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Comparison of Serum Uric Acid in Females with and without Gestational Diabetes Mellitus During Pregnancy

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ABSTRACT

Background: The widespread occurrence of Gestational diabetes mellitus (GDM) occurs during pregnancy because of glucose intolerance which leads to unfavorable health outcomes for both the mother and fetus. Research shows that serum uric acid exists as a potential metabolic dysfunction marker although these connections to GDM lack consistency. The research sought to assess serum uric acid levels between pregnant women who did or did not have gestational diabetes mellitus as a means to understand its predictive value. **Methodology:** The case-control analysis took place at Abbasi Shaheed Hospital in Karachi during the six-month period between July and December 2023. The study recruited 100 pregnant women in the third trimester with 50 subjects being GDM cases and 50 having non-GDM status. The researchers employed non-probability consecutive sampling to identify study participants. The analysis of serum uric acid levels occurred through a colorimetric assay. SPSS version 25.0 served as the statistical analysis tool and the groups were examined through independent sample t-tests to detect mean differences in uric acid values. Statistical analysis incorporated age, BMI and other demographic groups for stratification purposes and established a $p \leq 0.05$ threshold as the significance marker. **Results and Discussion:** The mean serum uric acid level was significantly higher in GDM cases (7.06 ± 0.88 mg/dl) compared to controls (4.76 ± 1.06 mg/dl) ($p < 0.001$). Age and BMI stratifications confirmed this association. Previous research supports the conclusion that high uric acid levels act as a component leading to insulin resistance and GDM development. **Conclusion:** The elevated level of uric acid in GDM patients demonstrates potential value as a screening measure. Future research needs to determine both cause-effect relationships and study the potential applications of uric acid assessment for pre-identifying and managing GDM patients.

INTRODUCTION

Gestational diabetes mellitus (GDM) causes carbohydrate intolerance during pregnancy which leads to hyperglycemia and impacts 7% of pregnant women according to research data that shows a variation between 1–14% (Gică & Huluță, 2023). Research demonstrates that Gestational diabetes mellitus shares shaping factors with type 2 diabetes mellitus through pancreatic β-cell dysfunction and insulin resistance (Mora-Ortiz & Rivas-García, 2024). Studies by Mahha et al. (2024) and Koech (2023) reveal that GDM risk is determined by maternal age and prior GDM diagnosis. Research indicates that various modifiable dietary and behavioral components help trigger GDM yet studies reveal disparities in these risk factors between different cultural groups (Yang et al., 2022; Ray et al., 2024). Despite the essential role of dietary habits and lifestyle in metabolic health within the Mediterranean territories researchers lack sufficient data regarding GDM prevalence rates and risk factors (Tranidou et al., 2023).

Science indicates that serum uric acid functions as a biomarker to detect metabolic dysfunction and diabetes (Zhao et al., 2022; Duo et al., 2024). Uric acid functions as an established biomarker of kidney health which proves vital for diagnosing chronic kidney disease and T2DM (Gherghina et al., 2022). Multiple studies have established links between increased uric acid levels and

insulin resistance properties in individuals who are not pregnant (Han, Zhang, & Jiang, 2022; Liu et al., 2024). Scientific evidence about the relationship between uric acid levels and GDM presents conflicting results. Research studies present conflicting findings with specific data demonstrating elevated mean serum uric acid levels in GDM subjects compared to non-GDM subjects yet other studies produce similar results (Yue et al., 2023; Duo et al., 2024). More research needs to establish the precise connection between GDM and serum uric acid levels owing to the observed inconsistencies between studies.

This study evaluates uric acid concentrations in pregnant women who do and do not have Gestational Diabetes during their third trimester by analyzing serum data (Zhao et al., 2022; Li et al., 2024). The establishment of hyperuricemia as a GDM indicator would help identify high-risk individuals early on and develop preventive measures (Ma et al., 2024 and Zhao et al., 2021 and Zhao et al., 2022 and Li et al., 2024). Targeted interventions would become possible following a confirmed link between high serum uric acid levels and GDM risk since this would enhance maternal and fetal outcomes (Ghanei et al., 2024). Women with GDM face higher risks of complications during pregnancy such as preeclampsia and macrosomia and newborn hypoglycemia (Cheung et al., 2024). The identification and appropriate management of women who are at risk must be done as soon as possible to minimize harmful pregnancy outcomes.

Medical experts have acknowledged skeletal muscle insulin resistance as a leading cause of T2DM development since Gilbert's 2021 publication. Recent research finds that insulin resistance within skeletal muscle functions as an adaptive defense to shield against metabolic strain while safeguarding the liver from fat buildup (Lee et al., 2022). Acute overfeeding leads to insulin resistance in both skeletal muscles and cardiac muscles which helps the body store excess energy as fat deposits. Medical studies about skeletal muscle mitochondrial function in GDM patients reveal similar results to those seen in T2DM patients. Different factors including genetics, life events at birth and physical inactivity influence this condition. GDM-related decreased mitochondrial functionality leads to decreased glucose consumption accompanied by a higher likelihood of metabolic dysfunction (Fisher et al., 2021).

The debate about effective GDM screening and proper screening times along with diagnostic criteria continues throughout the century-long study period for maternal and infant health outcomes from diabetes (Mohamed et al., 2024). Different screening programs operate on two main levels: universal tests and risk assessment-based methods. WHO advocates universal screening for GDM because unrecognized cases of the condition may lead to serious complications. The costs of testing and the psychological stress experienced during tests remain major screening-related issues. The official traditional definition identifies GDM as glucose intolerance that surfaces during pregnancy yet ignores type 2 diabetes disorders which emerge before conception (Liu et al., 2024; Choudhury & Rajeswari, 2021). The International Association of Diabetes and Pregnancy Study Groups (IADPSG) states that GDM diagnosis should be given only when no pre-existing diabetes cases exist (Juan et al., 2022; Gupta et al., 2024).

Each country adopts distinct strategies to identify Gestational Diabetes Mellitus cases. The American College of Obstetricians and Gynecologists (ACOG) endorses sequential screening through glucose challenge tests yet the IADPSG favors simultaneous testing through oral glucose tolerance tests (OGTT). Research from the Hyperglycemia and Adverse Pregnancy Outcomes study revealed that reducing diagnostic thresholds elevated the risk of delivering infants above gestational size yet medical specialists maintain divergent perspectives on the proper thresholds (McCance & Cassidy, 2024). Ottanelli, Mecacci, & Hod, 2022). Medical professionals at the NIH Consensus Conference decided diagnostic thresholds should not be lowered as this raised worries about healthcare costs. Retrospective research demonstrates that fetuses born to obese mothers are at higher risk for LGA infant status (Wolffenbuttel, 2022). Research by Hillier et al. proved that the one-step screening method led to increased GDM diagnoses at 16.5% while the two-step method yielded a diagnosis rate of 8.5% yet pregnancy outcomes remained unchanged.

Given the growing global burden of gestational diabetes mellitus and its associated complications, identifying reliable biomarkers for early detection and risk stratification is crucial. Serum uric acid, a potential indicator of metabolic dysfunction, may serve as a valuable marker in this context. By comparing serum uric acid levels in pregnant women with and without GDM during the third trimester, this study seeks to clarify its role in GDM pathophysiology. If a significant association is established, these findings could contribute to improved screening protocols and targeted interventions, ultimately enhancing maternal and fetal health outcomes.

METHODOLOGY

This case-control investigation took place at the Obstetrics & Gynecology department of Abbasi Shaheed Hospital in Karachi spanning six months from July to December 2023 after obtaining research synopsis approval. A total of 100 participants were involved in the study consisting of 50 case individuals alongside 50 control participants. Investigators calculated sample size using means and standard deviations from GDM patients

(5.95±0.97 mg/dl) and non-GDM controls (3.76±1.07 mg/dl). They used this data to ensure a 90% powerful test and maintain a 95% confidence level. The research used a non-probability consecutive sampling approach to select participants for the study.

Inclusion criteria comprised pregnant women aged 18 to 40 years with a parity of less than five and a gestational age of 24 to 28 weeks, confirmed through ultrasonography. Cases included females diagnosed with GDM as per the operational definition, while controls were pregnant women without GDM. Exclusion criteria involved women with pre-existing diabetes, those on steroids or uric acid-lowering drugs, and individuals with a history of kidney disease or failure. These conditions were assessed through medical history.

The research data collection process started with a selection of pregnant females at their third trimester who fit the study criteria. The researchers collected detailed demographic information from participants while obtaining their informed consent. They recorded variables for age and gestational age next to parity and BMI as well as occupation and lifestyle combined with socioeconomic status and residential location. Participants were divided into two groups: The study evaluated parturient individuals with diagnosed GDM against those who did not develop GDM. Staff nurses collected blood samples from patients under sterile methods and deposited them into gel-laden serum separation tubes for extraction purposes. The research team transferred these blood samples to the hospital laboratory for laboratory testing and centrifugation. Researchers used colorimetric methods to determine serum uric acid levels through laboratory measurements before capturing numerical values. The principal researcher maintained the data records in a structured documentation format.

The statistical evaluation utilized SPSS version 25.0 for analysis. The statistical analyses presented mean values ± standard deviation (SD) for continuous variables including gestational age, BMI, age, and uric acid levels. Researchers examined categorical variables such as parity together with occupation and lifestyle factors through frequency tables and percentages. Analysis through the independent sample t-test showed a comparison of mean serum uric acid levels between case members and controls at the established threshold of $p \leq 0.05$. The researchers implemented a data stratification method that accounted for age, BMI, gestational age, parity, occupation, lifestyle, socioeconomic status and residential factors as potential confounders. The independent sample t-test was employed within stratum-specific datasets that used a p-value threshold of 0.05 for statistical significance when evaluating serum uric acid levels.

RESULTS

Distribution of Age

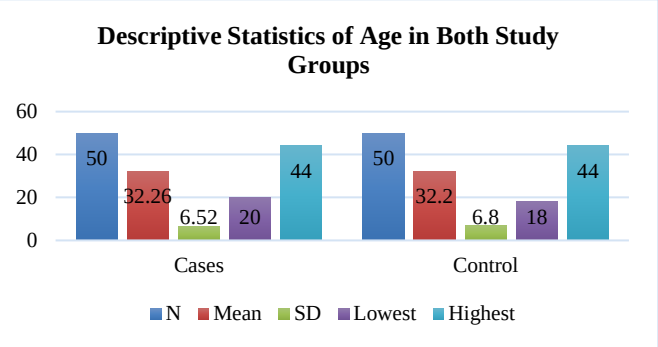
The mean age of the study population was 32.23 ± 6.63 years. The descriptive statistics for age in both cases and control groups are presented in Table 1.

Table 1

Descriptive Statistics of Age in Both Study Groups

Age (years)	Cases	Control
N	50	50
Mean	32.26	32.2
SD	6.52	6.80
Lowest	20	18
Highest	44	44

Figure 1



Distribution of Gestational Age

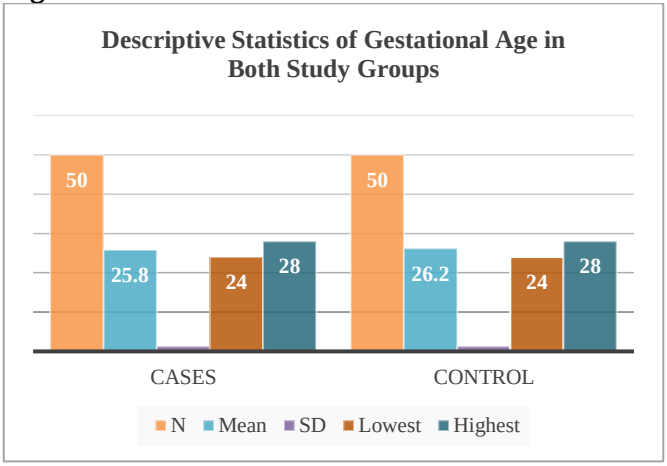
The mean gestational age was 26.08 ± 1.35 weeks. The descriptive statistics are shown in Table 2.

Table 2

Descriptive Statistics of Gestational Age in Both Study Groups

Gestational Age (weeks)	Cases	Control
N	50	50
Mean	25.8	26.2
SD	1.34	1.34
Lowest	24	24
Highest	28	28

Figure 2



Distribution of BMI

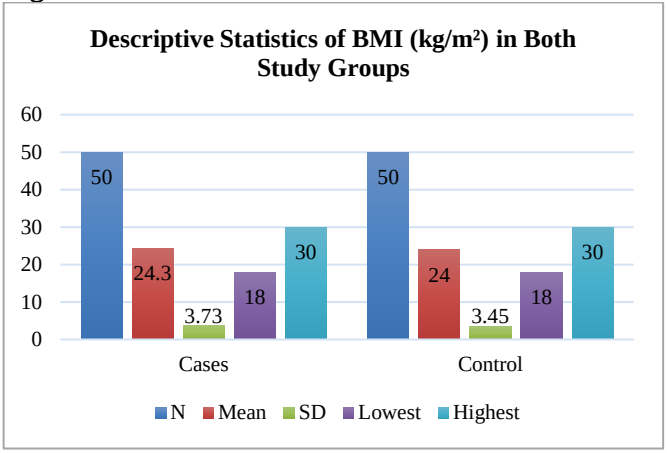
The mean BMI was 24.19 ± 3.58 kg/m². The details are in Table 3.

Table 3

Descriptive Statistics of BMI (kg/m²) in Both Study Groups

BMI (kg/m²)	Cases	Control
N	50	50
Mean	24.3	24.0
SD	3.73	3.45
Lowest	18.0	18.0
Highest	30.0	30.0

Figure 3



Distribution of Uric Acid

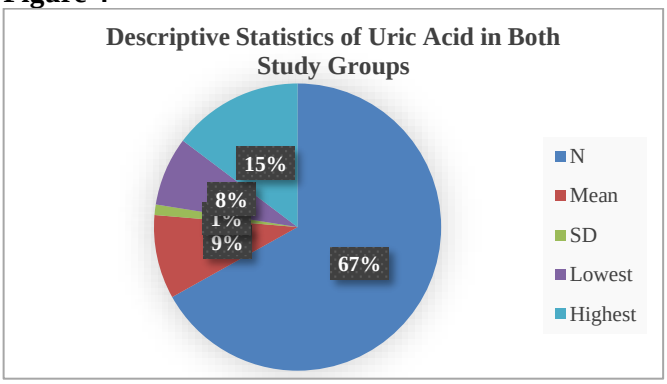
The mean uric acid was 5.91 ± 1.51 mg/dl. Table 4 provides a detailed comparison.

Table 4

Descriptive Statistics of Uric Acid in Both Study Groups

Uric Acid (mg/dl)	Cases	Control
N	50	50
Mean	7.06	4.76
SD	0.88	1.06
Lowest	5.80	2.00
Highest	11.0	6.70

Figure 4



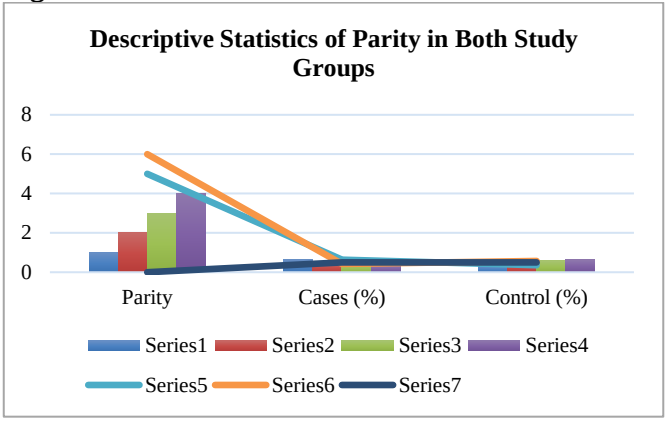
Parity Distribution

Table 5

Descriptive Statistics of Parity in Both Study Groups

Parity	Cases	Control	Total
1	13(65.0%)	7(35.0%)	20(100%)
2	9(47.4%)	10(52.6%)	19(100%)
3	7(41.2%)	10(58.8%)	17(100%)
4	4(36.4%)	7(63.6%)	11(100%)
5	9(64.3%)	5(35.7%)	14(100%)
6	8(42.1%)	11(57.9%)	19(100%)
Total	50(50.0%)	50(50%)	100(100%)

Figure 5



Uric Acid Comparison

A statistically significant difference was observed in uric acid levels between cases and controls ($p < 0.001$). Figure 1 illustrates the mean differences in uric acid levels.

Figure 1: Mean Uric Acid Levels in Cases and Controls

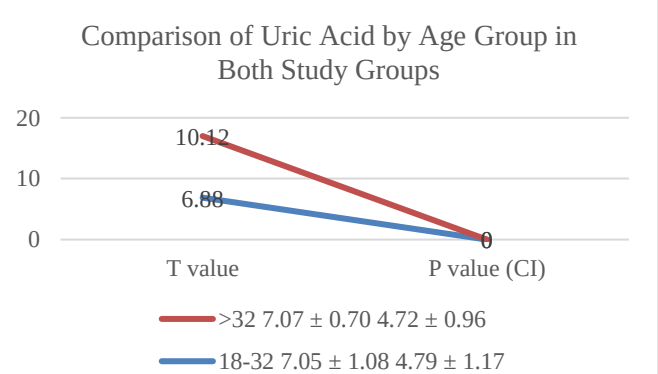
Uric Acid Comparison by Age Group

Table 6

Comparison of Uric Acid by Age Group in Both Study Groups

Age Group (years)	Cases Mean (SD)	Control Mean (SD)	T value	P value (CI)
18-32	7.05 ± 1.08	4.79 ± 1.17	6.88	0.00 (1.59 to 2.91)
>32	7.07 ± 0.70	4.72 ± 0.96	10.12	0.00 (1.88 to 2.82)

Figure 6



DISCUSSION

This research investigated uric acid levels in maternal blood between pregnant women diagnosed with gestational diabetes mellitus (GDM) and those with normal pregnancy during their third trimester. Researchers detected markedly higher uric acid serum levels among GDM women versus women without GDM which suggested a connection between hyperuricemia and GDM's pathophysiologic processes.

Our results align with previous studies that have reported higher uric acid levels in GDM patients,

reinforcing the hypothesis that uric acid may serve as a predictive biomarker for GDM. The mean serum uric acid level among GDM cases was 7.06 mg/dl, significantly higher than the 4.76 mg/dl observed in controls ($p < 0.001$). This finding suggests a potential role of uric acid in the metabolic disturbances characteristic of GDM, such as insulin resistance and impaired glucose metabolism. Elevated uric acid levels have been implicated in endothelial dysfunction, oxidative stress, and systemic inflammation, all of which contribute to the development of insulin resistance and metabolic disorders.

The observed association between hyperuricemia and GDM raises important clinical considerations. The identification of pregnant women with high uric acid levels during early gestation enables healthcare providers to establish specific treatments that minimize GDM-related complications. Given the known impact of GDM on both maternal and fetal health, including increased risks of preeclampsia, fetal macrosomia, and neonatal hypoglycemia, strategies to monitor and control uric acid levels may enhance perinatal outcomes. Further studies are needed to establish whether interventions targeting uric acid reduction, such as dietary modifications or pharmacological agents, could positively impact GDM management.

Our study also revealed variations in serum uric acid levels based on age groups. Women above the age of 32 years exhibited significantly higher uric acid levels in both GDM and non-GDM groups, suggesting that advanced maternal age may further exacerbate hyperuricemia in pregnancy. This aligns with existing literature indicating that age-related metabolic changes contribute to increased insulin resistance and oxidative stress, factors that may amplify the effects of elevated uric acid in GDM.

Despite the significant findings, this study has several limitations. First, the cross-sectional nature of the study limits the ability to establish a causal relationship between hyperuricemia and GDM. Additional longitudinal research tracing uric acid measurements across pregnancy duration needs to be conducted to determine if elevated uric acid emerges as a secondary result or directly contributes to gestational diabetes mellitus (GDM) development. The insufficient evaluation of potential confounding factors such as dietary intake and renal function alongside genetic predisposition may have affected the observed uric acid levels. Future investigations should include analyses of these variables to deliver a deeper understanding regarding the observed connections.

This research establishes a firm link between elevated serum uric acid levels and GDM diagnosis which supports the potential usefulness of hyperuricemia testing for GDM risk determination. Future research requires investigation of the fundamental metabolic processes that link prenatal uric acid levels to gestational diabetes and its health complications. Increasing awareness about hyperuricemia management in pregnant women might create new possibilities to enhance health outcomes for mothers and their fetuses in GDM patients.

CONCLUSION

Scientific data establishes a clear connection between high serum uric acid markers and Gestational Diabetes Mellitus (GDM) that supports hyperuricemia as a pathophysiological factor for GDM. This study showed that women with GDM displayed higher serum uric acid levels than non-GDM controls thereby validating uric acid as a tool for detecting high-risk groups. The research findings mirror established medical knowledge which connects elevated serum uric acid with insulin resistance as well as metabolic dysfunction.

The mounting GDM cases and serious health impacts on mothers and babies require researchers to identify dependable biomarkers for accurate risk assessment. Further validation of serum uric acid measurement may lead to its adoption in standard prenatal screening which would enable earlier implementation of preventive measures including customized interventions. The study results must be considered with caution because of its limited sample size and its exclusive focus on one research center. Larger multicenter studies should be conducted to identify clear cause-effect relationships between serum uric acid and gestational diabetes and investigate possible biochemical pathways. The research findings suggest that serum uric acid measurements can help screen and evaluate risk factors for gestational diabetes which results in enhanced maternal and newborn outcomes.

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