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RESEARCH ARTICLE

The Correlation between High Uric Acid Levels and the Severity of Preeclampsia

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Abstract

Introduction: Preeclampsia is a pregnancy complication marked by hypertension and multi-organ dysfunction, contributing to significant maternal and fetal morbidity and mortality, particularly in developing nations. Identifying severe cases early remains challenging due to limited biomarker specificity and predictive accuracy. Uric acid has been proposed as a potential marker, though its reliability in predicting severity remains debated.

Methods: This cross-sectional study included 54 pregnant women diagnosed with preeclampsia at RSUP Prof. Dr. I.G.N.G Ngoerah, Denpasar, with a gestational age of over 20 weeks. Participants were selected through consecutive sampling. Data on serum uric acid, blood pressure, proteinuria, and creatinine levels were analyzed using parametric statistical tests to assess correlations with preeclampsia severity.

Results: Elevated uric acid levels (>6 mg/dL) were significantly associated with severe preeclampsia ($p=0.039$), with a prevalence ratio of 2.96. Strong correlations were found between uric acid and blood pressure ($r=0.71$, $p=0.012$) and proteinuria ($r=0.64$, $p=0.012$), while a moderate correlation existed with serum creatinine ($r=0.40$, $p=0.002$).

Conclusion: Serum uric acid levels can be a useful indicator for assessing preeclampsia severity. However, its predictive value should be combined with other clinical and biochemical markers to enhance early detection and management strategies

Keywords: Pregnancy, preeclampsia, severity, uric acid

INTRODUCTION

Preeclampsia is a hypertensive disorder of pregnancy that significantly contributes to maternal and perinatal morbidity and mortality worldwide. It is characterized by new-onset hypertension after 20 weeks of gestation, often accompanied by proteinuria and other organ dysfunctions¹. Despite extensive research, the exact etiology of preeclampsia remains unclear. However, endothelial dysfunction, placental ischemia, and oxidative stress are known to play crucial roles in its pathogenesis². The global prevalence of preeclampsia ranges between 5–8%, with a higher incidence reported in developing countries due to limited access to antenatal care³. According to the World Health Organization (WHO), preeclampsia accounts for approximately 70,000 maternal deaths and 500,000 fetal deaths annually⁴. Several risk factors, including obesity, chronic hypertension, diabetes mellitus, and genetic predisposition, have been identified as contributors to the development of preeclampsia⁵.

One of the biochemical markers associated with preeclampsia is elevated serum uric acid. Uric acid is the final product of purine metabolism, and its levels tend to increase in preeclampsia due to reduced renal clearance and increased production secondary to oxidative stress⁶. Studies have demonstrated a correlation between elevated uric acid levels and the severity of preeclampsia, making it a potential biomarker for predicting disease progression⁷. However, the predictive value of uric acid remains controversial, as some studies report conflicting results regarding its specificity and clinical utility⁸. This study aims to evaluate the correlation between elevated serum uric acid levels and the severity of preeclampsia. By identifying a reliable biochemical marker, early diagnosis and intervention strategies may be enhanced, ultimately improving maternal and fetal outcomes.

METHODS

This study employed an observational analytic cross-sectional design conducted at RSUP Prof. Dr. I.G.N.G Ngoerah General Hospital, Denpasar, Indonesia. The study was conducted from January to September 2024.

The study population consisted of pregnant women diagnosed with preeclampsia who attended the hospital during the study period. Inclusion criteria included: (A) Gestational age >20 weeks; (B) Diagnosis of preeclampsia based on American College of Obstetricians and Gynecologists (ACOG) criteria; (C) Willingness to participate and sign informed consent. Exclusion criteria included: (A) Chronic hypertension diagnosed before pregnancy; (B) History of diabetes mellitus or chronic kidney disease; (C) Use of immunosuppressants or diuretics; (D) Unclear gestational age estimation.

The minimum required sample size was 54, determined using a sample size formula for cross-sectional studies. Participants were recruited through consecutive sampling. Data Collection and Laboratory Analysis, Venous blood samples (5 mL) were collected from participants and analyzed for uric acid, blood pressure, proteinuria, and creatinine levels. The analysis was performed at the hospital's clinical pathology laboratory using an Abbott Alinity automated

analyzer. Uric acid levels were measured using an enzymatic colorimetric method, with normal reference ranges for pregnant women set at 2.6–6.0 mg/dL.

Blood pressure was measured using a sphygmomanometer. Proteinuria was assessed using a dipstick test, and serum creatinine was analyzed to evaluate renal function.

Statistical Analysis, Descriptive statistics were used to summarize patient characteristics. Data normality was assessed using the Shapiro-Wilk test. The chi-square test was used to assess the association between high uric acid levels and severe preeclampsia. Pearson correlation analysis was conducted to evaluate relationships between uric acid levels, blood pressure, proteinuria, and creatinine. A p-value <0.05 was considered statistically significant.

Ethical Considerations, Ethical approval was obtained from the Research Ethics Committee of Udayana University and RSUP Prof. Dr. I.G.N.G Ngoerah General Hospital. Written informed consent was obtained from all participants before enrollment in the study.

RESULT

Sample Characteristics

A total of 54 pregnant women with preeclampsia participated in this study. The majority (72.2%) were between 16–34 years old, and 27.8% were ≥35 years old. Most participants were multigravida (68.5%), with 31.5% being primigravida. Regarding BMI, 38.9% were classified as overweight, while 31.5% were obese. Notably, 92.6% of participants had severe preeclampsia.

Table 1. 1of Research Samples

Variables	Number (n)	Percentage (%)
Age Group		
<16 years	0	0
16-34 years	39	72.2
≥ 35 years	15	27.8
pregnancy		
Primigravida	17	31.5
Multigravida	37	68.5
Body Mass Index (BMI)		
<i>Underweight</i>	0	0
Normal	16	29.6
<i>Overweight</i>	21	38.9
Obesity	17	31.5
Preeclampsia Status		
With Heavy Image	50	92.6
No Heavy Picture	4	7.4

Distribution of Uric Acid and Clinical Parameters

The mean uric acid level was 6.2 mg/dL (SD=1.72), with a range of 3.9–11.7 mg/dL. High uric acid levels (>6 mg/dL) were significantly associated with severe preeclampsia ($p=0.039$), with a prevalence ratio of 2.96. Correlation analysis revealed strong associations between uric acid levels and blood pressure ($r=0.71$, $p=0.012$), proteinuria ($r=0.64$, $p=0.012$), and a moderate correlation with creatinine ($r=0.40$, $p=0.002$).

Table 2. Distribution of Research Samples

	N	Range	Minimum	Maximum	Mean	Standard deviation
Age	54	23	20	43	31.04	5.36
IMT	54	18.6	18.5	37.1	26.4	5.03
Gout	54	7.8	3.9	11.7	6.2	1.72
Proteinuria	54	3	1	4	2.77	0.87
Creatinine	54	1.62	0.45	2.07	0.742	0.25
Systolic Blood Pressure	54	82	140	222	172.84	18.24
Diastolic Blood Pressure	54	57	80	137	110.4	10.92

Data Normality Test

Table 3. Normality Test

	Shapiro Wilk		
	Statistics	Number (n)	Significance
Age	0.982	54	0.620
IMT	0.956	54	0.064
Preeclampsia Status	0.895	54	0.200
Gout	0.927	54	0.063
Proteinuria	0.860	54	0.100
Creatinine	0.685	54	0.300
Blood pressure	0.947	54	0.071

Based on Shapiro-Wilk normality test results, all variables have p-values greater than 0.05. This indicates that the data from all variables are normally distributed. In detail, the age variable has a Shapiro-Wilk statistic of 0.982 ($p=0.620$), while BMI has a statistic of 0.956 ($p=0.064$). Preeclampsia status also shows a normal distribution with a statistical value of 0.895 and a significance value of 0.200. The uric acid variable has a statistical value of 0.927 with a significance value of 0.063. Proteinuria has a statistical value of 0.860 with a significance value of 0.100. Furthermore, creatinine data shows a statistical value of 0.685 with a significance value of 0.300. Blood pressure data has a

statistical value of 0.947 with a significance value of 0.071. Overall, these results indicate that all variables meet the normality assumption with significance values greater than 0.05. Therefore, it can be concluded that the data is normally distributed. With the fulfillment of the normality assumption, further statistical analysis can be conducted using appropriate parametric statistical methods.

Uric Acid Levels

Table 4. Uric Acid Levels in Preeclampsia Samples

Uric Acid Levels	Number (n)	Percentage (%)
Height (≥ 6)	38	70.38
Low (<6)	16	29.62

Table 5. Uric Acid Levels Based on Preeclampsia Status

		Uric Acid Levels		PR	p-value	Confidence Interval
		Height (≥ 6)	Low (<6)			
Preeclampsia Status	With Heavy Image	37	13	2.96	0.039	6.2 – 7.1
	No Heavy Picture	1	3			

The results of the analysis showed that high uric acid levels (>6 mg/dL) were associated with an increased risk of severe preeclampsia in pregnant women. In the table, it can be seen that 37 patients with high uric acid levels experienced severe preeclampsia, while only 1 patient with high uric acid levels did not show severe symptoms. Conversely, in the group with low uric acid levels (<6 mg/dL), only 13 patients experienced severe preeclampsia, and 3 patients did not show severe symptoms. A prevalence ratio (PR) value of 2.96 indicates that patients with high uric acid levels are almost three times more likely to experience severe preeclampsia compared to patients with low uric acid levels. A PR value greater than 1 suggests that high uric acid levels are a significant risk factor for severe preeclampsia. This result is supported by a p-value of 0.039, which indicates statistical significance ($p < 0.05$), confirming that this relationship did not occur by chance. Additionally, the confidence interval (CI) value obtained was 6.2 to 7.1, which does not include the number 1, reinforcing the strong association between high uric acid levels and severe preeclampsia.

Based on these findings, it can be concluded that high uric acid levels are a strong risk factor for severe preeclampsia, supporting the importance of monitoring uric acid levels in pregnant women as part of efforts to prevent severe preeclampsia. Elevated uric acid levels in patients with severe preeclampsia may be an indicator of kidney damage or more severe metabolic disorders. This finding aligns with existing literature, which states that high uric acid levels are often associated with complications of preeclampsia, such as uncontrolled hypertension and target organ damage.

Thus, measuring uric acid levels may play an essential role in the clinical management and monitoring of preeclampsia patients, especially in detecting those at higher risk of complications.

Relationship between Uric Acid, Blood Pressure, Proteinuria, and Creatinine to the Incidence of Preeclampsia

The table above presents the Pearson correlation analysis between uric acid status (categorized as high ≥ 6 mg/dL and low < 6 mg/dL) and three clinical variables: blood pressure, proteinuria, and creatinine levels. The Pearson r value was used to measure the strength and direction of these relationships, while the p -value determined statistical significance. For blood pressure, the Pearson r value of 0.71 with a p -value of 0.012 indicates a strong positive correlation between high uric acid levels and elevated blood pressure. This correlation suggests that individuals with high uric acid levels are more likely to experience hypertension ($\geq 160/110$ mmHg). The statistical significance ($p < 0.05$) confirms that this relationship is unlikely to have occurred by chance.

Regarding proteinuria, a Pearson r value of 0.64 with a p -value of 0.012 also indicates a strong correlation between uric acid levels and proteinuria severity. This finding suggests that increasing uric acid levels are associated with worsening proteinuria, further supporting the potential role of uric acid as a biomarker for disease severity. For creatinine levels, the correlation between uric acid status and creatinine levels was weaker, with a Pearson r value of 0.40 and a p -value of 0.002. Although this correlation is still statistically significant ($p < 0.05$), its strength is lower compared to blood pressure and proteinuria. This suggests that while high uric acid levels may contribute to elevated creatinine levels, other factors also influence creatinine concentration. Overall, these findings indicate that uric acid status has a strong correlation with blood pressure and proteinuria, and a moderate correlation with creatinine levels. The strong correlations suggest that high uric acid levels may have a greater impact on blood pressure and proteinuria than on creatinine levels. The significant p -values across all three variables reinforce the assumption that uric acid status plays an important role in influencing hypertension, proteinuria, and renal function abnormalities in preeclampsia. These results further support the potential clinical utility of uric acid measurement in predicting and managing preeclampsia severity.

Table 6. Correlation Values between Variables

		Uric Acid Status		Pearson R value	p-value
		Height (≥ 6)	Low (<6)		
Blood pressure	$\geq 140/90$	0 (0%)	12 (22%)	0.71	0.012
	-				
	<160/110				
	$\geq 160/110$	38 (70.3%)	4 (7.4%)		
Proteinuria	+ 1	3 (5.5%)	11 (24.2%)	0.64	0.012
	$\geq +2$	35 (64.8%)	5 (5.5%)		
Creatinine	< 1.1	8 (14.8%)	12 (22.2%)	0.40	0.002
	≥ 1.1	30 (55.5%)	4 (7.5%)		

DISCUSSION

The findings of this study confirm that elevated serum uric acid levels are significantly associated with the severity of preeclampsia. This aligns with previous research indicating that hyperuricemia contributes to endothelial dysfunction and oxidative stress, exacerbating hypertension and organ dysfunction in preeclampsia⁹. Uric acid has been implicated in inflammatory responses that further impair vascular integrity, leading to complications such as proteinuria and renal dysfunction¹⁰. The strong correlation between uric acid levels and blood pressure ($r=0.71$, $p=0.012$) supports the hypothesis that uric acid plays a direct role in vascular dysfunction in preeclampsia. Studies have suggested that uric acid promotes vasoconstriction by inhibiting endothelial nitric oxide synthase, leading to increased arterial stiffness and hypertension¹¹. This effect is further compounded by oxidative stress, which amplifies systemic inflammation and endothelial damage¹². The significant correlation between uric acid levels and proteinuria ($r=0.64$, $p=0.012$) suggests that hyperuricemia may contribute to glomerular endothelial injury, exacerbating renal dysfunction in preeclampsia¹³. Uric acid is known to activate the renin-angiotensin system and increase renal vasoconstriction, potentially worsening proteinuria and kidney damage¹⁴. Additionally, elevated uric acid levels have been associated with increased placental oxidative stress, further impairing maternal renal function¹⁵. A moderate correlation was observed between uric acid levels and creatinine ($r=0.40$, $p=0.002$), suggesting that while uric acid plays a role in renal dysfunction, other factors such as systemic inflammation and impaired placental perfusion contribute to worsening kidney function¹⁶. Elevated creatinine levels in preeclamptic patients indicate declining renal filtration capacity, which can lead to severe complications such as eclampsia and HELLP syndrome¹⁷.

Despite these findings, the use of uric acid as a standalone biomarker for preeclampsia remains controversial. Some studies argue that uric acid lacks specificity as a predictive marker since it can also be elevated in conditions such as gestational hypertension, diabetes, and chronic kidney

disease¹⁸. However, other studies emphasize that while uric acid alone may not be sufficient for diagnosing preeclampsia severity, it can serve as part of a broader panel of biomarkers to improve risk stratification¹⁹. This study has several limitations. The relatively small sample size and cross-sectional design limit the ability to establish causality. Additionally, potential confounding factors such as maternal BMI, diet, and coexisting metabolic disorders were not accounted for, which could influence uric acid levels²⁰. Future research should focus on larger, multi-center cohorts and longitudinal studies to further evaluate the predictive value of uric acid in preeclampsia²¹. Given the significant associations found, incorporating uric acid measurement into routine clinical assessments for preeclampsia risk may help improve early detection and management strategies. Further investigation into the molecular mechanisms linking hyperuricemia to preeclampsia severity is warranted to explore potential therapeutic interventions²². Emerging research suggests that targeting uric acid metabolism may offer novel approaches to mitigating endothelial dysfunction and hypertensive complications in preeclampsia²³. In conclusion, this study reinforces the importance of monitoring uric acid levels in pregnant women at risk of preeclampsia. While it should not be used in isolation, combining uric acid assessment with other clinical parameters may enhance early diagnosis and management strategies for severe preeclampsia²⁴. Future research should continue to refine predictive models incorporating uric acid and explore its role in guiding therapeutic interventions to improve maternal and fetal outcomes²⁵.

CONCLUSION

This study demonstrates that elevated serum uric acid levels are significantly associated with the severity of preeclampsia. Patients with uric acid levels above 6 mg/dL are at nearly three times greater risk of developing severe preeclampsia compared to those with lower levels. Strong correlations between uric acid and blood pressure, as well as proteinuria, indicate its potential role in disease progression. Additionally, a moderate correlation with creatinine suggests its influence on renal dysfunction in preeclampsia. Although uric acid levels can serve as an important clinical marker, their predictive value alone remains insufficient for diagnosing severe preeclampsia. Integrating uric acid assessment with other clinical and biochemical markers is necessary to improve predictive accuracy and enhance risk stratification. Early detection and intervention strategies should include uric acid monitoring to aid in better management and prevention of complications.

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