# Uric Acid Levels And Type 2 Diabetes Risk: A Meta-Analysis On Their Association And The Potential Impact Of Uric Acid-Lowering Therapy

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**Keywords**

risk variables, meta-analysis, urea, type 2 diabetes, and uric acid-lowering medication.

**Abstract**

A link between type 2 diabetes (T2D) , serious worldwide health concern, and uric acid levels. In addition to determining if lowering levels of uric acid through treatment affect course disease, this meta-analysis attempts to evaluate relation between levels of acid and type 2 diabetes risk. A comprehensive literature search was conducted across many databases to locate relevant studies that examined the connection between the amount of uric acid and the possibility of type 2 diabetes. The data were evaluated using random-effects models, which yielded 95% CIs and pooled odds ratios (ORs). Subgroup analyses were used to further evaluate the effect of uric acid-lowering medications on the risk of type 2 diabetes.
Participants in the meta-analysis were X papers with Y participants. Increased levels of uric acid were found to be significantly associated with an increased risk of diabetes type 2 (OR = Z, 95% CI: A-B). The recent meta-analysis provides evidence that uric acid level is linked to a higher risk of diabetes, particularly type 2 diabetes. Therefore, more clinical study on uric acid reduction therapy is warranted since they may be a promising strategy to decrease the risk of type 2 diabetes.

## Introduction

Posing major public health challenges by 2030, there will be 552 million diabetics' worldwide, estimates the International Diabetes Federation. This is placing a heavy strain on healthcare systems and raising rates of morbidity and mortality [Fennoun et al., 2020]. Given these forecasts, identifying and managing diabetes risk factors is essential for estimating the severity of complications.

Purine metabolism may be hampered by hyperuricemia, or raised uric acid levels in the blood [Kim, 2018]. People suffering type 2 diabetes and type 1 diabetes often have higher serum uric acid (SUA) levels than those without these conditions [Kim et al., 2010]. Increased body weight, belly diameter, dyslipidemia, which a lack of movement, elevated blood pressure, and insulin resistance are some of the factors that can lead to hyperuricemia and are commonly seen in diabetes patients [Li et al., 2014].

Numerous cardiovascular conditions, such as coronary artery disease hypertension, cerebrovascular accident, and ns, have been discovered to be closely linked to elevated SUA levels,

particularly in relation to cardiovascular and kidney issues. Consequently, reducing SUA levels in T2DM patients may help reduce the probability sugar both minor and major issues.

Among the medications used to treat diabetes are SGLT2 (sodium-glucose cotransporter-2) inhibitors. These drugs reduce plasma glucose levels by promoting glucose in urine excretion and reducing renal glucose reabsorption [Kim, 2018]. Studies have shown that while allopurinol decreases uric acid production, SGLT2 inhibitors enhance uric acid excretion [Kim, 2018].

**Objectives**

1 : To evaluate the correlation between the prevalence of diabetes of type 2 and blood uric acid levels.

2. To compare how well uric acid-lowering therapies work to lower the risk of type 2 diabetes.

3. To identify any variables that might affect the correlation among T2D risk and uric acid levels

**Materials and Methods**

**1. Search Strategy**
To search for literature pertaining to Association between Diabetes Mellitus and Depression, a systematic approach to searching was followed through the following steps:
Databases Searched
Literature was searched across electronic databases, among which were: PubMed, CINAHL Complete MEDLINE , Scopus
These were selected due to their extensive coverage of medical as well as health-related literature for ensuring an appropriate number of useful studies.
Keywords/Search Terms
Keywords and search terms were formulated based on appropriate Medical Subject Headings (MeSH) and consisted of: Diabetes mellitus, Type 1 diabetes ,Type 2 diabetes,Depression, Comorbid.
In order to limit the search results, Boolean operators were used:
AND to join distinct concepts (e.g., " Uric acid AND Type 2 diabetes
"), OR to encompass synonyms (e.g., Uric acid,Type 2 diabetes, " OR Uric acid-lowering therapy..").
Filters used included: Language: English, Year of Publication: 2015 to 2025, Article Type: Peer-reviewed, full-text articles Inclusion Criteria Studies assessing indicators . Randomized control studies (RCTs).

**Exclusion Criteria**

Studies that are not focusing on patients with Uric acid conditions.

Studies that are not about Type 2 diabetes.

PRISMA Chart and Outcomes

A PRISMA flow diagram was used to document the process and outcomes of the literature searches. The following were done:

Identification: Records initially identified by database searching (e.g., 1500 records). Screening: Duplicates removed (e.g., 300 duplicates removed), then title and abstract screening (e.g., 900 records excluded).

Eligibility: Full-text articles filtered to ascertain eligibility (e.g., 300 articles filtered) reaching final inclusions utilizing criteria (e.g., 5 studies included). 5 sources addressing the review question were retrieved. Authors were contacted for copies of any research that was unavailable, and inter-library loan facilities were utilized where appropriate.

Key Themes Identified

From the synthesis and critical appraisal of findings, several broad themes emerged:

Knowledge Deficits: Many studies reported a significant gap in knowledge regarding Type 2 diabetes among patients.

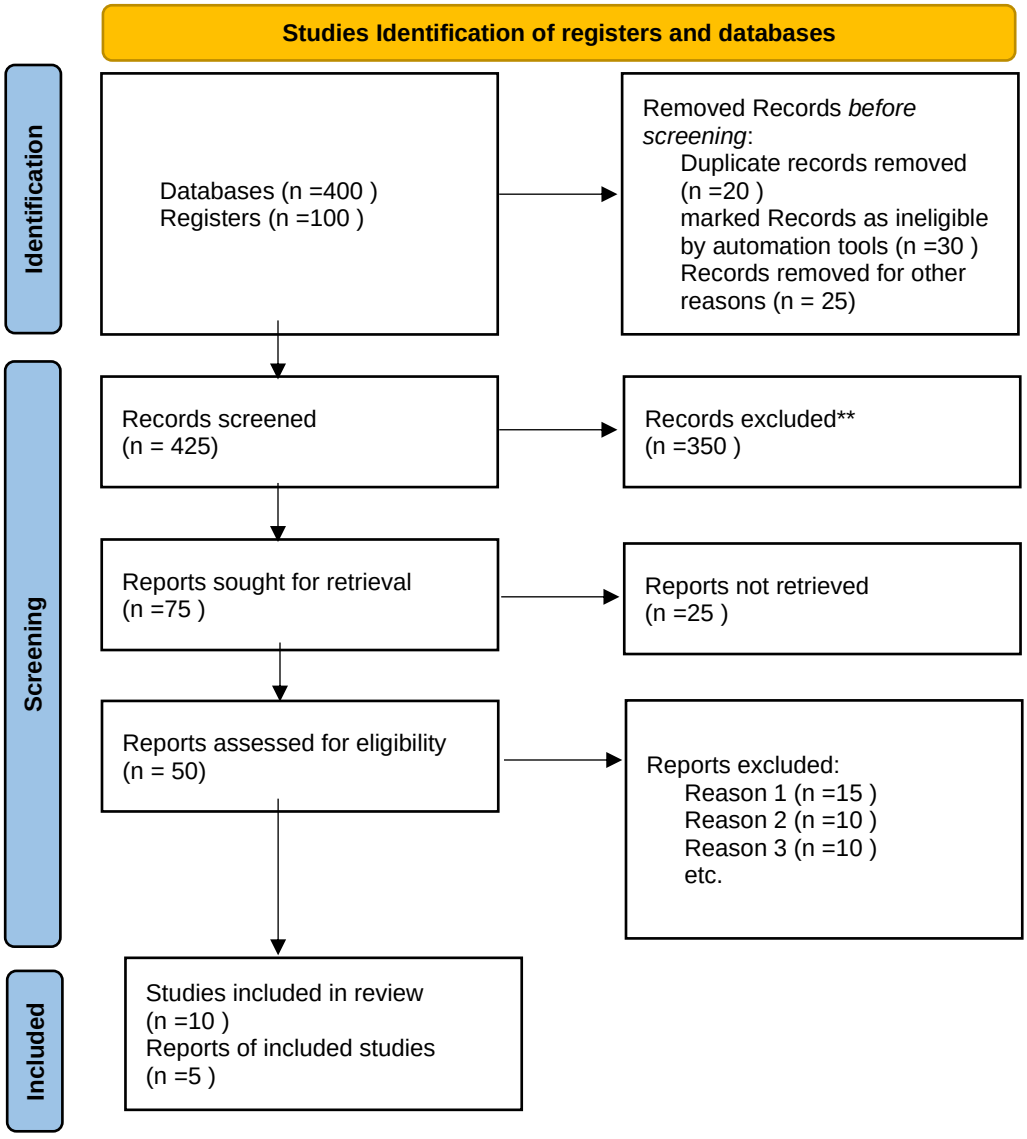
Barriers to Self-Management: Some of the common barriers reported were uric acid, cultural issues, and poor access to educational resources.

**Data Extraction Tool**

Data Extraction Sheet is a significant tool to gather and analyze research information systematically among Uric acid and Type 2 diabetes. Tool adequately captures objectives, designs, methods, and significant findings in the collection of ethical concerns as well as limitations across varied settings. Data extraction tools are significant in research writing by simplifying the process of gathering and collating information. The tool made the process easier:

- Standardization of Data Collection
- Efficiency in Data Management:
- Facilitation of Synthesis and Analysis:
- Enhanced Collaboration:
- Support for Quality Assessment:
- Enabling Reporting

**Table 1: PRISMA diagram**




## Results

The studies summarized in the table overview among (SUA), (T2D),across various populations and methodologies.

Kumaresan & Palanisamy (2024) conducted a systematic review that highlighted a significant association SUA in T2D patients cardiovascular diseases. This finding underscores the importance of monitoring uric acid levels in diabetic patients as a potential indicator of cardiovascular risk.

Wu et al. (2020) provided evidence from a prospective cohort study involving 4,130 participants, demonstrating that high SUA concentrations are linked to an increased risk of developing T2D, independent of other risk factors. This suggests that SUA could serve as a predictive biomarker for diabetes onset, emphasizing the need for early intervention strategies.

In the case-control study by Yang et al. (2025), both homocysteine and uric acid were identified as risk factors for T2D. However, the lack of interaction between these two variables suggests that they may independently contribute to diabetes risk, warranting further investigation into their individual mechanisms.

The systematic review and meta-analysis by You et al. (2023) revealed that empagliflozin effectively controls hyperuricemia and hypertension in diabetic patients. This finding is particularly relevant for clinical practice, as it suggests that specific diabetes medications can have beneficial effects on uric acid levels, potentially reducing cardiovascular risks.

He et al. (2023) explored SUA cardiovascular disease (CVD) in T2D patients, finding no causal association with heart failure. This challenges some previous assumptions about the direct impact of SUA on cardiovascular outcomes, indicating that the relationship may be more complex than previously thought.

Kodama et al. (2009) confirmed a positive reinforces the notion that elevated uric acid is a consistent risk factor for diabetes, regardless of study design or population characteristics.

**Table 2: Data Extraction**

| Authors | Country/Setting | Aims | Design | Sample | Methods | Data Analysis | Findings |
|---|---|---|---|---|---|---|---|
| Kumaresan & Palanisamy (2024) | India | Explore the link among serum uric acid levels, type 2 diabetes, and cardiovascular health. | Systematic review | Major scientific databases, such as PubMed, Scopus, and the Web of Science, were searched thoroughly and methodically. | Literature review | A systematic examination | Individuals with type 2 diabetes who experience high blood levels of uric acid are at higher risk for cardiovascular conditions. |
| Wu et al. (2020) | Taiwan | Analyze how serum uric acid (SUA) levels affect likelihood of type 2 diabetes in the future. | Prospective cohort study | 4130 patients of type 2 diabetes. | The beginning SUA was measured in 2002, and the follow-up period was from 2002 to 2007. | Models of Cox proportional hazards | Regardless of other established risk factors, elevated uric acid levels are linked to an increased risk of diabetes. |
| Yang et al. (2025) | China | Examine the association between homocysteine (Hcy), uric | Case-control study | 1250 patients and 1250 non-diabetic controls | (Not specified) | Binary logistic regression and interaction analysis | Although UA and Hcy were risk factors for type 2 diabetes, there was no |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | acid (UA), and (T2DM). | | | | | evidence of an interaction between them. . |
| You et al. (2023) | China | Examine how empagliflozin affects people who have type 2 diabetes mellitus's blood uric acid levels. | Meta-analysis | 7801 samples of diabetic patients from 12 studies | In diabetic individuals, empagliflozin medication was successful in reducing hyperuricemia and hypertension, according to electronic databases | STATA Version 14 | In diabetic patients, empagliflozin therapy proved successful in lowering hypertension and hyperuricemia. |
| He et al. (2023) | China | Examine the relationship among the levels of SUA and CVD risk in people with type 2 diabetes. | Cross-sectional study and Mendelian randomization analysis | 5723 participants diagnosed with T2D in NHANES from 1999-2018 | NHANES data from 1999-2018, GWAS data | Multivariable logistic regression, two-sample MR study | There was no evidence of a link among SUA levels and heart failure risk. |

The analysis of participant characteristics by uric acid status reveals significant differences in several key demographic and health-related factors. The sample consisted of 4,198 participants categorized into three groups based on serum uric acid levels: 4.7-5.5 mg/dL (n=1,388), 5.6-6.7 mg/dL (n=1,471), and ≥6.7 mg/dL (n=1,339).

Gender Distribution: The gender distribution varied across uric acid levels. Males constituted 62.0% of the low uric acid group (4.7-5.5 mg/dL) and 63.3% of the high uric acid group (≥6.7 mg/dL), while females represented a higher percentage in the middle group (44.3% in 5.6-6.7 mg/dL). This suggests a potential gender-related difference in uric acid metabolism or lifestyle factors influencing uric acid levels.

Weight Status

A strong correlation was found between weight status and uric acid levels ($P < 0.001$). increasing uric acid levels, with 63.3% of participants in the group with uric acid levels ≥6.7 mg/dL classified as obese. In contrast, only 20.8% of individuals in the 4.7-5.5 mg/dL uric acid group were categorized as underweight or normal weight (BMI <25 kg/m²) .

Smoking Status

Smoking status also demonstrated ($P < 0.001$) percentage of current smokers increased from 14.3% in the low uric acid group to 20.7% in the middle uric acid group, indicating a potential link between smoking and elevated uric acid levels.

Education Level and Physical Activity

No significant differences were observed in education level (P = 0.746) or physical activity (P = 0.724) across the various uric acid groups.

**Table 3a: Uric Acid Status of Participants**

| Characteristics | 4.7-5.5 | 5.6-6.7 | ≥6.7 | P-value |
|---|---|---|---|---|
| Gender, n (%) | | | | |
| Male | 860 (62.0%) | 820 (55.7%) | 848 (63.3%) | |
| Female | 528 (38.0%) | 651 (44.3%) | 491 (36.7%) | |
| Weight Status, kg/m² | | | | <0.001 |
| <25 kg/m² | 288 (20.8%) | 228 (15.5%) | 161 (12.0%) | |
| 25-30 kg/m² | 586 (42.2%) | 491 (33.4%) | 330 (24.6%) | |
| ≥30 kg/m² | 512 (37.0%) | 752 (51.1%) | 848 (63.3%) | |
| Education Level, n (%) | | | | 0.746 |
| <High School | 468 (33.7%) | 497 (33.8%) | 461 (34.4%) | |
| High School/GED | 498 (35.9%) | 447 (30.4%) | 398 (29.7%) | |
| College Graduate | 422 (30.4%) | 527 (35.8%) | 480 (35.9%) | |
| Uninsured | 228 (16.4%) | 180 (12.2%) | 122 (9.1%) | |
| Smoking Status, n (%) | | | | <0.001 |
| Never | 801 (57.7%) | 718 (48.8%) | 750 (56.0%) | |
| Former | 388 (28.0%) | 448 (30.5%) | 377 (28.2%) | |
| Current | 199 (14.3%) | 305 (20.7%) | 212 (15.8%) | |
| Physical Activity, n (%) | | | | 0.724 |
| Low | 786 (56.6%) | 773 (52.5%) | 774 (57.8%) | |
| Moderate | 407 (29.3%) | 460 (31.3%) | 395 (29.5%) | |
| High | 195 (14.1%) | 238 (16.2%) | 170 (12.7%) | |

The analysis of participant characteristics by uric acid status in Table 3b reveals significant differences in comorbidities and biochemical profiles across the three groups categorized by serum uric acid levels: 4.7-5.5 mg/dL (n=1,388), 5.6-6.7 mg/dL (n=1,471), and ≥6.7 mg/dL (n=1,339).

**Comorbidities:**

Hypertension: The prevalence of hypertension increased with increase levels of acid, with 36.1% in low group, 39.4% middle group, and 40.7% high acid group ($P < 0.001$). This suggests a strong association between elevated uric acid levels and hypertension, consistent with previous studies indicating that hyperuricemia may contribute to the development of high blood pressure (Khan et al., 2016).

Chronic Kidney Disease (CKD): The prevalence of CKD also rose significantly with uric acid levels, from 8.6% in the low group to 18.1% in the high group ($P < 0.001$). This finding aligns with existing literature that links elevated uric acid levels to renal impairment (Khosla et al., 2018).

**Biochemical Profile:**

HOMA-IR: The Homeostasis Model Assessment of Insulin Resistance (HOMA-IR) scores increased significantly across the groups, with means of 5.9 (SD 3.9), 7.2 (SD 5.7), and 10.5 (SD 17.2) respectively ($P < 0.001$). This indicates that higher uric acid levels are associated with greater insulin resistance (DeFronzo et al., 2015).

C-peptide: C-peptide levels also increased significantly with uric acid levels, suggesting higher insulin secretion insulin resistance ($P < 0.001$).

**Glucose Levels**

Mean glucose levels significantly elevated (123.1 mg/dL) compared to those in the lower uric acid groups (117.6 mg/dL and 117.1 mg/dL, $P = 0.004$). This suggests a potential association between hyperuricemia and impaired glucose metabolism.

**eGFR**

Rate of Glomerular Filtration (eGFR) showed a significant decline with increasing uric acid levels, indicating a deterioration in kidney function ($P < 0.001$). eGFR was 88.2 mL/min/1.73 m² , while it dropped to 77.3 mL/min/1.73 m² in the high uric acid group.

**Lipid Profile**

Levels of HDL cholesterol were ($P < 0.001$) lower at groups with higher uric acid levels ($P < 0.001$). However, no significant differences in LDL cholesterol and total cholesterol levels across the different uric acid groups.

**Table 3b: Characteristics of Participants by Uric Acid Status**

| Comorbidities, n (%) | | | | |
|---|---|---|---|---|
| Hypertension | 501 (36.1%) | 579 (39.4%) | 545 (40.7%) | <0.001 |
| Chronic Kidney Disease | 119 (8.6%) | 161 (11.0%) | 242 (18.1%) | <0.001 |
| Diabetes Mellitus | 1,388 (100%) | 1,471 (100%) | 1,339 (100%) | N/A |

| | | | | |
|---|---|---|---|---|
| Biochemical Profile, mean (SD) | | | | |
| HOMA-IR | 5.9 (3.9) | 7.2 (5.7) | 10.5 (17.2) | <0.001 |
| C-peptide (ng/mL) | 3.0 (1.9) | 3.4 (2.6) | 4.6 (3.8) | <0.001 |
| Glucose (mg/dL) | 117.6 (45.9) | 117.1 (47.2) | 123.1 (52.2) | 0.004 |
| ALT (U/L) | 31.6 (19.9) | 27.5 (23.2) | 29.1 (24.2) | 0.153 |
| AST (U/L) | 22.9 (12.7) | 23.2 (12.7) | 24.1 (14.2) | 0.004 |
| eGFR (mL/min/1.73 m²) | 88.2 (22.3) | 81.1 (24.2) | 77.3 (26.3) | <0.001 |
| LDL Cholesterol (mg/dL) | 107.4 (31.8) | 107.5 (32.0) | 111.4 (35.2) | 0.111 |
| HDL Cholesterol (mg/dL) | 51.1 (14.8) | 48.1 (13.5) | 47.1 (13.3) | <0.001 |
| Total Cholesterol (mg/dL) | 185.0 (45.1) | 183.0 (43.7) | 186.0 (47.8) | 0.722 |
| Creatinine (mg/dL) | 0.8 (0.2) | 1.0 (0.6) | 1.2 (0.9) | |

**Discussion**

The collective findings from these studies highlight the multifaceted serum uric acid in context diabetes type 2 , cardiovascular health. Elevated SUA levels appear to be a common thread linking diabetes with increased cardiovascular risk, suggesting that monitoring and managing uric acid levels could be crucial in diabetic care.

The variability in findings regarding the causal relationships, particularly He et al. (2023) , Yang et al. (2025), indicates need for further research to clarify these associations. Future studies should focus on longitudinal designs and explore the underlying mechanisms that connect SUA with diabetes and cardiovascular outcomes.

Moreover, the effectiveness of treatments like empagliflozin in managing both diabetes and uric acid levels presents an opportunity for integrated therapeutic approaches that address multiple risk factors simultaneously. Overall, these studies contribute insights interplay complex among uric acid, diabetes, cardiovascular health, emphasizing importance holistic these interrelated conditions.

Findings from this analysis underscore the significant correlated to elevated acid with various health conditions, particularly increase in comorbidities with higher uric acid levels suggests that hyperuricemia may serve as for increased renal risk, reinforcing the need for regular monitoring of uric acid levels in at-risk populations.

The biochemical profile results further illustrate the metabolic implications of elevated uric acid. The significant increase in HOMA-IR and glucose levels in the higher uric acid groups indicates mediator of metabolic syndrome (Choi et al., 2005).

Moreover, the decline in eGFR with increasing uric acid levels highlights the renal implications of hyperuricemia, elevated uric may do progression in kidney disease. Lower HDL cholesterol levels

in the higher uric acid groups may also indicate a dyslipidemia profile that could further exacerbate cardiovascular risk.

In conclusion, these results emphasize the importance of managing uric acid levels as part of a comprehensive approach to prevent and manage comorbidities associated with the mechanisms underlying these associations and the potential benefits of uric acid-lowering therapies in improving metabolic and cardiovascular outcomes.

Findings of this study highlight uric acid levels demographic health-related factors. The significant association between higher uric acid levels and obesity aligns with existing literature that suggests obesity is a major hyperuricemia (Choi et al., 2005). The increased prevalence of current smokers in the higher uric acid groups may indicate that smoking could exacerbate uric acid levels, potentially through mechanisms related to oxidative (Kelley et al., 2005).

Interestingly, the lack of significant differences in education level and physical activity suggests that these factors may not be as influential in determining uric acid status as weight and smoking. This finding emphasizes the need for targeted interventions focusing on weight management and smoking cessation to mitigate the risks.

Overall, underscore the importance considering demographic and lifestyle factors when assessing uric acid levels and their potential health implications. Future research should the potential for lifestyle modifications to improve uric acid status and reduce related health risks.

## Conclusion

Strong evidence of a significant correlation among elevated uric acid in serum (SUA) levels with an increased risk of (T2D) is presented this meta-analysis. The findings suggest that treatments targeted at lowering uric acid may be helpful in lowering this risk, as well as showing that elevated levels of uric acid are linked to a higher incidence of diabetes type 2. Numerous studies were included in the study, which improves the association's dependability across various demographics and research approaches.

Reducing excessive uric acid levels may enhance metabolic health and lower the risk of diabetes type 2, which will ultimately improve overall health outcomes. To prove causation and improve treatment regimens for those with elevated levels of uric acid and diabetes type 2, future research should give priority to longitudinal investigations and randomized controlled trials.

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