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Research Article

The study of prevalence of hyperuricemia and metabolic syndrome in type 2 diabetes mellitus

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ABSTRACT

Background: Type 2 diabetes mellitus (Type 2 DM) is associated with cardiovascular complications, of which metabolic syndrome plays a prominent role. The metabolic syndrome is a cluster of cardiovascular risk factors characterized by central obesity, insulin resistance, dyslipidemia and hypertension. Hyperuricemia is gaining importance as cardiovascular risk factor and has role in renal and metabolic diseases. Our study was aimed to find out the prevalence of hyperuricemia and metabolic syndrome in type 2 DM and to evaluate association of hyperuricemia with metabolic syndrome.
Methods: This observational longitudinal study was carried out on 150 patients of type 2 DM patients for determination of hyperuricemia and components of metabolic syndrome.
Results: Metabolic syndrome was diagnosed in 68 patients (45.3%) with higher prevalence in males (53.4%) than females (33.9%). Hyperuricemia was found in 38 patients (25.3%) with higher prevalence in males (33%) than females (14.5%). Hyperuricemia and metabolic syndrome was found in 32 (21.3%) patients with higher prevalence among males (27.3%) than females (12.9%). The patients with hyperuricemia and metabolic syndrome compared to those without hyperuricemia and metabolic syndrome had higher mean age (63.16 versus 55), mean FBS (139.31 versus 117.23), mean duration of diabetes (12.66 versus 5.64), mean BMI (28.71 versus 24.61), systolic BP (128.50 versus 122.12), diastolic BP (80.63 versus 74.27), TG (176.28 versus 141.69) and lower HDL (39.63 versus 52.03).
Conclusions: Prevalence of hyperuricemia is higher in patients of type 2 diabetes with metabolic syndrome and is positively correlated with BMI, blood pressure and triglycerides and negatively correlated with HDL-C.

Keywords: Atherogenic dyslipidemia, Cardiovascular risk, Central obesity, Hypertension, Hyperuricemia, Metabolic syndrome, Type 2 diabetes mellitus

INTRODUCTION

Type 2 diabetes mellitus (type 2 DM) is associated with cardiovascular complications, of which metabolic syndrome (Mets) plays a prominent role. The metabolic syndrome is a cluster of cardiovascular risk factors that is characterized by central obesity, insulin resistance, dyslipidemia and hypertension.[1] Hyperuricemia or elevated serum uric acid levels (SUA) is a biochemical entity that is gaining increasing importance as it is found by some researchers to be not only a cardiovascular risk factor but also plays a role in development of renal and metabolic diseases.[2-4] Some reports on SUA and metabolic syndrome have noted that increased SUA concentration is associated with increased prevalence of some of the parameters of the metabolic syndrome like obesity, dyslipidemia and hypertension.[5,6] In these reports, the documented prevalence rates of hyperuricemia ranged from 13-19% with greater proportions of males having elevated levels of SUA compared to females.[5,6] Although SUA levels are usually higher in males than females, there is an increase in SUA

levels in both sexes with increasing age. Available reports on hyperuricemia from sub-Saharan Africa showed that hyperuricemia was found to be associated with increased cardio-metabolic risk.[7,8] The aim of our study was to find out the prevalence of hyperuricemia and metabolic syndrome in type 2 DM and also to evaluate possible association of hyperuricemia with metabolic syndrome. Thus, we hope to document the scope of hyperuricemia and also describe the phenotype of cardiovascular risk factors of metabolic syndrome in patients of type 2 diabetes mellitus in Indian population.

METHODS

Study population

150 diagnosed patients of type 2 diabetes mellitus attending the outpatient department or admitted to medicine wards of a tertiary care hospital over a period of 1 year.

Inclusion criteria

Consecutive patients of diagnosed type 2 diabetes mellitus attending the outpatient department or admitted to medicine wards of a tertiary care hospital.

Exclusion criteria

- Pregnancy; Patients on Thiazides, O.C. pills, A.K.T drugs, Cytotoxic drugs, salicylate xanthine oxidase inhibitors or uricosuric drugs, lymphoma, leukaemia, nephrotic syndrome, alcoholics, smokers, organ transplantation and age below 30 years

Study design

This observational longitudinal study was carried out in medicine department of tertiary care hospital. In this study, 150 patients of already diagnosed type 2 diabetes mellitus who fulfilled the inclusion and exclusion criteria and who gave a written informed consent were considered for study. Patients were interviewed as per performa with appropriate history, physical examination and necessary investigations.

All patients were studied with the following parameters:

- Physical examinations.
- Anthropometry- weight, height, BMI and waist circumference.
- Blood parameters- lipids, renal and liver function tests, serum uric acid level, complete blood count and blood sugar levels.
- Imaging like X-ray chest, electrocardiography and ultrasonography of abdomen whenever required.

Method of data collection

Prior informed written consent was taken before evaluating each patient and detailed history was obtained from patients. Physical examination was done and blood pressure measurements were recorded. Blood pressure was recorded in the lying position in the right arm after rest with a mercury sphygmomanometer. Two readings were taken 5 minutes apart and the mean of the two was recorded as the blood pressure. Anthropometric measurements including height, weight, BMI, waist circumference and hip circumference were measured by height scale, weighing machine and inch tape respectively. All the female patients were examined in presence of a female attendant.

Anthropometric measurements

Height: Height was measured by fixing a tape measure to a wall and measuring the height with a movable headboard, with measures to the nearest centimetre. Patients were asked to stand upright without shoes, with their back against the wall, heels together and eyes directed forward.

Weight: Weight was measured with a weighing machine after asking patients to wear light clothing and weight was recorded to the nearest 0.5 kg.

Waist circumference: Waist circumference was measured using a non-stretchable measuring tape. Patients were asked to stand erect in a relaxed position with both feet together. One layer of light clothing was accepted. Waist circumference was measured at the midpoint between the iliac crest and the lower margin of the ribs. Waist circumference was measured to the nearest centimetre.

Definitions

Metabolic syndrome

According to the IDF definition for a person to be defined as having metabolic syndrome, must have:[9]

- Central obesity (waist circumference more than for men and 80 cm for women, plus any two of the following four factors.
- *Raised TG level:* More than 150 mg/dL, or specific treatment for this lipid abnormality.
- *Reduced HDL cholesterol:* Less than <40 mg/dL in males and <50 mg/dL in females, or specific treatment for this lipid abnormality.
- *Raised blood pressure:* More than Systolic BP 130 or diastolic BP 85 mm Hg, or treatment of previously diagnosed hypertension.
- *Raised fasting plasma glucose (FPG):* More than 100 mg/dL or previously diagnosed type 2 diabetes.

Hyperuricemia[10]

Patients having serum uric acid levels more than 7 mg% in males and more than 6 mg% in females.

Biochemical analysis

Blood samples collected in the clinical biochemistry laboratory were used for in vitro biochemical analysis. All the samples were collected by standard procedures under aseptic conditions. Standard procedures were followed for the preservation and storage of samples before analysis. Total cholesterol was determined enzymatically using an ERBA test kit (CHOD/PAP method). Similarly HDL-cholesterol (direct enzymatic method), triglyceride (GPO/PAP method) and uric acid (uricase/POD method) levels was measured using standard auto analyser. The values of LDL-cholesterol and VLDL-cholesterol and the risk ratio was calculated using Friedwald formula. Internal quality control for the laboratory determinations was regularly performed.

Statistical analysis

Statistical analysis was performed using SPSS version 13.0 software. Categorical variables are expressed as percentages. Comparisons between quantitative data were conducted using independent-sample t tests and categorical variables were analysed using chi-square tests. Data are presented as odds ratios (OR) with 95% confidence intervals (CI). A value of $p<0.05$ was considered statistically significant.

RESULTS

During the study period, 150 patients of already diagnosed type 2 diabetes mellitus who fulfilled the inclusion and exclusion criteria were enrolled in study. Subjects enrolled for the study were in age group of 30 to 84 years. The largest numbers of subjects; 51 (34%) were in the age group of 51-60 years and lowest 13 (8.67%) and 14 (9.33%) from age more than 71 years and less than 40 years respectively (Table 1).

Table 1: Age distribution of subjects studied.

Age group (years)	Male	Female	Total
<40	7	7	14 (9.33%)
41-50	24	21	45 (30%)
51-60	34	17	51 (34%)
61-70	16	11	27 (18%)
>71	7	6	13 (8.67%)
	88	62	150 (100%)

Out of these, 88 were males (58.67%) and 62 (41.33%) were females (Table 2).

Table 2: Sex distribution of subjects studied.

Sex	Number	Percentage (%)
Female	62	41.33%
Male	88	58.67%
Total	150	100.0%

Table 3: Sex-wise distribution of different variables among the study population.

Variables	Female				Male				Unpaired t-test		
	Mean	SD	Median	IQR	Mean	SD	Median	IQR	t-Value	P-Value	Difference
Age (years)	56.29	9.35	56.08	15.50	57.06	9.27	57.00	15.50	-0.546	0.585	Not Significant
FBS (mg%)	120.6	27.05	116.00	32.25	122.8	26.71	119.00	31.75	-0.796	0.426	Not significant
Duration of DM (years)	6.29	5.31	4.00	8.00	7.73	5.15	8.00	8.00	-1.897	0.058	Not significant
BMI (KG/M^2)	25.00	2.01	24.87	2.77	25.83	2.73	25.33	4.93	-1.632	0.103	Not significant
Systolic BP (mmHg)	122.4	11.37	120.00	10.00	124.2	14.32	120.00	20.00	-0.615	0.539	Not significant
Diastolic BP(mmHg)	74.77	6.96	70.00	10.00	76.23	8.23	80.00	10.00	-1.217	0.224	Not significant
Serum uric acid (mg%)	4.10	1.47	3.95	2.35	5.70	1.65	6.10	2.50	-5.534	<0.0001	Significant
HDL-C (mg%)	54.31	5.61	54.50	5.00	45.91	9.18	45.00	15.00	-5.747	<0.0001	Significant
TG (mg%)	139.8	23.10	135.00	32.50	155.5	27.84	164.50	50.75	-3.306	0.00095	Significant

Table 4: Sex distribution of metabolic syndrome.

Metabolic syndrome		Sex		Total
		Female	Male	
Yes	Number	21	47	68
No	Number	41	41	82
Total	Number	62	88	150
Chi-square tests	Value	df	p-value	Association
Pearson Chi-square	5.603	1	0.018	Significant
Risk estimate	Value	95% Confidence interval		
		Lower	Upper	
Odds ratio for metabolic syndrome (Yes / No)	0.447	0.228	0.875	
For cohort sex = Female	0.618	0.407	0.937	
For cohort sex = Male	1.382	1.057	1.808	

The distribution of variables like age, fasting blood sugar, duration of diabetes, BMI and blood pressure in study population was similar in both males and females and the difference observed is not statistically significant (p>0.05). However males had higher values of variables like serum uric acid and TG while values of HDL-C were higher in females and these differences are statistically significant (p<0.05) (Table 3).

Metabolic syndrome was diagnosed in 68 patients (45.3%) with the prevalence of metabolic syndrome in males (53.4%) being more than females (33.9%) and the difference is statistically significant (p<0.05) (Table 4).

Out of 72 subjects with duration of diabetes <5 years, only 15 (20.83%) had metabolic syndrome, whereas 20 (86.96%) out of 23 and 13 (86.67%) out of 15 with duration of 11-15 years and >16 years respectively had metabolic syndrome (Table 5).

Hyperuricemia was found in 38 patients (25.3%) with the prevalence of hyperuricemia in males (33%) being more than females (14.5%) and this difference is statistically significant (p<.0.05) (Table 6).

Out of the 150 subjects, 32 (21.3%) had hyperuricemia with metabolic syndrome and among these subjects having hyperuricemia and metabolic syndrome, 24 were males and 8 were females. The prevalence among male of hyperuricemia and metabolic syndrome together was more (27.3%) than females (12.9%) and this difference is statistically significant (p<0.05) (Table 7).

Table 5: Duration of diabetes and metabolic syndrome.

Duration of diabetes (years)	Cases with metabolic syndrome	Cases without metabolic syndrome	Total
<5	15 (20.83%)	57 (79.17%)	72 (100%)
6-10	20 (50%)	20 (50%)	40 (100%)
11-15	20 (86.96%)	03 (13.04%)	23 (100%)
>16	13 (86.67%)	02 (13.33%)	15 (100%)
	68(45.30%)	82 (54.70%)	150 (100%)

Table 6: Sex distribution of hyperuricemia.

Hyperuricemia		Sex		Total
		Female	Male	
Yes	Number	9	29	38
No	Number	53	59	112
Total	Number	62	88	150
Chi-Square tests	Value	df	p-value	Association
Pearson Chi-Square	6.537	1	0.011	Significant
Risk Estimate	Value	95%Confidence interval		
		Lower	Upper	
Odds Ratio for Hyperuricemia(Yes / No)	0.345	0.15	0.796	
For cohort Sex = Female	0.5	0.274	0.915	
For cohort Sex = Male	1.449	1.129	1.859	

Among the study subjects, out of 38 patients having hyperuricemia; 35 patients also had high triglyceride levels and only 3 patients of hyperuricemia had normal levels of triglyceride and this difference is statistically significant (p<0.05) (Table 8).

Out of 38 patients having hyperuricemia; 29 patients also had hypertension and 9 patients among non-hypertensive had hyperuricemia and this difference is statistically significant (p<0.05) (Table 9).

Table 7: Sex distribution of hyperuricemia with metabolic syndrome.

Metabolic syndrome with hyperuricemia		Sex		Total
		Female	Male	
Yes	Number	8	24	32
No	Number	54	64	118
Total	Number	62	88	150
Chi-Square tests	Value	df	p-value	Association
Pearson Chi-Square	4.475	1	0.034	Significant
Risk estimate	Value	95 % Confidence interval		
		Lower	Upper	
Odd ratio for metabolic syndrome and hyperuricemia	0.3951	0.1641	0.9508	
For cohort Sex = Female	0.5463	0.2361	1.2642	
For cohort Sex = Male	1.3828	0.751	2.5462	

Table 8: Relation between hyperuricemia and triglyceride.

Hyperuricemia		TG		Total
		High	Normal	
Yes	Number	35	3	38
No	Number	37	75	112
Total	Number	72	78	150
Chi-Square tests	Value	df	p-value	Association
Pearson Chi-Square	39.664	1	< 0.0001	Significant
Risk Estimate	Value	95% Confidence interval		
		Lower	Upper	
Odds Ratio for hyperuricemia (Yes / No)	23.649	6.822	81.974	
For cohort TG = High	2.788	2.108	3.688	
For cohort TG = Normal	0.118	0.039	0.352	

Table 9: Relation between hyperuricemia and hypertension.

Hyperuricemia		Hypertension		Total
		Yes	No	
Yes	Number	29	9	38
No	Number	51	61	112
Total	Number	80	70	150
Chi-Square tests	Value	df	p-value	Association
Pearson Chi-Square	10.801	1	0.001	Significant
Risk Estimate	Value	95% Confidence interval		
		Lower	Upper	
Odds Ratio for Hyperuricemia (Yes / No)	3.854	1.672	8.885	
For cohort Hypertension = Yes	1.676	1.281	2.193	
For cohort Hypertension = No	0.435	0.24	0.789	

Out of 38 patients having hyperuricemia; 26 patients also had low HDL-C and only 12 patients among normal HDL-C had hyperuricemia and this difference is statistically significant (p<0.05) (Table 10).

The patients with hyperuricemia compared to patients having normal uric acid levels had higher mean age (63.42 versus 54.47), higher mean FBS (136.5 versus 117), higher mean duration of diabetes (11.55 versus 5.63), higher mean BMI (27.97 versus 24.64), higher systolic BP (128.58 versus 121.75), higher diastolic BP (80.16 versus 74.09), higher TG (174 versus 140.6) and lower HDL (40.47 versus 52.4) and these differences are statistically significant for all the variables ($p<0.05$) (Table 11).

Table 10: Relation between hyperuricemia and HDL-C.

Hyperuricemia		HDL-C		Total
		Low	Normal	
Yes	Number	26	12	38
No	Number	9	103	112
Total	Number	35	115	150
Chi-Square tests	Value	df	p-value	Association
Pearson Chi-Square	57.835	1	<0.0001	Significant
Risk Estimate	Value	95% Confidence interval		
		Lower	Upper	
Odds Ratio for Hyperuricemia(Yes /No)	24.796	9.443	65.111	
For cohort HDL-C = Low	8.515	4.389	16.519	
For cohort HDL-C = Normal	0.343	0.214	0.55	

Table 11: Comparison of various variables between cases with and without hyperuricemia.

Variables	Hyperuricemia present				Hyperuricemia absent				Unpaired t-test applied		
	Mean	SD	Median	IQR	Mean	SD	Median	IQR	t-value	p-value	Difference
Age (years)	63.42	8.26	64.50	11.25	54.47	8.50	53.00	11.75	-5.17	<0.0001	Significant
FBS (mg%)	136.50	29.89	128.00	53.00	117.00	23.82	110.50	30.75	-3.57	0.0004	Significant
Duration of DM (years)	11.55	5.38	12.00	7.00	5.63	4.29	4.00	6.00	-5.57	<0.0001	Significant
BMI (Kg/m^2)	27.97	2.52	28.70	4.08	24.64	1.83	24.60	2.80	-6.44	<0.0001	Significant
Systolic BP (mmHg)	128.58	15.31	130.00	21.00	121.75	11.96	120.00	17.50	-2.41	0.0157	Significant
Diastolic BP (mmHg)	80.16	8.62	80.00	20.00	74.09	6.80	70.00	10.00	-3.72	0.0002	Significant
Serum uric acid (mg%)	7.13	0.54	7.20	0.43	4.33	1.43	4.55	2.50	-8.81	<0.0001	Significant
HDL-C (mg%)	40.47	8.03	39.00	13.25	52.40	6.97	54.00	9.00	-8.76	<0.0001	Significant
TG (mg%)	174.00	18.63	178.00	21.00	140.62	24.12	133.50	37.75	-6.49	<0.0001	Significant

Table 12: Comparison of various variables between cases with & without metabolic syndrome + Hyperuricemia.

Variables	MS+Hyperuricemia present				MS+Hyperuricemia absent				Unpaired t-test applied		
	Mean	SD	Median	IQR	Mean	SD	Median	IQR	t-value	p-value	Difference
Age (years)	63.16	7.01	62.50	9.75	55.00	9.07	53.00	12.25	-4.708	<0.0001	Significant
FBS(mg%)	139.31	30.39	134.50	52.50	117.23	23.74	111.00	30.25	-3.828	0.00013	Significant
Duration of DM (years)	12.66	4.54	12.50	6.50	5.64	4.36	4.00	6.25	-6.379	<0.0001	Significant
BMI (Kg/m^2)	28.71	1.94	28.90	3.43	24.61	1.80	24.60	2.73	-7.545	<0.0001	Significant
Systolic BP (mmHg)	128.50	14.85	130.00	23.00	122.12	12.40	120.00	12.50	-2.135	0.03276	Significant
Diastolic BP (mmHg)	80.63	8.78	80.00	20.00	74.27	6.87	70.00	10.00	-3.792	0.00015	Significant
Serum uric acid (mg%)	7.13	0.53	7.20	0.48	4.47	1.53	4.60	2.65	-7.907	<0.0001	Significant
HDL-C (mg%)	39.63	7.55	38.50	11.75	52.03	7.27	54.00	9.00	-6.444	<0.0001	Significant
TG (mg%)	176.28	17.47	178.50	20.75	141.69	24.37	135.50	41.00	-6.388	<0.0001	Significant

The patients with both hyperuricemia and metabolic syndrome compared to those without hyperuricemia and metabolic syndrome had higher mean age (63.16 versus 55), higher mean FBS (139.31 versus 117.23), higher mean duration of diabetes (12.66 versus 5.64), higher mean BMI (28.71 versus 24.61), higher systolic BP (128.50 versus 122.12), higher diastolic BP (80.63 vs.74.27), higher TG (176.28 versus 141.69) and lower HDL (39.63 versus 52.03) and these differences are statistically significant for all the variables ($p<0.05$) (Table 12).

DISCUSSION

The present study is conducted on type 2 diabetes patients to know the prevalence of hyperuricemia and metabolic syndrome. The national cholesterol education program's ATP III report identified the metabolic syndrome as a specific entity deserving more clinical attention. People with the syndrome have risk of developing cardiovascular disease, beyond the risk associated with individual components of the syndrome alone.[11] In this study; metabolic syndrome was defined using the new international diabetes federation (IDF) definition with specific cut off for waist circumference for Indian population[9].

In the present study, prevalence of metabolic syndrome in type 2 diabetes mellitus is 43.5% using the new international diabetes federation (IDF) definition. The present prevalence is higher than in the study conducted by Ramachandra et al, which found prevalence to be 41% in non-diabetic subjects, Misra A et al noted 29.9%.[12,13] The higher rate of prevalence in the present study may be due to the study group comprising of only diabetic patients. Eliaesson B et al noted higher prevalence of 77% in diabetic patients.[14] Our study showed higher prevalence of metabolic syndrome in males as compared to females (53.40% versus 33.9%) supported by Marques Vidal P et al (23 versus 12% respective study).[15] Similarly as described above, the higher rate of prevalence in the present study may be due to the study group comprising of only diabetic patients. In this study we found that prevalence of metabolic syndrome increases as duration of diabetes increases. The long standing diabetic mellitus probably allows for more time for other components of MS to develop.

Hyperuricemia is an increasingly common medical problem not only in the advanced countries, but also in the developing countries. It has been described that hyperuricemia is associated with metabolic syndrome components such as obesity, dyslipidemia, hyperglycemia and hypertension.[16-18] The purpose of our study was to investigate the prevalence of hyperuricemia and the association between uric acid levels and the various metabolic syndrome components in patients with metabolic syndrome. In our study, overall prevalence of hyperuricemia in type 2 diabetes patients is 25.3%. These findings correlate with the study conducted by Anthonia O et al (25%).[19] We found that the incidence of hyperuricemia in males was 33%, which is much higher than that in females (14.5%) that is statistically significant ($P<0.05$). This result is in line with Conen et al research which had prevalence of 35.1% and 8.7% in males and females respectively.[17] The pathogenic mechanism may be due to estrogen promoting uric acid excretion (Sumino et al.,)[20], so it may be more important for men to prevent hyperuricemia.[20] The prevalence of hyperuricemia in those with metabolic syndrome is 47.1% and 7.3% in those without metabolic syndrome ($p<0.05$). This is statistically significant. These findings are higher than the study conducted by Tuomilehto J et al who found prevalence of 22% and 11% for males and females respectively.[21] In our study, the data indicates that serum triglyceride is markedly associated with hyperuricemia ($p<0.05$). Conen et al and Schachter et al showed the same results ($p<0.05$).[17,18] Hyperuricemia and hypertriglyceridemia are suggested to be associated with insulin resistance syndrome.[22-24] The association between insulin resistance, hyperuricemia, and hypertriglyceridemia are complicated. This might be expected from the fact that uric acid production is linked to glycolysis and that glycolysis is controlled by insulin. It was shown that uric acid is negatively correlated with serum HDL-C ($p<0.05$). This finding is consistent with Rho et al research.[25] The mechanisms of this condition may due to the relationship between decreased HDL-C levels and insulin resistance syndrome (Schmidt et al).[26] In our study, it is found that uric acid concentration is positively correlated with blood pressure and is statistically significant ($p<0.05$). Similar correlation was suggested by Yoo et al and Feig and Johnson which showed serum uric acid concentration was found to independently correlate with hypertension.[27,28]

Thus, prevalence of hyperuricemia is significantly higher in patients of metabolic syndrome than patients with type 2 diabetes and general population in India. However the significance of this raised levels in terms of cardiovascular and other complications and also the possible benefit of treatment of hyperuricemia remains to be unanswered and further studies will be needed for the same. The interpretation of the present results is confronted by some limitations. Firstly, the data analysis was restricted to a cross-sectional study. Only a prospective study could confirm the interdependencies of changes in the metabolic syndrome components and serum uric acid levels. Secondly, no serum insulin levels were measured as an index for insulin resistance. As insulin resistance is believed to play a major role in the metabolic syndrome, the inclusion of this variable in our statistical analysis would have been important. On the other hand it is unlikely that adjustment for insulin resistance could significantly influence our strongest association of serum uric acid and triglycerides, nor let disappear the differences found in men and women.

CONCLUSION

Prevalence of metabolic syndrome in patients with type 2 diabetes mellitus is 43.5% and that of hyperuricemia is 23.3%. Prevalence of metabolic syndrome is significantly higher in males than females with diabetes mellitus. Prevalence of metabolic syndrome increases with the duration of diabetes mellitus. Serum uric acid levels are significantly higher in patients of diabetes with metabolic syndrome than those with only diabetes. Prevalence of hyperuricemia is more in males than females with diabetes mellitus. Hyperuricemia is positively correlated with BMI, blood pressure and triglycerides while hyperuricemia is negatively correlated with HDL-C.

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