J Hum Ecol, 62(1-3): 41-46 (2018)
PRINT: ISSN 0970-9274 ONLINE: ISSN 2456-6608
DOI: 10.31901/24566608.2018/62.1-3.3121

Metabolic Syndrome and Its Components: Endogamy and Urban-Rural Differences

P. Chandrasekhar Rao[1], S. A. A. Latheef[2] and P. Venkatramana[3]

[1]Department of Anthropology, S.V. University, 517 502, Tiruapti, Andhra Pradesh, India
[2]School of Life Sciences, University of Hyderabad, 500 046, Hyderabad, India
[3]Discipline of Anthropology, School of Social Sciences, IGNOU, New Delhi 110 068, India

KEYWORDS Blood Pressure. Glucose. Triglycerides. Waist Circumference. Andhra Pradesh. Caste Populations

ABSTRACT In this study, the researchers made an attempt to study the effect of endogamy and residence on the prevalence of metabolic syndrome (MS) and its components and also investigated the predictors of MS involving *Reddy* and *Madiga* subjects of urban and rural areas. Anthropometric measurements and blood pressure were recorded. Glucose and lipid parameters were estimated and the prevalence of MS was estimated. Prevalence of MS was not different between Reddy and Madiga in urban and rural areas but was significantly higher in urban than rural Madiga ($p<0.05$). Prevalence of high waist circumference (WC) and high blood pressure was significantly higher in Reddy than Madiga in urban and rural areas. High triglycerides and high blood pressure were significantly higher in urban than rural Madiga ($p<0.01$). Two way analysis of variance showed significant effect of endogamy and residence on WC, triglycerides and blood pressure. Body mass index and total cholesterol were found to be the common predictors of MS in both endogamous and residence groups.

INTRODUCTION

Collective group of risk factors such as elevated blood pressure, dyslipidemia, central obesity and impaired fasting glucose is known as metabolic syndrome (MS) (Chinawale et al. 2018). Reported prevalence of MS was thirty-four percent in USA (Moore et al. 2017); 24.3 percent in Europe (Scuteri et al. 2015) and 11.9-37.1 percent in Asia-Pacific countries (Ranasinghe et al. 2017). The prevalence of MS was reported to be 34.8-52.5 percent in Asian migrants (Savadatti et al. 2018), 18-50 percent in urban and 9-12 percent in rural populations of India (Deedwania et al. 2014). A five-fold and two-fold increased risk of type 2 diabetes and cardiovascular disease was observed in those suffering from metabolic syndrome and also increases the risk of all causes of mortality (Bhagat et al. 2017; Harikrishnan et al. 2018). Disease transition from infectious to non-communicable diseases, increased life expectancy, increasing growth of population, unplanned urbanization, rural to urban migration and the consequent sedentary life and changed dietary intake were shown to increase the prevalence of MS (Ranasinghe et al. 2017). Diagnosis of MS will help for assessment of cardiovascular health of the population and the development and evaluation of intervention to control the rising burden of non-communicable diseases (Harikrishnan et al. 2018).

Majority of the studies on MS in India were conducted in aggregated social groups as general population without much emphasis on endogamous populations (Sarkar et al. 2005, 2006). Indian population is distributed into different religious, tribal and caste groups. These social groups follow strict endogamy. Endogamy was shown to influence homozygosity and diseases (Bittles 2015) and provide ideal framework to study the effect of environment in increasing the susceptibility to the diseases. Higher prevalence of diabetes, hypertension and ischemic heart disease were reported in endogamous populations of India (Bawaskar et al. 2015). Studies on the prevalence of MS in endogamous populations of India are sparse (Sarkar et al. 2005, 2006; Gupta et al. 2005; Lokanath et al. 2014; Kandpal et al. 2016; Ismail et al. 2016; Sinha et al. 2016; Bandela et al. 2017). The two endogamous populations namely *Reddy* and *Madiga* were selected for the present study belonging to urban and rural areas. If MS prevalence and its components are different between two endogamous populations then it is assumed that endogamy is associated with the prevalence of MS and its components. If environmental factors play an important role, populations of *Reddy* and *Madiga* of rural area should show low prevalence of MS and its components than their urban counterparts (Sarkar et al. 2005, 2006). Therefore, in this preliminary study, the researchers have investigated the association of endogamy and residence with prevalence of MS and its components in two endogamous populations.

METHODOLOGY

One hundred and fifty subjects each (Male: 75 and Female: 75) from urban and rural areas belonging to the *Reddy* and the *Madiga* caste populations participated in the study. Urban samples were recruited from Tirupati town of Andhra Pradesh state and the rural samples from five villages viz., Ramapuram, Nadimuru, Diguva Ramapuram, Diguva Ramapuram Harijanawada, Kampalli Harijanawada of Ramachandrapuram of Chittoor district of Andhra Pradesh. After explaining the study objectives and clarification of details, the consent of subjects was obtained and the procedures followed were in accordance to the Helsinki Declaration 1975 and as revised in 2000. Data on age enquired and were documented. Height, weight, waist, hip circumferences (Lohman et al. 1988) and blood pressure were measured. Body mass index was calculated using the formula of weight (Kg)/height (m^2). Venous blood samples were drawn after 12 hours of fasting. Plasma glucose, total cholesterol, triglycerides and high density lipoprotein cholesterol were estimated using enzymatic kits of Dr. Reddy's Laboratories on Spectrophotometer (ELCO, model SL 159) following the recommendations of the manufacturer. Low density lipoprotein cholesterol was calculated using Friedewald et al. (1972) formula.

Metabolic syndrome was defined if three or more risk factors of the following are present: waist circumference (>90 cm: men and >80 cm: women); triglycerides (>150mg/dl); low HDL-C (<40: men and <50mg/dl: women); blood pressure (systolic blood pressure >130 or diastolic blood pressure > 85 mmHg) and fasting plasma glucose (>100 mg/dl) (modified ATPIII/ID).

Statistical Analysis

Data were analyzed using SPSS version 20 Chicago, Inc. Categorical variables are presented in proportions and compared by Chi-square and Fisher's exact test. Association between dependent variable MS and independent variables was examined employing logistic regression analysis. Two way analysis of variance was done to investigate the interaction of endogamy and residence and also to find difference in the variance of variables used as components of MS.

RESULTS

Prevalence of MS was 16.66 percent and 22.66 percent in rural and urban Reddy, whereas it was 13.33 percent and 23.33 percent in rural and urban Madiga populations respectively. Prevalence of MS was not significantly different between Reddy and Madiga castes in urban (22.66 vs 23.33%) and rural areas (16.66 vs 13.33%). In both caste populations, prevalence of MS was higher in urban than rural populations (Reddy: 22.66 vs 16.66%) but significant only in Madiga population (23.33 vs 13.33%, $p<0.05$).

In both endogamous and residence groups, low HDL cholesterol was found to be the predominant MS component (Table 1). Significantly higher prevalence of high waist circumference (25.33 vs 13.33%, $p<0.01$) in Reddy when compared to Madiga was observed in urban area. Comparison of prevalence of components of MS between Reddy and Madiga in rural area showed higher prevalence of high waist circumference (22.66 vs 8.66%, $p<0.01$) and high blood pressure (22.66 vs 13.33%, $p<0.05$) in the former than the later population. No statistically significant difference in the prevalence of components of MS was observed between urban and rural Reddy population. Significantly higher prevalence of high triglycerides (26 vs 16.66%, $p<0.05$) and high blood pressure (31.33 vs 13.33%, $p<0.01$) was observed in urban than rural Madiga (Table 1).

To find out the predictors of MS, logistic regression analysis was performed after adjusting age and sex variables among both endogamous populations and residences. For urban Reddy population, body mass index (BMI) ((Beta coefficient(B): 0.208, Odds ratio (OR): 1.232, 95% level of confidence interval (CI): 1.093-1.388, $p<0.01$) and total cholesterol (total-C) (B: 0.028, OR: 1.029, 95% CI: 1.007-1.052, $p<0.01$) were found to be the significant predictors of MS and accounted for 33.4 percent variation in metabolic syndrome as shown by Nagelkerke R^2 (0.334).

Table 1: Prevalence of metabolic syndrome and its components by endogamous group and residence

Variables	Reddy						Madiga					
	Urban			Rural			Urban			Rural		
	Male (n=75)	*Female (n=75)*	*Total (n=150)*	*Male (n=75)*	*Female (n=75)*	*Total (n=150)*	*Male (n=75)*	*Female (n=75)*	*Total (n=150)*	*Male (n=75)*	*Female (n=75)*	*Total (n=150)*
WC(M> 90 cm; F>80 cm)	8 (11)	30 (40)**	38 (25.33)	10 (13)	24 (32)**	34 (22.66)	4 (5)	16(21)**	20(13.33)	1(1)	12 (16)**	13(8.66)
TG >150mg/dl	28 (37)	18 (24)	46 (30.66)	17 (23)	17 (23)	34 (22.66)	23 (31)	16(21)	39(26.00)	14(19)	11 (15)	25(16.66)
HDL-C (M<50 mg/dl; F<40 mg/dl)	12 (16)	67 (89)**	79 (52.66)	10 (13)	67 (89)**	77 (51.33)	10 (13)	65(87)**	75(50.00)	8(11)	62 (82.66)**	70(46.66)
SBP >130mmHg or DBP > 85mmHg	16 (21)	23 (31)	39 (26.00)	19 (25)	15 (20)	34 (22.66)	25 (33)	22(29)	47(31.33)	9(12)	11 (15)	20(13.33)
FBG>100 mg/dl	15 (20)	21 (28)	36 (24.00)	15 (20)	15 (20)	30 (20.00)	15 (20)	17(23)	32(21.33)	21(28)	23 (31)	44(29.33)
Metabolic Syndrome	10 (13)	24 (32)**	34 (22.66)	8 (11)	17 (23)*	25 (16.66)	11 (15)	24(32)*	35(23.33)	4 (5)	16 (21)**	20(13.33)

* indicating significant difference between genders at p<0.05 and, ** at p<0.01; M: Male; F: Female; WC: Waist circumference; TG: Triglycerides; HDL-C: HDL cholesterol; FBG: Fasting blood glucose. Parenthesis indicates percent

Variables such as BMI (B: 0.307, OR: 1.359, 95% CI: 1.139-1.621, p=0.001), total-C (B: 0.014, OR: 1.015, 95% CI: 1.000-1.029, p<0.05) and primary education (B:-1.383, OR: 0.215, 95% CI: 0.064-0.986, p<0.05) were significantly associated and accounted for 23.3 percent variation for MS in rural Reddy population (Table 2).

In urban Madiga population, BMI (B:0.353, OR: 1.424, 95% CI: 1.199-1.690, p<0.01) and total-C (B: 0.029, OR: 1.030, 95% CI: 1.010-1.049, p<0.01) were found to be associated and accounted for 55.6 percent variation for MS. BMI (B: 0.228, OR:1.256, 95% CI: 1.040-1.517, p<0.05) was found to be significantly associated and accounted 26.9 percent variation for MS in rural Madiga populations (Table 2).

DISCUSSION

Socio-economically divergent caste populations namely Reddy and Madiga are residents of Chittoor district, Andhra Pradesh. The district occupies an area of 15, 152 sq.km. Total population of the district was 41,74,064 as per 2011 census including scheduled caste population of 7,85,760. The Reddy is a forward caste population, practice endogamy, has 88 sub-castes and for the present study, only Akuthota Reddy were selected. Their chief occupation is agriculture, horticulture, animal husbandry and government jobs. The Madiga, is a scheduled caste population, involved in leather work and agriculture labour. There are 25 sub-castes in this population. They practice consanguinity and for the present study, Telugu Madiga were recruited.

Various organizations use different set of variables to define MS such as National cholesterol education programme (NCEP), World health organization (WHO), International diabetes federation (IDF), American association of clinical endocrinologists (AACE) and European group of insulin resistance (EGIR). IDF in 2005 released a definition for MS using race and gender specific waist circumference cut-off placing emphasis on central obesity (Rampal et al. 2012). In the present study, the researchers followed modified ATPIII/IDF criteria for estimating the prevalence of MS and its components.

About one billion people in the world were estimated to be suffering from MS, mostly spread in urban areas of developing than developed countries and consumption of high calorie and low fibre food and reduced physical activity

Table 2: Predictors of metabolic syndrome by endogamous group and residence

Variable	*B*	*S.E.*	*Wald*	*OR*	*95%CI*	*P value*	*Variable adjusted*	*Nagelkerke R^2*
				Urban Reddy				
BMI	0.208	0.061	11.619	1.232	1.093-1.388	0.001	Age, gender	0.334
Total cholesterol	0.028	0.011	6.442	1.029	1.007-1.052	0.011		
				Rural Reddy				
BMI	0.307	0.090	11.588	1.359	1.139-1.621	0.001	Age, gender	0.233
Total cholesterol	0.014	0.007	3.809	1.015	1.000-1.029	0.051		
Primary education	-1.383	0.698	3.922	0.251	0.064-0.986	0.048		
				Urban Madiga				
BMI	0.353	0.087	16.307	1.424	1.199-1.690	0.00	Age, gender	0.556
Total cholesterol	0.029	0.010	9.039	1.030	1.010-1.049	0.003		
				Rural Madiga				
BMI	0.228	0.096	5.622	1.256	1.040-1.517	0.018	Age, gender	0.269

BMI: Body mass index; OR: Odds ratio; P: Probability; OR: Odds ratio; CI: Confidence Interval

were found to be responsible for MS, resulting in to the loss of economic activity and health care cost running into trillions (Saklayen 2018). About 1/5 of the Asia-Pacific population was reported to be suffering from MS and the major reasons attributed were increased life expectancy, control of infectious diseases, unplanned urbanization and population growth (Ranasinghe et al. 2017). In India, higher prevalence of MS was observed in urban than rural areas (Deedwania et al. 2014). Body mass index, age, female gender, high social status, sedentary life, positive family history of MS, lower education, inadequate fruit intake, hypercholesterolemia, general obesity, and tobacco chewing were found to be the risk factors for MS (Harikrishnan et al. 2018; Chinawale et al. 2018; Sharma et al. 2016; Chakraborty et al. 2015; Prasad et al. 2012; Sarkar et al. 2005, 2006).

Of the available studies on MS in endogamous populations in India, Bhutia (30-50 %) (Sarkar et al. 2005, 2006), Bhatia (42.60%) (Gupta et al. 2005) and Kodavas (60.77 %) (Lokanath et al. 2014), population were from urban areas. Prevalence of MS in both urban Reddy and Madiga of the present study was lower than Bhutia, Bhatia and Kodava populations. Bhutia (27.6-52.6%), Toto (3.80-8.70%) (Sarkar et al. 2005, 2006), Rang Bhotia (39.2%) (Kandpal et al. 2016), Sugali (21.8%) (Bandela et al. 2017) and tribes of Kannur (28.3%) (Ismail et al. 2016) endogamous populations were from rural areas had shown the prevalence of MS. The prevalence of MS in both Reddy and Madiga of rural areas in the present study was lower than Bhutia, Kodavas, Rang Bhotia and Sugali populations but higher than Toto population. Difference in the prevalence may be due to the use of different criteria for defining MS by the earlier studies (Sarkar et al. 2005, 2006; Ismail et al. 2016) or difference in the cultural factors (Bandela et al. 2017; Kandpal et al. 2016; Lokanath et al. 2014). No significant difference in the prevalence of MS was observed between two caste populations studied in the present study and is in agreement with earlier study (Sinha et al. 2016).

Higher prevalence of MS was observed in both caste population in urban areas than rural areas of the present study may be due to altered life style changes such as nutritional imbalance, physical inactivity, stress, increased consumption of tobacco and alcohol (Shalini et al. 2013). In both caste populations, higher prevalence of MS was observed in female when compared to male subjects in both urban (Reddy: 32 vs 13%, $p<0.01$; Madiga: 32 vs 15%, $p<0.05$) and rural (Reddy: 23 vs 11%, $p<0.05$; Madiga: 21 vs 5%, $p<0.01$) areas (Table 1). Higher prevalence of metabolic syndrome was also observed in women of general population in earlier studies (Mabry et al. 2010; Jesmin et al. 2012; Prasad et al. 2012). The higher prevalence of MS in women than in men is due to the application of stringent cut-offs of waist circumference, HDL and metabolic changes associated with menopause (Prasad et al. 2012).

Reddy showed higher prevalence of high waist circumference than Madiga in urban area. Reddy also showed high waist circumference and high blood pressure in rural areas than Madiga. Higher prevalence of high triglycerides and high blood pressure in urban than rural Madiga was observed. Two way analysis of variance was performed to investigate the interaction of endogamy and residence and also to find significant difference of endogamous and residence groups in variables used as components of MS. No significant interaction of endogamy and residence was observed in the components of MS. Significant difference in waist circumference, triglycerides and diastolic blood pressure ($p<0.01$) was observed in endogamous groups. In variables such as waist circumference, triglycerides ($p<0.05$), systolic and diastolic blood pressure ($p<0.01$), significant difference was observed between urban and rural subjects. These observations suggest that endogamy show the effect on waist circumference and blood pressure, whereas, residence show the effect on waist circumference, triglycerides and blood pressure.

Fasting glucose in rural subjects and BMI in urban subjects were found to be predictors of MS in endogamous populations reported earlier (Sarkar et al. 2005, 2006). In the present study, BMI and total-C ($p<0.01$) in urban Reddy; BMI ($p<0.01$), total-C and primary education ($p<0.05$) in rural Reddy; BMI and total-C ($p<0.01$) in urban Madiga and BMI ($p<0.05$) in rural Madiga were found to be the predictors of MS in the present population.

Significant difference in mean and prevalence of MS components such as waist circumference and blood pressure between two endogamous populations and also between urban and rural subjects in mean and prevalence of MS components such as triglycerides and blood pressure also suggest the role of environment in increasing the risk of MS (Sarkar et al. 2005, 2006). Significant association of BMI, total-C with MS indicate the role of dietary factors and physical activity besides urbanization in increasing the risk of MS. Association of primary education with MS suggest there is a need to improve the literacy levels of people to adapt healthy life style to reduce the risk of MS.

CONCLUSION

The researchers' study showed no significant difference in the prevalence of MS between Reddy and Madiga. In addition to the effect of residence, endogamy by influencing the components of MS, may increase the risk of MS. These observations also suggest that besides advocating life style changes, endogamy may also be taken into consideration before initiating interventions for MS. This is a preliminary study involving small sample size and studies with larger sample size may be needed to confirm the findings of this study.

RECOMMENDATIONS

To evaluate the effect of endogamy on the prevalence of MS and its components, large number of studies in different endogamous groups needs to be conducted. Screening of populations will identify the predictors of MS which help in containing the MS and to reduce the burden of non-communicable diseases. Subjects with history of central obesity, lipid abnormalities, hyperglycemia and high blood pressure should be advised for lifestyle changes and brought under drug regimen under care of physicians. General public can be educated by conducting awareness on MS, encouraging physical activity and promoting balanced diet. Policy makers can encourage physical activity by better urban planning and may also promote good dietary habits by taxing junk foods and restricting the media advertisement of junk foods.

REFERENCES

Bandela PV, Dongre NN, Ambekar JG, Prasada KD, Devaranavadagi BB 2017. Study of metabolic syndrome and its components among Kurnool district population of Andhra Pradesh with different ethnic backgrounds. *J Cardiovasc Dis Res,* 8: 83-88.

Bawaskar HS, Bawaskar PH, Bawaskar PH 2015. Health and the Indian caste system. *The Lancet,* 385: 416.

Bhagat A, Malhotra AS, Kaur G, Kapoor N 2017. Metabolic syndrome: Not even the urban Indian youth is saved. *Indian J Physiol Pharmacol,* 61(4): 368-377.

Bittles AH 2005. Endogamy, consanguinity and community disease profiles. *Community Genet,* 8: 17-20.

Chakraborty SN, Roy SK, Rahaman MA 2015. Epidemiological predictors of metabolic syndrome in urban West Bengal, India. *J Family Med and Prim Care,* 4(4): 535-538.

Chinawale CG, Parmar DV, Kavathia P, Rangnani T, Thakkar J, Kartha G 2018. Metabolic syndrome among adults of Surendra Nagar District of Saurashtra, Gujarat: A cross-sectional study. *Indian J Community Med*, 43: 24-28.

Deedwania PC, Gupta R, Sharma KK, Achari V, Gupta B, Maheshwari A, Gupta A 2014. High prevalence of metabolic syndrome among urban subjects in India: A multisite study. *Diabetes Metab Syndr,* 8(3): 156-161.

Friedewald WT, Levy RI, Fredrickson DS 1972. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clin Chem,* 18(6): 499-502.

Gupta R, Sarna M, Rastogi P, Kaul V, Gupta VP 2005. Association of obesity with coronary risk factors in the north Indian Bhatia community: Jaipur heart watch-3. In: human obesity: a major health burden. *J Human Ecol,* 13: 101-110.

Harikrishnan S, Sarma S, Sanjay G, Jeemon P, Krishnan MN, Venugopal K, Mohanan PP, Jeyaseelan L, Thankappan KR, Zachariah G 2018. Prevalence of metabolic syndrome and its risk factors in Kerala, South India: Analysis of a community based cross-sectional study. *PLoS ONE,* 13(3): e0192372.

Ismail IM, Azeez K, Antomy A, Kunnummal SV 2016. Metabolic syndrome and its associated factors among the adult population residing in Kannavam tribal area of Kannur District, Kerala. *Trop J Med Res,* 19: 36-41.

Jesmin S, Islam R, Islam S, Mia S, Sultana SN, Zaedi S et al. 2012. Comprehensive assessment of metabolic syndrome among Rural Bangladeshi Women. *BMC Public Health,* 12: 49.

Kandpal V, Sachdeva MP, Saraswathy KN 2016. An assessment study of CVD related risk factors in a tribal population of India. *BMC Public Health,* 16: 434.

Lohman TG, Roche AF, Martorell R 1988. *Anthropometric Standardization Reference Manual*. Champaign, IL: Human Kinetics Books.

Lokanath DA, Chandrashekariah SA, Xaviour D, Rao J 2014. The incidence and alliance of metabolic syndrome with cardiovascular risk markers among Kodavas. *Open J Endocr Metab Dis,* 4: 158-166.

Mabry RM, Reeves MM, Eakin EG, Owen N 2010. Gender differences in prevalence of the metabolic syndrome in gulf cooperation council countries: A systematic review. *Diabet Med,* 27: 593-597.

Moore JX, Chaudhary N, Akinyemiju T 2017. Metabolic syndrome prevalence by race/ethnicity and sex in the United States, National Health and Nutrition Examination Survey, 1988-2012. *Prev Chronic Dis,* 14: 160287.

Prasad DS, Kabir Z, Dash AK, Das BC 2012. Prevalence and risk factors for metabolic syndrome in Asian Indians: A community study from urban Eastern India. *J Cardiovasc Dis Res,* 3(3): 204-211.

Rampal S, Mahadeva S, Guallar E, Bulgiba A, Mohamed R et al. 2012. Ethnic differences in the prevalence of metabolic syndrome: Results from a multi-ethnic population-based survey in Malaysia. *PLoS ONE,* 7(9): e46365. Doi:10.1371/journal.pone.0046365.

Ranasinghe P, Mathangasinghe Y, Jayawardena R, Hills AP, Misra A 2017. Prevalence and trends of metabolic syndrome among adults in the Asia-Pacific region: A systematic review. *BMC Public Health*, 17: 101.

Saklayan MG 2018. The global epidemic of the metabolic syndrome. *Current Hypertension Reports,* 20:12

Sarkar S, Das M, Mukhopadhyay B, Sekhar Chakraborty C, Majumder PP 2005. Prevalence of metabolic syndrome in two tribal populations of the sub-Himalayan region of India: Ethnic and rural-urban differences. *Am J Hum Biol,* 17: 814 - 817.

Sarkar S, Das M, Mukhopadhyay B, Chakrabarti CS, Majumder PP 2006. High prevalence of metabolic syndrome and its correlates in two tribal populations of India and the impact of urbanization. *Indian J Med Res,* 123: 679-686.

Savadatti SS, Bell EM, Gates MA, Hosler AS, Yucel RM, Misra R 2018. Metabolic syndrome among Asian Indians in the United States. *J Public Health Manag Pract*, 24(1). Doi: 10.1097/PHH.000000 0000000738.

Scuteri A, Laurent S, Cucca F, Cockcroft J, Cunha PG, Mañas LR, Mattace Raso FU, Muiesan ML, Ryliškytë L, Rietzschel E, Strait J, Vlachopoulos C, Völzke H, Lakatta EG, Nilsson PM 2015. Metabolic syndrome across Europe: Different clusters of risk factors. *Eur J Prev Cardiol*, 22(4): 486-491.

Shalini M, Suresh Babu KP, Srinivasa Murthy AG, Girish B, Hamsaveena, Mounika K, Vaishnavi B 2013. Metabolic syndrome among urban and rural women population. *J Clin Diagn Res*, 7(9): 1938-1940.

Sharma S, Aggarwal N, Joshi B, Suri V, Badada S 2016. Prevalence of metabolic syndrome in pre- and post-menopausal women: A prospective study from apex institute of North India. *J Mid-Life Health,* 7(4): 169-174.

Sinha N, Bhattacharya A, Deshmukh PR, Panja TK, Yasmin S, Arlappa N 2016. Metabolic syndrome among elderly care-home residents in southern India: A cross-sectional study. *WHO South-East Asia J Public Health*, 5(1): 62-69.

Paper received for publication on October 2017
Paper accepted for publication on July 2018