

## Original Research Article

# Prevalence of metabolic syndrome in type 2 diabetic patients

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### ABSTRACT

**Background:** Metabolic syndrome (MetS) and diabetes mellitus concurrently potentiates a number of risk factors, significantly higher prevalence of cardiovascular diseases. Numerous risk factors associated with diabetes gets intensified by the presence of metabolic syndrome. Diabetes and metabolic syndrome together can increase the risk of cardiovascular disease by 2 to 4 folds. The main objective of this study was to determine the prevalence of MetS in type 2 diabetic mellitus (T2DM) patients. Components of metabolic syndrome were measured and compared to determine the prevalence.

**Methods:** Hospital based cross-sectional study was conducted from September 2019 to December 2019 at star hospital and modern technical college, Sanepa, Nepal. A total number of 353 patients with T2DM visiting star hospital were included in the study.

**Results:** Among 353 participants, MetS was diagnosed in 242 (68.5%) participants using NCEP-ATP III criteria. The prevalence of MetS was 68.5% among which male were 123 (76.3%) and female were 119 (61.9%). MetS was found to be highest in age group of 50-59 years with 34.2% (83) participants. Dyslipidemia with raised TG (triglyceride) 71.4% and reduced HDL 76% was found to be most prevalent component in our study followed by hypertension 73.1%.

**Conclusions:** 68.5% prevalence of MetS in T2DM with 76.3% male and 61.9% female according to NCEP-ATP III was found with anthropometric indices significantly higher in the male population compared to female population.

**Keywords:** Diabetes mellitus, Metabolic syndrome, Dyslipidemia, Hypertension

### INTRODUCTION

Diabetes mellitus, common form of diabetes is chronic metabolic disorder that has enormous social, health and economic consequences.<sup>1</sup> The clinical state of prolonged increase in levels of plasma glucose due to ineffective or inadequate amount of insulin is referred as diabetes mellitus. It is the third most leading causes of death among developing countries following heart diseases and cancer which can lead to serious health complications such as cardiovascular disorders, stroke, diabetic retinopathy and kidney dysfunction.<sup>2</sup>

A cluster of three of the five conditions specifically abdominal obesity, elevated TG, reduced HDL cholesterol, raised blood pressure and elevated plasma glucose is clinically recognized as metabolic syndrome.<sup>3</sup> These factors are linked to a higher probability of cardiovascular disease and diabetes mellitus. Components contributing to risk of metabolic syndrome are increasing age, genetic makeup, sedentary lifestyle, stress, poor diet and other health conditions. Metabolic syndrome and diabetes mellitus are hence correlated.<sup>3,4</sup>

Presence of visceral fat alters the level of substances such as adiponectin, resistin with increase in plasma levels of TNF- $\alpha$ . This triggers the formation of inflammatory cytokines that stimulates cell signaling with TNF- $\alpha$  receptor that can lead to insulin resistance.<sup>3</sup>

Immune cells increase with the increase in the adipose tissue which contributes to inflammation. This has a significant role in increased risk of diabetes and atherosclerosis. High fat diet and provisions lead to production of inflammatory mediators called eicosanoids.<sup>3</sup>

Sedentary lifestyle, poor diet and family history can cause body's cell to inhibit the ability to utilize glucose from the blood, referred to as insulin resistance, which ultimately leads to MetS.<sup>5</sup>

The burden of diabetes mellitus and its increasing rates are leading to high mortality rates.<sup>6</sup> T2DM is now pandemic and affecting various individuals across the globe.<sup>7</sup>

The study intended to determine the prevalence of MetS in T2DM following NCEP-ATP III criteria.

## METHODS

### Study setting and population

Hospital based cross-sectional study was conducted from August 2019 to December 2019 at Star hospital Sanepa, Nepal. Total 353 patients with T2DM visiting Star hospital were included in the study. Presence of diabetes mellitus was ascertained by history of patient's medical condition and medication. Patients with type 1 diabetes, heart diseases, chronic illness, pregnancy and malignancy were excluded from the study. As the study was confined to patients visiting Star hospital during certain period, non-probability purposive sampling technique was used. The subjects were 33-85 year old diagnosed with T2DM. Questionnaire was used to obtain history and information regarding T2DM.

### Sample size determination

There were 353 clinical specimens. Sample size was determined using the formula:

$$n = \frac{Z^2 pq}{e^2},$$

where,

n=required sample,

p=estimated prevalence=73.1% (Pokharel et al 2014),

q=100-p=26.9%,

e=allowable error=8% of p=4.41,

z=1.96 for 0.05 significance level (95% confidence interval),

$$n = \frac{(1.96)^2 \times 73.1 \times 26.9}{(4.41)^2},$$

n=379,

n $\approx$ 353.

In this study the calculated data size was 379 but due to limited time and hemolysis we were able to process 353 samples.

### Metabolic syndrome definition criteria

In our study we have used NCEP-ATP III definition of metabolic syndrome. According to this definition participant are suffering from metabolic syndrome when they meet three or more of following criteria.<sup>8</sup> The criterias are central obesity: waist circumference  $\geq$ 102 cm (male),  $\geq$ 88 cm (female); dyslipidemia: TG  $\geq$ 1.7 mmol/l (150 mg/dl); high density lipoprotein (HDL-C): <40 mg/dl (male), <50 mg/dl (female); blood pressure  $\geq$ 130/85 mmHg; fasting plasma glucose  $\geq$ 6.1 mmol/l (110 mg/dl).

As we were taking diabetes patients as our subject we used only 4 criteria from above mentioned 5 criteria excluding FBS.

### Data collection

#### Anthropometric and lifestyle related variables

Patients were interviewed within the hospital before sample collection using prepared questionnaire. After taking the consent from the patients' blood pressure, height, weight, waist circumference was measured.

BP measurement was taken using manual sphygmomanometer. Height and weight of the participant was taken using stadiometer and weighing machine in upright standing position, respectively. BMI was calculated as,

$$BMI = \frac{\text{weight (kg)}}{\text{height (m)}^2}.$$

**Table 1: WHO guidelines for Asians.**

BMI (in kg/m <sup>2</sup> )	
<18.5	Underweight
18.5-22.9	Normal
23-25	Overweight
>25	Obese

The waist circumference was measured using WHO guideline for waist measurement. The abdominal obesity

*Sample collection and biochemical investigations*

Blood sample was collected by venous blood collection method using 5 ml syringes. Participant must be on overnight fasting for the examination of FBS and lipid profile. About 5 ml fasting blood was drawn from each participant. Two tubes were used for the sample collection, gel tube (yellow cap vial) for lipid profile (TG and HDL) estimation and fluoride tube (grey cap vial) for plasma glucose estimation.

Glucose oxidase peroxidase method was used for the estimation of fasting plasma glucose.

Glycerol phosphate oxidase-para-aminophenazone enzymatic method was used for analysis of serum TG.

Precipitation method was used for the measurement of serum HDL-cholesterol.

These parameters were analyzed at biochemistry laboratory, Star hospital using semi-auto analyzer following all the protocol and SOP provided by manufacturer company ELITech Clinical System.

**Quality assurance**

All the procedures were done according to standard operating procedure provided by ELITech Clinical System. Internal quality controls were run on daily bases before the analysis of sample. ELITech QC of each reagent was provided by the company. Control ELITROL I (low) and ELITROL II (high) were run before the analysis to check the QC and the graph.

was defined according to NCEP criteria.<sup>9</sup>

**Data entry and statistical analysis**

From the patients information, anthropometric variables, biochemical investigation and history data was collected and was entered in Microsoft excel 2013.

For the analysis of data statistical package for social sciences (SPSS) was used. All the data from excel was analyzed using SPSS version 20.

Independent t test was used to compare the mean value between the groups. Chi square test was used to determine significant difference between categories. P value <0.05 was considered statistically significant.

**RESULTS**

A total 353 T2DM patients were enrolled with mean age of 55±11.196 years. Table 2 shows the anthropometric parameters of patients with mean age of male subject 53.89±10.545 years and female subject 55.93±11.660 years. The anthropometric parameters of patients such as weight, height and waist circumference were found to be significantly higher in the male population compared to female population.

Among the biochemical parameters, assayed TG level of male was significantly higher than female while HDL level was significantly higher in female than male. There was no significant difference between systolic/diastolic blood pressure and plasma glucose level among male and female (Table 3).

MetS was diagnosed in 242 (68.5%) participants using NCEP-ATPIII criteria. The prevalence of MetS was 68.5% among which male were 123 (76.3%) and female were 119 (61.9%) (Table 4).

**Table 2: Anthropometric parameters of diabetic patients stratified by gender.**

Parameters	Female	Male	P value
Age (in years)	55.93±11.660	53.89±10.545	0.089
Weight (in kg)	61.88±8.467	69.50±11.146	0.000
Height (in m)	1.78±0.414	1.98±0.156	0.000
BMI (in kg/m <sup>2</sup> )	26.49±3.771	26.98±3.827	0.226
Waist (in inches)	33.77±3.982	36.47±4.198	0.000
Waist (in cm)	85.71±10.262	92.65±10.865	0.000

**Table 3: Haemodynamic and biochemical parameters of study population stratified by gender.**

Parameters	Female	Male	P value
Systolic pressure (mmHg)	128.70±13.513	129.63±10.876	0.483
Diastolic pressure (mmHg)	87.76±10.754	88.76±10.444	0.380
Fasting blood sugar (mg/dl)	120.73±38.041	129.58±48.567	0.056
TG (mg/dl)	149.19±71.008	194.27±125.617	0.000
HDL (mg/dl)	42.64±6.373	38.25±4.944	0.000

**Table 4: Prevalence of MetS according to NCEP-ATP III stratified by gender.**

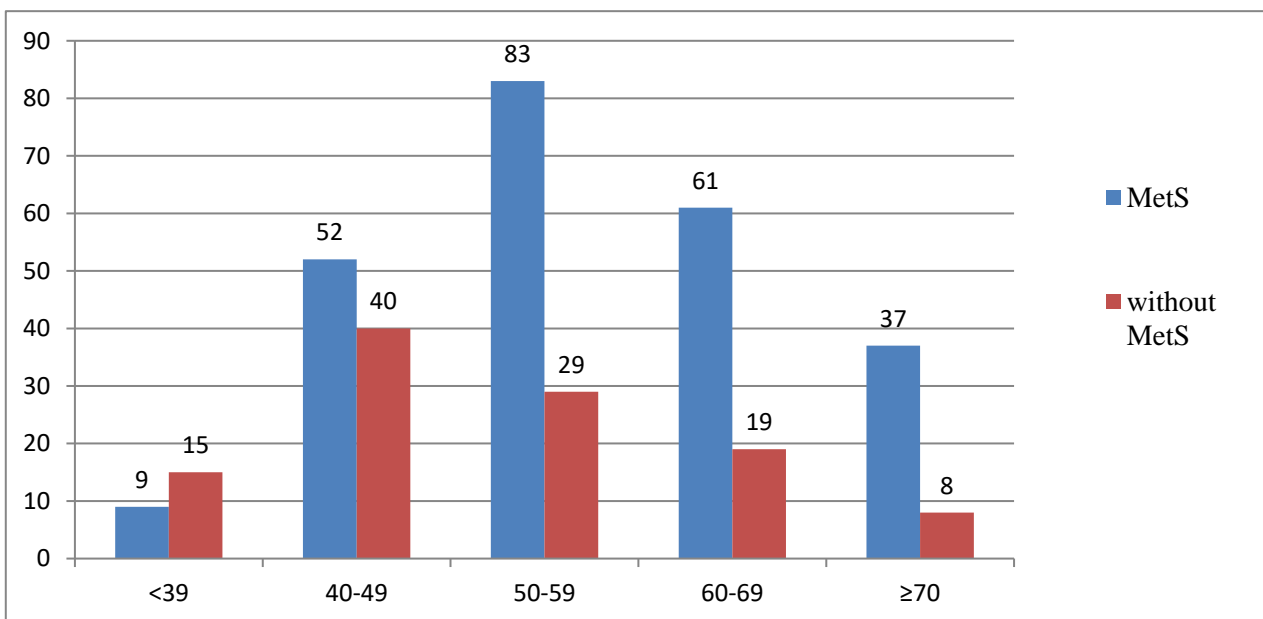
Gender	Positive (%)	Negative (%)	P value	Total
Female	119 (61.9)	73 (38.1)	0.004	192
Male	123 (76.3)	38 (23.7)		161
<b>Total</b>	<b>242 (68.55)</b>	<b>111 (31.45)</b>		<b>353</b>

**Table 5: Comparison of anthropometric, haemodynamic and biochemical parameters in diabetic patients with and without MetS.**

Parameters	Metabolic syndrome		P value
	With MetS (positive)	Without MetS (negative)	
<b>Number</b>	242	111	
<b>Age (in years)</b>	56.51±10.608	51.71±11.775	0.000
<b>BMI (kg/m<sup>2</sup>)</b>	27.45±3.920	25.11±2.952	0.000
<b>Systolic (mmHg)</b>	132.02±12.376	122.75±9.717	0.000
<b>Diastolic (mmHg)</b>	90.85±10.317	82.48±8.864	0.000
<b>Waist (cm)</b>	91.79±11.319	82.50±7.246	0.000
<b>TG (mg/dl)</b>	185.37±110.892	135.68±68.377	0.000
<b>HDL (mg/dl)</b>	39.56±5.159	42.98±7.412	0.000
<b>Fasting</b>	127.97±46.015	117.78±35.991	0.040

**Table 6: Percentage of the parameters within the MetS.**

Parameters	Metabolic syndrome	
	Yes, N (%)	No, N (%)
<b>Blood pressure ≥130/85 mmHg</b>	177 (73.1)	34 (30.6)
<b>Dyslipidemia</b>		
TG ≥150 mg/dl	173 (71.4)	74 (66.6)
<b>Reduced HDL</b>	184 (76.0)	32 (28.8)
<b>Increased waist circumference</b>	92 (38.0)	9 (8.1)
<b>BMI</b>	81 (33.4)	8 (7.2)
<b>FBS ≥110 mg/dl</b>	149 (61.5)	60 (54.0)



**Figure 1: Prevalence of MetS stratified by age.**

Figure 1 shows the MetS stratified by different age group with the prevalence found to be highest in age group of 50-59 years with 34.2% (83) participants. Also age group of 40-49 and 60-69 years were found to be almost similar with 52 (21.48%) and 61 (25.20%) participants, respectively. Lower prevalence was observed in age group of <39 years (3.7%).

All the parameters like age, BMI, systolic/diastolic pressure, waist circumference, TG, HDL were found to be significant in metabolic syndrome group compared with non-metabolic syndrome (Table 5).

Table 6 shows the most prevalent component in our study. Dyslipidemia with and reduced HDL (76%) and raised TG (71.4%) was found to be most prevalent component in our study followed by hypertension (73.1%).

## DISCUSSION

MetS and T2DM concurrently potentiates significantly higher prevalence of cardiovascular diseases. Numerous risk factors are associated with diabetes which is further intensified by the presence of metabolic syndrome. Diabetes and MetS together can increase the risk of cardiovascular disease by 2 to 4 folds.

Only limited research article on prevalence of MetS in T2DM were available conducted among Nepalese population. Development of cardiovascular disease cannot be fully confirmed since our study design was a cross-sectional however it suggested criteria for diagnosis of MetS and an indicator of future cardiovascular risk.

The prevalence of metabolic syndrome in T2DM patients was found to be 68.5% according to NCEP-ATP III. Prevalence in male and female were 76.3% and 61.9% respectively showing significantly higher prevalence in male population than in female.

Past study conducted in Nepal showed a greater prevalence of metabolic syndrome in T2DM. Tamang et al showed the prevalence of 76.9% according to NCEP-ATP III.<sup>10</sup> Study done by Bhattarai et al in 2012 showed that 71% diabetic patients had metabolic syndrome with prevalence of male and female of 72% and 91% respectively.<sup>11</sup> The study conducted in Manjil teaching hospital had the prevalence of 73.9% according to NCEP-ATP III with 80.3%, 69.9% and 66.8% according to harmonized, WHO and IDF definition respectively.<sup>12</sup>

Our study found a high prevalence of dyslipidemia followed by hypertension while Shakyia et al showed high prevalence of central obesity followed by hypertension.<sup>13</sup>

Our research found prevalence of 76.3% and 61.9% in male and female respectively, showing a higher prevalence in male while the research conducted by Bhattarai et al showed higher prevalence in female with

prevalence of male and female of 72% and 91% respectively.<sup>11</sup>

Anthropometric indices such as weight, height and waist (cm) were significantly higher in the male population compared to female population in our study are similar to the study done in Gwalior, India.<sup>14</sup>

Our study showed highest prevalence in the age group 50-59 years old followed by age group of 40-49 and 60-69 years. The reason may be sedentary lifestyle, retirement and diet intake of this group participant. Lower prevalence was observed in age group of <39 years (3.7%) as this age group is physically active age group.

All the parameters like BMI, blood pressure, fasting sugar, raised TG, reduced HDL and central obesity was found to be significantly higher in participant diagnosed with MetS than with the participant without MetS.

Almost all these components are interrelated with each other by direct or indirect means. Obesity, dyslipidemia, hypertension all can lead to diabetes in some context by signaling and triggering insulin resistance. Similarly, uncontrolled diabetes, insulin resistance and insulin deficiency leads to dyslipidemia, obesity, hypertension as it affects body several mechanism and metabolism in different way.

Other factors like genetics, medication, age factor, certain disease condition could also pitch in complication of MetS.

Increased incidence of diabetes is associated with increasing urbanization and lifestyle changes in context of developing countries like Nepal. With urbanization and development people tend to follow sedentary lifestyle for their ease and comfort.

Nepalese population tends to have packaged food, fast food than the authentic Nepalese food which contributes to the development of MetS. The authentic diet and lifestyle of Nepalese society can help to reduce further risk to prevent MetS. However increased urbanization, comfort life, working habits and influences from western society somehow can enhance the development of MetS and diabetes.

## CONCLUSION

68.5% prevalence of MetS in T2DM patients with 76.3% male and 61.9% female according to NCEP-ATP III was found with anthropometric indices significantly higher in the male population compared to female population. Dyslipidemia was the most prevalent component followed by hypertension. It may be concluded that the prevalence of MetS is increasing in Nepal as our study was conducted in small population visiting Star hospital which concluded that as we have this prevalence in this



population than in overall population MetS is increasing day by day.

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