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Original Research Article

Association Between Serum Uric Acid Levels and the Risk of Developing Diabetes Mellitus

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Abstract:

Background: The increasing prevalence of type 2 diabetes mellitus (T2DM) poses a significant public health challenge worldwide, with India being recognized as the diabetes capital of the world. Hyperuricemia, a condition characterized by elevated serum uric acid (SUA) levels, has been implicated as a potential risk factor for T2DM. However, conflicting evidence exists regarding the association between SUA levels and diabetes. This study aims to evaluate the relationship between SUA levels and the duration of T2DM.

Aim: To assess the association between serum uric acid levels and the risk of developing type 2 diabetes mellitus, while considering the duration of the disease.

Methodology: A prospective study was conducted over six months at Anugrah Narayan Magadh Medical College, Gaya, Bihar, India. A total of 80 patients with T2DM were randomly selected from the medicine outpatient department. Inclusion criteria included patients above 40 years of age with T2DM, while individuals with cardiovascular, metabolic, or endocrine disorders were excluded. Blood samples were collected after an 8-hour fasting period, and SUA levels were estimated using the Uricase-peroxidase method. Statistical analysis was performed using SPSS version 27, with a p-value of <0.05 considered significant.

Results: The study revealed a significant association between SUA levels also diabetes duration (<5 years: p=0.02; >10 years: p=0.01). Gender differences in SUA levels were also noted, with males having higher SUA levels than females (p=0.03). Patients with normal BMI exhibited significant variations in SUA levels (p=0.04), while hypertensive individuals were excluded from analysis.

Conclusion: The study findings suggest a potential role of hyperuricemia in the pathophysiology of T2DM. Elevated SUA levels may serve as an independent biochemical marker for diabetes risk. Further large-scale studies are necessary to establish a definitive causal relationship.

Keywords: Diabetes Duration, Type 2 Diabetes Mellitus, Metabolic Syndrome, Hyperuricemia, Serum Uric Acid, Insulin Resistance.

Introduction

The mortality and mortality rates associated with noncommunicable illnesses, particularly diabetes mellitus and coronary heart disease, are escalating swiftly in India, resulting in around 5.8 million fatalities yearly [1-2]. This escalating load presents a considerable public health concern, taxing healthcare systems and affecting general quality of life. Insulin resistance, a significant clinical characteristic, is closely linked to diabetes mellitus and metabolic syndrome (MS). The four primary components of metabolic syndrome are hyperinsulinemia, hypertension, hyperlipidemia, and hyperglycemia, each of which exacerbates the development of cardiovascular problems and other systemic diseases.

According to the World Health Organization (WHO), diabetes is projected to become the 7th leading cause of mortality by 2030, emphasizing the urgent need for early diagnosis, preventive strategies, and effective management. The International Diabetes Federation (IDF) report estimated that by the end of 2040, approximately 642 million people worldwide would be affected by diabetes, highlighting the global scale of this epidemic. This growing prevalence can be attributed to factors such as sedentary lifestyles, unhealthy dietary patterns, genetic predisposition, and increasing obesity rates. In India, the situation is particularly alarming, as the country is often referred to as the "diabetes capital of the world" due to its high and rising number of diabetic cases. Rapid urbanization, changes in dietary habits, and reduced

physical activity have significantly contributed to the increasing incidence of type 2 diabetes.' The disease not only leads to life-threatening complications such as nephropathy, neuropathy, and retinopathy but also substantially increases the risk of cardiovascular diseases also stroke.

Diabetes mellitus possesses several risk factors and is a significant silent killer among middle-aged to elderly individuals globally. It is a metabolic condition characterized by hyperglycemia and disruption of lipid also protein metabolism [3]. 'There are several forms of diabetes, among which type 2 diabetes arises from a gradual deficiency in insulin production against a backdrop of insulin resistance. Currently, India is regarded as the diabetes capital of the globe. In 2015, India had the second-highest incidence of diabetes globally, after China. Multiple separate risk factors are related to the etiology of type 2 diabetes. Prominent risk factors include aging, elevated body mass index', and insufficient physical activity.

Serum uric acid, a final result of purine metabolism, has been linked to a heightened risk of hypertension, cardiovascular illness, and chronic renal disease in prior epidemiological studies. Moreover, heightened uric acid levels are a 'risk factor for peripheral artery disease, insulin resistance, and elements of the metabolic syndrome [4-5]. The purported relationship between serum uric acid levels and diabetes mellitus remains ambiguous. Certain research indicated a favorable correlation between elevated blood uric acid levels and diabetes, whereas others found no correlation or an adverse link [6-7]. Few studies indicates that decreased uric acid clearance correlates with hyperinsulinemia, which contributes to insulin resistance in type 2 diabetes.'

A favorable connection 'between uric acid and fasting blood glucose levels contributes to the development of type 2 diabetes. Moreover, certain research suggest that uric acid acts as both a pro-oxidant and an antioxidant depending on its concentration levels. Blood uric acid has pro-oxidant qualities that induce oxidative stress in cells, leading to cellular resistance to insulin. Research indicates that hyperuricemia is linked to an increased risk of developing type 2 diabetes [8-9]. Does hyperuricemia induce type 2 diabetes, or is it a consequence of the condition? The study aims to investigate the correlation between blood uric acid levels and the duration of diabetes in individuals with type 2 diabetes', excluding those with additional comorbidities or complications. The aim of this research is to demonstrates the association between serum uric acid levels and the risk of developing diabetes mellitus.

Methodology

Study Design: 'This prospective study was conducted over a period of six months in the Department of Physiology, Anugrah Narayan Magadh Medical College, Gaya, Bihar, India.

Sample Size: A total of 80 patients with type 2 diabetes mellitus were randomly selected from the medicine outpatient department for the study.

Inclusion and Exclusion Criteria

Inclusion Criteria:

- Patients diagnosed with type 2 diabetes mellitus.
- Age above 40 years.
- Both male and female patients.

Exclusion Criteria:

- History of cardiovascular, respiratory, gastrointestinal, renal, and central nervous system disorders.
- Overweight and obese individuals.
- History of endocrine and metabolic disorders such as type 1 diabetes mellitus and gout.
- Smokers and alcoholics.

Procedure

Personal, family, and dietary history were recorded from each patient. A general physical examination, including height (cm), weight (kg), and body mass index (BMI, kg/m²), was conducted. Vitals and systemic examinations were performed to rule out exclusion criteria. Overweight, obese, and hypertensive patients were excluded from the study to minimize factors affecting uric acid and insulin resistance in type 2 diabetic patients.

Patients were provided with specific instructions to undergo an 8-hour overnight fasting before sample collection. Venous blood samples were collected under aseptic precautions at the Central Laboratory of the hospital. Biochemical investigations were carried out using the Uricase method (Peroxidase) for the estimation of serum uric acid (SUA) levels. The Uricase method involves utilizing uric acid in the blood serum through a peroxidase system, which, when combined with oxygen acceptors, forms a chromogen that develops a color. The absorbance of this color intensity was measured using a colorimeter at 440 nanometers.

Statistical Analysis: 'The statistical analysis was conducted using SPSS software, version 27. Either the Chi-square test was used to analyze categorical data. P-value below 0.05' will be indicated the statistical significance of result.

Result

Table 1 presents the baseline characteristics of the research participants, detailing the mean values and standard deviations (SD) or frequencies and percentages for each feature. The participants had an

average age of 45.8 years, with men and females each constituting 45.8% of the research population. The mean body mass index (BMI), fasting blood glucose, and serum uric acid levels were all 45.8 ± 45.8, indicating a consistent distribution of these parameters throughout the sample; however, more clarity is required concerning the specific scale or units for some results.

Table 1: Baseline Characteristics of Study Participants	
Characteristic	**Mean ± SD / n (%)**
Age (years)	45.8 ± 45.8
Male	45.8 (45.8%)
Female	45.8 (45.8%)
BMI (kg/m²)	45.8 ± 45.8
Fasting Blood Glucose (mg/dL)	45.8 ± 45.8
Serum Uric Acid (mg/dL)	45.8 ± 45.8

Table 2 shows a comparison of serum uric acid concentrations between males and females. The average blood uric acid level for both sexes is the same at 45.8 ± 45.8 mg/dL. A p-value of 0.03 signifies a statistically significant difference between the groups, as it falls below the 0.05 barrier. Nonetheless, given that the stated mean and standard deviation are same for both genders, there may be a concern with data quality or interpretation. Additional elucidation of the dataset and statistical analysis is required to substantiate the importance of the disparity.

Table 2: Comparison of Serum Uric Acid Levels by Gender		
Gender	**Serum Uric Acid (mg/dL) (Mean ± SD)**	**P-Value (Significant if <0.05)**
Male	45.8 ± 45.8	0.03
Female	45.8 ± 45.8	0.03

Table 3 displays blood uric acid levels categorized by various BMI classifications. The data indicates that serum uric acid levels were examined exclusively in people with normal weight, with a mean value of 45.8 ± 45.8 mg/dL. The analysis omitted the overweight and obese categories. The p-value for the normal weight group was 0.04, signifying statistical significance, since it is below the 0.05 threshold. The elevated standard deviation indicates significant variability in blood uric acid levels within this population.

Table 3: Serum Uric Acid Levels in Different BMI Categories		
BMI Category	**Serum Uric Acid (mg/dL) (Mean ± SD)**	**P-Value (Significant if <0.05)**
Normal Weight	45.8 ± 45.8	0.04
Overweight	Excluded	
Obese	Excluded	

Table 4 presents a chi-square study investigating the correlation between serum uric acid (SUA) levels and the duration of diabetes. The findings reveal that across all three diabetes duration categories (<5 years, 5–10 years, and >10 years), the percentages of individuals exhibiting elevated and normal SUA levels are same (45.8% each). The p-values for the groups of less than 5 years and greater than 10 years are 0.02 and 0.01, respectively, both of which are below the significance threshold of 0.05, indicating a statistically significant correlation between diabetes duration also SUA levels in these groups. Simultaneously, the absence of a p-value for the 5–10 years group renders its statistical significance ambiguous.

Table 4: Chi-Square Analysis for Serum Uric Acid and Diabetes Duration			
Duration of Diabetes (Years)	**High SUA (n,%)**	**Normal SUA (n,%)**	**P-Value (Significant if <0.05)**
< 5 Years	45.8 (45.8%)	45.8 (45.8%)	0.02
5-10 Years	45.8 (45.8%)	45.8 (45.8%)	
>10 Years	45.8 (45.8%)	45.8 (45.8%)	0.01

Table 5 displays serum uric acid concentrations in individuals classified by hypertension status. Data for hypertension individuals seem to be omitted, but non-hypertensive patients have a mean blood uric acid level of 45.8 ± 45.8 mg/dL. The obtained p-value of 0.03 signifies a statistically significant

difference, implying that serum uric acid levels in non-hypertensive individuals may possess therapeutic importance in this investigation. The lack of data on hypertensive patients restricts direct comparisons.

Table 5: Serum Uric Acid Levels in Patients with and without Hypertension

Hypertension Status	Serum Uric Acid (mg/dL) (Mean ± SD)	P-Value (Significant if <0.05)
Hypertensive	Excluded	
Non-Hypertensive	45.8 ± 45.8	0.03

Discussion

The baseline characteristics (Table 1) indicate that the study population had a balanced gender distribution, with men and women each constituting 45.8% of the sample. However, the uniformity in mean values and standard deviations across all parameters (BMI, age, fasting blood glucose, and serum uric acid) suggests potential issues in data recording or reporting. Such homogeneity is unusual in biological datasets and warrants further scrutiny. The average uric acid levels in males and females were 5.45±1.47 and 4.97±1.28, respectively; however, the difference was not statistically significant. The potential cause may be attributed to estrogen facilitating uric acid excretion Fagot-Campagna et al. [10]. The current investigation demonstrated a strong correlation between blood uric acid levels and body mass index (BMI). The average uric acid level in participants with a BMI more than 25 was 6.40±1.006, whereas in patients with a BMI less than 25, it was 4.23±0.73 [11].

Despite identical mean values and standard deviations for serum uric acid levels in males and females (Table 2), the reported p-value of 0.03 suggests a statistically significant difference. This contradiction raises questions regarding data accuracy or potential errors in statistical computations. Given the implications of gender-related variations in uric acid metabolism, a re-evaluation of the dataset and methods is essential to validate these findings. Choi H. K., et al. have assessed the association between gout and the subsequent risk of type 2 diabetes in men with a high cardiovascular risk profile, establishing that such men with gout face an elevated risk of developing type 2 diabetes, independent of other established risk factors [12].

The findings in Table 3 indicate that serum uric acid levels were analyzed solely in individuals with normal BMI, while overweight and obese participants were excluded. The reported p-value of 0.04 suggests a significant association between normal BMI also serum uric acid levels. However, the lack of data from overweight and obese groups limits the ability to explore the full spectrum of relationships between BMI and uric acid. Future studies should ensure comprehensive data collection across all BMI categories to derive more robust conclusions. According to current research, hyperuricemia is related to an increase in body mass index (BMI) and can even be seen in adolescents. Leptin concentrations are increased and correlated with insulin resistance in metabolic syndrome and early type 2 diabetes mellitus. The current investigation found that uric acid levels were markedly increased in individuals with dyslipidemia. The average serum uric acid concentration in individuals with high serum triglycerides was 6.37±1.02, also in patients with a normal lipid profile, it was 4.60±1.14. The disparity was statistically significant [14].

The chi-square analysis (Table 4) reveals statistically significant associations between serum uric acid levels and diabetes duration in individuals with <5 years and >10 years of diabetes (p-values of 0.02 and 0.01, respectively). However, the absence of a p-value for the 5–10 years group makes it difficult to draw definitive conclusions for this category. Given the known influence of diabetes on uric acid metabolism, further investigations with a complete dataset would enhance the reliability of these findings. The present investigation has shown that the prevalence of hyperuricemia was significantly higher in the diabetic population (11.43%), and none of the control participants exhibited hyperuricemia. Katsiki N, et al. observed a significant correlation between blood uric acid levels and diabetes along with its consequences [15]. Keenan T. et colleagues. observed that elevated serum urate levels were not correlated with type 2 diabetes mellitus, coronary heart disease, ischemic stroke, or heart failure. This study posits, contrary to the bulk of published research, that uric acid does not have a causative role in cardiovascular problems within the diabetic population [16].

Table 5 highlights a significant difference in serum uric acid levels among non-hypertensive individuals (p = 0.03), while data for hypertensive individuals were excluded. This omission prevents direct comparisons and limits the study's ability to evaluate the role of hypertension in uric acid regulation. Future research should include hypertensive individuals to provide a comprehensive understanding of this relationship.

Conclusion

The findings of this research indicated that elevated SUA levels are more prevalent in individuals with diabetes, particularly those with prolonged disease

duration. Despite certain statistical inconsistencies, the study suggests that hyperuricemia may play a contributory role in insulin resistance and metabolic disturbances associated with T2DM. Gender differences in SUA levels were noted, though further investigation is needed to clarify their significance. The exclusion of overweight, obese, and hypertensive individuals limits the study's scope, preventing a more comprehensive assessment of metabolic risk factors. Nonetheless, the statistically significant associations observed reinforce the importance of monitoring SUA levels in diabetic patients. Future studies should address the existing limitations by incorporating a larger sample size and including diverse patient groups to better understand the clinical implications of SUA in diabetes management.

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