polycystic ovarian syndrome women in a hospital of Tehran. Iran J Reprod Med. 2012;10(2):127-30.
17. Oliveira BM, Medeiros MM, de Cerqueira JV, de Souza Quixada RT, Oliveira IM. Metabolic syndrome in patients with rheumatoid arthritis followed at a university hospital in North eastern Brazil. Rev Bras Reumatol Engl Ed. 2016;56(2):117-25.
18. Lin CH, Lai SW, Liu CS. Prevalence of metabolic syndrome in Taiwanese adults: a hospital - based study. Ann Saudi Med. 2006;26(1):46-8.
19. Zeller M, Steg PG, Ravisy J, Laurent Y, Janin-Manificat L, L'Huillier I, et al. Prevalence and impact of metabolic syndrome on hospital outcomes in acute myocardial infarction. Arch Intern Med. 2005;165(10):1192-8.
20. Gisondi P, Tessari G, Conti A, Piaserico S, Schianchi S, Peserico A, et al. Prevalence of metabolic syndrome in patients with psoriasis: a hospital-based case-control study. Br J Dermatol. 2007;157(1):68-73.
21. Salvi V, D'Ambrosio V, Rosso G, Bogetto F, Maina G. Age-specific prevalence of metabolic syndrome in Italian patients with bipolar disorder. Psych Clin Neuro Sci. 2011;65:47-54.
22. Enas EA, Yusuf S, Mehta JL. Prevalence of coronary artery disease in Asian Indians. Am J Cardiol. 1992;70(9):945-9.
23. Pradeepa S, Surendar J, Indulekha K, Chella S, Anjana RM, Mohan V. Prevalence of metabolic syndrome and its association with coronary artery disease among an urban elderly south Indian population (CURES 145). J Assoc Physicians India. 2016;64:20-5.
24. Ismail IM, Azeez K, Antomy A, Kunnummal SV. Metabolic syndrome and its associated factors among the adult population residing in Kannavam tribal area of Kannur District, Kerala. Trop J Med Res. 2016;19:36-41.

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