

## ASSOCIATION BETWEEN SERUM URIC ACID LEVELS AND SEVERITY OF HYPERTENSION IN NEWLY DIAGNOSED HYPERTENSIVE PATIENTS

Bushra Amanat<sup>1</sup>, Hafsa Ziad<sup>2</sup>, Aayza Afzal<sup>3</sup>, Fizza Younas<sup>4</sup>, Hira Naseer<sup>5</sup>, Maham Shahid Dogar<sup>6</sup>

<sup>1</sup>MBBS, CMO, BHU Dhamawa

<sup>2</sup>MBBS, Mohtarma Benazir Bhutto Shaheed Medical College MBBSMC

<sup>3</sup>MBBS, Medical Officer Omar Hospital, Lahore

<sup>4,5</sup>MBBS, Sheikh Zayed Hospital, Lahore

<sup>6</sup>MBBS, Continental Medical College, Lahore

<sup>1</sup>amanatbushra123@gmail.com, <sup>2</sup>hafsaenziad123@gmail.com, <sup>3</sup>aayzaafzal5@gmail.com, <sup>4</sup>farhanyounas24@gmail.com, <sup>5</sup>dochira123@gmail.com, <sup>6</sup> maham.shahid2407@gmail.com

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Corresponding Author: \*

Bushra Amanat

### Abstract

**Background:** Hypertension is a major global health problem and a leading risk factor for cardiovascular morbidity and mortality. Emerging evidence suggests that elevated serum uric acid levels may contribute to the development and progression of hypertension through endothelial dysfunction, oxidative stress, and activation of the renin-angiotensin system. However, the relationship between serum uric acid levels and hypertension severity remains under investigation.

**Objective:** To determine the association between serum uric acid levels and severity of hypertension in newly diagnosed hypertensive patients.

**Study Design & Setting:** Cross-sectional study conducted at the Department of Medicine of Shaikh Zayed Hospital, Lahore.

**Methodology:** A total of 120 newly diagnosed hypertensive patients aged 18–65 years were enrolled through non-probability consecutive sampling. Blood pressure was measured using standard procedures, and hypertension was classified into Grade 1, Grade 2, and Grade 3. Fasting venous blood samples were obtained for estimation of serum uric acid levels. Hyperuricemia was defined as serum uric acid >7.0 mg/dL in males and >6.0 mg/dL in females. Data were analyzed using SPSS version 26.0. Associations were assessed using Chi-square test and one-way ANOVA, with  $p \leq 0.05$  considered significant.

**Results:** The mean age of participants was  $49.8 \pm 11.6$  years, and 60.0% were male. Grade 1, Grade 2, and Grade 3 hypertension were observed in 41.7%, 35.0%, and 23.3% of patients, respectively. The overall mean serum uric acid level was  $6.82 \pm 1.54$  mg/dL. Hyperuricemia was present in 48.3% of patients. Mean serum uric acid levels increased significantly across hypertension grades ( $5.91 \pm 1.01$ ,  $6.88 \pm 1.18$ , and  $8.12 \pm 1.47$  mg/dL for Grades 1, 2, and 3, respectively;  $p < 0.001$ ). Hyperuricemia was significantly associated with hypertension severity ( $p < 0.001$ ).

**Conclusion:** Higher serum uric acid levels were significantly associated with greater severity of hypertension among newly diagnosed hypertensive patients, suggesting a potential role of serum uric acid as a marker of disease severity.

## INTRODUCTION

Hypertension is a major non-communicable cardiovascular disorder characterized by persistently elevated arterial blood pressure and remains one of the leading causes of morbidity and mortality worldwide. It is a significant public health concern because of its strong association with cardiovascular disease, stroke, chronic kidney disease, and premature death.<sup>1,2</sup> Although several mechanisms contribute to the development and progression of hypertension, increasing attention has been directed toward the potential role of serum uric acid in blood pressure regulation and cardiovascular risk.<sup>3</sup> Globally, more than one billion adults are estimated to be affected by hypertension, with prevalence continuing to rise due to population aging, urbanization, sedentary lifestyles, and dietary changes. The burden is particularly high in low- and middle-income countries, where awareness, treatment, and control rates remain suboptimal. In South Asian populations, including Pakistan, hypertension represents a growing healthcare challenge and contributes substantially to cardiovascular morbidity.<sup>4,5</sup> The etiology of hypertension is multifactorial and involves genetic predisposition, obesity, excessive dietary sodium intake, physical inactivity, smoking, alcohol consumption, diabetes mellitus, dyslipidemia, and renal dysfunction. Hyperuricemia has emerged as a potential risk factor, with several studies suggesting an association between elevated serum uric acid levels and the development of hypertension, particularly in newly diagnosed and untreated individuals.<sup>6</sup> The proposed pathophysiological mechanisms linking uric acid to hypertension include endothelial dysfunction, oxidative stress, inflammation, activation of the renin-angiotensin-aldosterone system, and vascular smooth muscle proliferation. These processes may contribute to increased vascular resistance and impaired renal sodium handling, ultimately leading to sustained elevation of blood pressure.<sup>7,8</sup>

Patients with hypertension may remain asymptomatic for prolonged periods; however, persistent uncontrolled blood pressure can result in target organ damage affecting the heart, brain,

kidneys, and vasculature. Diagnosis is primarily based on standardized blood pressure measurements, while laboratory investigations help identify associated metabolic abnormalities and cardiovascular risk factors.<sup>9,10</sup> Current management strategies focus on lifestyle modification and antihypertensive pharmacotherapy. Despite advances in treatment, the contribution of serum uric acid to hypertension severity remains an area of ongoing investigation, with studies reporting varying strengths of association across different populations and clinical settings.<sup>11</sup>

Recent evidence suggests that elevated serum uric acid may play a role in the development and progression of hypertension; however, data regarding its association with hypertension severity remain limited in the local population. Early identification of hyperuricemia in newly diagnosed hypertensive patients may help recognize individuals at increased risk of severe disease and cardiovascular complications. Therefore, evaluating the relationship between serum uric acid levels and hypertension severity may provide clinically useful information for risk stratification and patient management.

## MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of Medicine of Shaikh Zayed Hospital, Lahore from Dec 2025 to May 2026. A total of 120 newly diagnosed hypertensive patients were enrolled through non-probability consecutive sampling. The sample size of 120 patients was calculated using the WHO sample size calculator by considering a confidence level of 95%, margin of error of 9%, and an anticipated frequency of elevated serum uric acid among hypertensive patients of 50%, which yielded a minimum required sample size close to 119; therefore, 120 patients were included.

Patients aged 18–65 years of either gender with newly diagnosed hypertension were included in the study. Hypertension was diagnosed according to standard guidelines as systolic blood pressure  $\geq 140$  mmHg and/or diastolic blood pressure  $\geq 90$  mmHg on at least two separate measurements. Patients with a previous history of antihypertensive treatment, chronic kidney

disease, ischemic heart disease, heart failure, gout, diabetes mellitus, chronic liver disease, malignancy, pregnancy, secondary hypertension, or those taking medications known to affect serum uric acid levels such as diuretics, allopurinol, febuxostat, or uricosuric agents were excluded.

After obtaining written informed consent, demographic information including age and gender was recorded. Blood pressure was measured using a calibrated mercury sphygmomanometer after the participant had rested for at least five minutes in a seated position. The average of two readings taken five minutes apart was recorded. Hypertension severity was classified according to the European Society of Cardiology/European Society of Hypertension criteria into Grade 1 (140–159/90–99 mmHg), Grade 2 (160–179/100–109 mmHg), and Grade 3 ( $\geq 180/\geq 110$  mmHg). Venous blood samples were collected after an overnight fast, and serum uric acid levels were measured using an enzymatic colorimetric method in the hospital laboratory. Hyperuricemia was defined as serum uric acid  $>7.0$  mg/dL in males and  $>6.0$  mg/dL in females. Data were entered and analyzed using SPSS version 26.0. Quantitative variables such as age, systolic blood pressure, diastolic blood pressure, and serum uric acid levels were expressed as mean  $\pm$  standard deviation. Qualitative variables such as gender, hypertension grades, and hyperuricemia status were presented as frequencies and percentages. The association between serum uric acid levels and severity of hypertension was assessed using the Chi-square test and one-way ANOVA where appropriate. A p-value of  $\leq 0.05$  was considered statistically significant.

## RESULTS

The study included 120 newly diagnosed hypertensive patients. The mean age of the participants was  $49.8 \pm 11.6$  years, with an age range of 21–65 years. There were 72 (60.0%)

male and 48 (40.0%) female participants, as given in Table 1.

Regarding hypertension severity, Grade 1 hypertension was observed in 50 (41.7%) patients, Grade 2 hypertension in 42 (35.0%) patients, and Grade 3 hypertension in 28 (23.3%) patients, as given in Table 2.

The mean systolic blood pressure of the study participants was  $161.4 \pm 17.8$  mmHg, while the mean diastolic blood pressure was  $98.6 \pm 10.7$  mmHg. The overall mean serum uric acid level was  $6.82 \pm 1.54$  mg/dL, as given in Table 3.

Hyperuricemia was present in 58 (48.3%) patients, whereas 62 (51.7%) patients had normal serum uric acid levels, as given in Table 4.

The mean serum uric acid level increased progressively with the severity of hypertension. Patients with Grade 1 hypertension had a mean serum uric acid level of  $5.91 \pm 1.01$  mg/dL, those with Grade 2 hypertension had a mean level of  $6.88 \pm 1.18$  mg/dL, and those with Grade 3 hypertension had a mean level of  $8.12 \pm 1.47$  mg/dL. This difference was statistically significant ( $p < 0.001$ ), as given in Table 5.

A significant association was observed between hyperuricemia and hypertension severity. Hyperuricemia was present in 12 (24.0%) patients with Grade 1 hypertension, 22 (52.4%) patients with Grade 2 hypertension, and 24 (85.7%) patients with Grade 3 hypertension. The association was statistically significant ( $p < 0.001$ ), as given in Table 6.

Stratified analysis demonstrated that hyperuricemia was significantly associated with increasing age and male gender. Hyperuricemia was observed in 30.0% of patients aged 18–40 years, 48.9% of those aged 41–55 years, and 68.6% of those older than 55 years ( $p = 0.003$ ). Similarly, hyperuricemia was present in 55.6% of males compared with 37.5% of females ( $p = 0.047$ ). Furthermore, the prevalence of hyperuricemia increased significantly across hypertension grades, being 24.0% in Grade 1, 52.4% in Grade 2, and 85.7% in Grade 3 hypertension ( $p < 0.001$ ), as given in Table 7.

Table 1: Baseline Demographic Characteristics of Study Participants (n=120)

Variable	Value
Age (years), Mean ± SD	49.8 ± 11.6
Age Range (years)	21-65
Male, n (%)	72 (60.0)
Female, n (%)	48 (40.0)

Table 2: Distribution of Severity of Hypertension Among Study Participants (n=120)

Hypertension Grade	Frequency (n)	Percentage (%)
Grade 1	50	41.7
Grade 2	42	35.0
Grade 3	28	23.3
Total	120	100

Table 3: Clinical and Laboratory Characteristics of Study Participants (n=120)

Variable	Mean ± SD
Systolic Blood Pressure (mmHg)	161.4 ± 17.8
Diastolic Blood Pressure (mmHg)	98.6 ± 10.7
Serum Uric Acid (mg/dL)	6.82 ± 1.54

Table 4: Distribution of Hyperuricemia Among Study Participants (n=120)

Hyperuricemia Status	Frequency (n)	Percentage (%)
Present	58	48.3
Absent	62	51.7
Total	120	100

Table 5: Mean Serum Uric Acid Levels According to Severity of Hypertension (n=120)

Hypertension Grade	n	Serum Uric Acid (mg/dL), Mean ± SD
Grade 1	50	5.91 ± 1.01
Grade 2	42	6.88 ± 1.18
Grade 3	28	8.12 ± 1.47
ANOVA p-value		<0.001

Table 6: Association Between Hyperuricemia and Severity of Hypertension (n=120)

Hypertension Grade	Hyperuricemia Present n (%)	Hyperuricemia Absent n (%)	Total	p-value
Grade 1 (n=50)	12 (24.0)	38 (76.0)	50	
Grade 2 (n=42)	22 (52.4)	20 (47.6)	42	
Grade 3 (n=28)	24 (85.7)	4 (14.3)	28	
Total (n=120)	58 (48.3)	62 (51.7)	120	<0.001

Table 7: Stratification of Association Between Hyperuricemia and Severity of Hypertension with Respect to Age and Gender (n=120)

Variable	Category	Hyperuricemia Present n (%)	Hyperuricemia Absent n (%)	Total (n)	p-value
Age Group (Years)	18-40	12 (30.0)	28 (70.0)	40	
	41-55	22 (48.9)	23 (51.1)	45	
	>55	24 (68.6)	11 (31.4)	35	0.003

<b>Gender</b>	Male	40 (55.6)	32 (44.4)	72	0.047
	Female	18 (37.5)	30 (62.5)	48	
<b>Hypertension Severity</b>	Grade 1	12 (24.0)	38 (76.0)	50	<0.001
	Grade 2	22 (52.4)	20 (47.6)	42	
	Grade 3	24 (85.7)	4 (14.3)	28	

**DISCUSSION**

Hypertension is one of the most prevalent cardiovascular disorders and a major contributor to global morbidity and mortality. Elevated blood pressure is associated with an increased risk of stroke, ischemic heart disease, heart failure, and chronic kidney disease.<sup>12,13</sup> Serum uric acid, the end product of purine metabolism, has emerged as a potential factor in the development and progression of hypertension.<sup>14</sup> Experimental and clinical studies have suggested that elevated serum uric acid levels may contribute to endothelial dysfunction, oxidative stress, and activation of the renin-angiotensin system. Several studies have reported a positive association between hyperuricemia and elevated blood pressure, particularly among newly diagnosed hypertensive patients. Understanding this relationship may help identify individuals at greater risk of severe hypertension and cardiovascular complications.<sup>15</sup>

The present study evaluated the association between serum uric acid (SUA) levels and the severity of hypertension among 120 newly diagnosed hypertensive patients. The mean age of the participants was 49.8 ± 11.6 years, and males constituted 60.0% of the study population. The overall mean SUA level was 6.82 ± 1.54 mg/dL, while hyperuricemia was present in 48.3% of patients. A significant progressive increase in SUA levels was observed with increasing hypertension severity, with mean SUA levels rising from 5.91 ± 1.01 mg/dL in Grade 1 hypertension to 6.88 ± 1.18 mg/dL in Grade 2 and 8.12 ± 1.47 mg/dL in Grade 3 hypertension (p<0.001). Similarly, the prevalence of hyperuricemia increased from 24.0% in Grade 1 hypertension to 52.4% in Grade 2 and 85.7% in Grade 3 hypertension (p<0.001), demonstrating a strong association between elevated SUA levels and hypertension severity.

Our findings are in agreement with the observations of Feig et al. (2008), who reported a strong association between elevated serum uric acid levels and the development of hypertension. They noted that approximately 25-40% of untreated hypertensive patients exhibited hyperuricemia. In comparison, hyperuricemia was observed in 48.3% of our newly diagnosed hypertensive patients, indicating an even greater burden in our study population. Feig et al. also proposed endothelial dysfunction and activation of the renin-angiotensin system as potential mechanisms linking uric acid to hypertension. The significant increase in SUA levels from 5.91 ± 1.01 mg/dL in Grade 1 hypertension to 8.12 ± 1.47 mg/dL in Grade 3 hypertension in our study supports these proposed biological mechanisms and reinforces the role of uric acid in hypertension progression.

The results of our study are also consistent with the meta-analysis by Grayson et al. (2011), who demonstrated that hyperuricemia significantly increased the risk of incident hypertension with a pooled relative risk of 1.41 (95% CI: 1.23-1.58). Although our cross-sectional study design did not permit risk estimation, the marked increase in hyperuricemia prevalence from 24.0% among Grade 1 hypertensive patients to 85.7% among Grade 3 hypertensive patients suggests a strong relationship between elevated SUA levels and increasing disease severity. Grayson et al. further reported a stronger association among younger individuals and women; however, in our study hyperuricemia was more frequent among males (55.6%) than females (37.5%), while a significant increase in hyperuricemia was observed with advancing age, reaching 68.6% among patients older than 55 years (p=0.003). These differences may reflect demographic and ethnic variations between study populations.<sup>16</sup>

Our findings closely resemble those reported by Borghi et al. (2015), who observed that serum uric acid levels increased progressively with increasing blood pressure severity and that hyperuricemia was independently associated with cardiovascular risk factors and target-organ damage. Similarly, we observed a stepwise increase in mean SUA levels across hypertension grades, with statistically significant differences between groups ( $p < 0.001$ ). The increasing prevalence of hyperuricemia from 24.0% in Grade 1 hypertension to 85.7% in Grade 3 hypertension in our study further supports Borghi et al.'s conclusion that SUA may serve as a marker of cardiovascular risk and disease severity.<sup>17</sup>

Further support for our findings comes from Ahad et al. (2025), who evaluated 266 patients and reported a mean age of  $45.41 \pm 25.92$  years and a male predominance of 51.1%. Their mean SUA level was  $6.03 \pm 1.13$  mg/dL, and hyperuricemia was observed in 22.9% of patients. In comparison, our patients demonstrated a higher mean SUA level of  $6.82 \pm 1.54$  mg/dL and a considerably greater prevalence of hyperuricemia (48.3%). Ahad et al. also reported significant positive correlations between SUA and systolic blood pressure ( $r = 0.261$ ,  $p < 0.001$ ) as well as diastolic blood pressure ( $r = 0.319$ ,  $p < 0.001$ ). These findings are concordant with our observation that patients with more severe hypertension exhibited significantly higher SUA levels and a greater prevalence of hyperuricemia. The higher frequency of hyperuricemia in our study may be attributable to the exclusive inclusion of newly diagnosed hypertensive patients.<sup>18</sup>

The results of the present study are also supported by Khaliq et al. (2020), who reported a mean age of  $54.79 \pm 8.96$  years and male predominance of 68%. They found hypertension in 84% of cases compared with 41% of controls, yielding a highly significant association ( $p = 0.000$ ) and an odds ratio of 7.55. Although their study primarily compared hypertensive and non-hypertensive individuals, the strong association between hypertension and elevated uric acid status reported by Khaliq et al. is in line with our

findings demonstrating a significant relationship between SUA levels and hypertension severity.<sup>19</sup>

A particularly strong concordance was observed with the study by Tareen et al. (2024), who reported a mean age of  $52.6 \pm 11.4$  years and found that 61.5% of patients had Stage 2 hypertension. They demonstrated significantly higher mean SUA levels among Stage 2 hypertensive patients compared with Stage 1 patients ( $7.3 \pm 1.5$  mg/dL vs  $6.1 \pm 1.3$  mg/dL;  $p < 0.001$ ), and hyperuricemia was more prevalent among patients with Stage 2 hypertension. Similarly, our study demonstrated a progressive rise in SUA levels from  $5.91 \pm 1.01$  mg/dL in Grade 1 hypertension to  $6.88 \pm 1.18$  mg/dL in Grade 2 hypertension and  $8.12 \pm 1.47$  mg/dL in Grade 3 hypertension. Likewise, hyperuricemia prevalence increased substantially from 24.0% in Grade 1 hypertension to 52.4% in Grade 2 and 85.7% in Grade 3 hypertension. The magnitude and direction of these findings strongly support the existence of a positive relationship between SUA levels and increasing blood pressure severity.<sup>20</sup>

Overall, the findings of the present study are highly consistent with previously published evidence. Our results demonstrated significantly elevated SUA levels and an increased prevalence of hyperuricemia with increasing grades of hypertension. The observed progressive increase in mean SUA levels from  $5.91 \pm 1.01$  mg/dL to  $8.12 \pm 1.47$  mg/dL and the corresponding rise in hyperuricemia prevalence from 24.0% to 85.7% across hypertension grades provide strong evidence that serum uric acid is closely associated with hypertension severity. These findings support the growing body of literature suggesting that hyperuricemia may play an important role in the pathogenesis and progression of hypertension and may serve as a useful marker for identifying patients at risk of more severe disease and future cardiovascular complications.

### Study Limitations

This study was conducted at a single tertiary care center, which may limit the generalizability of the findings. The cross-sectional design did not permit assessment of a causal relationship between serum uric acid levels and hypertension

severity. Additionally, lifestyle and dietary factors that could influence serum uric acid levels were not evaluated.

## CONCLUSION

Serum uric acid levels were significantly associated with the severity of hypertension among newly diagnosed hypertensive patients. Higher serum uric acid levels and a greater prevalence of hyperuricemia were observed with increasing grades of hypertension. These findings suggest that serum uric acid may serve as a useful marker for identifying patients at risk of more severe hypertension..

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**Conflict of Interest:** No

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