## Original Article

# Prevalence of metabolic syndrome crossing 40% in Northern India: Time to act fast before it runs out of proportions

# Yasmee Khan[1], Arati Lalchandani[2], Ajesh Chandra Gupta[2], Sagar Khadanga[1], Sanjeev Kumar[3]

*Departments of [1]Medicine and [3]CFM, AIIMS Bhopal, Bhopal, Madhya Pradesh, [2]Department of Medicine, GSVM Medical College, Kanpur, Uttar Pradesh, India*

## Abstract

**Background:** Metabolic syndrome (MetS) is a constellation of high blood pressure, hyperglycemia, obesity, and dyslipidemia. Its presence makes the patient more prone for cardiovascular events. Its prevalence has been documented as 11%–41%. The present study was undertaken to find out the demographic profile of the MetS in Kanpur region of northern India. **Materials and Methods:** This is a hospital based, cross-sectional study with adequate sample size. **Results:** Out of the randomly selected 420 patients (232 males and 188 females), 172 cases (61 males and 111 females) were found to have MetS adopting the National Cholesterol Education Program Adult Treatment Panel III criteria. The overall prevalence of MetS was found to be 40.9% (26.2% of total males and 59% of total females). Among the 172 cases of MetS, females were more than males (64.5% vs. 35.4%). Maximum numbers of MetS cases were in the age range of 50–59 years (55/172 = 31.9%) followed by 40–49 years (50/172 = 29%), >60 years (35/172 = 20.3%), 30–39 years (30/172 = 17.4%), and <30 years (2/172 = 1.1%). In the total study population of 420 cases, hyperglycemia was the most common (29.2%) and hyperglycemia, obesity, and high triglyceride were significantly higher prevalence in females. Among the participants of 111 cases of MetS, hyperglycemia was the most common (71.5%) and high blood pressure, and low high density lipoprotein was significantly higher among males. **Conclusion:** The prevalence of MetS was more than 40% and its prevalence in <40 years age group is rapidly increasing. Its high time to be more active physically, before fatal cardiovascular events.

**Keywords:** Dyslipidemia, hypertension, metabolic syndrome, obesity

## Introduction

Metabolic syndrome (MetS) is a concept rather than a disease in itself.[1] The concept was developed way back in 1920 when Kylin, a Swedish physician found an association between hyperglycemia, high blood pressure and gout. MetS is a constellation of interconnected physiological, clinical, and metabolic abnormalities that directly increase the risk of cardiovascular disease and related mortality. The most common biophysiological abnormalities are increased blood pressure, insulin resistance, visceral adiposity, and atherogenic dyslipidemia. MetS is a major public health challenge globally due to rapid urbanization, sedentary lifestyle, and surplus energy intake. MetS has been associated with a 5-fold increase in the risk of development of diabetes mellitus and 2-fold increased risk of developing the cardiovascular disease over the next 5–10 years.[2] Patients with MetS are at 2–4 fold more likely to have stroke and 3–4 fold likelihood of myocardial infarction in their lifetime.[3-6]

There is no uniform definition of MetS. Various organizations, for example, the World Health Organization (WHO),[7] the

**Address for correspondence:** Dr. Sagar Khadanga,
Department of Medicine, AIIMS Bhopal, Saket Nagar, Bhopal,
Madhya Pradesh, India.
E-mail: sagar.genmed@aiimsbhopal.edu.in

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European Group for the study of Insulin Resistance (EGIR),[8] the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III),[9] American Association of Clinical Endocrinologists (AACE),[10] and the International Hyperglycemia Federation (IDF),[11] use different definitions. Although each definition possesses many common features, there are several parameters which differ. The AACE, WHO, and EGIR definitions are all largely focused on insulin resistance, and are primarily used for research,[12] The NCEP ATP III definition is more clinician-friendly which use measurements and laboratory results that are readily available.[12]

Worldwide prevalence of MetS ranges from <10% to as much as 84%, depending on the region, urban-rural environment, composition (sex, age, race, and ethnicity) of the patient, and the definition used.[13-18] The prevalence of MetS in India has been documented to be from 11% to 41% across this vast country with numerous socio-cultural varieties. The present study was undertaken to find out the demographic profile of the MetS in Kanpur region of northern India.

## Materials and Methods

This is a hospital-based observational type of cross-sectional study conducted at a tertiary health center in Uttar Pradesh. Required sample size to estimate the prevalence of MetS among the outpatient with an estimated prevalence of 35%, at a 95% confidence interval of 30%–40% is 350 persons. Considering nonresponse rate of 20% the final sample size was calculated to be 420.

Medicine outpatient department is attended by approximate 200 patients/day of which 60% are male. We generated 2 random numbers each day in between 1 and 200. A healthcare professional was instructed to identify the randomly allocated cases by looking at the token number. A total of 420 cases who attended the medicine department were included in the study after random allocation of the number. All patients who attended the medicine OPD were eligible for inclusion. Exclusion criteria were age <14 years and pregnant females. Patients were diagnosed as MetS according to NCEP ATP III Criteria. According to the NCEP ATP III criteria, the diagnosis of MetS was made when three or more of the following were present:

1. Waist circumference >102 cm in male and >88 cm in female
2. Fasting blood glucose >110 mg/dl
3. Systolic blood pressure >130 mmHg or diastolic blood pressure >85 mmHg
4. Fasting triglyceride (TG) >150 mg/dl
5. High density lipoprotein cholesterol (HDL-C) <40 mg/dl in men and <50 mg/dl in women.

Approval from the Institutional ethical committee was attained before conduction of the study. The data were summarized as frequencies and percentages.

## Observation

Out of the 420 cases of total study participants, males were 232 in number versus 188 numbers of females maximum numbers of patients were in the age range of 40–49 years and 50–59 years (110 patients, i.e., 27.5% in each age group) followed by the age group of 30–39 years and >60 years (90 patients, i.e., 22.5%). Least number of cases was in the age group of <30 years (20 patients, 5%) [Figure 1]. The Chi-square $P = 0.76$ indicating the group was homogeneous.

Out of the total study participants of 420 cases, 172 cases (172/420 = 40.9%) were identified to be having MetS. Among the 172 cases of MetS, 111 were females (111/172 = 64.5%) versus 61 males (61/172 = 35.4%). Among the male patients the prevalence of MetS was 26.2% (61/232) versus 59% (111/188) in females. Prevalence of MetS was significantly more common in females than in males ($\chi^2 = 46.06$, Chi-square $P < 0.05$). Among the 172 cases of MetS, maximum numbers of cases were in the age range of 50–59 years (55/172 = 31.9%) followed by 40–49 years (50/172 = 29%), >60 years (35/172 = 20.3%), 30–39 years (30/172 = 17.4%). Least number of cases were in <30 years age group range, i.e., (2/172 = 1.1%) [Figure 2].

When the entire study participants were further analyzed for presence of different components of MetS, hyperglycemia was the most common accompanying disease (29.2%) followed by high TG (19.7%), obesity (19.5%), high blood pressure (18.3%), and low HDL in 18.3% of cases [Table 1]. Hyperglycemia (22.3% vs. 19.3%), obesity (30.8% vs. 10.3%), and high TG (27.1% vs. 13.7%) were significantly higher prevalent in female patients (Chi-square $P < 0.05$). Although high blood pressure (22.3% vs. 15%) and low HDL (18.6% vs. 18.3%) were also more common females, their prevalence was not statistically significant ($P > 0.5$).

As evident from Table 2, among patients diagnosed with MetS, hyperglycemia was the most common component (71.5%), followed by high TG (48.25%), obesity (47.6%), high blood
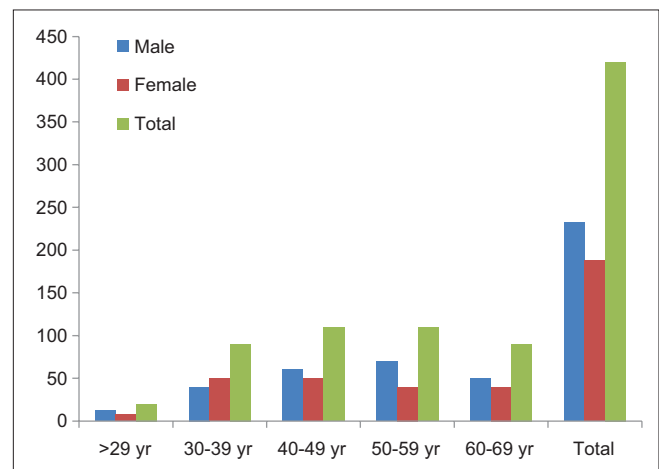


**Figure 1:** Age and sex distribution of 420 study population. The Chi-square $P = 0.76$ indicating the group was homogeneous

## Table 1: Prevalence of components of metabolic syndrome in the study population (*n*=420)

| Components of MetS | Male (*n*=232), *n* (%) | Female (*n*=188), *n* (%) | Total (*n*=420), *n* (%) | $\chi^2$ | *P* (two-tailed) |
|---|---|---|---|---|---|
| Abnormal BP | 35 (15) | 42 (22.3) | 77 (18.3) | 3.65 | 0.056 |
| Hyperglycemia | 45 (19.3) | 78 (41.4) | 123 (29.2) | 24.5 | 0.000002 |
| Obesity | 24 (10.3) | 58 (30.8) | 82 (19.5) | 27.8 | 0.000001 |
| TG >150 mg/dl | 32 (13.7) | 51 (27.1) | 83 (19.7) | 11.6 | 0.0006 |
| Low HDL | 42 (18.1) | 35 (18.6) | 77 (18.3) | 0.02 | 0.9 |

Hyperglycemia, obesity, and high TG were significantly higher prevalent in female subjects. MetS: Metabolic syndrome; BP: Blood pressure; HDL: High density lipoprotein; TG: Triglyceride

## Table 2: Prevalence of components of metabolic syndrome among the subjects of metabolic syndrome (*n*=172)

| Component | Male (*n*=61), *n* (%) | Female (*n*=111), *n* (%) | Total (*n*=172), *n* (%) | $\chi^2$ | *P* | OR (95% CI) |
|---|---|---|---|---|---|---|
| Abnormal BP | 35 (57.3) | 42 (37.8) | 77 (44.7) | 6.1 | 0.01 | 2.21 (1.17-4.18) |
| Hyperglycemia | 45 (73.3) | 78 (70.2) | 123 (71.5) | 0.24 | 0.63 | 1.19 (0.59-2.4) |
| Obesity | 24 (39.3) | 58 (52.2) | 82 (47.6) | 2.63 | 0.1 | 0.6 (0.3-1.1) |
| TG >150 mg/dl | 32 (52.4) | 51 (45.9) | 83 (48.2) | 0.67 | 0.41 | 1.3 (0.69-2.43) |
| Low HDL | 42 (68.8) | 35 (31.5) | 77 (44.7) | 22.2 | 0.000004 | 4.8 (2.4-9.4) |

High BP and low HDL were significantly higher among males as compared to females. BP: Blood pressure; HDL: High density lipoprotein; TG: Triglyceride; OR: Odds ratio; CI: Confidence interval
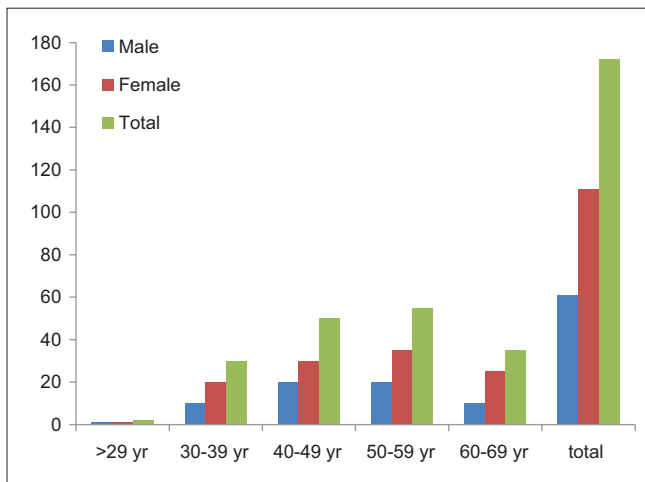


**Figure 2:** Age and sex distribution of 172 metabolic syndrome cases. Nearly 80% of the metabolic syndrome patients were >40 years and prevalence was significantly high in females

## Discussion

The prevalence of MetS in India is increasing due to urbanization, high calorie diet and lack of physical activity. There are many available criteria which have been used in various studies of MetS,[11] Depending on the study participants and criteria used, MetS has been documented in 11%–41% of cases.[19] In our study, the overall prevalence of MetS was 40.9%. Another study from the same institute reported a prevalence of 37.65%.[20] This is in accordance to our study and reaffirms the high regional prevalence of MetS in Uttar Pradesh. Studies across South Indian urban subject documented the prevalence ranging from 22.1% to 41%.[21-23] Another northern Indian study reported a prevalence of MetS, as 22.37%.[24] Prasad *et al.* in their study reported the prevalence of MetS as 43.2% in a community-based study from the eastern part of coastal India.[25]

High prevalence of MetS in female patient has been previously documented across the globe.[23,26-31] In our study, the prevalence of MetS was significantly higher in female patients (59% vs. 26.2%, Chi-square *P* < 0.05). Another group from the same institute but from a different subset of subjects (patients of acute coronary syndrome [ACS]) also demonstrated a higher prevalence of MetS in female (35.24% vs. 24.25%).[20] The study was more close to the eastern Indian study of Prasad *et al.* where they documented the female prevalence of 52.2% versus 34.25% in males.[25] Higher prevalence of MetS in females might be due to the gender bias in MetS characterization in waist circumference and HDL value. There might also be some role of metabolic parameters such as hormonal effect and menopause.

Maximum numbers of cases of MetS were in the age range of 40–49 years and 50–59 years. About 80% of patients of MetS were >40 years. This is in accordance with an earlier study from our institute where the mean age was found to be 60.3 ± 8.4 years.[20] Prasad *et al.* also mentions prevalence of >65% of MetS cases in above >40 years age group.[25] Yadav *et al.* also reported highest prevalence of 38% in the age group of 50–59 years. The same study

pressure (44.7%), and low HDL (44.7%) [Table 2]. High blood pressure and low HDL was significantly higher among males than females. This was in contrast to hyperglycemia, obesity, and high TG values which were similarly distributed among both the sexes.

Age- and sex-wise distribution of all MetS cases is shown in [Table 3]. The prevalence of all the components of MetS were more in >40 years subject than <40 years subject in both the genders [Table 3]. The prevalence of high blood pressure, hyperglycemia, obesity, high TG and low HDL among males of >40 years and <40 years was 11.2% versus 3.8%, 11.2% versus 3.8%, 8.6% versus 1.7%, 10.7% versus 3%, and 15% versus 3%, respectively. The prevalence of high blood pressure, hyperglycemia, obesity, high TG and low HDL among females of >40 years and <40 years was 21.2% versus 1%, 34% versus 7.45%, 26.5% versus 4.2%, 23.9% versus 3.1%, and 15.9% versus 2.6%, respectively.

### Table 3: Age- and gender-wise distribution of metabolic syndrome cases

| MetS components | 20-29 years | | 30-39 years | | 40-49 years | | 50-59 years | | 60-69 years | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female |
| Abnormal BP | | | | | | | | | | | | |
| Positive | 1 | 0 | 8 | 2 | 10 | 10 | 8 | 15 | 8 | 15 | 35 | 42 |
| Negative | 0 | 1 | 2 | 18 | 10 | 20 | 12 | 20 | 2 | 10 | 26 | 69 |
| Hyperglycemia | | | | | | | | | | | | |
| Positive | 1 | 1 | 8 | 13 | 10 | 18 | 18 | 26 | 8 | 20 | 45 | 78 |
| Negative | 0 | 0 | 2 | 7 | 10 | 12 | 2 | 9 | 2 | 5 | 16 | 33 |
| Obesity | | | | | | | | | | | | |
| Positive | 1 | 1 | 3 | 7 | 5 | 15 | 10 | 25 | 5 | 10 | 24 | 58 |
| Negative | 0 | 0 | 7 | 13 | 15 | 15 | 10 | 10 | 5 | 15 | 37 | 53 |
| Abnormal TG | | | | | | | | | | | | |
| Positive | 1 | 0 | 6 | 6 | 10 | 12 | 10 | 18 | 5 | 15 | 32 | 51 |
| Negative | 0 | 1 | 4 | 14 | 10 | 18 | 10 | 17 | 5 | 10 | 29 | 50 |
| Abnormal HDL | | | | | | | | | | | | |
| Positive | 1 | 1 | 6 | 4 | 15 | 10 | 15 | 10 | 5 | 10 | 42 | 35 |
| Negative | 0 | 0 | 4 | 16 | 5 | 20 | 5 | 25 | 5 | 15 | 19 | 81 |

MetS: Metabolic syndrome; BP: Blood pressure; HDL: High density lipoprotein; TG: Triglyceride

reported nearly 95% of cases were >40 year old in Gwalior region of India.[32] It is obvious that with passing decades the incidence of various components of MetS increases. However, the notable feature is the prevalence of MetS cases in <40 years age group. Less than 40 years is considered as pre-disease state, where the patient is exposed to lifestyle modifications, up gradation of socioeconomic status and physical inactivity. We report the prevalence of MetS nearly 18% in this age group. Yadav *et al.* reported nearly 5% of cases in the age group of 30–39 years.[32] They have not taken into account of cases <30 years and the study was undertaken only in type 2 hyperglycemia cases which is uncommon in <30 years. On the other hand, Prasad *et al.* documented the prevalence of MetS nearly 35% in this age group.[25] This higher prevalence might be due to different criteria used in the study (waist circumference of 102 cm in male and 88 cm in female in our study vs. 90 cm in males and 80 cm in females in the study by Prasad).

In our study, the prevalence of components of MetS in the study population in the decreasing order was hyperglycemia (29.2%), high TG (19.7%), obesity (19.5%), high blood pressure (18.3%), and low HDL in 18.3% of cases [Table 1]. Prasad *et al.* reported the prevalence of the components: high blood pressure 63.1%, obesity 48.9%, low HDL 46.9%, triglyceridemia 37.7%, and hyperglycemia 31.2%.[25] The spectrum of prevalence in our study seems completely different from the above mentioned eastern Indian study.[25] The prevalence of different components of MetS in another study from our institute was reported to be 63.11% for high blood pressure, 47.54% for abdominal obesity, 46.72% for hyperglycemia, 38.53% for high TG levels, and 31.96% for low HDL.[20] This difference in prevalence can be explained by a different set of the study population (patient attending medicine outpatient department in our study vs. patients of ACS in other study). Although all the components of MetS were more prevalent in females of our study, only hyperglycemia, obesity, and high TG were significantly higher prevalence than male patients. In previous studies, it has been reported that central

obesity and low HDL was more common in female patient and high blood pressure and triglyceridemia was more common in male patients, rendering the males to be more at risk for cardio vascular events.[33,34] We did not find any such differences. This probably means that females are no more at less risk than male patients in development of cardiovascular events.

In our study, among the patients diagnosed with MetS, the prevalence of components of MetS in decreasing order are hyperglycemia (71.5%), high TG (48.25%), high blood pressure (44.7%), obesity (47.6%), and low HDL (44.7%). Sinha *et al.* from the same institute as that of our but from a different subject of ACS patients reported the prevalence as follows: high blood pressure (63.11%), obesity (47.54%), and hyperglycemia in 46.72% of cases.[20] They have not mentioned the prevalence of abnormal lipid profile. The different prevalence of hyperglycemia and high BP may be due to difference in study participant. Yadav *et al.* reported the prevalence of components among the patients of MetS (as per IDF definition) as follows: obesity: 87%, high blood pressure: 69%, low HDL: 59% and high TG in 44% of cases.[32] The higher prevalence of obesity might be because of different criteria used in the study (waist circumference of 102 cm in male and 88 cm in female in our study vs. 90 cm in males and 80 cm in females in their study). Among the MetS patients, high blood pressure and low HDL was significantly higher among males as compared to females in our study. This was in contrast to hyperglycemia, obesity and high TG values which were similarly distributed among both the sexes [Table 2]. As per Yadav *et al.* among the patients of MetS, only blood pressure was more prevalent in males (75.5% vs. 57%).[32] However, they have not reported the degree of association of the various components of MetS and gender. In contrast to our study higher prevalence of low HDL was found in female MetS patient in eastern Indian subject.[25] This again makes us believe firmly that the previously reported higher HDL in females is no more relevant in today's changing socioeconomic scenario.

The strength of the present study was adequate sample size and representative sampling technique. The limitations of the study are hospital-based, observational, and cross-sectional study. We adopted NCEP III criteria to diagnose MetS without its modification to Indian subject.

## Conclusion

The prevalence of MetS was more than 40%, and the prevalence was significantly higher in females. Although MetS was more prevalent in >40 year age group (80% of total MetS cases), the prevalence in <40 years age group is rapidly increasing. Hyperglycemia, obesity, and high TG were significantly higher prevalence in female population. Among the subset of MetS patients, high blood pressure and low HDL was significantly higher among males.

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## Conflicts of interest

There are no conflicts of interest.

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