International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Study of Serum Uric Acid in Type 2 Diabetes Mellitus in Association with Cardiovascular Risk Factors

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Abstract: ***Objective: This study aims to investigate the correlation between serum uric acid levels and cardiovascular risk factors in individuals with Type 2 Diabetes Mellitus (T2DM). The research focuses on understanding the potential role of serum uric acid as a biomarker for cardiovascular complications in T2DM patients. Methods: A cross - sectional study was conducted on a cohort of individuals diagnosed with T2DM. SUA levels were measured, and participants were categorized into separate groups based on their cardiovascular risk factors, including hypertension, dyslipidemia, obesity, and smoking status. Statistical analyses and the two determined cardiovascular risk assessment criteria were associated. Results: Preliminary findings suggest a strong correlation that is positive between elevated cardiovascular risk factors and serum uric acid levels in people within individuals with T2DM. Specifically, participants with hypertension, dyslipidemia, obesity, and those who smoke exhibited higher SUA levels compared to their counterparts without these risk factors. The data also indicate a potential link between hyperuricemia and an increased likelihood of developing cardiovascular complications in T2DM. Conclusion: This study underscores the significance of evaluating A possible marker for determining T2DM patients who might experience cardiovascular problems. To clarify the underlying mechanisms and investigate if therapies aimed at lowering uric acid levels could be helpful in lowering cardiovascular risk in this population, more study is required on SUA levels and as an elevated risk. The outcomes of this investigation may contribute valuable insights for the development of preventive strategies and personalized management approaches in individuals with T2DM.***

Keywords: Type 2 Diabetes, serum uric acid, cardiovascular risk, biomarkers, hyperuricemia

1. Introduction

1.1 Background

The prevalence of (T2DM) continues to rise globally, posing a substantial burden on healthcare systems. T2DM is associated with an increased risk of cardiovascular complications, necessitating a comprehensive understanding of contributing factors for effective management. Serum uric acid (SUA) has emerged as a potential biomarker linked to metabolic dysregulation and cardiovascular risk. This study aims to explore the associations between SUA levels and cardiovascular risk factors in individuals with T2DM.

Along with cardiovascular disease (CVD), respiratory illness, and cancer, diabetes is one of the biggest global health concerns of our century and one of the top 10 causes of death. The World Health Organization (WHO) reports that non - communicable diseases (NCDs) accounted for 74% of fatalities worldwide in 2019. Diabetes was the main cause of mortality globally in 2019 with 1.6 million deaths. It is estimated that 592 million people are expected to pass away from diabetes by the year 2035.

Men have slightly higher rates of diabetes (9.6%) than women (9.0%), with the International Diabetes Federation (IDF) reporting that 8.8% of adults worldwide have the disease.1 According to recent global figures, between 463 million and 374 million people worldwide have impaired glucose tolerance (IGT), a syndrome that precedes diabetes. By 2045, it is predicted that there would be 700 million diabetics and 548 million IGT patients, a 51% rise from 2019.1.

Between 2009 and 2019, the prevalence of diabetes in India rose from 7.1% to 8.9%. It is anticipated that 25.2 million adults currently have IGT, and that number will rise to 35.7 million in 2045.

Chronic hyperglycemia and dyslipidemia of diabetes are associated with long - term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels[2]. Secondary dyslipidemia occurs due to hypothyroidism, obstructive liver disease, obesity, diabetes mellitus, pregnancy, chronic renal failure, alcohol, cigarettes, smoking, bypass surgery, and stress.3Diabetic dyslipidemia is a condition where the good cholesterol (HDL) levels are decreased and raise triglyceride and bad cholesterol (LDL), which raise the chance of developing heart disease and stroke[4].

The 4 primary risk variables for CVD are hypercholesterolemia, hypertension, DM & cigarette smoking. Insulin resistance state is associated with DM and metabolic syndrome (MS). The 4 major features of metabolic syndrome are hyperinsulinemia, hypertension, hyperlipidemia, and hyperglycemia. Each of these features has been demonstrated to be an independent risk factor for coronary artery disease (CAD) and capable of working together synergistically to accelerate both non - diabetic atherosclerosis and Atherosclerosis associated with MS and type 2 DM[5].

However, whether uric acid is an independent risk factor for cardiovascular mortality is still disputed, as several studies have suggested that hyperuricemia is merely associated with CVD because of confounding factors such as obesity, dyslipidemia, hypertension, the application of diuretics, and insulin resistance[5].

2. Objectives

To assess the association of HUA with cardiovascular risk factors in T2DM patients

Inclusion Criteria:

- Patients are already on treatment Regarding T2DM.
- Newly detected individuals with T2DM.
- Both genders were included.

Exclusion Criteria:

Patients with

- Renal failure
- Gout patients are on hypouricemic drugs.
- Alcoholics
- Myeloproliferative and Lymphoproliferative disorders
- Psoriasis
- Pregnancy and lactating mothers
- Drugs which can alter the UA levels.

Sample: A total of 150 patients participated in this cross - sectional study conducted in tumkur district.

3. Results

Table 1: Age Distribution of Participants in the Study

Age (yrs)	Frequency	Percent
<=40	25	16.7
41 - 50	59	39.3
51 - 60	41	27.3
>60	25	16.7
Total	150	100

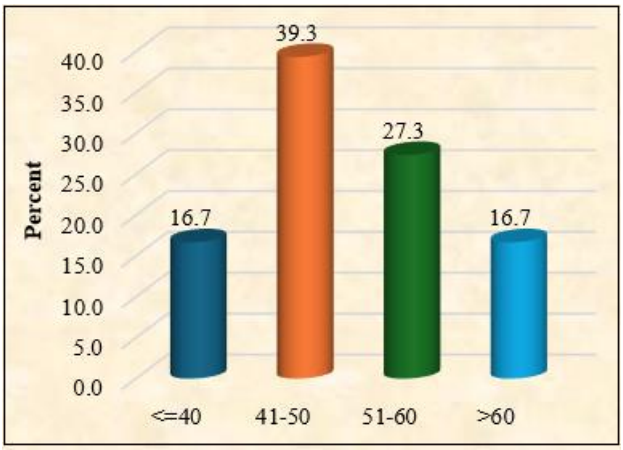

Figure 1: Age Distribution of Research People

Table 2: Sex Distribution in the Study

Sex	Frequency	Percent
Male	110	73.3
Female	40	26.7
Total	150	100

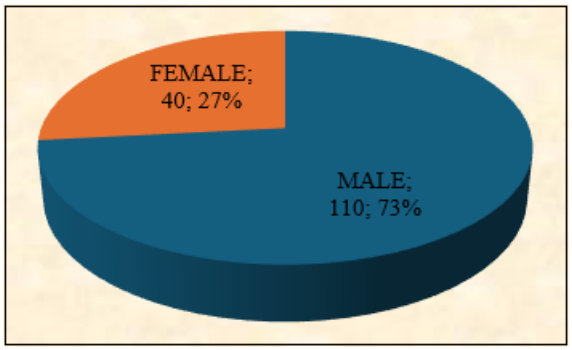

Figure 2: The Gender Distribution of Patients in the Study

Table 3: Distribution by Duration of Diabtetes

Duration	Frequency	Percent
1 - 5 years	52	34.7
6 - 10 years	73	48.7
>10 years	25	16.7
Total	150	100

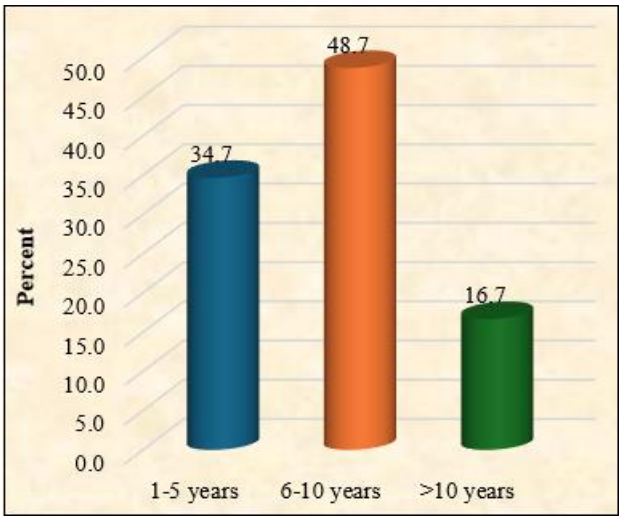

Figure 3: Distribution by Duration of Diabtetes

Table 4: Distribution based on Serum Levels of UA

Serum Uric Acid	Frequency	Percent
NORMAL	126	84
HYPERURICEMIA	24	16
Total	150	100

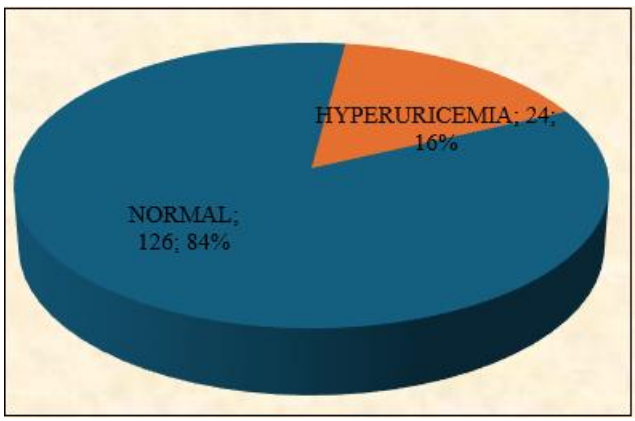

Figure 4: Distribution by Sua Levels

Table 5: Association of Hua with Age

Age (In Years)	Serum Uric Acid		Total	CHI - Square, P - Value
	Normal	Hyperuricemia		
<=40	20 (15.9%)	5 (20.8%)	25 (16.7%)	0.914, 0.822
41 - 50	51 (40.5%)	8 (33.3%)	59 (39.3%)	
51 - 60	35 (27.8%)	6 (25.0%)	41 (27.3%)	
>60	20 (15.9%)	5 (20.8%)	25 (16.7%)	
TOTAL	126 (100.0%)	24 (100.0%)	150 (100.0%)	

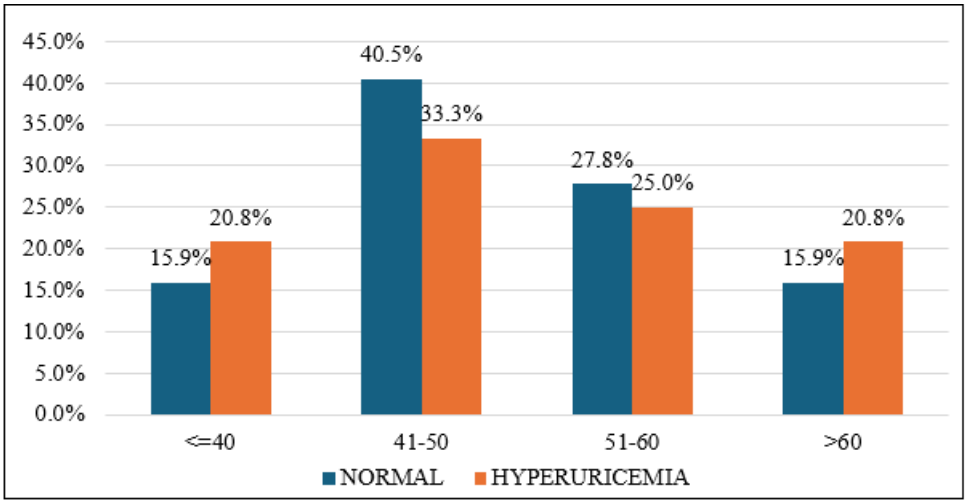

Figure 5: Association of Hua with Age

Table 6: Association of Hua with Sex

Sex	Serum Uric Acid		Total	Chi - Square, P - Value
	Normal	Hyperuricemia		
Male	100 (79.4%)	10 (41.7%)	110 (73.3%)	14.651, <0.001
Female	26 (20.6%)	14 (58.3%)	40 (26.7%)	
Total	126 (100.0%)	24 (100.0%)	150 (100.0%)	

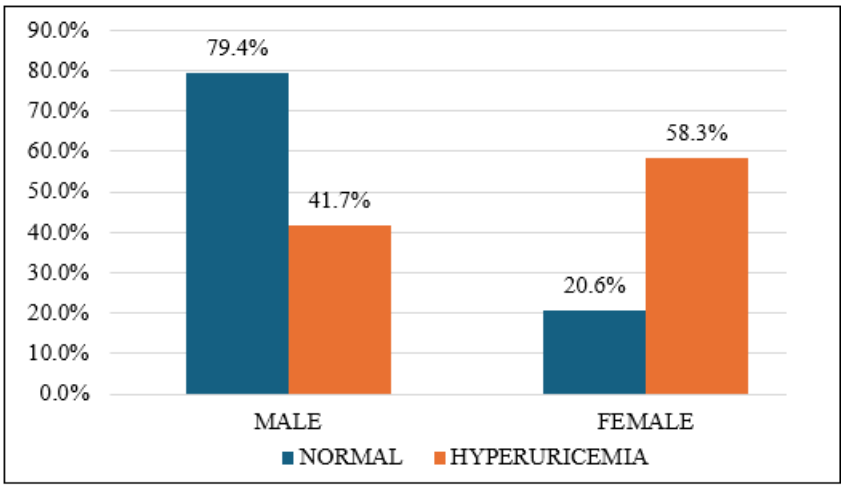

Figure 6: Hyperuricemia Association with Sex

Table 7: Association of Hua with Duration of Diabetes

DUR_DIAB	Serum Uric Acid		Total	Chi - Square, P - Value
	Normal	Hyperuricemia		
1 - 5 years	41 (32.5%)	11 (45.8%)	52 (34.7%)	1.760, 0.415
6 - 10 years	64 (50.8%)	9 (37.5%)	73 (48.7%)	
>10 years	21 (16.7%)	4 (16.7%)	25 (16.7%)	
TOTAL	126 (100.0%)	24 (100.0%)	150 (100.0%)	

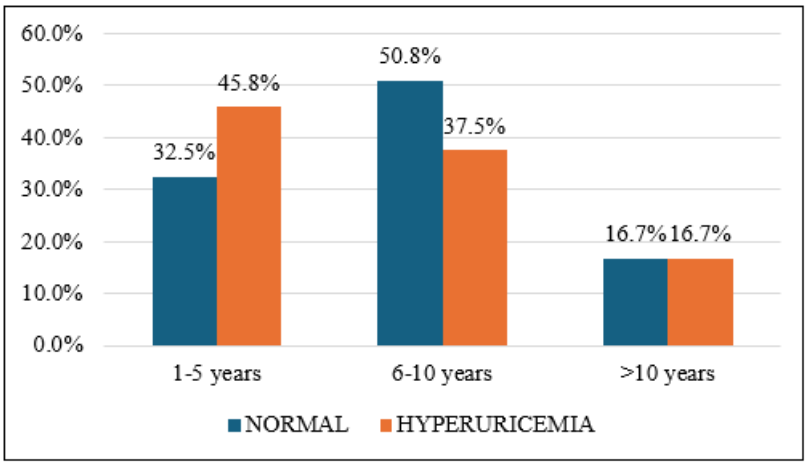

Figure 7: Association of Hua with Duration of Diabetes

Table 8: Association of Hua with Smoking

Smoking	Serum Uric Acid		Total	Chi - Square, P - Value
	Normal	Hyperuricemia		
No	99 (78.6%)	10 (41.7%)	109 (72.7%)	13.824a, <0.001
Yes	27 (21.4%)	14 (58.3%)	41 (27.3%)	
Total	126 (100.0%)	24 (100.0%)	150 (100.0%)	

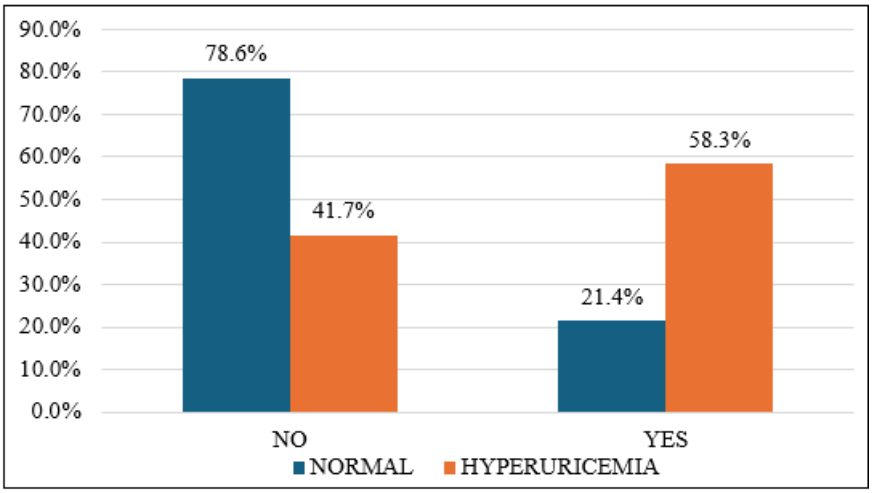

Figure 8: Association of Hua with Smoking

Table 9: Association of HUA with Hypertension

HTN	Serum Uric Acid		Total	Chi - Square, P - Value
	Normal	Hyperuricemia		
YES	84 (66.7%)	21 (87.5%)	105 (70.0%)	4.167, 0.041
NO	42 (33.3%)	3 (12.5%)	45 (30.0%)	
TOTAL	126 (100.0%)	24 (100.0%)	150 (100.0%)	

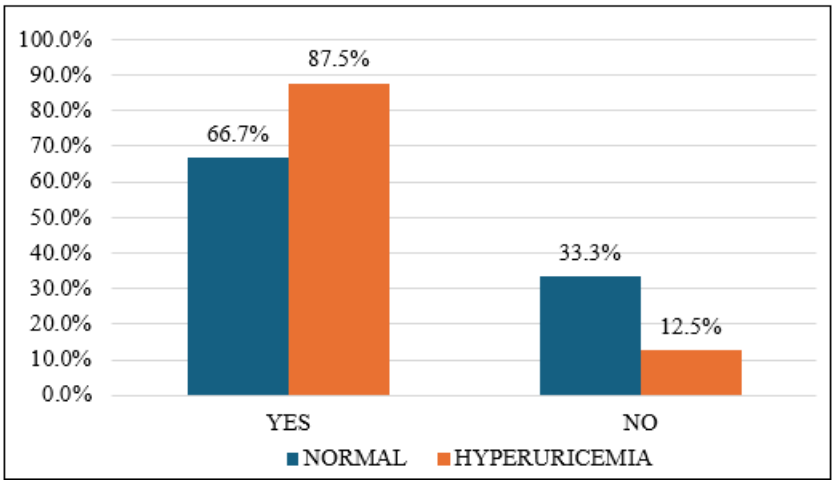

Figure 9: Association of HUA with Hypertension

Table 10: Association of HUA with BMI

BMI	Serum Uric Acid		Total	Chi - Square, P - Value
	Normal	Hyperuricemia		
<25 Kg/m2	62 (49.2%)	12 (50.0%)	74 (49.3%)	8.156, 0.017
25 - 29.9 Kg/m2	55 (43.7%)	6 (25.0%)	61 (40.7%)	
>=30 Kg/m2	9 (7.1%)	6 (25.0%)	15 (10.0%)	
TOTAL	126 (100.0%)	24 (100.0%)	150 (100.0%)	

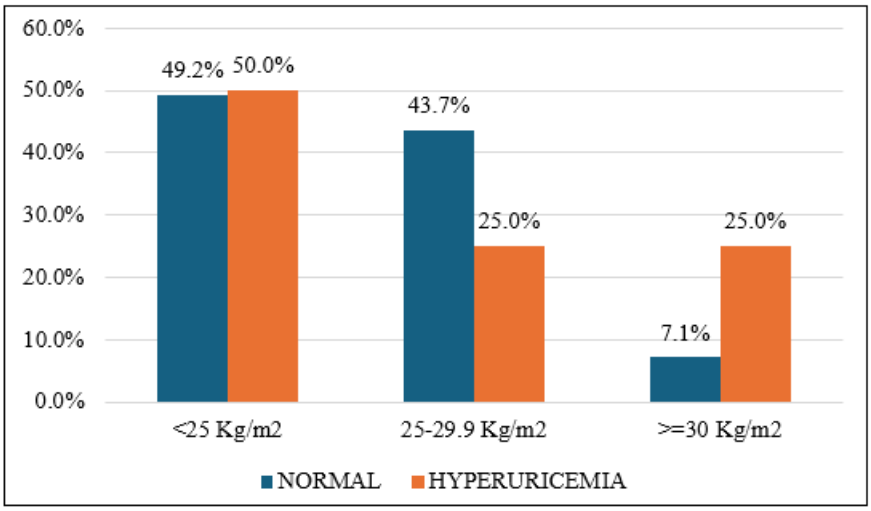

Figure 10: Association of HUA with BMI

Table 11: Association of HUA with Total Cholesterol

Total Cholesterol	Serum Uric Acid		Total	Chi - Square, P - Value
	Normal	Hyperuricemia		
Normal (<200)	113 (89.7%)	17 (70.8%)	130 (86.7%)	6.198a, 0.013
Abnormal (>=200)	13 (10.3%)	7 (29.2%)	20 (13.3%)	
Total	126 (100.0%)	24 (100.0%)	150 (100.0%)	

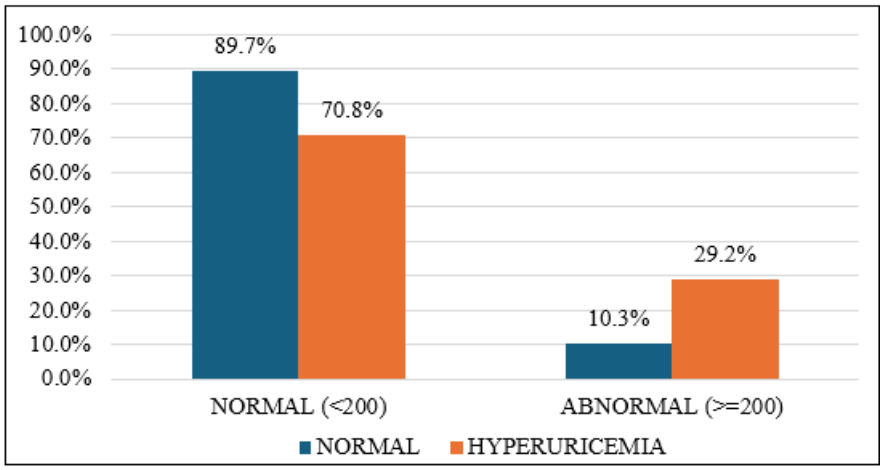

Figure 11: Association of HUA with TC

Table 12: Association of HUA with HDL

HDL	Serum Uric Acid		Total	Chi - Square, P - Value
	Normal	Hyperuricemia		
Normal (>=40)	98 (77.8%)	12 (50.0%)	110 (73.3%)	7.955, 0.005
Abnormal (<40)	28 (22.2%)	12 (50.0%)	40 (26.7%)	
Total	126 (100.0%)	24 (100.0%)	150 (100.0%)	

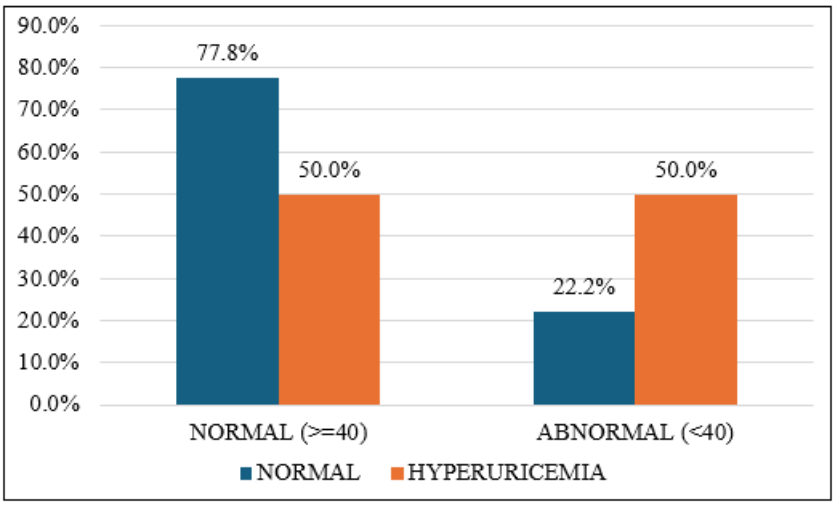

Figure 12: Association of HUA with HDL

Table 13: Association of HUA with LDL

LDL	Serum Uric Acid		Total	Chi - Square, P - Value
	Normal	Hyperuricemia		
Normal (<130)	114 (90.5%)	18 (75.0%)	132 (88.0%)	4.573a, 0.032
Abnormal (>=130)	12 (9.5%)	6 (25.0%)	18 (12.0%)	
Total	126 (100.0%)	24 (100.0%)	150 (100.0%)	

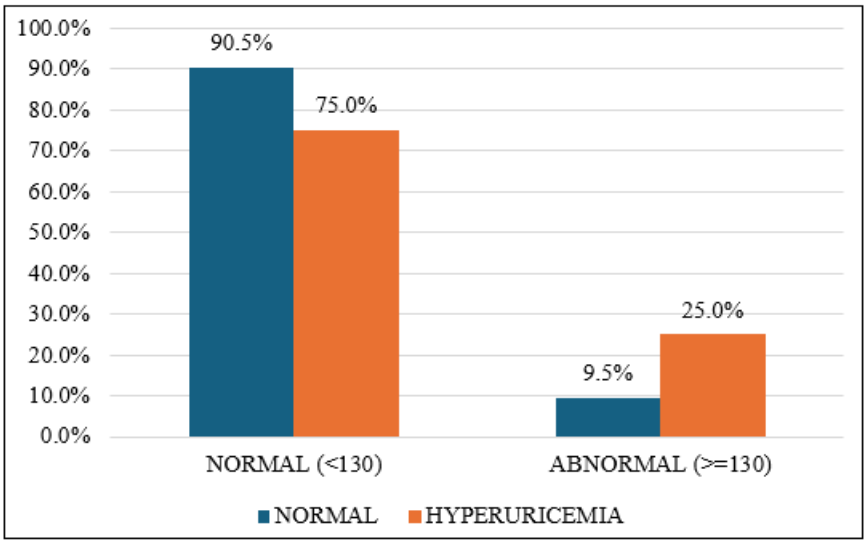

Figure 13: Association of HUA with LDL

Table 14: Association of HUA with Triglycerides

Triglycerides	Serum Uric Acid		Total	Chi - Square, P - Value
	Normal	Hyperuricemia		
Normal (100 - 139)	112 (88.8%)	18 (75.0%)	130 (86.6%)	4.453, 0.047
Abnormal (>=140)	14 (11.2%)	6 (25.0%)	20 (13.4%)	
Total	126 (100.0%)	24 (100.0%)	150 (100.0%)	

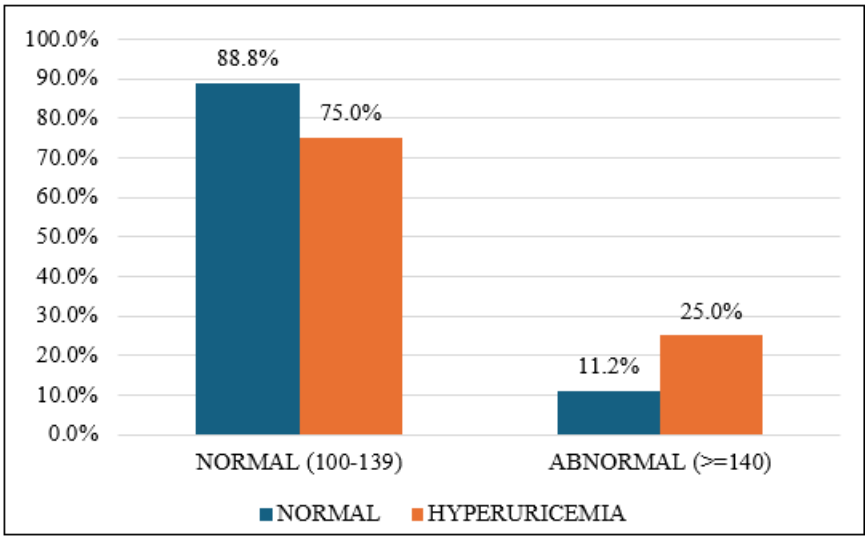

Figure 14: Association of HUA with Triglycerides

Table 15: Association of Hua with Ischemia

Ischemia	Serum Uric Acid		Total	Chi - Square, P - Value
	Normal	Hyperuricemia		
NO	67 (53.2%)	7 (29.2%)	74 (49.3%)	4.649a, 0.031
YES	59 (46.8%)	17 (70.8%)	76 (50.7%)	
TOTAL	126 (100.0%)	24 (100.0%)	150 (100.0%)	

Table 16: Comparison of Parameters between Groups

Parameters	Normal	Hyperuricemia	T - Value	P - Value
AGE (IN YEARS)	50.05±12.22	50.29±14.37	-0.087	0.931
DURATION OF T2DM	7.84±4.54	6.79±3.74	1.064	0.289
BMI	22.92±3.68	25.79±3.84	-3.481	0.001
TOTAL CHOLESTEROL	179.32±27.92	195.71±20.95	-2.73	0.007
HDL	41.10±2.69	35.58±4.45	8.183	<0.001
LDL	104.67±14.35	112.63±17.01	-2.15	0.033
TRIGLYCERIDES	124±12.24	139±13.73	-5.763	<0.001
Hb	11.43±1.11	11.14±1.02	1.203	0.231
FBS	155.33±20.27	154.88±21.95	0.098	0.922

PPBS	267.11±24.88	275.42±42.04	-1.321	0.189
HBA1C	8.30±0.61	8.28±0.63	0.143	0.887
CREAT	0.50±0.25	0.45±0.27	0.795	0.428

***** *Independent sample t - test, Statistically significant if P<0.05*

Table 17: Correlation of Serum Uric acid With Lipid Profile, Age and Duration of Diabetes.

	Correlation	P - Value
AGE (IN YEARS)	0.128	0.086
DURATION OF T2DM	0.086	0.181
BMI	0.179	0.028
TOTAL CHOLESTEROL	0.383	0.042
HDL	-0.244	0.003
LDL	0.21	0.01
TRIGLYCERIDES	0.318	0.003

4. Discussion

One feature of our study is the correlation that we found between cardiovascular risk variables and blood uric SUA levels in those who have type 2 diabetes, offering insights into the complex interplay link problems with the heart and disorders of metabolism. A significant positive connection between higher SUA levels and the findings were found and various established cardiovascular risk factors, such as high blood pressure, dyslipidemia, obesity, and smoking.

- **Hypertension and SUA:** Our study demonstrated a noteworthy positive correlation between SUA levels and hypertension among those who have type 2 D. This aligns with previous research suggesting a potential link between hyperuricemia and elevated blood pressure. The discussion may delve into potential mechanism uric acid's effects on endothelial function and vascular remodeling, for instance.
- **Dyslipidemia and SUA:** The study identified a favorable relationship between SUA and dyslipidemia, highlighting a possible uric acid's function in lipid metabolism in T2DM. Discussions could explore the impact of hyperuricemia on lipoprotein metabolism, inflammation, as well as insulin resistance, which exacerbates the dyslipidemia profile often seen in diabetes.
- **Obesity and SUA:** increased SUA concentrations were associated with obesity inside our cohort, reinforcing the existing body of literature linking hyperuricemia with adiposity. Potential pathways involving insulin resistance, adipokine dysregulation, and inflammatory processes may be discussed to elucidate the connection between obesity and SUA in T2DM
- **Smoking and SUA:** According to our research, smoking status and SUA levels are positively correlated. The conversation might go into the possible effects of smoking - related inflammation and oxidative stress on uric acid metabolism and vice versa, illuminating the complex connection between smoking, SUA, and cardiovascular risk in T2DM.
- **Clinical Implications:** There are important clinical ramifications for the connections between SUA and cardiovascular risk factors linked to type 2 DM. Measuring SUA levels during regular clinical evaluations may help identify diabetics who are more likely to develop cardiovascular problems. This may lead to the creation of tailored treatment regimens and early intervention techniques that address both diabetes control and cardiovascular risk reduction.
- **Early Intervention:** Tracking SUA levels may provide a preemptive warning of increased cardiovascular risk in type 2 DM. Early intervention could lower the chance of cardiovascular problems and enhance overall results. This includes pharmacological therapies to lower SUA levels and lifestyle adjustments.
- **Integrated Cardiovascular Care:** The results highlight how crucial it is to include cardiovascular risk assessment in the all - encompassing care of individuals with type 2 DM. In addition to monitoring and controlling cardiovascular risk factors, healthcare providers managing diabetes should also consider SUA as a possible extra parameter.
- **Screening Programs:** The study backs up the inclusion of SUA measures in more comprehensive screening programs for people with T2DM or individuals who have received a diagnosis of the illness. Identifying those who are more likely to experience cardiovascular disease by including SUA in routine screens. This would help with early intervention and prevention efforts.
- **Treatment Strategies:** Physicians could investigate how therapies aimed at SUA levels affect cardiovascular consequences for people with type 2 DM. It might be feasible to reduce the chance of cardiovascular incidents in this population by looking into pharmaceuticals or lifestyle changes that successfully lower SUA.
- **Patient Education:** Enhanced cognizance of the correlation among SUA, diabetes, and cardiovascular hazards can enable those who have type 2 DM to take an active role in their treatment. It can be even more important to educate patients on lifestyle changes, such as eating better and quitting smoking.
- **Follow - up Monitoring**: Long - term management strategies should include routine SUA level monitoring in T2DM patients. With this method, we could monitor changes in SUA levels over time and modify our treatment plans, accordingly, helping to maintain cardiovascular risk reduction.

5. Limitations and Future Directions

Our study's cross - sectional design makes it difficult to determine a link's temporal or causal connection between SUA levels and cardiovascular risk variables. To better understand the predictive usefulness of SUA for cardiovascular consequences among T2DM individuals, longitudinal studies are necessary. Furthermore, the conventional cardiovascular risk factors were the focus of our study; future investigations should investigate the connection between SUA levels and other recently discovered risk factors, such as inflammation and endothelial dysfunction.

6. Conclusion

- The present study is predominated by male gender and older adult age years.

- DM was linked to around one - third of individuals with elevated SUA levels.
- Our findings point to a positive relationship between SUA and HbA1c levels as well as between changed blood glucose and levels of serum uric acid.
- Patients with diabetes who also had higher HbA1c levels had higher SUA levels. As a result, SUA could be a useful biomarker for the decline in glucose metabolism.
- SUA levels rose as diabetes duration increased.
- SUA levels were noticeably increased in CAD patients with diabetes.
- A marker or risk factor for CAD in the diabetic population is an SUA level greater than 4 mg/dl.

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