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Incidence and Association of Metabolic Syndrome in Newly Diagnosed Type 2 Diabetes Mellitus Patients Visiting Tertiary Care Centre.

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KEYWORDS
Type 2 Diabetes Mellitus, metabolic syndrome, cardiovascular risk ,organ damage

ABSTRACT:

Background: Metabolic syndrome, characterized by central obesity, hypertriglyceridemia, reduced HDL cholesterol, hyperglycemia and hypertension which significantly increases the risk of cardiovascular disease and other complications. The prevalence of this syndrome is influenced by various factors including age, ethnicity and diagnostic criteria. In India, the Diabetes burden is rapidly increasing, with projections indicating over 134 million affected individuals by 2045. Studies highlight a high prevalence of metabolic syndrome among newly diagnosed Type 2 Diabetes Mellitus . This emphasizes the critical need for early detection and comprehensive management to mitigate cardiovascular risks and other complications. However, there remains a notable lack of research on the metabolic profile of metabolic syndrome in this patient group within the Indian context.

Aim and objective of study: To assess the incidence of Metabolic syndrome in newly diagnosed type 2 DM patients visiting tertiary care centre. To find the association between risk factors and presence of Metabolic syndrome in newly detected type 2 DM.

Materials & Methods: Informed consent was obtained after fully explaining the procedure and objective of the study. Seven measures representing the Metatabolic syndrome are obtained, including fasting blood glucose (FBG), waist circumference, high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C), triglycerides (TG), systolic blood pressure (SBP), and diastolic blood pressure (DBP), and additionally body mass index (BMI).The data was collected and analysed in Microsoft excel. The qualitative data was represented as frequencies and percentages while quantitative data was expressed as mean and Standard deviation (SD).

Results: The current study included 100 newly diabetic patients with/ without metabolic syndrome. On comparing the various parameters including vitals and laboratory parameters, a statistical increase in the blood pressure, anthropometric variables including Waist circumference and BMI and lipid profile (LDL cholesterol and Triglycerides) was noted in patients with metabolic syndrome. Additionally, a statistical increase in hypertension as comorbidity was seen in patients with metabolic syndrome. A point highlighted in the study was other comorbid conditions including hypothyroidism, CVD and CAD were more prevalent in patients with metabolic syndrome, however comparable to patients without

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metabolic syndrome. Other demographic parameters were however comparable between groups. This highlights that concomitant hypertension , dyslipidenia and obesity in newly diagnosed patients of diabetes could be possible risk factor for the development of metabolic syndrome.

Introduction

Metabolic syndrome, also known as Syndrome X or insulin resistance syndrome, is a cluster of conditions that markedly increase the risk of cardiovascular disease (CVD) and diabetes mellitus. This syndrome is characterized by central obesity, elevated triglycerides, reduced high-density lipoprotein (HDL) cholesterol, hyperglycaemia and hypertension. The prevalence of metabolic syndrome varies internationally, influenced by factors such as age, ethnicity, and the diagnostic criteria employed, which generally show an increase in prevalence with age[1][2][3] . Various organizations, including the WHO[2][4] , NCEP-ATP III 2001(Figure 1)[1][2][5], the European Group for the Study of Insulin Resistance[2][6] and the International Diabetes Federation (IDF)[2][7] , have proposed criteria for diagnosing metabolic syndrome. According to the IDF, the diagnosis of metabolic syndrome requires central obesity—defined as a waist circumference greater than 90 cm for Asian men and 80 cm for Asian women—along with any two of the following conditions: triglyceride levels of 150 mg/dL or higher, HDL cholesterol below 40 mg/dL in men and 50 mg/dL in women, a blood pressure of 130/85 mm Hg or higher, or a fasting plasma glucose level of 100 mg/dL or more [7]. .These factors contribute to increased risks of atherosclerosis and organ damage. The global diabetes burden is especially pronounced in developing countries like India, exacerbated by rising obesity rates and sedentary lifestyles. It was estimated in 2019 that 77 million individuals in India were living with diabetes, with projections suggesting this number could rise to over 134 million by 2045, with approximately 57% of these cases remaining undiagnosed[9] .A study within an urban Indian population noted that 77.2% of individuals with Type 2 diabetes also exhibited metabolic syndrome, emphasizing the importance of early diagnosis and comprehensive management to mitigate associated health risks[10]. Research on the prevalence and characteristics of metabolic syndrome in newly diagnosed Type 2 Diabetes Mellitus patients in India remains limited, indicating a significant research gap that needs addressing to better manage and understand this health challenge[1][2][3][7][9][10].

Objective : Identifying the metabolic syndrome in patients with newly diagnosed type 2 Diabetes mellitus becomes very important and provides a great opportunity for more aggressive treatment, including lifestyle, dietary modification, weight management, and treatment of comorbid factors to attain cardiovascular and or any other end organ damage risk reduction.

Materials & Methods

This was a hospital based cross sectional observational study which was conducted in the Department of General medicine of Meenakshi Medical College Hospital and Research Institute with study period of 6 months from February 2023 to July 2023. The total sample size of the study was 100 patients.

Inclusion criteria:

1) Patients more than 18 years of age
2) Newly diagnosed Type 2 Diabetes Mellitus
3) Patients visiting in out patient department and admitted in the hospital and who have given consent to the study.

EXCLUSION CRITERIA:

1) Previously diagnosed to have Diabetes Mellitus whether they have been receiving treatment or not.
2) Patients <18 years of age.
3) Patients who have not given consent for the study.

The incidence and prevalence of metabolic syndrome was defined by NCEP:ATPIII 2001 and Harmonizing definition criteria for the metabolic syndrome.(Figure 1)[2][5][8][1]

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NCEP:ATPIII 2001	HARMONIZING DEFINITION[b]		
Three or more of the following: • Central obesity: waist circumference >102 cm (males), >88 cm (females) • Hypertriglyceridemia: triglyceride level ≥150 mg/dL or specific medication • Low HDL[c] cholesterol: <40 mg/dL and <50 mg/dL for men and women, respectively, or specific medication • Hypertension: blood pressure ≥130 mmHg systolic or ≥85 mmHg diastolic or specific medication • Fasting plasma glucose level ≥100 mg/dL or specific medication or previously diagnosed type 2 diabetes	**Three of the following:** Waist circumference (cm)		
	Men	**Women**	**Ethnicity**
	≥94	≥80	Europid, sub-Saharan African, Eastern and Middle Eastern
	≥90	≥80	South Asian, Chinese, and ethnic South and Central American
	≥85	≥90	Japanese
	• Fasting triglyceride level >150 mg/dL or specific medication • HDL cholesterol level <40 mg/dL and <50 mg/dL for men and women, respectively, or specific medication • Blood pressure >130 mm systolic or >85 mm diastolic or previous diagnosis or specific medication • Fasting plasma glucose level ≥100 mg/dL (alternative indication: drug treatment of elevated glucose levels)		

Figure 1 : Shows NCEP:ATPIII 2001 and Harmonizing definition criteria for the metabolic syndrome.[1]

Informed consent was obtained after fully explaining the procedure and objective of the study. Seven measures representing the MetS are obtained, including fasting blood glucose (FBG), waist circumference, high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C), triglycerides (TG), systolic blood pressure (SBP), and diastolic blood pressure (DBP), and additionally body mass index (BMI). At the baseline examination, blood samples are taken after a minimum 6-hours overnight fast.

Waist circumference was measured in the horizontal plane midway between the inferior margin of the ribs and the superior border of the iliac crest with the subject standing erect, arms by the sides but away from the trunk, abdomen, and breathing normally. A non-stretchable tape measure graduated in centimetre was used for the measurement. The plane of the tape was parallel to the floor and the tape was snug, but not to compress the skin. The measurements were recorded to the nearest 0.5 cm and taken at the end of normal inspiration.

BMI was calculated as the ratio of body weight to square of body height (kg/m2). Obesity was defined based on Asia Pacific BMI scale[11]Height measurement was done using a stadiometer and the subject stood barefoot with feet together, arms by the sides, and in a fully erect posture on the stadiometer foot-rest. The movable headboard is then placed on top of the subject's head height and is read off to the nearest 0.01 m. Weight is measured using a weighing scale and the subject wearing only light clothing and standing at the centre of the weighing scale.

Blood pressure was calculated as the average of three measurements taken under standardized conditions in a sitting position with a sphygmomanometer and hypertension was defined as ≥130 mmHg systolic blood pressure and ≥85 mmHg diastolic blood pressure[2] . Diabetes mellitus was defined as a fasting blood glucose ≥100 mg/dL .[2]

The data was collected and analysed in Microsoft excel. The qualitative data was represented as frequencies and percentages while quantitative data was expressed as mean and Standard deviation (SD). We employed fischer exact/ chi square test to compare frequencies while unpaired t test was used to compare means. P-value of less than 0.5 was considered significant.

Result

The mean age of 100 newly diagnosed type 2 diabetic patients included in the study was 43.7±10.7 years with an age range between 18-70 years. The study included 58% males and 42% females, highlighting a slight male preponderance.

On further analysis, we found that the study included 24 metabolic syndrome patients, while 76 participants had no metabolic syndrome.

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Table 1 : Age distribution of patients with metabolic syndrome

Age distribution of patients with metabolic syndrome	**With metabolic syndrome (n=24)**	**P-value (Fischer exact test)**
Young adult (25-39 years) (n=34)	7 (29.1%)	0.03*
Middle aged (40-59 years) (n=54)	17 (31.5%)	
Old aged (60 years and above) (n=12)	0 (0)	

"*" Indicate p<0.05, significant difference on Fischer exact test.

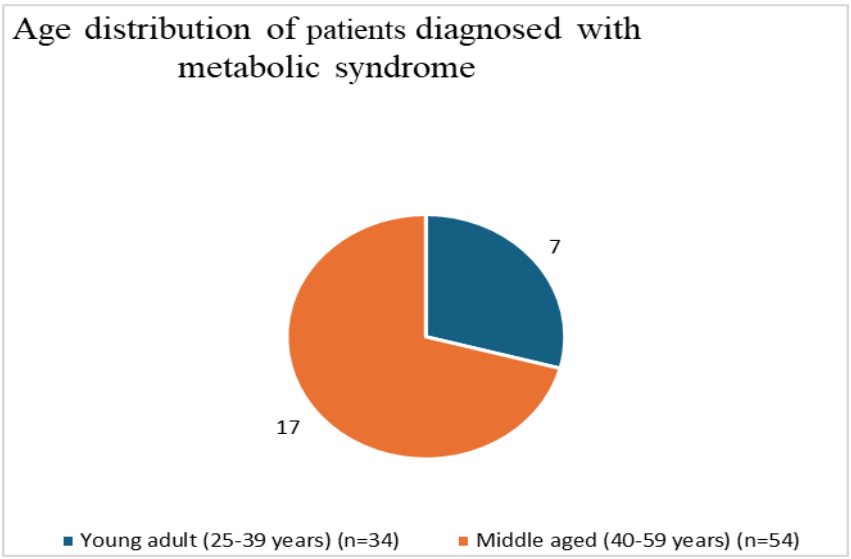

Figure 2: Pie chart showing age distribution of patients with metabolic syndrome

Given below are the comparative assessments made between the study groups.

Table 2 : Comparison of demographic details and vital parameters among with and without metabolic syndrome patients.

Variable of observation	**With metabolic syndrome (n=24)**	**Without metabolic syndrome (n=76)**	**Mean difference confidence interval (95% CI)**	**P-value (Unpaired T-test)**
Age (in years)	43.92 ± 8.69	43.58 ± 11.35	[-4.67, 5.35]	0.89

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Waist circumference (in cm)	98.67 ± 8.7	92.83 ± 10.3	[1.22, 10.46]	0.01*
Body mass index (in kg/m^2)	29.58 ± 3.1	26.1 ± 3.4	[1.93, 5.03]	0.0001*
Systolic blood pressure (in mmHg)	138.6 ± 9.2	130.3 ± 16.05	[1.46, 15.14]	0.01*
Diastolic blood pressure (in mmHg)	85.1 ± 6.7	80.87 ± 8.8	[0.35, 8.11]	0.03*

"*" Indicate $p<0.05$, significant difference on Unpaired T-test.

From the above table comparing the demographic details and vital parameters among with and without metabolic syndrome patients, it was noted that a statistical increase in blood pressure (SBP and DBP) and anthropometric measurements including BMI and waist circumference was noted in metabolic syndrome patients with $p<0.05$ on unpaired T-test. However, no difference was noted in other variables of assessment.

Table 3 : Comparison of gender difference and presence of co-morbidity among with and without metabolic syndrome patients.

Variable of observation	**With metabolic syndrome (n=24)**	**Without metabolic syndrome (n=76)**	**P-value (Chi-square test)**
Gender difference			
Male	8 (33.3%)	42 (55.3%)	0.9
Female	16 (66.7%)	34 (44.7%)	
Presence of comorbidity			
Hypertension	14 (58.3%)	18 (23.6%)	0.002*
Hypothyroidism	3 (12.5%)	8 (10.5%)	0.9
Cerebrovascular accident (CVD)	1 (4.2%)	2 (2.6%)	0.7
Coronary artery	1 (4.2%)	7 (9.2%)	0.4

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disease (CAD)			

"*" Indicate p<0.05, significant difference on Chi-square test.

The study showed a significant increase in the patients with hypertension in patients with metabolic syndrome patients (58.3% versus 23.6%; p=0.002 on Chi-square test). Although, an increase in percentage of hypothyroidism, CVD and CAD was observed in patients with metabolic syndrome, no significant difference in were noted in the two groups (p>0.05, on chi-square test).

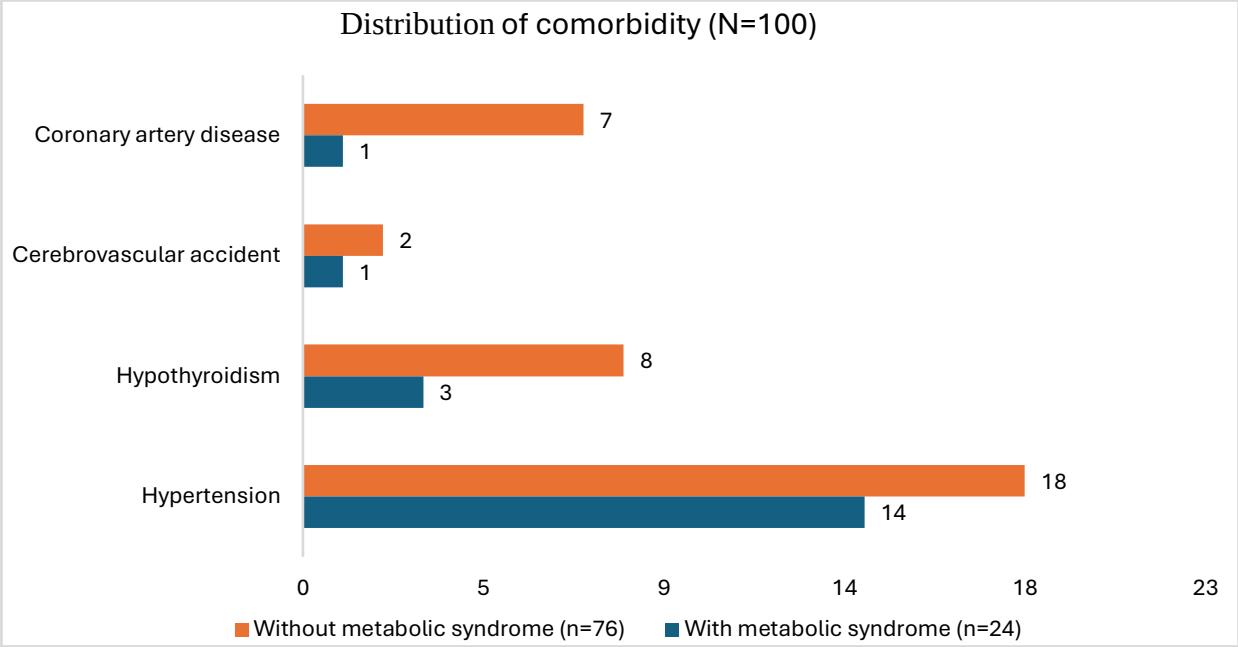

Figure 3 : Graph of distribution of various comorbidities

Table 4: Comparison of laboratory parameters among newly diagnosed and no metabolic syndrome patients.

Variable of observation	**With metabolic syndrome (n=24)**	**Without metabolic syndrome (n=76)**	**Mean difference confidence interval (95% CI)**	**P-value (Unpaired T-test)**
Fasting blood glucose (in mg/dL)	174.42 ± 40.8	169.7 ± 62.2	[-26.9, 26.9]	0.7
High density cholesterol (in mg/dL)	36.1 ± 7.4	37.4 ± 7.1	[-4.63, 2.03]	0.4

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Low density cholesterol (in mg/dL)	124.5 ± 18.2	112.6 ± 24.5	[1.13, 22.67]	0.03*
Triglycerides (in mg/dL)	224 ± 47.7	201.25 ± 45.5	[1.36, 44.14]	0.03*

*" Indicate p<0.05, significant difference on Unpaired T-test.

From the above table comparing the laboratory parameters among with and without metabolic syndrome patients, it was noted that statistical increase in levels of lipid profile (LDL and TG) with p<0.05 on unpaired T-test. However, no statistical difference was noted in Fasting glucose and HDL levels. Hence, these parameters were comparable among the two groups.

Table 5 : Comparison of parameters by gender distribution.

Variable of observation	**Male (n=58)**	**Female (n=42)**	**P-value (Unpaired T-test)**
Waist circumference (in cm)	95.91 ± 10.22	94.38 ± 9.62	0.4
Body mass index (in kg/m2)	28.6 ± 3.15	29.9 ± 3.5	0.06*
Fasting blood glucose (in mg/dL)	165.3 ± 59.59	178.4 ± 54.65	0.2
High density cholesterol (in mg/dL)	37.7 ± 5.8	36.2 ± 8.7	0.2
Low density cholesterol (in mg/dL)	117.1 ± 20.1	114.4 ± 26.9	0.5
Triglyceride level (in mg/dL)	214.8 ± 52.1	222.7 ± 73.4	0.5

"*" Indicate p<0.05, significant difference on Unpaired T-test.

From the above table comparing the various parameters among female and male diabetic patients, it was noted that a statistical increase in BMI was noted in females, while all other parameters were comparable between males and females.

Discussion:

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In India, the prevalence of metabolic syndrome among the adult population is reported at 30%, with a confidence interval ranging from 28% to 33%. The data indicates a progressive increase in prevalence with age, starting from 13% in the 18–29 years age group and rising to 50% among those aged 50–59 years. Metabolic syndrome significantly heightens the likelihood of developing type 2 diabetes mellitus and cardiovascular diseases, multiplying the risk by five and two times respectively over the next decade. Additionally, individuals with metabolic syndrome face a fourfold increased risk of experiencing stroke or myocardial infarction, and double the risk of mortality from such events compared to those without the syndrome, regardless of their cardiovascular history. Promptly recognizing individuals who have or are at risk for metabolic syndrome is vital, as it facilitates the anticipation of potential severe health complications and highlights the urgent need for effective preventive, promotional, or therapeutic interventions.[12]

We conducted a study in tertiary care hospital with a sample size of 100 patients among which average age of 100 newly diagnosed type 2 diabetic patients included in the study was 43.7±10.7 years with an age range between 18-70 years. The study included 58% males and 42% females, highlighting a slight male preponderance. Out of 100 patients, found that the study included 24 metabolic syndrome patients, while 76 participants had no metabolic syndrome. In the group identified with metabolic syndrome, 33.3% were male and 66.7% were female. On comparing patients with and without metabolic syndrome, it was observed that those with metabolic syndrome had significantly higher blood pressure (both systolic and diastolic) as well as greater body mass index (BMI) and waist circumference. The research indicated a substantial rise in hypertension among patients with metabolic syndrome, with 58.3% of these patients exhibiting hypertension compared to 23.6% of those without metabolic syndrome. While there was also an observed increase in the prevalence of hypothyroidism, cardiovascular disease (CVD), and coronary artery disease (CAD) among the metabolic syndrome group, these differences did not reach statistical significance .The comparison of laboratory parameters between patients with and without metabolic syndrome revealed a statistically significant increase in lipid levels (LDL and TG) .On the other hand, no significant differences were observed in fasting glucose and HDL levels between the two groups, suggesting that these parameters were similar for both groups. In the comparison of various health parameters between male and female diabetic patients, the analysis showed that BMI was significantly higher in females compared to males. However, all other health parameters were similar between the two genders. The findings of the current study align with those reported in existing research. **Nsiah K, Shang VO, et al.** In the study on a Ghanaian population, metabolic syndrome (MetS) was found in 58% of participants, with hypertension being the most prevalent risk factor at 60%. This was followed by central obesity (48.67%) and dyslipidemia (37%). Female patients with Type 2 diabetes showed a higher incidence of MetS and exhibited more associated risk factors compared to males. Also identified being female, having a higher body mass index, and lower educational status as key predictors of MetS [13] **Alebiosu CO, et al**. In this study, 25.2% of participants were found to have metabolic syndrome (MS), with systemic hypertension identified as the most prevalent component. Dyslipidemia was observed more frequently in males, whereas obesity was more common in females. Notably, the presence of MS and its components was strongly linked to increased risks of stroke, peripheral vascular disease, and microalbuminuria. The study recommends a long-term, focused intervention addressing multiple cardiovascular risk factors to reduce the incidence of both cardiovascular and microvascular complications in individuals with type-2 diabetes mellitus.[14]**Singh Jayant S, Gupta R, Rastogi A, et al.**In a study of 303 individuals, the occurrence of metabolic syndrome was observed at a rate of 32.1 per 1000 person-years (95% CI 26.3–38.7 per 1000 person-years). Among those who developed metabolic syndrome, 52% exhibited four or more components, with low HDL-C emerging as the most prevalent issue. Individuals diagnosed with metabolic syndrome demonstrated a significantly increased risk of developing diabetes, almost five times higher (OR: 4.94; 95% CI: 2.27–9.96; $p < 0.001$), and triple the risk of hypertension (OR: 2.67; 95% CI: 1.30–5.48; $p = 0.006$).The conclusion drawn highlights that Asian-Indians, influenced by sedentary lifestyles

leading to central obesity, exhibit a high incidence rate of metabolic syndrome [15]

Overall, this research illuminates the critical intersections between metabolic syndrome and type 2 Diabetes Mellitus, advocating for integrated clinical pathways to manage these intertwined health challenges effectively.

Conclusion : This study, undertaken at a tertiary care hospital with 100 newly diagnosed type 2 Diabetes Mellitus patients, has significantly advanced our understanding of the prevalence and ramifications of metabolic syndrome within this demographic. Our findings indicate a substantial prevalence of metabolic syndrome among newly diagnosed Diabetic patients, particularly highlighting its association with heightened cardiovascular risk factors such as hypertension, elevated lipid levels and central obesity. The study also noted that other co-existing conditions such as hypothyroidism, cardiovascular disease (CVD), and coronary artery disease (CAD) occurred more frequently among patients diagnosed with metabolic syndrome.These insights underscore the critical need for early screening and proactive management of metabolic syndrome in diabetic patients to mitigate the risk of subsequent cardiovascular complications. The study effectively delineates by documenting the differential prevalence of metabolic syndrome and associated cardiovascular risks, it furnishes valuable data that could inform targeted interventions aimed at reducing the burden of comorbidities in diabetic populations. Furthermore, it emphasizes the importance of lifestyle modifications such as improved diet and increased physical activity as fundamental strategies to manage and prevent metabolic syndrome in this patient group.Future studies should explore the long-term outcomes of metabolic syndrome management in diabetic patients, including the effectiveness of lifestyle interventions across different demographics and geographic locations. Additionally, the need for regular screening for diabetes and metabolic syndrome in at-risk populations is evident, aiming to diagnose and address these conditions before they develop into more severe complications.

Limitations of the Study The primary limitation of this study is its relatively small sample size and its confinement to a single tertiary care setting, which may not provide a comprehensive view of the broader diabetic population. Moreover, the cross-sectional nature of the study limits the ability to discern causal relationships between metabolic syndrome and the development of cardiovascular diseases.

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Conflicts of interest: Nil

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List of abbreviations

CVA	**Cerebrovascular accident**
CAD	**Coronary artery disease**
SBP	**Systolic blood pressure**
DBP	**Diastolic blood pressure**
TG	**Triglyceride**
HDL-C	**High density lipoprotein-Cholesterol**
LDL-C	**Low density lipoprotein-Cholesterol**
SD	**Standard deviation**
FBG	**Fasting blood glucose**