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METABOLIC SYNDROME AND RISK OF CARDIOVASCULAR DISEASE IN RURAL AND URBAN PATIENTS IN NORTH INDIA

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ABSTRACT

Introduction: Metabolic syndrome (MetS) and cardiovascular disease (CVD) have been associated with the variables of anthropometric and biochemical measurements. This study evaluated the effect of MetS and risk of CVD factors in rural and urban population. **Aim:** To compare the effect of MetS and CVD risk factors in rural and urban population of Greater Noida. **Material and methods:** A total three hundred sixty seven participants were recruited in the study, aged 20 to 55 years. Comprising, 290 patients (149 rural and 141 urban) and 77 were healthy age, sex matched controls from the study area. Over a period of 3 months by employing personal interview, anthropometric measurements, clinical and laboratory examination information was obtained. Blood pressure (BP), waist circumference (WC), hip circumference, waist hip ratio (WHR), body mass index (BMI), fasting blood glucose (FBG), triglycerides, high density lipoprotein (HDL), cholesterol and glycated haemoglobin (HbA1c) were compared in both rural and urban populations. Data were analysed by using Statistical Package for Social Survey (SPSS) for windows 16.0 software (SPSS Inc., Chicago, IL, USA) and result where expressed on mean ± SD. **Results:** There were significant differences in biochemical measurements and anthropometric measurements of study population ($p<0.05$). As per NCEP ATPIII criteria, the prevalence of MetS in rural patient population was 13.8% in male and 18.8% in female. Whereas in urban male and female exhibited 21.7% and 27.8% of MetS respectively. The risk of CVD in a rural patient population was 6.3% in male and 11.6% in female. Whereas in urban male and female exhibited 13.0% and 15.3% of CVD respectively. **Conclusion:** Metabolic syndrome in the presence of type 2 diabetes (T2DM) plays an important role in elevation of blood pressure, low-density lipoprotein and triglycerides which are precursors risk of CVD.

KEYWORDS: Body mass index, Central obesity, Glycated haemoglobin, Type 2 diabetes mellitus.

INTRODUCTION

The worldwide incidence of MetS and CVD have been reported to increase over the years and has become the leading cause of premature death and disability. The incidence of MetS and coronary heart disease (CHD) is increasing in many developed countries, but also increasing in developing and traditional countries, partly as a result of increasing longevity, urbanization and lifestyle changes, more than 50-60% of the global burden of CHD observed in developing countries.[1] The MetS is a multiple and a major risk factor for CVD.[2,3] The syndrome developed through the interplay of obesity and metabolic susceptibility. The co-occurrence of MetS and T2DM precede the CVD risk associated with each condition.[4,5] Several studies have reported that MetS is associated with double risk of CVD.[6] The scenario of the MetS factors may vary with age, gender, geographic elements and type of population.[7] The prevention and treatment modalities of MetS and CVD are very expensive as well as fatal. Early detection of MetS among patients with T2DM is very helpful for the multiple risk reduction, including changes in lifestyle factors within conclusion reason of prevention and intervention of CVD.[8] The present scientific study conducted in Greater Noida (district Gautam Budha Nagar) which is adjoining to capital city Delhi. It has 40.9% rural population and 59.1% urban population, an increase of life expectancy, rapid population growth and unplanned urbanization raising the risk of MetS[9] and CVD. Thus the study is designed with an aim to compare the effect of MetS and CVD among rural and urban population.

MATERIAL AND METHODS

The present study was carried out at tertiary care centers (multicentric hospital based study) in Greater Noida district Gautam Budha Nagar. The period of study was Feb 2014 to Jan 2016. Ethical clearance was taken from the ethics committee of the institution. A cross sectional study design was used among rural and urban areas who are the permanent resident of study areas in the age group of 20-55 years. A total of 301 patients were participated in the study. Total 11 patients (5 rural and 6 urban) were dropped out from the study, due to ill health and not turned up for follow up. Out of 290 patients, 149 patients were from rural and 141 were from urban areas. This study also recruited 77 subjects were normal and healthy considered as a control (35 rural and 42 urban). The participants were selected from tertiary care centers of Greater Noida district Gautam Budha Nagar. The inclusion criteria were participants attending medicine outpatient department (OPD) aged 20-55 years of both sexes having signs and symptoms of MetS and CVD along with altered lipid profile were selected. Exclusion criteria were participants with a nonsignificant history of coronary heart disease (CHD) and MetS. Pregnant female and migrating population was excluded from the study. The participants were interviewed to obtain relevant data like weight, height, age, sex and family history. Blood pressure was measured by using sphygmomanometer, after keeping participant in a resting position for 15 minutes. WC and hip circumference were measured by using flexible measuring tape. Relevant data were documented in a pretested computerized study proforma.

Approximately 7 ml of fasting venous blood samples early morning after an overnight (8-10 hrs) was collected from the participants. Approximately 2 ml of blood was collected in sodium fluoride vial and centrifuged for 20 minutes to obtained the plasma, it was used for FBG. Plasma FBG concentration was measured using glucose oxidase-peroxidase method.[10] Approximately 3ml of blood was collected in plain vial without any antocoagulant and centrifuged for 20 minutes to obtained the serum, it was used for measuring cholesterol, triglycerides and HDL-C. Cholesterol and triglycerides respectively, were measured using enzymatic cholesterol oxidase-peroxidase and glycerophosphate-oxidase (GPO/PAP) method.[11,12] HDL-C was measured using precipitation/enzymatic method, low density lipoprotein cholesterol (LDL-C) was calculated using Friedwald's equation and holds valid only for triglyceride levels <400 mg/dl. Approximately 2ml of blood was collected in EDTA vial and used for HbA1c estimation. HbA1c was processed by fluorescence immunoassay based technique with internal and external quality control. Biochemical analyses were carried out by standard authenticated, established techniques using semi-autoanalyzer.

BMI was calculated by standard procedure that is body weight in kilogram/height in meter^2 (kg/m^2). MetS was defined as detailed in the National Cholesterol Education Program, Adult Treatment Panel III (NCEP, ATP III) report, participants having 3 or more of the following of five factors.[13] Central obesity: abdominal waist circumference, male> 102 cm, female> 88 cm, FBG ≥ 110 mg/dl, serum triglycerides ≥ 150 mg/dl, serum HDL-C male<40 mg/dl, female<50 mg/dl and blood pressure ≥ 130 / ≥ 85 mm Hg. The purpose of ATP lll was to identify people who are at increased risk for CVD and to find out lifestyle intervention to reduce risk.

Statistical Analysis

The comparative data of patient and control were presented as mean±SD. The data were compared using student's "t" test. To investigate the associations of the different variables with MetS and CVD. In all the statistical calculations for the variables p value <0.05 was considered significant. All the statistical analysis was carried out by using Statistical Package for Social Survey (SPSS) for windows 16.0 software (SPSS Inc., Chicago, IL, USA).

RESULTS

There were 77 controls recruited in the study. In rural area 18 were male controls with the mean age of 39.16±9.93 years, ranging from 24 years to 54 years whereas in urban area there were 21 male controls with the mean age of 35.95±8.44 years, ranging from 23 years to 50 years [Table-1]. In rural area there were 17 females with the mean age of 35.88±9.49 years, ranging from 24 years to 53 years whereas in urban area there were 21 females with the mean age of 37.76±10.97 years, ranging from 21 years to 53 years [Table-2]. The rural control group compared with the urban control group, whereas urban patients group compared with the rural patient group and statistically significant ($p<0.05$) the mean value.

[Table-1]: Comparison mean value of MetS and CVD risk factors studied in male control group. Data expressed as mean ± SD p<0.05 significant.

Male control (n=39)			
Variables	**Rural area male (n=18) Mean ± SD**	**Urban area male (n=21) Mean ± SD**	**p-value**
Age (years)	39.16±9.93	35.95±8.44	>0.05
Systolic BP (mm Hg)	124.89±3.31	127.52±2.69	<0.05
Diastolic BP (mm Hg)	82.00±1.81	82.14±2.22	>0.05
Waist circumference (cm)	84.39±4.55	80.00±3.97	<0.05
Hip circumference	97.00±4.00	93.19±4.08	<0.05
Waist Hip Ratio	0.87±0.03	0.85±0.03	<0.05
BMI (kg/m^2)	22.72±1.09	23.29±0.89	>0.05
FBG (mg/dl)	96.83±7.43	86.72±17.31	<0.05
Triglycerides (mg/dl)	135.53±10.20	139.93±5.71	<0.05
HDL –C (mg/dl)	47.58±5.54	50.00±5.10	<0.05
Cholesterol (mg/dl)	172.28±17.87	177.68±16.21	<0.05
LDL –C (mg/dl)	97.57±17.77	99.63±18.60	<0.05
HbA1c (%)	5.07±0.60	4.64±0.32	<0.05

Rural male control was compared with urban male control, there was a statistically significant difference was noticed in mean values of systolic blood pressure, waist circumference, hip circumference, waist hip ratio, FBG, triglycerides, HDL-C, cholesterol, LDL-C and HbA1c ($p<0.05$). The mean levels of age, diastolic blood pressure and BMI were statistically insignificant ($p>0.05$) [Table-1].

[Table-2]: Comparison mean value of MetS and CVD risk factors studied in female control group. Data expressed as mean ± SD p<0.05 significant.

Female Control (n=38)			
Variables	**Rural area female (n=17) mean ± SD**	**Urban area female (n=21) mean ± SD**	**p-value**
Age (years)	35.88±9.49	37.76±10.97	>0.05
Systolic BP (mm Hg)	125.76±3.46	125.57±3.26	>0.05
Diastolic BP (mm Hg)	80.47±1.50	81.81±2.06	<0.05
Waist circumference (cm)	83.12±4.06	81.43±5.20	<0.05
Hip circumference	100.35 ± 4.85	98.42± 4.57	<0.05
Waist Hip Ratio	0.82±0.02	0.82±0.03	<0.05
BMI (kg/m^2)	23.63±1.04	23.23±1.29	>0.05
FBG (mg/dl)	93.38±8.01	88.36±8.24	<0.05
Triglycerides (mg/dl)	132.87±12.39	131.21±17.42	<0.05
HDL –C (mg/dl)	53.16±2.08	54.94±2.97	<0.05
Cholesterol (mg/dl)	165.95±19.53	176.31±18.53	>0.05
LDL –C (mg/dl)	84.74±16.71	95.15±19.43	<0.05
HbA1c (%)	4.69±0.38	4.55±0.58	>0.05

Rural female control was compared with urban female control, there was a statistically significant difference was noticed in mean values of diastolic blood pressure, waist circumference, hip circumference, waist hip ratio, FBG, triglycerides, HDL-C and LDL-C ($p<0.05$). The mean levels of age, systolic blood pressure, BMI, cholesterol and HbA1c were statistically insignificant ($p>0.05$) [Table-2].

In patient group 80 were rural male with the mean age of 43.87±8.18 years, ranging from 26 years to 55 years while 69 were urban male with the mean age of 43.65±8.68 years, ranging from 26 years to 55 years [Table-3]. In rural area there were 69 females with the mean age of 43.95±8.78 years, ranging from 23 years to 55 years whereas in urban areas there were 72 females with the mean age of 42.66±9.34 years, ranging from 24 years to 55 years [Table-4].

Urban male patients have significantly higher mean levels of diastolic blood pressure, waist circumference, hip circumference, waist hip ratio and cholesterol in comparison to rural patients in present study ($p<0.05$). The mean levels age, systolic blood pressure, BMI, FBG, triglycerides, HDL-C, LDL-C and HbA1c were statistically insignificant (p>0.05) (Table-3). Urban female in general, had a significantly higher systolic blood pressure, waist circumference and hip circumference (p<0.05). The mean levels age, diastolic blood pressure, waist hip ratio, BMI, FBG, triglycerides, HDL-C, cholesterol, LDL-C, and HbA1c were statistically insignificant (p>0.05) [Table-4]. Female patients have low increased BMI than male counterparts. The incidence of hypertension increased with age and correlated with respondents' blood glucose levels.

[Table-3]: Comparison of MetS and CVD risk factors studied in male patients. Data expressed as mean ± SD, P < 0.05 significant.

Male patients (n=149)			
Variables	**Rural area male (n=80) mean ± SD**	**Urban area male (n=69) mean ± SD**	**p-value**
Age (years)	43.87±8.18	43.65±8.68	>0.05
Systolic BP (mm Hg)	127.30±6.64	128.45±6.43	>0.05
Diastolic BP (mm Hg)	81.56±4.45	83.61±5.01	<0.05
Waist circumference (cm)	88.65±9.33	92.38±7.78	<0.05
Hip circumference	99.92±7.25	102.14±6.24	<0.05
Waist Hip Ratio	0.88±0.05	0.90±0.04	<0.05
BMI (kg/m^2)	23.50±2.18	24.10±2.53	>0.05
FBG (mg/dl)	101.62±19.14	105.20±25.02	>0.05
Triglycerides (mg/dl)	151.09±54.18	163.48±83.65	>0.05
HDL –C (mg/dl)	45.50±7.03	44.19±7.97	>0.05
Cholesterol (mg/dl)	184.43±33.27	196.00±43.15	<0.05
LDL –C (mg/dl)	111.71±34.39	119.65±43.91	>0.05
HbA1c (%)	5.56±1.10	5.64±1.18	>0.05

[Table-4]: Comparison of MetS and CVD risk factors studied in female patients. Data expressed as mean ± SD, p < 0.05 significant.

Female patients (n=141)			
Variables	**Rural area female (n=69) mean ± SD**	**Urban area female (n=72) mean ± SD**	**p-value**
Age (years)	43.95±8.78	42.66±9.34	>0.05
Systolic BP (mm Hg)	127.65±5.57	130.64±7.02	<0.05
Diastolic BP (mm Hg)	84.54±4.16	84.26±5.30	>0.05
Waist circumference (cm)	86.96±5.26	89.61±9.30	<0.05
Hip circumference	101.39±4.03	104.26±5.80	<0.05
Waist Hip Ratio	0.85±0.06	0.85±0.06	>0.05
BMI (kg/m^2)	23.96±2.15	24.43±2.34	>0.05
FBG (mg/dl)	102.79±21.43	108.08±27.56	>0.05
Triglycerides (mg/dl)	154.95±57.81[@]	158.89±86.96	>0.05
HDL –C (mg/dl)	49.28±7.40	48.85±8.82	>0.05
Cholesterol (mg/dl)	192.85±44.64	192.42±39.05	>0.05
LDL –C (mg/dl)	113.77±45.41	111.83±40.36	>0.05
HbA1c (%)	5.60±1.42	5.86±1.42	>0.05

In the present study, Urban patients had higher triglyceride cholesterol levels than rural counterparts. The circulatory level of triglycerides 33.4%, total cholesterol 26.3%, and low levels of HDL-C were higher in urban patients as compared to rural patients. A significant family history of the disease (includes siblings and parents) found in urban compared with rural patients. Both urban and rural female had significantly higher risk for abdominal obesity and low levels of HDL-C than the male counterpart (Table-5).

[Table-5]: Comparison of MetS and CVD risk factors studied in patients.

Patients rural and urban area (n=290)						
Characteristics	**Male (n=80)**	**Female (n=69)**	**Total %**	**Male (n=69)**	**Female (n=72)**	**Total %**
Triglyceridemia %	23.7%	27.5%	25.6%	37.7%	29.2%	33.4%
Cholesterolemia %	20.0%	24.6%	22.3%	29.0%	23.6%	26.3%
Hypertension %	12.5%	20.3%	16.4%	24.6%	25.0%	24.8%

[Table-6]: Comparison of disease manifestation in studied patients.

Patients rural and urban area (n=290)						
Characteristics	**Rural area patients**			**Urban area patients**		
	Male (n=69)	**Female (n=72)**	**Total %**	**Male (n=69)**	**Female (n=72)**	**Total %**
CVD %	6.3%	11.6%	8.9%	13.0%	15.3%	14.1%
MetS %	13.8%	18.8%	16.3%	21.7%	27.8%	24.7%

Urban patients have also significantly higher CVD 14.1% and MetS 24.7% in comparison to rural patients 8.9% and 16.3%, respectively, with significant gender differences in three of the five criteria of MetS recommended by NCEP, ATP III. Rural study patients, unaware that they are suffering from MetS and CVD. The highest burden of MetS and CVD risk factors in urban and rural study population provides a basis for cost-effective prevention and intervention in such resource - constrained setting. The prevalence of MetS is significantly higher among urban female 27.8%. A similar pattern was noted among rural male and female for CVD. The rates of abdominal obesity, increased systolic, diastolic blood pressure and low HDL-C were more or less similar among MetS patients compared to CVD urban and rural patients. The present study shows that the higher risk of MetS and CVD increased due to urbanization in urban areas as compared to rural areas [Table-6].

DISCUSSION

A comprehensive investigative study was carried out to compare MetS and CVD risk factors in rural and urban patients attending tertiary care centers using standardized field measurements. Hypertension and lipid abnormalities, are major risk factors of MetS and

CVD. Hypertension was more reported in urban than rural ones (24.8% versus 16.4%) in the present study, In our study findings correlate with reported findings of Bhansali et al (2015) the prevalence of hypertension 28.1% -31.5% of urban patients and 19.8% -26.2% in rural patients.[14] In the current study, the mean levels of cholesterol and triglycerides were higher in urban male patients than rural counterparts similar to our findings, most surveys have shown higher mean concentrations of cholesterol and triglycerides in urban compared with rural patients, with a low mean concentration of HDL-C.[15] T2DM was the established index in assessing CHD which is a major risk factor of CVD.[16] In current study urban patients having high MetS 24.7% when compared with the rural patients 16.3%. In a study Deedwania et al (2014) MetS was more reported 36.8% in urban areas.[17] Pranita Kambli et al (2010) conducted a cross sectional study in rural Wardha population, central India found the MetS prevalence at 5%, which is similar to the present study.[18] The majority of the other studies also found higher rates of MetS in urban areas as compared to rural areas. There was a high prevalence of CVD 14.1% in the urban patients as compared with rural patients 8.9% in our study a similar data on CVD rates have a range 8%-10% in urban areas and 3%-4% in rural areas in 2003,[19,20] however, in 2008 Enas et al were found to be 12% and 6% respectively.[21] The dysmetabolic phenotype of urban inhabitants is due to rapid nutrition transition, physical inactivity and stress respectively. The changing dietary profile over the last decade includes increased consumption of non-traditional food stuff and ‘energy-dense’ Asian Indian dietary components, more so in urban areas. Elevated prevalence of MetS and other CVD risk factors in rural and urban patients is due to decreased consumption of the traditional diet, lack of labour-intensive work due to mechanization, commuting and increased obesity. Worldwide studies have shown that Asian Indians develop CVD a decade earlier than other ethnic groups.[22] Here again, the primary reason is that the change from a traditional diet to energy-dense, high saturated fat diet is occurring more rapidly in children as well as young adults. Importantly, the prevalence of CVD is higher in urban than rural age group patients >40 - 55 years, providing an opportunity for early application of preventive strategies. A notable feature was the high prevalence of the MetS and CVD in female as compared to male in both urban and rural areas earlier reported study from other regions of India.[23] This is primarily due to the high prevalence of abdominal obesity and low levels of HDL-C in the female. Two factors contribute to such a phenotype, first the largely sedentary lifestyle of female in India[24] and second one inability to shed weight gained post-pregnancy contributed by inactivity and imbalanced diet during prenatal and postnatal periods. In rural northern India, female who gained more weight during and after pregnancy were sedentary and had thicker skin fold and showed more tendency to hyperglycemia after pregnancy.[25] Interestingly, in the current study despite higher prevalence of the MetS in female, the prevalence of CVD was almost similar to the male. It is likely that if female with the MetS continue with the current inadequate physical activity and lifestyle, conversion to diabetes may occur rapidly, thus prevalence of diabetes may also elevate later on. High prevalence of generalized and abdominal obesity is clearly a precursor for the cluster development of risk factors comprising the MetS and CVD also increases subclinical inflammation. The typical Asian Indian phenotype of obesity consists of high body fat for comparatively low BMI, high subcutaneous and intra-abdominal fat, and ectopic fat deposition in the liver. The T2DM have four fold increases in the chances of having CVD compared to subjects without diabetes mellitus. Hyperlipidemia is associated with atherosclerosis. Atherosclerosis is one of the major risk factors for CVD. Thus, hyperlipidemia, hyperglycemia coupled with raised diastolic blood pressure may contribute to the observed four fold increase in CVD patients.[26] Among urban Indians, the average levels fall in the high cardiovascular risk category and are a concern given that it mediates the relationship between body fat, other inflammatory markers and coronary artery disease.[27,28] Moreover, circulatory cholesterol levels were higher in female, in both urban and rural areas compared to male counterparts. Poor CVD control due to late diagnosis and poor medical care among rural patients who were mostly illiterates, unaware of MetS and CVD. Its consequences suggest that health education, early diagnosis, effective, manageable and affordable treatment are the prime needs in rural study areas. One of our study reported that successful reduction of key risk factors (WC and BP) and FBG levels among rural and urban population. The intervention improved intake of fiber and protein besides lowering obesity in youth and adults.

CONCLUSION

There was a high prevalence of MetS and CVD in urban area as compared to rural areas along with elevated levels of cholesterol, triglyceride and Low HDL-C. Furthermore, there was progressive worsening of all metabolic parameters between urban patients, which provide a confirmatory basis for tailored prevention and intervention programs, an economically beneficial feature in such resource constrained settings.

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REFERENCES

1. The global health observatory data repository, 2015.
2. Kaur JA, Comprehensive Review on Metabolic Syndrome. Hindawi publishing corporation cardiology research and practice, 2014; article ID 943162: 21 pages.
3. Shin JA, Lee JH, Lim SY, et al,. Metabolic syndrome as a predictor of type 2 diabetes and its clinical interpretations and usefulness. Journal of Diabetes Investigation, 2013; 4(4): 334–343.
4. Wong ND, Nelson JC, Granston T, et al,. Metabolic syndrome, diabetes, and incidence and progression of coronary calcium: the Multiethnic Study of Atherosclerosis study. JACC:Cardiovascular Imaging, 2012; 5(4):358–366.
5. Gyakobo M, Amoah AGB, Marteymarbell DA, Snow R C,. Prevalence of the metabolic syndrome in a rural population in Ghana. BMC Endocrine Disorders, 2012; 12: article 25.
6. Lakka HM, Laaksonen DE, Lakka TA, Niskanen LK, Kumpusalo E, Tuomilehto J, et al,. The metabolic syndrome and total and cardiovascular disease mortality in middle-aged men. JAMA, 2002; 288: 2709-2716.
7. Biino G, Concas MP, Cena H, Parracciani D, Vaccargiu S, et al,. Dissecting metabolic syndrome components: data from an epidemiologic survey in a genetic isolate. Springer Plus, 2015; 4(1): 324.
8. Kengne AP, Limen SN, Sobngwi E, Djouogo CFT, Nouedoui C,. Metabolic syndrome in type 2 diabetes: comparative prevalence according to two sets of diagnostic criteria in sub-Saharan Africans. Diabetology and Metabolic Syndrome, 2012; 4: article 22.
9. Low WY, Lee YK, Samy AL,. Non-communicable diseases in the Asia-Pacific region: Prevalence, risk factors and community-based prevention. Int J Occup Med Environ Health, 2015; 28(1): 20–26.
10. Thomas L,. Clinical laboratory diagnostics, 1st ed. Frankfurt: TH-Books Verlagsgesellschaft, 1998; 131-7.
11. Tietz textbook of clinical chemisty and molecular diagnostics. Burtis, C A., Ashwood, E R., Bruns, D E; 5th edition, WB Saunders Company, 2012.

12. Rifai N, Bachorik PS, Alberts JJ. Lipids, lipoproteins and apolipoproteins. In: Burtis CA, Ashwood ER, editors Tietz textbook of clinical chemistry. 3rd ed. Philadelphia: W.B Saunders Company, 1999; 809-61.
13. Expert panel on detection: Executive summary of the third report of the National Cholesterol Education Program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III). JAMA, 2001; 285(19): 2486-2497.
14. Bhansali A, Dhandania VK, Deepa M, et al,. Prevalence and risk factors for hypertension in urban and rural India: The ICMR-INDIAB study. Journal of human hypertension, 2015; 29(3): 204-209.
15. Misra A, Luthra K, Vikram NK,. Dyslipidemia in Asian Indians: determinants and significance. J Assoc Physicians India, 2004; 52: 137–142.
16. Anjana RM, Deepa M. Prevalence of diabetes and prediabetes in 15 states of India: results from the ICMR–INDIAB population-based cross-sectional study, for the ICMR–INDIAB Collaborative Study Group. lancet diabetes endocrinol, 2017.
17. Deedwania PC, Gupta R, Sharma KK, Achari V, Gupta B, Maheshwari A et al,. High prevalence of metabolic syndrome among urban subjects in India: A multisite study. Diabetes Metab Syndr, 2014; 8(3): 156-161.
18. Pranita K et al,. Metabolic syndrome in adult population of rural Wardha, Central India. Indian journal of medical research, 2010; 132: 701-705.
19. Gupta R,. "Burden of coronary heart disease in India".Indian Heart Journal, 2005; 57: 632-8.
20. Gupta R,. Coronary heart disease in India: Absolute numbers and economic burden. rapid response to Ghaffar A, Reddy KS, Singhi M. Burden of non-communicable diseases in South Asia. British Medical Journal, 2004; 328: 807-810.
21. Enas EA, Singh V, Munjal YP, Gupta R, Patel KC, Bhandari S, et al,. Recommendations of the second Indo-US health summit on prevention and control of cardiovascular disease among Asian Indians. Indian Heart J, 2009; 61: 165–274.
22. Qiao Q, Hu G, Tuomilehto J, Nakagami T, Balkau B, Borch-Johnsen K, et al,. Age and sex-specific prevalence of diabetes and impaired glucose regulation in 11 Asian cohorts. Diab Care, 2003; 26: 1770–80.
23. Chow CK, Mc Quillan B, Raju PK, Iyengar S, Raju R, Harmer JA, et al,. Greater adverse effects of cholesterol and diabetes on carotidintima-media thickness in South Asian

Indians: comparison of risk factor-IMT associations in two population-based surveys. Atherosclerosis, 2008; 199: 116–122.

24. Misra A, Vikram NK,. Insulin resistance syndrome (metabolic syndrome) and obesity in Asian Indians: evidence and implications. Nutrition, 2004; 20: 482–491.
25. Kulkarni SR, Fall CH, Joshi NV, Lubree HG, Deshpande VU, Pasarkar RV, et al,. Determinants of incident hyperglycemia 6 years after delivery in young rural Indian mothers: the Pune Maternal Nutrition Study (PMNS). Diab Care, 2007; 30: 2542–7.
26. Mandsorwale D, Nagtilak S, Lalchandani A, Srivastava AK,. Myeloperoxidase-A prognostic marker in cardiovascular disease. Int. Journal of Pharma & Bio-science, 2014; 5(4): B776-782.
27. Mohan V, Deepa R, Velmurugan K, Premalatha G,. Association of C-reactive protein with body fat, diabetes and coronary artery disease in Asian Indians: the Chennai Urban Rural Epidemiology Study (CURES-6). Diabet Med, 2005; 22: 863–70.
28. Sainani GS, Karatela RA,. Plasma leptin in insulin-resistant and insulin-nonresistant coronary artery disease and its association with cardio-metabolic risk factors among Asian Indians. Metab Syndr Relat Disord, 2009; 7: 335–40.