Association between Serum Uric Acid and Essential Hypertension in Bangladeshi Adults Attending the Outpatient Department of a Tertiary Medical College Hospital

Sumon Das[1*] Nayeema Tasnim[2] Shimu Mohajan[3] Shantanu Dutta[4] Hafsa Hasina[1] Maghna Barua[5]

Abstract

Background: Among the many confounding factors linked to essential Hypertension (HTN) high Serum Uric Acid (SUA) is a promising biomarker. The study's objective was to determine how SUA levels and essential hypertension related in a major academic Hospital at Chattogram, Bangladesh.

Materials and methods: This cross-sectional comparative study included 42 newly diagnosed hypertensive patients (Aged 18–65 years) as cases from Chittagong Medical College Hospital and 42 normotensive controls were matched in terms of age and gender.

Results: The mean SUA level was 6.5±0.9 mg/dl (Range: 4.7-9.0) and 5.6±0.9 mg/dl (Range: 3.8-7.5) in the case and control group, respectively ($p<0.001$). The proportion of participants with Hyperuricemia was higher in the case group (17/42, 40.5%) than the control group (4/42, 9.5%) and the difference was significant statistically ($p=0.001$, Chi-square test).

Conclusion: The number of participants with hyperuricemia and the mean serum uric acid levels were found to be considerably greater in cases than in controls.

Key words: Bangladeshi adults; Hyperuricemia; Newly diagnosed hypertension; Serum uric acid.

Introduction

Hypertension (HTN) is a serious public health issue due to its great global incidence. High blood pressure is the cause of about 7.5 million fatalities or 12.8% of all deaths worldwide annually.[1] One of the main causes of mortality and morbidity is high blood pressure and its complications.[2] Bangladesh has experienced a rapid increase in hypertension.[3] A recent meta-analysis of 53 studies found that the overall prevalence of hypertension in Bangladeshi adults was 20%, varying from 1.10% to 75%.[4] That's why identification of those with high risk of hypertension is crucial.

Studies comparing hypertensive patients to healthy participants have revealed greater incidences of hyperuricemia in the former group.[5,6,7] One possible independent risk factor for the development of essential hypertension in the general population is elevated Serum Uric Acid (SUA).[8]

The last by product of purine metabolism in humans is uric acid, the kidneys remove approximately 70% and the remaining 30% by the intestine. Uric acid accounts for up to two thirds of the total antioxidant capacity in human blood. Uric acid protects DNA and cell membranes from damage by inhibiting free radicals like peroxyl and peroxynitrite, while also acting as a buffer against vitamin C and E. However, while acute increases seem to provide antioxidant protection, chronic uric acid increases are associated with a higher risk for coronary artery disease (infarction). SUA is correlated with an increased risk of hypertension, diabetes mellitus. renal failure, obesity and metabolic syndrome. It is known that anthropometric parameters, dyslipidemia, hypertension, inflammation, and insulin resistance can increase the uric acid concentration.[9] High Serum Uric Acid (SUA) has long been recognized as an independent risk indicator for cardiovascular illnesses.[10] The number of cases of hyperuricemia has increased recently and there is more evidence connecting it to development of HTN and insufficient blood pressure control.[11-13] As a result, this field of study is expanding.

1. Lecturer of Biochemistry
Chittagong Medical College , Chattogram.
2. Professor of Biochemistry
Chittagong Medical College, Chattogram.
3. Post Graduate Student of Pediatrics (Phase-A)
Chittagong Medical College, Chattogram.
4. Assistant Professor of Biochemistry
Institute of Applied Health Sciences (IAHS) Chattogram.
5. Assistant Professor of Biochemistry
BGC Trust Medical College, Chattogram.

***Correspondence:** **Dr. Sumon Das**
Cell : 01711 23 73 30
E-mail: sumon.f7@gmail.com

Submitted on : 23.10.2024
Accepted on : 25.11.2024

The renin-angiotensin system's activation and effects on the kidney's glomerular apparatus, increased insulin resistance and hyperinsulinemia, which reduce uric acid and electrolyte excretion by the renal tubules. Along withthe action of uric acid itself these promote smooth muscle cell proliferation and endothelial dysfunction, are the mechanisms by which hyperuricemia is thought to contribute to hypertension.[14-16]

Research on the connection between Serum Uric Acid (SUA) and hypertension in adult Bangladeshi population is still scarce.[17,18] This study assessed the association between SUA levels and hypertension in patients attending at a tertiary hospital in Chattogram, Bangladesh.

Materials and methods

This cross-sectional comparative study was conducted in the Department of Biochemistry, Chittagong Medical College in collaboration with the Outpatient Department (OPD) of Medicine and Cardiology of Chittagong Medical College Hospital from March 2022 to February 2023. Forty-two (42) hypertensive patients attending the Medicine and Cardiology OPD of Chittagong Medical College Hospital were included in the case group along with forty-two (42) normotensive age and gender-matched healthy subjects from the accompanying persons of the patients and hospital staff (Doctors, nurses, and others) were included in the control group by purposive sampling. The Chittagong Medical College Ethical Review Committee accepted this research strategy. Participants gave their informed consent in paper, guaranteeing confidentiality, voluntary participationand counseling regarding clinical and biochemical results. Participants who had abnormal results were notified.

Inclusion criteria

A. For case group:

- Newly diagnosed patients of essential hypertension according to 2020 International society of hypertension Global hypertension practice guidelines.[19]
- Patients aged ≥18 years and ≤65 years irrespective of gender.
- Willing to participate in the study.

B. For control group:

- Normotensive age and gender-matched otherwise healthy subjects from the accompanying persons of the patients and hospital staffs (Doctors, nurse and others) were enrolled in the group.
- Willing to participate in the study.

Exclusion criteria

For case group:

- Age below 18 years and above 65 years.
- Diagnosed cases of secondary hypertension, ischemic heart disease, leukemia, polycythemia, lymphoma, carcinoma, psoriasis, pregnancy, diabetes mellitus, tuberculosis, chronic renal failure.
- Patients on levodopa, ethambutol, pyrazinamide, cytotoxic drugs, anti-cancer therapy, aspirin, diuretics, and uric acid lowering medication.

B. For control group:

- Age below 18 years and above 65 years.
- Diagnosed cases of ischemic heart disease, leukemia, polycythemia, lymphoma, carcinoma, psoriasis, pregnancy, diabetes mellitus, tuberculosis and chronic renal failure.
- Patients on levodopa, ethambutol, pyrazinamide, cytotoxic drugs, anti-cancer therapy, aspirin, thiazide and loop diuretics, uric acid lowering medication.

List of variables

Demographic variables: Age, gender.
Risk factors of hypertension: Family history of hypertension, BMI, physical activity.
Biochemical variable: Serum Uric Acid.

Operational Definitions

Hyperuricemia was defined as a SUA level >7 mg/dL for males and >6 mg/dL for females.[19]

Hypertension: According to 2020 International society of hypertension Global hypertension practice guidelines[20]: Normal BP <130 and <85, High-normal BP 130–139 and/or 85–89 Grade1 hypertension 140–159 and/or 90–99, Grade 2 hypertension ≥160 and/or ≥100 mm of Hg.

Essential hypertension can be defined as a rise in blood pressure of unknown cause.[19]

Physical activityis defined as any bodily movement produced by skeletal muscles that require energy expenditure. A participant was considered doing sufficient physical activity (During work, transport and recreational activities) if he or she reported at least 150 minutes of moderate-intensity physical activity per week or 75 minutes of vigorous-intensity physical activity per week.[21]

Body Mass Index (BMI) was defined according to Asia-Pacific guideline,underweight < 18.5Kg/m^2, normal 18.5-22.9Kg/m^2, overweight 23-24.9Kg/m^2 and obesity were defined as a participant with BMI ≥25.0 Kg/m^2.[22]

Data collection was performed using a structured questionnaire. Blood pressure was measured according to standard procedures. Body Mass Index (BMI) was calculated after measuring height and weight. After data collection, the data were processed and analyzed using SPSS version 23. Categorical variables were presented as frequencies (Percentages). The differences in categorical variables includesfamilyhistory of hypertension, physical activity status, obesity categories, hyperuricemic statewere compared using the Chi-square test between cases and controls. The differences in the mean values of continuous variables, such as age, BMI, and blood pressure,Serum Uric Acid (SUA) level were also analyzed using the independent sample t-test between two groups. A p-value of less than 0.05 was considered statistically significant.

Results

In the case group, 25 patients (59.5%) were male and 17 (40.5%) were female, with a male-to-female ratio of 1.5:1. The control group also included 25 men and 17 women. The demographic details of the participants are plotted in Table I. The average age was approximately 45 years, and both age and gender were comparable between hypertensive cases and normotensive controls. The age group most commonly observed in hypertensive patients was 41-50 years, comprising 33.3% of the cases, followed by the 31-40 years age group at 28.6%. A total of 23.8% were in the 51-60 years age group, and 7.1% of patients were either ≤30 years or above 60 years old.

Table I Age and gender distribution of the study population

Variables	Cases (n=42)	Controls (n=42)	p-value
Age, years			
Mean ±SD	44.8±10.7	45.8±10.9	Matched
Range	23.0-66.0	23.0-66.0	
Gender			
Male	25 (59.5)	25 (59.5)	Matched
Female	17 (40.5)	17 (40.5)	

Higher proportion of the hypertensive cases reported a positive family history for hypertension (54.8%) compared to the controls (33.3%) and the difference was marginally significant statistically (p=0.048). More than half of the participants in both groups were moderately active on account of physical activity, without any significant statistical difference between two groups.

Table II Family history of hypertension and physical activity status of the study population stratified by the study groups

Variables	Cases (n=42)	Controls (n=42)	p-value
Family history of HTN			
Present	23 (54.8)	14 (33.3)	0.048*
Absent	19 (45.2)	28 (66.7)	
Physical activity status			
Mildly active	17 (40.5)	18 (42.9)	0.855*
Moderately active	25 (59.5)	24 (57.1)	

Data were expressed as frequency (%) if not mentioned otherwise. *Chi-square test.

Table III showed hypertensive patients had higher mean BMIs and proportions of overweight and obese participants than controls (p=0.001).

Table III Comparison of mean BMI and obesity category between two groups

Variables	Cases (n=42)	Controls (n=42)	p-value
BMI, kg/m^2			
Mean ±SD	23.7±1.8	22.0±2.4	0.001†
Range	20.0-28.0	19.0-29.0	
Obesity category			
Normal	13 (31.0)	29 (69.0)	0.001*
Overweight	23 (54.8)	8 (19.0)	
Obese	6 (14.3)	5 (11.9)	

Data were expressed as frequency and percentage if not mentioned otherwise.

*Chi-square test, †Independent sample t test.

In the hypertensive case group, most of the participants (71.4%) had Grade II hypertension, and the rest (28.6%) had Grade I hypertension. In the normotensive group, 4 (9.5%) individual were in prehypertensive stage and rest of the 38(90.5%) individuals had normal blood pressure (Table IV).

Table IV Distribution of study population according to category of blood pressure between cases and controls

Category	Cases (n=42)	Controls (n=42)
Normal BP	0 (0)	38 (90.5)
High normal BP	0 (0)	4 (9.5)
Grade I hypertension	12 (28.6)	0 (0)
Grade II hypertension	30 (71.4)	0 (0)

Figure 1 depicted that, the proportion of participants with Hyperuricemia was higher in the case group (17/42, 40.5%) than the control group (4/42, 9.5%) and the difference was significant statistically (p=0.001, Chi-square test).

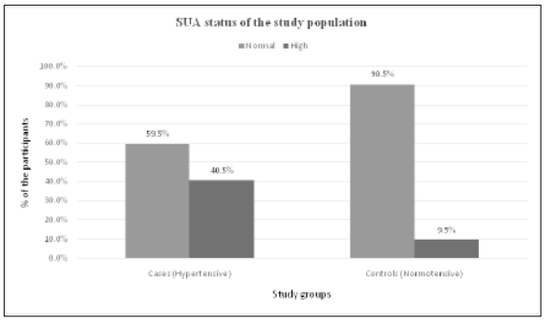

Figure 1 Comparison of the SUA status between two groups

Table V showed that hypertensive individuals have significantly higher mean serum uric acid levels than healthy controls (p< 0.001). This association is evident in both males (6.95 ± 0.84 mg/dL vs. 5.39 ± 1.16 mg/dL, P< 0.001) and females (5.70 ± 0.70 mg/dL vs. 4.77 ± 0.89 mg/dL, p = 0.002). These results suggest that hyperuricemia is strongly associated with hypertension.

Table V Serum Uric Acid (SUA) level in case and control

Variables	Cases (n=42) Mean ± SD	Controls (n=42) Mean ± SD	p-value
Uric Acid (mg/dl)	6.45±1	5.14±1.09	<0.001†
Uric acid in male (mg/dl)	6.95±0.84	5.39±1.16	<0.001†
Uric acid in female (mg/dl)	5.70±0.70	4.77±0.89	0.002

†Independent sample t test.

The categorical relationship between hyperuricemia and hypertension, allocated by gender, is displayed in Table VI. 40% of male hypertensive, 41.2% of female hypertensive and 40.5% of total hypertensive had hyperuricemia. Similarly, it was discovered that the percentages of hyperuricemia in male healthy controls, female healthy controls and total healthy controls were 12%, 5.9% and 9.5%, respectively. The percentage of hyperuricemia is more in case than controls in both gender with p-value<0.05.

Table VI Distribution of study population according to hyperuricemia in male and female

	Male		Female		Total	
	Case	Control	Case	Control	Case	Control
Total number	25	25	17	17	50	34
Hyperuricemia(n)(%)	10(40.0)	3 (12.0)	7 (41.2)	1 (5.9)	17(40.5)	4 (9.5)
p-value*	0.024	0.015	<0.001			
Odds ratio	4.89	11.20	6.46			
95% CI for OR	1.15-20.79	1.93-105.14	1.94-21.46			

*Chi-square test, OR: Odds Ratio, CI: Confidence Interval.

Discussion

In this study, analyses of categorical and continuous data showed that hyperuricemia increased the risk of developing hypertension. The risk of hypertension appeared to increase with increasing SUA level. Furthermore, the association was consistent across subgroups (Male and female). After adjusting the effects of age, gender, and other cardiovascular risk factors such as family history of hypertension, physical activity and BMI hypertensive patients exhibit significantly higher Serum Uric Acid (SUA) levels compared to controls. Numerous studies, including those conducted in Bangladesh, have identified SUA as a positive predictor of hypertension.[17,18,23-32]

In the present study, it was observed that, the mean SUA level was significantly higher in hypertensive group (6.5±0.9 mg/dl) than the normotensive control group (5.6±0.9 mg/dl). The present study findings were similar to the previous works in Bangladesh. In the study of Ahammed et al.[17] the SUA levels were 6.10±0.88 and 5.38±0.54 mg/dl, respectively in hypertensive and normotensive control group. The mean SUA level was comparatively lower in the study of Kashem et al.[18] where the mean SUA levels were 5.8 ± 1.5 4 and 4.5 ± 1.2 mg/dl, respectively in hypertensive

and normotensive control group. Poudel et al[30] from Nepal observed similar significant difference in mean SUA levels between hypertensive and normotensive individuals, but the SUA levels were comparatively lower than the present study (4.8 and 4.1 mg/dl, respectively in hypertensive and normotensive individuals). It is to be noted that, none of the mentioned studies including the present one was a community based epidemiological study. These were institution-based study with limited sample size, which might be attributable for the difference in their mean SUA levels in hypertensive and normotensive groups.

When SUA levels were categorized as normal and high level, it was observed that, the proportion of participants with hyperuricemia was significantly higher in the case group (40.5%) than the control group (9.5%) in the present study, which was similar to most of the studies done in this part of the world. Despite a large range in the reported rates observed, numerous researchers worldwide have discovered that people with essential hypertension had a higher frequency of hyperuricemia than normotensive subjects. Hyperuricemia was present in 28.3% of persons with essential hypertension in Nepal, this frequency was 55.4% in Egypt, 37.4% in Pakistan, and 34% in India.[31,32--34]The prevalence of hyperuricemia among hypertensive and normotensive individuals was reported to be 25.4% and 9.8%, respectively, in a previous study carried out in Bangladesh by Kashem et al. and 29.7% and 6.0%, respectively, in the Ahmed et al. study.[17,18]

There are numerous confounding factors including age, sex, family history of hypertension, obesity, alcohol consumption, salt intake, fluid volume status, tobacco consumption, etc. in the association of hyperuricemia and hypertension.[16,31]After adjusting for age and sex and accounting for confounding factors like BMI and a family history of hypertension, the current study demonstrated a significant correlation between hyperuricemia and hypertension. Recent research has demonstrated a positive association between Serum Uric Acid (SUA) levels and hypertension in adult populations in Bangladesh, China and Japan that is consistent with the result of present study.[16,17,25,65,28,29]

Limitation

The cross-sectional design, limited sample size, and data from two OPD of a single tertiary hospital in Chattogram could restrict generalizability and create bias. Selection bias could also arise from the control group's selection.

Conclusion

This study inferred that elevated level of SUA is significantly associated with newly diagnosed hypertension while controlling the effect of confounding factors like age, gender, family history of hypertension. The findings indicated that hyperuricemia might be a therapeutic target for the prevention of hypertension or at leastdelay the onset hypertension, provided rationale for the design of future interventional studies.

Recommendation

More prospective research is required to confirm the relevance of elevated serum uric acid with essential hypertension in Bangladeshi population, and it should be taken into account in conjunction with other risk factors for the prevention of hypertension.

Acknowledgement

We researchers pay our heartiest gratitude to our participating patients and patient’s relatives, nurse and doctors of Chittagong Medical College Hospital who helped us in carrying out this study and without whom the study would not have been possible.

Contribution of authors

SD- Conception, design, data collection and final approval.

NT- Conception, critical revision, design and final approval.

SM- Data collection, drafting and final approval

SD- Design, interpretation of data and final approval.

HH- Conception, data analysis, drafting and final approval.

MB- data analysis, drafting and final approval.

Disclosure

All the authors declared no conflict of interest.

References

1. Singh S, Shankar R, Singh GP. Prevalence and Associated Risk Factors of Hypertension: A Cross-Sectional Study in Urban Varanasi. Int J Hypertens. 2017;2017:5491838.

2. Queasem I, Shetye SM, Alex SC. Prevalence, awareness, treatment, and control of hypertension among the elderly in Bangladesh and India. Bull World Health Organ. 2001;79(6):490-500.

3. National Institute of Population Research Training. Bangladesh Demographic and Health Survey 2017–18. Dhaka, Bangladesh: NIPORT/ICF. 2020.

4. Chowdhury MZ, Rahman M, Akter T, Akhter T, Ahmed A, Shovon MA, Farhana Z, Hypertension prevalence and its trend in Bangladesh: Evidence from a systematic review and meta-analysis. Clinical hypertension. 2020; 26:1-9.

5. Poudel B, Yadav BK, Kumar A, Jha B, Raut KB. Serum uric acid level in newly diagnosed essential hypertension in a Nepalese population: A hospital-based cross-sectional study. Asian Pac J Trop Biomed. 2014;4(1):59-64.

6. Neki NS, Tamilmani.A Study of Serum Uric Acid level in Essential Hypertension. J Int Med Sci Academy. 2015; 28(1):13.

7. Shah M, Godbole V, Parmar U, Gosai F, Pathak T. A study to assess the relationship between Uric Acid and Blood pressure among patients attending tertiary care hospital in Central Gujarat. Int J Res Med. 2015;4(3):24-28.

8. Shankar A, Klein R, Klein BE, Nieto FJ. The association between serum uric acid level and the long-term incidence of hypertension: Population-based cohort study.J Hum Hypertension. 2006;20(12):937-945.

9. Erick Prado de Oliveira, Fernando Moreto, Luciana Vaz de Arruda Silveira, and Roberto Carlos Burini.Dietary, anthropometric, and biochemical determinants of uric acid in free-living adults, Nutrition Journal. 2013;12:11 www. nutrition .com /content/12/1/11.

10. Verdecchia P, Schillaci G, Reboldi G, Santeusanio F, Porcellati C, Brunetti P. Relation between serum uric acid and risk of cardiovascular disease in essential hypertension. The PIUMA study. hypertension. 2000;36(6):1072-1078.

11. Mellen PB, Bleyer AJ, Erlinger TP, Evans GW, Nieto FJ, Wagenknecht LE, et al. Serum uric acid predicts incident hypertension in a Biethnic Cohort: The Atherosclerosis Risk in Communities Study. Hypertension. 2006;48(6):1037-1042.

12. Buzas R, Tautu OF, Dorobantu M, Ivan V, Lighezan D. Serum uric acid and arterial hypertension-Data from Sephar III survey. PLoS One. 2018;13:e0199865.

13. Corry DB, Eslami P, Yamamoto K, Ny by MD, Makino H, Tuck ML. Uric acid stimulates vascular smooth muscle cell proliferation and oxidative stress via the vascular renin-angiotensin system. J Hypertens. 2008;26(2):269-275.

14. Higashi Y, Kihara Y, Noma K. Endothelial dysfunction and hypertension in aging. Hypertens Res. 2012;35(11):1039-1047.

15. Kang DH, Park SK, Lee IK, Johnson RJ. Uric acid-induced C-reactive protein expression: implication on cell proliferation and nitric oxide production of human vascular cells. J Am Soc Nephrol. 2005;16(12):3553-3562.

16. Ali N, Mahmood S, Islam F, Rahman S, Haque T, Islam S et al. Relationship between serum uric acid and hypertension: A cross-sectional study in Bangladeshi adults. Scientific reports. 2019;9(1):1-7.

17. Ahammed SK, Hasan AK, Kabir MR, Paul G, Basak SK, Chakraborty SR, et al. Serum uric acid level in Bangladeshi adults with essential hypertension. International Journal of Advances in Medicine. 2020;7(7):1136.

18. Kashem MA, Hossain MZ, Ayaz KM, Alam MB, Khan MH, Alam AB, et al. Relation of serum uric acid level and essential hypertension among patients without metabolic syndrome. Journal of Dhaka Medical College. 2011;20(1):5-8.

19. Song et al.Prevalence and correlates of hyperuricemia in the middle-aged and older adults in China. Scientific Reports. 2019;8:4314.

20. Unger T, Borghi C, Charchar F, Khan NA, Poulter NR, Prabhakaran D, Ramirez A, Schlaich M, Stergiou GS, Tomaszewski M, Wainford RD. 2020 International Society of Hypertension global hypertension practice guidelines. Hypertension. 2020;75 (6):1334-1357.

21. Bull FC et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour.Br J Sports Med. 2020;54:1451–1462.

22. Pan WH, Yeh WT. How to define obesity? Evidence-based multiple action points for public awareness, screening, and treatment: An extension of Asian-Pacific recommendations. Asia Pac J ClinNutr. 2008.

23. World Health Organization. Non-communicable disease risk factor survey, Bangladesh. 2010

24. Misra A, Shrivastava U. Obesity and dyslipidemia in South Asians. Nutrients. 2013 Jul 16; 5 (7):2708-2733.

25. Ali N, Miah R, Hasan M, Barman Z, Mou AD, Hafsa JM, Trisha AD, Hasan A, et al. Association between serum uric acid and metabolic syndrome: A cross-sectional study in Bangladeshi adults. Scientific Reports. 2020;10(1):1-7.

26. Huda N, Hossain S, Rahman M, Karim MR, Islam K, Al Mamun A et al. Elevated levels of plasma uric acid and its relation to hypertension in arsenic-endemic human individuals in Bangladesh. Toxicology and applied pharmacology. 2014;281(1):11-18.

27. Cheng W, Wen S, Wang Y, Qian Z, Tan Y, Li H, et al. The association between serum uric acid and blood pressure in different age groups in a healthy Chinese cohort. Medicine. 2017;96(50): e8953.

28. Yu C, Ren X, Pan L, Zhao H, Wang Y, Chang L et al. Association between serum uric acid and hypertension in Han and Yugur of Gansu province: The China National Health Survey. Kidney and Blood Pressure Research. 2021;46(6):723-733.

29. Kansui Y, Ohtsubo T, Goto K, Sakata S, Ichishima K, Fukuhara M et al. Association of Serum Uric Acid With Blood Pressure in Japanese Men–Cross-Sectional Study in Work-Site Group–. Circulation Journal. 2011;75(12):2827-2832.

30. Kuwabara M, Niwa K, Nishi Y, Mizuno A, Asano T, Masuda K et al. Relationship between serum uric acid levels and hypertension among Japanese individuals not treated for hyperuricemia and hypertension. Hypertension Research. 2014;37(8):785-789.

31. Kuwabara M, Hisatome I, Niwa K, Hara S, Roncal-Jimenez CA, Bjornstad P et al. Uric acid is a strong risk marker for developing hypertension from prehypertension: A 5-year Japanese cohort study. Hypertension. 2018;71(1):78-86.

32. 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;16(9):e0256557.

33. Poudel B, Yadav BK, Kumar A, Jha B, Raut KB. Serum uric acid level in newly diagnosed essential hypertension in a Nepalese population: A hospital based cross sectional study. Asian Pacific journal of tropical biomedicine. 2014;4(1):59-64.

34. Afifi A, Sarhan I, El Sharkawy M, Kamel M, Anwar W, Helmy N et al. Uric acid metabolism in a sample of Egyptian hypertensive patients with normal kidney function. The Egyptian Journal of Hospital Medicine. 2013;52(1):608-614.