Original Research Article

Prevalence of metabolic syndrome in a rural population- a cross sectional study from Western Uttar Pradesh, India

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ABSTRACT

Background: Prevalence of non-communicable diseases like hypertension, diabetes mellitus and coronary artery disease is on the rise due to the change in lifestyle, unfavourable dietary habits and obesity. Metabolic syndrome is a simple tool by which we can predict the future risk of diabetes mellitus and cardiovascular disease. Studies showed that prevalence of metabolic syndrome is rising in Indian population, but majority of them were done in urban population. This study was conducted to look into the current status of the metabolic syndrome in rural population.
Methods: The study was conducted among a population of 2982. Each participant was subjected to clinical examination, anthropometric measurements and necessary laboratory investigations. Metabolic syndrome was diagnosed based on modified NCEP: ATP III criteria.
Results: The prevalence of metabolic syndrome was found to be 11.7% and was higher among female population (13.8%) as compared to males (9.6%). The prevalence of metabolic syndrome increased with increasing age. 28.3% of the participants over the age of 50 years had metabolic syndrome whereas it was only 0.4% below the age of 20 years. Nearly half (47.1%) of the obese individuals were suffering from metabolic syndrome implicating obesity as one of the most important risk factors in the etiopathogenesis of metabolic syndrome. The prevalence was only 1.1% among the underweight group.
Conclusions: Present study has shown moderate prevalence of metabolic syndrome among the rural population of Western Uttar Pradesh, India with a more female predisposition.

Keywords: Cardiovascular disease, Obesity, Metabolic syndrome, Rural population

INTRODUCTION

The metabolic syndrome is a constellation of metabolic abnormalities that confer increased risk of cardiovascular diseases and type 2 diabetes mellitus. The major features of this syndrome are insulin resistance, central obesity, hypertension and dyslipidemia. Obesity and insulin resistance are thought to be the major underlying determinants of this condition. Other risk factors include physical inactivity, high calorie diet, habitual alcohol drinking, smoking, psychosocial stress and increase in proinflammatory cytokines.[1] The precise mechanism by which these factors cause metabolic syndrome is yet to be determined. Newer studies suggest oxidative stress also play a significant role in metabolic syndrome and associated cardiovascular diseases.[2] In addition to cardiovascular risk, the metabolic syndrome is strongly associated with a large number of clinical conditions like non-alcoholic fatty liver disease, cholesterol gall stones, obstructive sleep apnoea, hyperuricemia, polycystic ovarian syndrome and psoriasis.[3-8] The exact relationship between most of these conditions and metabolic syndrome is an area of ongoing research. Currently different diagnostic criteria exist for the diagnosis of

metabolic syndrome including those proposed by NCEP:ATP III (National Cholesterol Education Program: Adult Treatment Plan III), IDF (International Diabetes Federation) and WHO (World Health Organization).[9,10] Each criterion make use of different parameters with different cut offs. Modified NCEP-ATP III criteria is widely used in most of the epidemiological studies as it is feasible to carry out among different population.

Regardless of the existing controversies in diagnosis and definition, the metabolic syndrome is still considered to be a useful diagnostic tool in primary care prevention. Many clinicians find the concept of metabolic syndrome useful because it fits the profile of many patients presenting in primary care in contemporary practice. It gives opportunity for early patient identification and education on proper health behavioural changes implicated in the development of the cardiovascular diseases. Patients could be educated early about the relationship between their lifestyle, health risks and medical outcomes.[11]

The major aim in the treatment of metabolic syndrome is to reduce the risk of cardiovascular disease and type 2 diabetes mellitus. There is no specific treatment for metabolic syndrome. Each individual is treated according to the risk factors the person is found to have. While there is no drug treatment that directly treats the underlying insulin resistance in metabolic syndrome, diet modification and exercise to promote weight loss have been advocated to improve insulin resistance.[12] Reduction of LDL cholesterol, blood pressure and blood glucose levels to the recommended levels by various non pharmacological and pharmacological measures is advised to prevent both the short term and long term complications of metabolic syndrome.[13,14]

METHODS

We conducted a population based cross sectional study among 2982 subjects who satisfied all the inclusion criteria. The study population was selected from different villages of Western Uttar Pradesh, India by health camp approach. The duration of study was from 2015 January to 2016 December.

Inclusion criteria

- Age >18 years and <55 years
- Individuals giving written, informed consent
- Those who are free from critical illnesses

Exclusion criteria

- All critically ill patients
- All type 1 diabetes mellitus patients
- Diagnosed cases of secondary hypertension
- All pregnant and lactating mothers
- Patients with psychiatric illnesses

- Patients who have been taking long term steroids
- Patients with ascites and anasarca
- Persons with any condition which may render them unable to complete the study or which may pose a significant risk to the physical or mental health of the subject.

Written informed consent was taken from all the participants at the time of recruitment. Printed questionnaires were distributed to collect information on social, demographical, occupational, dietary and medical history.

Anthropometric measurements were taken at the time of recruitment and was entered into the proforma sheet. Height was measured without shoes to the nearest 0.1cm by a portable stadiometer. Weight was measured in light indoor clothing without shoes to the nearest 0.1kg by an electronic weighing balance. Waist circumference was measured as the minimum circumference between the inferior margin of ribcage and the crest of the ileum. Resting blood pressure was measured in sitting position in right upper limb after 20 minutes of rest using a mercury sphygmomanometer independently by 2 doctors

The serum lipid profile was estimated by the enzymatic CHOD-PAP method for total cholesterol, GPO method for triglycerides and PVS/PEGME method for HDL cholesterol. These estimations were carried out by using ERBA-XL 300 (Transasia) fully automated analyzer.

LDL cholesterol was calculated by using Friedenwald equation

LDL cholesterol = Total cholesterol – HDL cholesterol – Triglycerides/2.2

Metabolic Syndrome was diagnosed by NCEP-ATP III criteria modified for waist circumference as follows.

3 or more of the following:

- Central obesity: waist circumference ≥90cm (male), ≥80cm (female)
- Hypertriglyceridemia: Triglyceride ≥150mg/dl or specific medication
- Low HDL cholesterol: <40mg/dl(male) and <50mg/dl(female) or specific medication
- Blood pressure: Systolic blood pressure ≥130mmHg or diastolic blood pressure ≥85mmHg or specific medication
- Fasting plasma glucose ≥100mg/dl or specific medication or previously diagnosed type 2 diabetes.

RESULTS

The demographic, anthropometric and baseline biochemical characteristics of the study population are given in Table 1. The majority (61.1%) of the subjects

were under 40 years of age. About one third of the patients were in the age group of 20-30 years (29.9%) followed by 41-50 years (24%), 31-40 years (22.2%), >50 years (15%) and <20 years (9%).

Table 1: Demographic, anthropometric and baseline biochemical characteristics of the study population.

Characteristics	Mean standard deviation
Age (years)	36.61±12.25
Weight (kg)	60.14±9.48
Height (cm)	159.9±7.2
Body mass index (kg/m^2)	23.5±3.35
Systolic blood pressure (mmHg)	126±16.95
Diastolic blood pressure (mmHg)	78.16±10.82
Fasting blood sugar (mg/dl)	82.58±26.68
Triglycerides (mg/dl)	92.68±30.89
HDL cholesterol (mg/dl)	42.37±12.74

Table 2: Age distribution of patients.

Age in years	Frequency (n=2982)	Percentage
<20	268	9.0
20-30	891	29.9
31-40	662	22.2
41-50	715	24.0
>50	446	15.0

Mean BMI of the study group was 23.5±3.35kg/m^2. Majority (63.1%) of the participants were having normal BMI (18.5-24.9kg/m^2). Proportion of overweight (25-29.9kg/m^2) and obese (≥30kg/m^2) individuals was 26.9% and 4.1% respectively. This is represented in Figure 1.

Figure 2 shows the prevalence of metabolic syndrome. The overall prevalence of metabolic syndrome was 11.7% (95% CI=10.6-12.9). The prevalence was more among females (13.8%) as compared to males (9.6%).
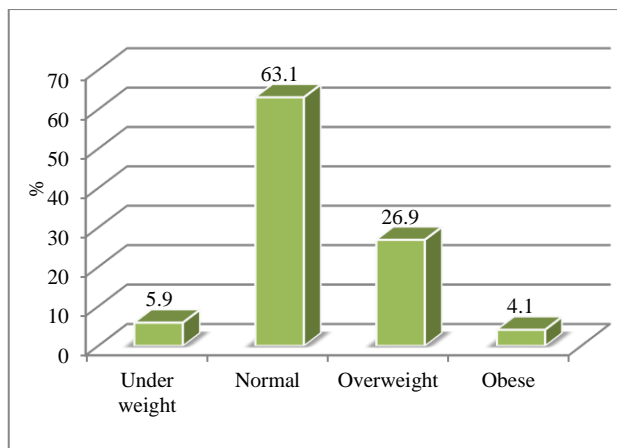

Figure 1: Distribution of patients according to BMI.

Prevalence of metabolic syndrome was significantly higher among obese (47.2%) and overweight (23.7%) individuals than those with a normal BMI (5.3%) and the results were highly significant (p-value=0.001). Almost half of obese individuals and one quarter of overweight individuals were suffering from metabolic syndrome establishing the importance of obesity in the pathogenesis of this syndrome (Figure 3).
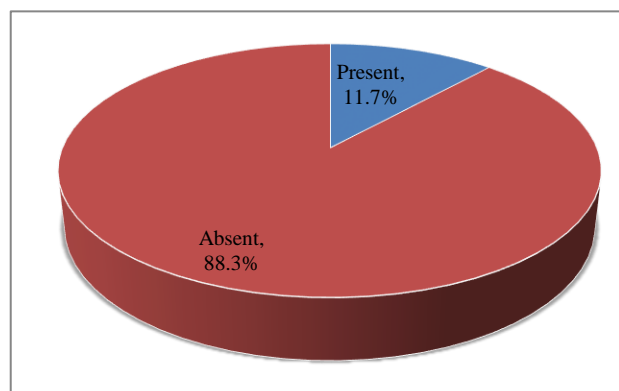

Figure 2: Prevalence of metabolic syndrome.

Table 3: Prevalence of metabolic syndrome according to fasting blood glucose (FBG).

FBG	No. of patients	Prevalence of metabolic syndrome				OR (95%), CI	p-value[1]
		Present		Absent			
		No.	%	No.	%		
<100	2707	195	7.2	2512	92.8	1.00 (Ref.)	<100
100-125	165	70	42.4	95	57.6	9.49 (6.74-13.35)	0.0001*
>125	110	85	77.3	25	22.7	43.79 (27.39-70.01)	0.0001*

OR-Odds ratio, CI-Confidence interval, [1]Binary logistic regression, Ref.: Reference, *Significant.

Table 3 shows the prevalence of metabolic syndrome according to fasting blood glucose level. The prevalence of metabolic syndrome was higher among those whose fasting blood glucose level was >125mg/dl (77.3%) than 100-125mg/dl (42.4%) and <100mg/dl (7.2%). The prevalence of metabolic syndrome was 9.49 times significantly higher in patients with fasting blood glucose

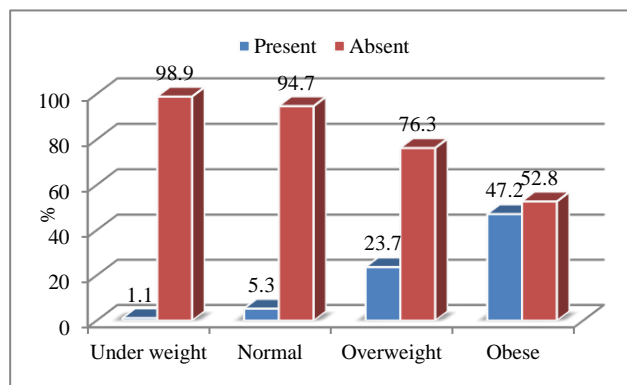100-125mg/dl than those with <100mg/dl (OR=9.49, 95% CI=6.74-13.35, p=0.0001).

Figure 3: Prevalence of metabolic syndrome according to BMI.

DISCUSSION

The prevalence of metabolic syndrome in India according to various studies is given in Table 4.

The overall prevalence of metabolic syndrome in our study was found to be 11.7% using the NCEP-ATP III criteria modified for waist circumference of Southeast Asian population. This is almost equivalent to the prevalence in the study done by Deepa et al which showed 11.2%.[15]

The syndrome was more prevalent among females (13.8%) than in males (9.6%) like most of the studies like Deepa et al study (12.9% vs 9.9%), Gupta et al (17.5% vs 7.9%), Pranita Kamble et al (10.7% vs 8.2%), Deepak Pathania et al (11.64% vs 6.45%) and PS Singh et al (11.5% vs 4.9%).[15,17,19-21]

Table 4: Prevalence of metabolic syndrome in India according to various studies.

Study	Place	Setting	Age	Population	Prevalence
Deepa et al[15]	Chennai	Urban	>20 years	1070	11.2%
Ramachandran et al[16]	Chennai	Urban	20-75 years	475	41.1%
Gupta et al[17]	Jaipur	Urban	>20 years	1091	12.8%
Surana SP et al[18]	Mumbai	Urban	Type 2 diabetes of any age	5088	77.2%
Kamble P et al[19]	Wardha	Rural	>18 years	300	9.3%
Pathania et al[20]	Ambala	Rural	>20 years	1200	9.2%
Singh PS et al[21]	Western Uttar Pradesh	Rural	25-65 years	5400	9.4%

Many hypotheses can explain the low prevalence of metabolic syndrome in present study. The first reason is the relatively younger age of the study population. 61.1% of the study population were under the age of 40 years and it is well known that prevalence of metabolic syndrome increases with age due to the increasing prevalence of insulin resistance, obesity, dyslipidemia and hypertension associated with aging.

Even in the present study 28.3% of the population above 50 years of age had metabolic syndrome whereas the prevalence of metabolic syndrome under 20 years of age was only 0.4%. These findings are correlating with the results of Kamble P et al study which showed a low prevalence of 4% below 30 years of age but a high prevalence of 24.5% above 50 years of age.[19]

In present study 77.3% of the diabetic patients were found to be suffering from metabolic syndrome which is significantly high compared to the general population. According to present study diabetes imparts a risk of 43.79 times to develop metabolic syndrome compared to non-diabetics. This finding declares diabetes the single most important determinant of metabolic syndrome. Other studies like Val FK et al and Nsiah K et al showed lower prevalence of 55.9% and 58% respectively.[22,23] The prevalence of metabolic syndrome among non-diabetics was considerably very low (7.2%) and the results were significant (p-value=0.0001).

CONCLUSION

The study revealed a moderate prevalence of metabolic syndrome using modified NCEP-ATP-III criteria which is slightly more than the prevalence detected in some other studies in similar settings. Females were found to be at high risk to develop metabolic syndrome rather than males. Diabetes mellitus was found to be the single most independent risk factor for the development of metabolic syndrome. Hence all the diabetic patients should be screened for other components of this syndrome and appropriate timely interventions to be taken.

Smoking, alcoholism and tobacco chewing might impart the risk of metabolic syndrome but absolute risk could not be predicted since other confounding variables were not ruled out. The tools for the diagnosis of metabolic syndrome are simple, cheap and cost effective. Hence early detection will enable the treating primary care physicians to educate the patients about the significance

of weight reduction, dietary modification, increasing physical activity and treatment of associated risk factors. Future cardiovascular morbidity and mortality could be prevented to a great extent by these simple measures. More studies in rural set up with large sample size will enable the epidemiologists to generalize the results to apply for national recommendations. Further research is required to formulate a unique criterion for the diagnosis of metabolic syndrome which will be accepted universally, feasible to carry out in large epidemiological studies and cost effective.

REFERENCES

1. Kahn R, Buse J, Ferranninie E, Stern M. The metabolic syndrome: time for a critical appraisal: joint statement from the American Diabetes Association and the European Association for the Study of Diabetes. Diabetes Care. 2005;28(9):2289-304.
2. Ford ES. Risks for all-cause mortality, cardiovascular disease and diabetes associated with the metabolic syndrome: a summary of the evidence. Diabetes Care. 2005;28(7):1769-78.
3. Kotronen A, Jarvinen YH. Fatty liver: a novel component of the metabolic syndrome. Arterioscler Thromb Vasc Biol. 2008;28(1):27-38.
4. Mendez-Sanchez N, Tapia CNC, Kuba MD, Lara SK, Ponciano-Rodriguez G, Baptista H, Uribe M. Metabolic syndrome as a risk factor for gall stone disease. World J Gastroenterol. 2005;11(11):1653-57.
5. Bhushan B, Misra A, Guleria R. Obstructive sleep apnoea is independently associated with the metabolic syndrome in obese Asian Indians in Northern India. Metab Syndr Relat Disord. 2010;8(5):431-35.
6. Billiet L, Doaty S, Katz JD, Velasquez MT. Review of hyperuricemia as new marker for metabolic syndrome. ISRN Rheumatol. 2014;2014:852954.
7. Ehrmann DA, Liljenquist DR, Kasza K, Azziz R, Legro RS, Ghazzi MN. PCOS/Troglitazone study group. Prevalence and predictors of the metabolic syndrome in females with PCOD. J Clin Endocrinol Metab. 2006;91(1):48-53.
8. Love TJ, Qureshi AA, Karlson EW, Gelfand JM, Choi HK. Prevalence of metabolic syndrome in psoriasis: Results from the National Health and Nutritional Examination Survey 2003-2006. Arch Dermatol. 2011;147(4):419-24.
9. 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;285:2486-97.
10. Alberti KG, Eckel RH, Grundy SM. Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes federation Task Force on Epidemiology and prevention. National Heart, Lung and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the study of Obesity. Circulation. 2009;120:1640-45.
11. Kahn R. Metabolic syndrome: What is the clinical usefulness? Lancet. 2008;371:1892-2008.
12. Glueck CJ, Fontaine RN, Wang P, Subbiah MT, Weber K, Illig E, et al. Metformin reduces weight, centripetal obesity, insulin, leptin, and low-density lipoprotein cholesterol in nondiabetic, morbidly obese subjects with body mass index greater than 30. Metabolism. 2001;50(7):856-61.
13. Stone NJ, Robinson J, Lichtenstein AH, Merz BCN, Jones LDM, Blum CB, McBride P, et al. ACC/AHA guideline on the treatment of blood cholesterol to reduce atherosclerotic cardiovascular risk in adults. J Am Coll Cardiol. 2014;63(25 Pt B):2889-934.
14. Hasslacher C. ACE inhibitor in metabolic syndrome. Z Kardiol. 1994;83(4):21-9.
15. Deepa R, Shantiram CS, Premalatha G, Sastry NG, Mohan V. Prevalence of insulin resistance syndrome in a selected South Indian population- the Chennai urban population study-7(CUPS-7). Indian J Med Res.2002;115:118-27.
16. Ramachandran A, Snehalatha C, Satyavani K, Sivasankari S, Vijay V. Metabolic syndrome in urban Asian Indian adults- a population study using modified ATP III criteria. Diabetes Res Clin Pract. 2003;60(3):199-204.
17. Gupta A, Gupta R, Sarna M, Rastogi S, Gupta VP, Kothari K. Prevalence of Diabetes, impaired fasting glucose and insulin resistance syndrome in an urban indianpopulation. Diab Res Clin Pract. 2003;61:69-76.
18. Surana SP, Shah DB, Gala K, Susheja S, Hoskote SS, Gill N, Joshi SR. Prevalence of metabolic syndrome in an urban Indian diabetic population using the NCEP ATP III guidelines. JAPI.2 008;56(11).865-68.
19. Kamble P, Deshmukh PR, Garg N. Metabolic syndrome in adult population of rural Wardha, Central India. Indian J Med Res. 2010;132:701-5.
20. Pathania D, Bunger R, Mishra P, Pathak R, Arora A. A study to assess prevalence of metabolic syndrome and its sociodemographic risk factors in rural area of district Ambala, Haryana. J Comm Med Health Educ. 2013;3(5):1-4.
21. Singh PS, Kumar M, Pulakraj, Chauhan S. Metabolic syndrome in rural population of Western UP (India)- A prospective study. Int J Contemp Med. 2014;2(2):170-3.
22. Val FK, Titty WK, Owiredu WK, Frempong AMT. Prevalence of metabolic syndrome and its individual

components among diabetic patients in Ghana. J Biol Sci. 2008;8(6):1057-61.

23. Nsiah K, Shang OV, Boateng AK, Mensah FO. Prevalence of metabolic syndrome in type 2 diabetes mellitus patients. Int J Appl Basic Med Res. 2015;5(2):133-8.