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Original Article

Assessment of Serum Uric Acid in Hypertensive Patients

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ABSTRACT

Introduction: *Hypertension is a global health issue, impacting over 1.13 billion people and increasing risks of cardiovascular disease, stroke, and kidney failure. Defined by blood pressure readings over 130/80 mmHg, it is primarily essential hypertension with no specific cause. Untreated can increase serum uric acid (SUA) levels due to decreased renal blood flow. Hyperuricemia, often from under-excretion, contributes to hypertension, chronic kidney disease, and heart disease.* ***Aim of the study:*** *The study aims to assess the serum uric acid levels in essential hypertension and its correlation with the severity and known duration of hypertension.* ***Methods & Materials:*** *This observational study was conducted at Dhaka Medical College's Nephrology Department over 18 months to investigate essential hypertension in 58 patients. Participants were selected based on specific inclusion and exclusion criteria, excluding those under 18, diabetic patients, and those with specific medical histories..* ***Result:*** *The study population consisted of 58 participants, predominantly aged 41-50 (37.93%), with a mean±SD age of 52.2±11.8 years. There were more males (65.52%) than females (34.48%), indicating a higher prevalence of hypertension in males. Most participants had a BMI of 18.5-24.9 kg/m^2 (56.90%), with a mean BMI of 28.0±3.6 kg/m^2. The average systolic and diastolic blood pressures were 154.91±10.07 mmHg and 93.19±7.24 mmHg, respectively..* ***Conclusion:*** *The study finds a strong link between serum uric acid levels and hypertension severity in patients. Higher uric acid levels correlate with*

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more severe hypertension, emphasizing the importance of regular monitoring and treatment. Addressing hyperuricemia could improve blood pressure control and reduce cardiovascular risks in hypertensive patients.

Keywords: *Serum Uric Acid, BMI, Hypertensive, Hyperuricemia*

INTRODUCTION

Hypertension is a major public health concern, affecting millions of people worldwide and significantly increasing the risk of cardiovascular disease and mortality. According to the American Heart Association, hypertension is defined as a sustained increase in blood pressure, with readings exceeding 130/80 mmHg, and is associated with elevated risks of stroke, myocardial infarction, and kidney failure[1]. It affects approximately 1.13 billion people globally, and its prevalence is expected to rise due to aging populations and lifestyle changes associated with urbanization and economic development[2]. In more than 95% cases, no specific underlying cause is found-such patients are said to have essential hypertension[3]. Evidence suggest that untreated essential hypertension increases serum uric acid excretion[4]. Uric acid, synthesized in the liver from dietary and endogenous purines, is also produced in peripheral tissues like the intestine and kidney. Released as soluble monosodium urate, it is filtered by the glomerulus and reabsorbed by proximal tubular cells, with a normal fractional excretion of about 10%[5]. Hyperuricemia may develop as a consequence of either over production or under excretion or both. But in most cases, it occurs as a result of under excretion[6]. Under normal conditions, the kidneys excrete about two-thirds of the daily produced uric acid through a process involving glomerular filtration, tubular secretion, reabsorption, and post-secretory reabsorption. A defect in any of these steps can lead to elevated serum uric acid levels[7]. It has emerged recently that elevated serum UA level is a risk factor for hypertension[8], chronic kidney disease and coronary heart disease[9,10]. The increase in serum uric acid in hypertension is due to decrease in renal blood flow that accompanies the hypertensive state and low renal blood flow increase urate reabsorption[11]. Furthermore, experimental studies have shown that hyperuricemia can induce endothelial dysfunction, increase oxidative stress, and activate the renin-angiotensin system, all of which are key mechanisms in the development of hypertension[12]. Serum uric acid (SUA) has been closely linked to the development and progression of hypertension, with numerous studies demonstrating a strong association between elevated SUA levels and increased blood pressure[13,14]. The severity and duration of hypertension have also been found to correlate with SUA levels. Patients with stage 2 hypertension, characterized by higher blood pressure readings, have been shown to have significantly higher SUA levels compared to those with stage 1 hypertension or isolated hypertension. Additionally, patients with a longer duration of hypertension (>5 years) tend

to have higher SUA levels than those with a shorter duration (<5 years)[13]. In this study, we aim to assess the serum uric acid levels in essential hypertension and its correlation with the severity and known duration of hypertension. By investigating this relationship, we hope to contribute to the understanding of the role of SUA in hypertension and its potential implications for risk stratification and management.

METHODS & MATERIALS

This observational study was conducted at the Department of Nephrology, Dhaka Medical College (DMC), Dhaka, Bangladesh. Fifty-eight patients with essential hypertension were enrolled during 18 months, from February 2021 to August 2022. Before starting the study, ethical approval was taken from DMC's Ethical Review Committee (ERC). Selection of the patients was started according to inclusion and exclusion criteria. After the selection of participants, they were approached for inclusion in the study. Following the information about the study's aim, objectives, and procedure, informed written consent was obtained from each participant.

Inclusion criteria:

- Patients with essential hypertension.
- Healthy age-matched normotensive individual.

Exclusion criteria

- Patients Age <18 years.
- Patients with Diabetes Mellitus
- H/O of Gout
- H/O alcohol abuse
- H/O drugs known to cause hyperuricemia, e.g., thiazide diuretics and anticancer therapy.
- History of leukemia, polycythemia, lymphoma, or any neoplastic disease.
- Patients with CKD
- Patients with Hypothyroidism

History taking focusing on clinical features and physical examination were done per standard protocol. All subjects were dipstick negative for proteinuria. In some cases, the diagnosis of essential hypertension was based on the exclusion of secondary causes by history, clinical examination, and investigation. BP measurement was done in resting condition, sitting position, and arms rest on the arm of the chair. Thick clothing was removed, and palpation of the brachial artery was done. Then, the cuff was warped 2.5 cm above the antecubital fossa and placing the diaphragm of the stethoscope was placed over the brachial artery crossing the cubital fossa, and inflation of the cuff was done and reached above 10 mm of HG from the obliteration of the brachial artery pulsation. Then, the cuff was deflated 2 to 3 mm of HG/sec, and systolic and diastolic BP were measured on the appearing and disappearing sounds. A second measurement was taken after 5 minutes of rest in case of high BP.

After all aseptic precautions, 3 ml venous blood was collected in a tube to measure serum uric acid. For the measurement of serum uric acid, 11 microlitre serum was taken from a tube and centrifuge for 10-12 minutes, and then a bar code was attached and ran into a multichannel

biochemical analyzer (Atellica, Siemens Germany). The system automatically dispenses reagent N-ethyl-N-sulfopropyl-3-methyl-aniline into the sample and incubates the mixture at 37 degrees Celsius. The result was obtained after 7 minutes. Serum uric acid was measured by the uricase method. All laboratory investigations were carried out in the laboratory of the Department of Biochemistry, Bangabandhu Sheikh Mujib Medical University, Dhaka. According to JNC-8 clinical practice guidelines:

Normal blood pressure:
Systolic BP <140 mm of Hg and
Diastolic BP <90 mm of Hg

Stage-1 hypertension:
Systolic BP 140-159 mm of Hg and Diastolic BP 90-99 mm of Hg.

Stage-2 hypertension:
Systolic BP ≥160 mm of Hg and Diastolic BP ≥100 mm of Hg.

Hyperuricemia:
Hyperuricemia is serum uric acid over 7mg/dl for males and over 6mg/dl for females[15].

Body Mass Index (BMI):
BMI defines a person as underweight, normal weight, overweight, or obese instead of traditional height vs. weight charts. However, individual variations do exist. WHO recommends that ≥ 30.0 is obese, 25-29.9 is overweight, 18.5-24.9 is normal, and <18.5 is underweight[16].

Data collection procedure:

All the patients were enrolled using a purposive sampling technique. They were explained about the type and nature of the study, and it was ensured to them that there was no potential risk of this study, and no experimental drug was used on them. Prior to data collection, both verbal and informed written consent was taken from all subjects. Data regarding sociodemographic characteristics, clinical parameters, and ultimately, the results of laboratory investigation and the patient's current medical document, along with these other variables, was recorded. Every individual questionnaire was preserved with proper identification of the patient, maintaining confidentiality.

Data analysis:
Collected data were compiled and edited. The data were then processed with the help of the software Statistical Package for Social Sciences (***SPSS, version 26).*** Categorical data were presented as frequency with percentage, and numerical data were presented as mean with standard deviation or median with range. The statistical test for different variables was performed using the Chi-square, Unpaired t-test, and Pearson correlation tests. *p*-value<0.05 was considered statistically significant.

RESULT
The study population comprised 58 hypertensive patients. The age distribution showed that 22 participants (37.93%) were aged between 41 and 50, and the second most were 31.03% of participants aged 51 to 60. Only 8.62% of participants were aged ≤30 years. The mean age of the study population was

52.2 years, with a standard deviation (SD) of 11.8 years (**Table I**).

Table I: Demographic Characteristics of Study Population (*n*=58)

Age (years)	Frequency (*n*)	Percentage (%)
≤30	5	8.62
31-40	13	22.41
41-50	22	37.93
51-60	18	31.03
>60	0	0.00
Mean±SD	52.2 ± 11.8	

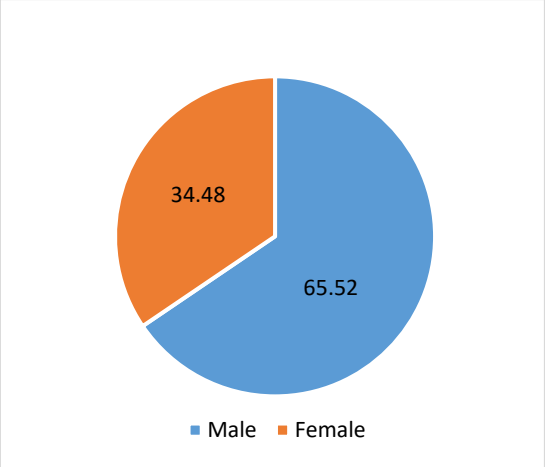

Figure – 1: Percentage Wise Comparison of Study Groups Based on ASA Grade

Figure 1 highlights a higher prevalence of hypertension among males (65.52%) compared to females (34.48%). According to BMI distribution, most of 33(56.90%) patients had a BMI of 18.5-24.9 kg/m^2, 16(27.59%) patients had a BMI of 25-29.9 kg/m^2 and 4(6.90%) patients had a BMI of >30 kg/m^2. The mean BMI of the study population was 28.0±3.6 kg/m^2 (**Table II**).

Table – II: Distribution of the Study Population According to BMI (Body Mass Index) in Total Population

BMI (Kg/m2)	Frequency (*n*)	Percentage (%)
<18.5	5	8.62
18.5-24.9	33	56.90
25–29.9	16	27.59
>30	4	6.90
Mean±SD	28.0 ± 3.6	

The mean systolic blood pressure (SBP) among the study population was 154.91±10.07 mmHg, the mean diastolic blood pressure (DBP) was 93.19±7.24 mmHg, and the mean arterial pressure (MAP) was 112.96±5.14 mmHg (**Table III**).

Table – III: Distribution of the Study Population According to Blood Pressure in Total Population

Blood Pressure (mmHg)	Mean±SD
Systolic BP	154.91±10.07
Diastolic BP	93.19±7.24
MAP	112.96±5.14

A significant proportion of the study population (39 patients, 67.24%) had a family history of hypertension, while 19(32.76%) did not report such a history. Regarding the duration of hypertension, 10(17.24%) patients had been hypertensive for less than five years, whereas the majority, 48(82.76%) patients had been hypertensive for more than five years. According to **Table IV**, hypertension stage 1 was mostly seen in

the study population of 72.4%, and the rest, 27.6%, had stage 2.

Table – IV: Distribution of the Study Population According Family History, Duration in Total Population

Variables	Frequency (*n*)	Percentage (%)
Family History of HT		
Yes	39	67.24
No	19	32.76
Duration of Hypertension		
< 5 years	10	17.24
> 5 years	48	82.76
Stages of hypertension		
Stage 1	42	72.4
Stage 2	16	27.6

More than 72% of the study population had normal uric acid levels, whereas 16(27.59%) patients suffered from hyperuricemia, and the mean±SD of serum uric acid level was 6.71±1.10 mg/dl (**Table V**).

Table – V: Distribution of the Study Population According to S. Uric Acid in Total Population

Variable	Frequency (*n*)	Percentage (%)
Hyperuricemia	16	27.59
Normal uric acid	42	72.41
S. Uric acid (mg/dl)		
Mean±SD	6.71±1.10	

DISCUSSION

Hyperuricemia is commonly linked with hypertension. Elevated serum uric acid has been strongly associated with the onset of hypertension and may serve as an indicator of vulnerability or as a precursor in the progression toward hypertension[13]. This study aimed to assess the relationship between serum uric acid levels and hypertension among patients at a tertiary care hospital. The findings provide insight into the prevalence of hyperuricemia in hypertensive individuals and its association with different stages of hypertension. The study population consisted of 58 hypertensive patients, with a significant majority being male (65.52%). This demographic trend aligns with existing literature that suggests hypertension prevalence increases with age, particularly in males, indicating a potential area for targeted preventive measures in younger populations[17,18]. However, ***Belo et. al.*** and Ofori and Odia studies observed a female predominant, which may be due to racial or ethnic differences[19,20]. The age distribution showed that the majority of patients (37.93%) were in the 41-50 years age group, followed by those aged 51-60 years (31.03%) and 31-40 years (22.41%). Only a tiny percentage (8.62%) were aged 30 or younger, and no participants were older than 60. The majority of participants were aged between 41 and 60 years, reflecting the increased risk of hypertension with age[21]. The mean age of the study population was 52.2±11.8 years. One study conducted by Aggarwal et al. found that the mean age was 42.50±10.89, which was smaller than ours[22]. Ofori

and Odia also made similar observations[17]. The study by Dar et al. observed that the mean age in cases was 51 years, and 49 were in the control group, which was almost similar to the present study [13]. Other observations regarding the higher mean age and age range also revealed the same results[7,23-25]. The higher and lesser mean age and age range obtained by the above authors may be due to geographical variations, racial and ethnic differences, and genetic causes that may have significant influence on their study subjects. The BMI data indicates that 56.90% of participants fell within the normal range (18.5-24.9 kg/m^2), while 27.59% were classified as overweight (25-29.9 kg/m^2) and 6.90% as obese (>30 kg/m^2). The mean BMI was reported as 28.0 (SD ± 3.6), suggesting that a significant portion of the population is at risk for obesity-related complications, including hypertension. Previous research has demonstrated a significant association between higher BMI and elevated blood pressure, emphasizing the necessity of weight management in hypertensive patients[13,26]. In comparison to relevant literature, the mean BMI of the subjects in this study was within the normal range, aligning closely with the findings of ***Praveen et. al.***[27]. Additionally, ***Feng Yu et. al.*** [28] reported a mean BMI of 26.04 with a standard deviation 2.96 in their subjects. Jawed et al. identified a higher mean BMI that fell into the obese category[29]. The mean systolic blood pressure (SBP) among the study population was 154.91±10.07 mmHg, while the mean diastolic blood pressure (DBP) was 93.19±7.24 mmHg. The mean arterial pressure (MAP) was calculated to be 112.96±5.14 mmHg. These values indicate that the majority of our study population had uncontrolled hypertension, which aligns with global data showing high rates of uncontrolled hypertension among hypertensive patients[30,31]. The study of Dar et al. demonstrated that overall mean systolic BP mmHg and mean diastolic BP closely resembled the present study [13]. A notable 67.24% of participants reported a family history of hypertension, and 82.76% had been hypertensive for more than five years. This familial link suggests a genetic predisposition to hypertension, which is supported by numerous studies indicating that family history is a significant risk factor for developing hypertension[26,32]. The prevalence of Stage 1 hypertension (72.4%) in this cohort aligns with findings that indicate early-stage hypertension is common among individuals with prolonged exposure to risk factors. The comparison of serum uric acid levels between different stages of hypertension revealed that stage II hypertensive patients had significantly higher serum uric acid levels compared to stage I hypertensive patients. This finding is consistent with existing literature that suggests a positive correlation between serum uric acid levels and the severity of hypertension[30]. Elevated uric acid levels are thought to contribute to hypertension through various mechanisms, including endothelial dysfunction and increased vascular resistance[33]. ***Tykarski et. al.***[34] also observed that patients with higher uric acid levels were more likely to be in stage II compared to stage I[35]. Our study's

mean serum uric acid level was 6.71±1.10 mg/dL. In 27.59% of the participants, hyperuricemia was observed, while 72.41% had normal serum uric acid levels. A study by ***Razak et. al.*** reported a mean serum uric acid level of 8.03 mg/dl, which is higher than our findings[36]. This difference is mainly because most patients in their study were non-vegetarian in dietary habits. In contrast, the current study states a mixed population of vegetarians and non-vegetarians by diet. In contrast, ***Vishnu et. al.***'s research on the Kerala population found serum uric acid levels lower than in our study[37]. The results of this study highlight the importance of monitoring serum uric acid levels in hypertensive patients. Hyperuricemia not only correlates with increased blood pressure but may also serve as an independent risk factor for the development and progression of hypertension. This supports the integration of serum uric acid measurement into routine clinical practice for hypertensive patients to manage better and mitigate the risk of complications associated with elevated blood pressure.

Limitations of the study:

The study, conducted over a very short period at a single hospital in Dhaka city, may not reflect the broader national context due to its limited and culturally specific population sample. Additionally, the study's design did not allow for a longitudinal examination of the impact of lowering serum uric acid levels on hypertension, indicating the need for future research with a larger sample size and extended duration.

Conclusion and Recommendations

In conclusion, this study demonstrates a significant association between serum uric acid levels and the stages of hypertension in a cohort of hypertensive patients. Our findings suggest that higher serum uric acid levels are linked to more severe hypertension, highlighting the need for regular monitoring and potential therapeutic intervention. Addressing hyperuricemia in hypertensive patients could play a crucial role in improving blood pressure control and reducing the risk of cardiovascular events.

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Conflict of Interest

The authors declare no conflict of interest.

Ethical Approval

The study was approved by the Institutional Ethics Committee.

REFERENCES

1. *Flack JM, Adekola B. Blood pressure and the new ACC/AHA hypertension guidelines. Trends in cardiovascular medicine. 2020 Apr 1;30(3):160-4.*
2. *World Health Organization. (2021). Hypertension. Retrieved from https://www.who.int/news-room/fact-sheets/detail/hypertension*
3. *Penman ID, Ralston SH, Strachan MW, Hobson R, editors. Davidson's Principles and Practice of Medicine E-Book: Davidson's Principles and Practice of Medicine E-Book. Elsevier Health Sciences; 2022 Jun 20.*
4. *Viazzi F, Leoncini G, Ratto E, Falqui V, Parodi A, Conti N, Derchi LE, Tomolillo C, Deferrari G, Pontremoli R. Mild hyperuricemia and subclinical renal damage in untreated*

primary hypertension. American journal of hypertension. 2007 Dec 1;20(12):1276-82.

5. *Mandell BF. Clinical manifestations of hyperuricemia and gout. Cleveland Clinic journal of medicine. 2008 Jul 1;75:S5-8.*
6. *Luk AJ, Simkin PA. Epidemiology of hyperuricemia and gout. Am J Manag Care. 2005 Nov 1;11(15 Suppl):S435-42.*
7. *Singh V, Gomez VV, Swamy SG. Approach to a case of hyperuricemia. Ind J Aerospace Med. 2010;54(1):40-6.*
8. *Grayson PC, Kim SY, LaValley M, Choi HK. Hyperuricemia and incident hypertension: a systematic review and meta-analysis. Arthritis care & research. 2011 Jan;63(1):102-10.*
9. *Ohno I. Relationship between hyperuricemia and chronic kidney disease. Nucleosides, Nucleotides and Nucleic Acids. 2011 Dec 1;30(12):1039-44.*
10. *Kim YS, Kim HS, Oh HY, Lee MK, Kim CH, Kim YS, Wu D, Johnson-Levonas AO, Oh BH. Prevalence of microalbuminuria and associated risk factors among adult Korean hypertensive patients in a primary care setting. Hypertension Research. 2013 Sep;36(9):807-23.*
11. *Vaidya B, Pudasaini K, Nakarmi S. Changes in urinary microalbumin levels after correction of hyperuricemia in patients with gout: an observational cohort study. International Journal of Rheumatology. 2020;2020(1):8310685.*
12. *Soltani Z, Rasheed K, Kapusta DR, Reisin E. Potential role of uric acid in metabolic syndrome, hypertension, kidney injury, and cardiovascular diseases: is it time for reappraisal?. Current hypertension reports. 2013 Jun;15:175-81.*
13. *Dar WR, Gupta SK, Ahmad A. Serum uric acid levels in essential hypertension and its correlation with the severity of hypertension. Int J Adv Med. 2020 Nov;7:1738-42.*
14. *Borghi C, Agnoletti D, Cicero AF, Lurbe E, Virdis A. Uric acid and hypertension: a review of evidence and future perspectives for the management of cardiovascular risk. Hypertension. 2022 Sep;79(9):1927-36.*
15. *Bardin T, Richette P. Definition of hyperuricemia and gouty conditions. Current opinion in rheumatology. 2014 Mar 1;26(2):186-91.*
16. *The SuRF Report 2 (PDF). The Surveillance of Risk Factors Report Series (SuRF). World Health Organization. 2005. p. 22.*
17. *Timerga A, Haile K. Evaluation of uric acid disorders and associated factors in essential hypertensive patients at Wolkite University specialized hospital, Southern Ethiopia. Plos one. 2021 Sep 10;16(9):e0256557.*
18. *Abdul-Razzaq MA, Saiba MA, Hadi NR. Assessment of serum uric acid level in patients with systemic arterial hypertension. Iraq Medical Journal. 2022 Dec 26;6(4).*
19. *Ofori SN, Odia OJ. Serum uric acid and target organ damage in essential hypertension. Vascular health and risk management. 2014 May 2:253-61.*
20. *Belo AA, Machado EL, de Souza Figueiredo AF, Figueiredo EL. Microalbuminuria in White and Black Hypertensive Nondiabetic Brazilian Patients. World Journal of Cardiovascular Diseases. 2014 May 6;4(05):236.*
21. *Fryar CD, Ostchega Y, Hales CM, Zhang G, Kruszon-Moran D. Hypertension prevalence and control among adults: United States, 2015-2016.*
22. *Aggarwal HK, Jain D, Mor S, Yadav RK, Jain P. Prevalence and clinical correlates of microalbuminuria in patients with essential hypertension-a tertiary care center cross sectional study. J Assoc Physicians India. 2018 May 1;66(5):30-4.*
23. *Reddy RP, Monigari N, Hande M. Study of serum uric acid in essential hypertension. International Journal of Scientific and Research Publications. 2015 Aug;5(8):1-2.*
24. *Poudel B, Yadav BK, Nepal AK, Jha B, Raut KB. Prevalence and association of microalbuminuria in essential hypertensive patients. North American journal of medical sciences. 2012 Aug;4(8):331.*
25. *Eisen A, Benderly M, Goldbourt U, Haim M. Is serum uric acid level an independent predictor of heart failure among patients with coronary artery disease?. Clinical cardiology. 2013 Feb;36(2):110-6.*
26. *Timerga A, Haile K. Evaluation of uric acid disorders and associated factors in essential hypertensive patients at Wolkite University*

specialized hospital, Southern Ethiopia. Plos one. 2021 Sep 10;16(9):e0256557.

27. *Praveen M, Sinha RB. Assessment of serum uric acid in patients suffered from essential hypertension. Int J Med Health Res. 2018;10:215-7.*
28. *Yu FN, Shi YX, Cheng HY, Huang XL, Liu SS. An observational study on the relationship between serum uric acid and hypertension in a Northern Chinese population aged 45 to 59 years. Medicine. 2017 Apr 1;96(17):e6773.*
29. *Jawed S, Khawaja TF, Sultan MA, Ahmad S. The effect of essential hypertension on serum uric acid level. Biomedica. 2005 Jul 15;21(July-December):98-102.*
30. *Bulpitt CJ. Serum uric acid in hypertensive patients. Heart. 1975 Dec 1;37(12):1210-5.*
31. *Kim YH, Do Suh Y, Son SP, Shim YW, Shin YW, Shin YK. Observation of the serum uric acid in essential hypertension. The Korean journal of internal medicine. 1986 Jan;1(1):14.*
32. *Kuwabara M, Niwa K, Nishi Y, Mizuno A, Asano T, Masuda K, Komatsu I, Yamazoe M, Takahashi O, Hisatome I. Relationship between serum uric acid levels and hypertension among Japanese individuals not treated for hyperuricemia and hypertension. Hypertension Research. 2014 Aug;37(8):785-9.*
33. *Grayson PC, Kim SY, LaValley M, Choi HK. Hyperuricemia and incident hypertension: a systematic review and meta-analysis. Arthritis care & research. 2011 Jan;63(1):102-10.*
34. *Feig DI, Madero M, Jalal DI, Sanchez-Lozada LG, Johnson RJ. Uric acid and the origins of hypertension. The Journal of pediatrics. 2013 May 1;162(5):896-902.*
35. *Tykarski A. Evaluation of renal handling of uric acid in essential hypertension: hyperuricemia related to decreased urate secretion. Nephron. 1991 Dec 11;59(3):364-8.*
36. *G Al-Gebouri H, Abdul Razak Al-Sharifi Z. Uric Acid and Endothelial Dysfunction in Essential Hypertension. Kerbala Journal of Medicine. 2010 Dec 28;3(7):914-8.*
37. *Vishnu RS, Dash LK, Murmu M. Observation of Serum Uric Acid levels in essential hypertension. Kerala Medical Journal. 2013 Sep 27;6(3):65-70.*