Content available at: https://www.ipinnovative.com/open-access-journals

Indian Journal of Clinical Anatomy and Physiology

Journal homepage: https://www.ijcap.org/

Original Research Article

A study on association of serum uric acid and blood pressure in hypertensives at a tertiary care centre

Malika Noorjehan Samozai[1], Rajashree Devarapalli[1], K Ranjith Babu[2,*]

[1]*Dept. of Physiology, Mallareddy Medical College for Women, Hyderabad, Telangana, India*
[2]*Dept. of Physiology, Dr. Patnam Mahender Reddy Institute of Medical Sciences, Chevella, Telangana, India*

ARTICLE INFO

Article history:
Received 19-10-2021
Accepted 13-11-2021
Available online 07-12-2021

Keywords:
Hypertension
Serum uric acid
Uricemia
SBP
DBP
BMI

ABSTRACT

Hypertension(HTN) is the most common and significant cardiovascular disease because of its prevalence and severity of the damage to the mankind globally. Hyperuricemia, a condition of increased levels of Serum Uric acid (UA) has been proposed to have an association with hypertension in various studies. In certain studies, serum uric acid levels has been found to be an independent predictor for developing hypertension. On the basis of the above observations, we have proposed to the present study to compare the relationship between serum UA and hypertension in a single cohort with adjustment of all possible confounding factors.

A total of 245 subjects were enrolled in this study during a regular routine health checkup. All subjects were informed about the study aims Individuals having a known history of gout and cardiac or severe renal diseases and patients who are already under medication for anti-hyperuricemic were excluded from the study. General information like Name, Age, Sex, Occupation, Address along with history of any drug intake and anthropometric indices - body weight (BW), body height (BH), hip circumference (HC), waist circumference (WC), and lifestyle information have been obtained. The data has been arranged in tables with mean ± SD for further analysis. The data is analyzed using IBM SPSS version 23. The difference between the groups for baseline variables was done by independent sample t-test (two-tailed). Pearson's correlation coefficient test was performed to assess the interrelationships between baseline variables and SUA concentrations. The differences for the variables among the groups was determined by using One-way ANOVA.

Of the 245 subjects, mean age of the participants was 42.4 ± 8.4 years (range 18–70 years). There was no significant difference in the mean levels of Height, Weight and BMI between the two groups. Mean levels of WC, HC were significantly different between two group ($p < 0.05$) subjects. The mean levels of SBP and DBP were also significantly more in the hypertensive subjects ($p < 0.001$). In Pearson's correlation coefficient test, SUA levels were significantly related with SBP and DBP. In this study, we have observed comparatively a stronger relationship for SUA concentration with hypertension and prehypertension in the participants.

The extended mechanism for the effect of SUA on hypertension is yet to be elucidated. There are some hypotheses partly explain the association between SUA and high blood pressure. One of the possible mechanism might be uric acid deposition on the blood vessels walls activates the renin-angiotensin system, suppress the liberate of carbon monoxide, enhance inflammation, and leads to vasoconstriction on later stage, which consequently leads to hyperplasia and incidence of hypertension. Another possibility involving oxidative stress and endothelial dysfunction associated with high SUA levels may contribute to high blood pressure.

https://doi.org/10.18231/j.ijcap.2021.058

1. Introduction

Hypertension(HTN) is the most common and significant cardiovascular disease because of its prevalence and severity of the damage to the mankind globally. In India also, the prevalence and occurrence of HTN is increasing regularly and also found to be associated with certain age, sex, occupation, life style etc., resulting in increase of morbidity and mortality. These effects of HTN are known to be relate with incidence of myocardial infarction, heart failure, stroke, and renal failure.[1–4]

Hyperuricemia, a condition of increased levels of Serum Uric acid (UA) has been proposed to have an association with hypertension in various studies. In certain studies, serum uric acid levels has been found to be an independent predictor for developing hypertension.[5–7] Irrespective of the different ethnic origins & regions, a certain association between serum UA and blood pressure (BP) has been seen in African-Americans and whites[8,9] as well as in the Asians[7,10] including Koreans.[11–13] In the study of causal role of serum UA in the development of hypertension, Mazzali et al.[14] observed an elevation in the levels of serum UA followed by an increase in BP via a crystal-independent mechanism in rat models. Further it has also been found that reduction of serum UA was associated with a decrease in BP through the regulation of renin-angiotensin and nitric oxide system.[15]

On the basis of the above observations, we have proposed to the present study to compare the relationship between serum UA and hypertension in a single cohort with adjustment of all possible confounding factors. This study is focused on the association between serum UA and hypertension.

2. Materials and Methods

A total of 245 subjects (123 hypertensives and 122 normotensives; age >18 years) were enrolled in this study during a regular routine health checkup. All subjects were informed about the study aims and written informed consent was obtained from them prior to enrollment in the study. Individuals having a known history of gout and cardiac or severe renal diseases and patients who are already under medication for anti-hyperuricemic were excluded from the study. Ethical Clearance was obtained from the Institutional Ethical Committee, Dr.Patnam Mahender Reddy Institute of Medical Sciences, Chevella, Telangana. The procedure and the methods used in the present study were in accordance with the institutional guidelines and regulations.

General information like Name, Age, Sex, Occupation, Address along with history of any drug intake and anthropometric indices - body weight (BW), body height (BH), hip circumference (HC), waist circumference (WC), and lifestyle information have been obtained. BW was measured to the nearest 0.1 kg using a calibrated digital weighing machine and BH was recorded to the nearest 0.1 cm using a height measuring tape. Body mass index (BMI) was calculated as the weight in kg divided by height in meter square. WC was measured by placing the tape horizontally midway between the iliac crest on the mid-axilliary line and the ribs lowest border. HC was measured at the largest circumference of the buttocks. Blood pressure (BP) was measured by trained professionals using a digital BP machine (Omron M10, Omron Corporation, Tokyo, Japan) on the left arm in a sitting position after atleast 10 minutes of rest. Three recordings of blood pressure as systolic and diastolic blood pressure (SBP and DBP) has been taken after a minimum of 5 minutes of rest to avoid any possible effects of anxiety and with an interval of 5 minutes. The venous blood samples were obtained after an overnight fasting (≥12hrs). The blood sample was centrifuged and serum was stored at −20 °C for further analysis. The concentration of SUA, and serum lipids: total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C), were determined calorimetrically using commercially available diagnostic kits (Human Diagnostic, Germany). All the biochemical tests were measured using a auto-analyzer (Humalyzer 3000, USA). Hypertension was defined as SBP ≥ 140 mm Hg and/or DBP ≥ 90 mm Hg and prehypertension as when SBP 120–139 mm Hg; and/or DBP 80–89 mm Hg.[16] Hyperuricemia was defined as SUA levels >416.4 μmol/L (7.0 mg/dL) in men and >356.9 μmol/L (6.0 mg/dL) in women.[17,18] The participants were divided into groups – Normotensives and hypertensives and the prevalence of Urecemia in correlation with hypertension was studied in each group.

The data has been arranged in tables with mean ± SD for further analysis. The data is analyzed using IBM SPSS version 23. The difference between the groups for baseline variables was done by independent sample t-test (two-tailed). Pearson's correlation coefficient test was performed to assess the interrelationships between baseline variables and SUA concentrations. The differences for the variables among the groups was determined by using One-way ANOVA analysis. The relationship between SUA and hypertension was evaluated by logistic regression modeling. A p-value < 0.05 was considered to be statistically significant.

3. Results

In our present study, increased Serum Uric Acid levels is significantly related to incidence of hypertension.

The baseline characteristics of all the subjects are presented in Table 1. Of the 245 subjects, mean age of the participants was 42.4 ± 8.4 years (range 18–70 years).

* *Corresponding author*.
E-mail address: drranjithbabu@gmail.com (K. R. Babu).

Table 1: Baseline characteristics of each group by age

Variables	Total	Normotensives	Hypertensives
	Mean±SD	Mean±SD	Mean±SD
Age (years)	42.4±8.4	32.4±4.5	58.1±4.6
Height (cms)	164.4±5.1	166.4±5.4	160±1.2
Weight (kgs)	65.4±11.5	66.1±19.4	60.5±15.6
Waist circumference (cms)	69.4±34.4	62.4±35.4	78.4±27.8
Hip circumference (cms)	94.5±4.6	94.4±5.4	98.5±4.5
BMI (Kg/m^2)	22.6±4.6	23.4±2.4	22.4±1.5
SBP (mmHg)	138.5±15.6	120.4±15.4	154.5±17.5
DBP (mmHg)	82.4±5.6	86.1±5.2	90.4±4.6
Serum UA (mg/dl)	7.3±1.2	6.1±1.4	8.1±1.1
Total Cholesterol (mg/dl)	185.4±26.4	188.5±34.5	194.5±25.4
HDL (mg/dl)	51.3±15.2	50.6±21.6	58.1±19.5
Tg (mg/dl)	106±64.4	126.4±45.6	146.1±41.6
LDL (mg/dl)	104±45.5	155.4±56.4	156±40.4

There was no significant difference in the mean levels of Height, Weight and BMI between the two groups. Mean levels of WC, HC were significantly different between two group ($p < 0.05$) subjects. The mean levels of SBP and DBP were also significantly more in the hypertensive subjects ($p < 0.001$). In Pearson's correlation coefficient test, SUA levels were significantly related with SBP and DBP ($p < 0.001$). Hypertensives have been found to have increased mean levels of SUA than in the normotensive subjects ($p < 0.001$). The average level of TG and HDL-C were also significantly different between the groups ($p < 0.001$). Overall, hyperuricemia prevalence was 9.7% with 0.9% in normotensive and 9.3% in hypertensive subjects.

4. Discussion

The present study reveals a positive association between elevated SUA levels and hypertension in a general adult cohort. This association was persisted after adjustment for age, sex, BMI, and lipid profile. An increasing trend for the incidence of prehypertension and hypertension was found with elevated levels of SUA in the quartiles. Some studies have demonstrated the relationship between hyperuricemia and hypertension in adult population.[19–24] A study of Japanese adults has showed that hypertension OR was 1.20 for each 1 mg/dL increase in SUA concentration.[19] Another cross-sectional study in US observed elevated SUA levels were positively associated with prehypertension, and the multivariate OR comparing highest quartile of SUA (>356.9 μmol/L) with the lowest quartile (<237.9 μmol/L) was 1.96 (1.38–2.79).[23] Another study conducted of non-hypertensives in US reported multivariate relative risk was 1.65 when compared to the highest quartile with the lowest quartile.[22] Framingham Heart Study, after examining the participants for 4 years, have reported increased SUA levels by each standard deviation was related with an OR of 1.17 for developing hypertension.[25] Similar to our findings, in some recent studies, a positive association between SUA and hypertension was found in adult cohorts of China and Korea.[26–29]

In this study, we have observed comparatively a stronger relationship for SUA concentration with hypertension and prehypertension in the participants. It is known that hypertensives with uricemia are more vulnerable to hypertension.[30] The extended mechanism for the effect of SUA on hypertension is yet to be elucidated. There are some hypotheses partly explain the association between SUA and high blood pressure. One of the possible mechanism might be uric acid deposition on the blood vessels walls activates the renin-angiotensin system, suppress the liberate of carbon monoxide, enhance inflammation, and leads to vasoconstriction on later stage, which consequently leads to hyperplasia and incidence of hypertension.[31–34] Another possibility involving oxidative stress and endothelial dysfunction associated with high SUA levels may contribute to high blood pressure.[35]

Our study had a few limitations. First, the cross-sectional design of this study may preclude the cause-effect relationships between SUA concentrations and hypertension being assumed. Second, the sample size of this study was relatively small; therefore, the findings may not represent for the whole population. Third, we did not have individual information on family history of hypertension and physical activity which may affect the incidence of high blood pressure. Moreover, all participants of this study were apparently healthy adults; whether our finding is similar in other ethnic populations needs to be further studied. However, this study findings are worthy as a reference for future investigations. Further studies are required to establish the potential mechanism between SUA and hypertension in humans.

5. Conclusions

Increased levels of SUA were positively associated with hypertension among general adults. The SUA quartiles

also showed significant correlation with SBP and DBP. Our study findings suggest an independent relationship of elevated SUA with hypertension and indicate the significance of maintaining normal SUA concentration to prevent hypertension. Early and proper management of SUA levels, as well as blood pressure, may be useful in preventing the development of future CVDs.

6. Source of Funding

None.

7. Conflict of Interest

The authors declare no conflict of interest.

References

1. Feig DI, Johnson RJ. Hyperuricemia in childhood primary hypertension. *Hypertension*. 2003;42:247–52.
2. Coresh J, Wei GL, Mcquillan G, Brancati FL, Levey AS, Jones C, et al. Prevalence of high blood pressure and elevated serum creatinine level in the United States: findings from the third National Health and Nutrition Examination Survey (1988-1994). *Arch Intern Med*. 2001;161:1207–16.
3. Park JK. Epidemiology of hypertension. *J Korean Soc Hypertens*. 1995;1:6–17.
4. Kim JS, Lee HC, Yoo WS, Yoo UH. Mean blood pressure, prevalence and epidemiologic characteristics of hypertension among representative Korean adult population. *J Korean Soc Hypertens*. 1998;4:89–98.
5. Jossa F, Farinaro E, Panico S, Krogh V, Celentano E, Galasso R. Serum uric acid and hypertension: the Olivetti heart study. *J Hum Hypertens*. 1994;8:677–81.
6. Brand FN, Mcgee DL, Kannel WB, Stokes J, Castelli WP. Hyperuricemia as a risk factor of coronary heart disease: the Framingham study. *Am J Epidemiol*. 1985;121:11–8.
7. Kansui Y, Ohtsubo T, Goto K, Sakata S, Ichishima K, Fukuhara M. Association of serum uric acid with blood pressure in Japanese men. Crosssectional study in work-site group. *Circ J*. 2011;75:2827–32.
8. Longo-Mbenza B, Luila EL, Mbete P, Vita EK. Is hyperuricemia a risk factor of stroke and coronary heart disease among Africans? *Int J Cardiol*. 1999;71:17–22.
9. Klein R, Klein BE, Cornoni JC, Maready J, Cassel JC, Tyroler HA. Serum uric acid: its relationship to coronary heart disease risk factors and cardiovascular disease. *Arch Intern Med*. 1973;132:401–10.
10. Kuwabara M, Niwa K, Nishi Y, Mizuno A, Asano T, Masuda K. Relationship between serum uric acid levels and hypertension among Japanese individuals not treated for hyperuricemia and hypertension. *Hypertens Res*. 2014;37:785–9.
11. Kim YH, Suh YD, Son SP, Shim YW, Shin YW, Shin YK. Observation of the serum uric acid in essential hypertension. *Korean J Med*. 1985;28:56–63.
12. Chin HJ, Na KY, Kim Y, Chae DW, Kim S. The impact of uric acid and metabolic syndrome on the incidence of hypertension in a Korean population. *Korean J Med*. 2007;73:58–66.
13. Yoo TW, Sung KC, Kim YC, Hwang ST, Oh SY, Shin HS. The relationship of the hypertension, insulin resistance, and metabolic syndrome in the serum uric acid level. *Korean Circ J*. 2004;34:874–82.
14. Mazzali M, Hughes J, Kim YG, Jefferson JA, Kang DH, Gordon KL. Elevated uric acid increases blood pressure in the rat by a novel crystalindependent mechanism. *Hypertension*. 2001;38:1101–6.
15. Mazzali M, Kanellis J, Han L, Feng L, Xia YY, Chen Q. Hyperuricemia induces a primary renal arteriolopathy in rats by a blood pressure independent mechanism. *Am J Physiol Renal Physiol*. 2002;282:991–7.
16. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL, et al. Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Hypertension*. 2003;42:1206–52.
17. Sui X, Church TS, Meriwether RA, Lobelo F, Blair SN. Uric acid and the development of metabolic syndrome in women and men. *Metabolism*. 2008;57:845–52.
18. You L, Liu A, Wuyun G, Wu H, Wang P. Prevalence of hyperuricemia and the relationship between serum uric acid and metabolic syndrome in the Asian Mongolian area. *J Atheroscler Thromb*. 2014;21:355–65.
19. Kuwabara M, Niwa K, Nishi Y, Mizuno A, Asano T. Relationship between serum uric acid levels and hypertension among Japanese individuals not treated for hyperuricemia and hypertension. *Hypertens Res*. 2014;37(8):785–9. doi:10.1038/hr.2014.75.
20. Perlstein TS, Gumieniak O, Williams GH, Sparrow D, Vokonas PS. Uric acid and the development of hypertension: the normative aging study. *Hypertension*. 2006;48(6):1031–6. doi:10.1161/01.HYP.0000248752.08807.4c.
21. Sundström J, Sullivan L, D'Agostino RB, DLevy, Kannel WB, Vasan RS. Relations of serum uric acid to longitudinal blood pressure tracking and hypertension incidence. *Hypertension*. 1979;45(1):28–33. doi:10.1161/01.HYP.0000150784.92944.9a.
22. Shankar A, Klein R, Klein BEK, Nieto FJ. The association between serum uric acid level and long-term incidence of hypertension: Population-based cohort study. *J Hum Hypertens*. 2006;20:937–45.
23. Syamala S, Li J, Shankar A. Association between serum uric acid and prehypertension among US adults. *J Hypertens*. 2007;25:1583–9.
24. Yokokawa H. Association Between Serum Uric Acid Levels/Hyperuricemia and Hypertension Among 85,286 Japanese Workers. *J Clin Hypertens*. 2016;18:53–59.
25. Culleton BF, Larson MG, Kannel WB, Levy D. Serum uric acid and risk for cardiovascular disease and death: the Framingham Heart Study. *Ann Intern Med*. 1999;131:7–13.
26. 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 (Baltimore)*. 2017;96:8953.
27. Cui L, Shi HJ, Wu S, Shu R, Liu N, Wang GY, et al. Association of serum uric acid and risk of hypertension in adults: a prospective study of Kailuan Corporation cohort. *Clin Rheumatol*. 2017;36:1103–10.
28. Lai X, Yang L, Légaré S, Angileri F, Chen X, Fang Q, et al. Dose-response relationship between serum uric acid levels and risk of incident coronary heart disease in the Dongfeng-Tongji Cohort. *Int J Cardiol*. 2016;224:299–304. doi:10.1016/j.ijcard.2016.09.035.
29. Lee JJ, Ahn J, Hwang J, Han SW, Lee K, Kim JB, et al. Relationship between uric acid and blood pressure in different age groups. *Clin Hypertens*. 2015;21:14. doi:10.1186/s40885-015-0022-9.
30. Grayson PC, Kim SY, Lavalley M, Choi HK. Hyperuricemia and incident hypertension: A systematic review and metaanalysis: Risk of Incident Hypertension Associated With Hyperuricemia. *Arthritis Care Res*. 2011;63:102–10.
31. Sarki AM, Nduka CU, Stranges S, Kandala NB, Uthman OA. Prevalence of Hypertension in Low- and Middle-Income Countries: A Systematic Review and Meta-Analysis. *Medicine (Baltimore)*. 2015;94:1959.
32. Bjornstad P, Wadwa RP, Sirota JC, Snell-Bergeon JK, McFann K, Rewers M, et al. Serum uric acid and hypertension in adults: a paradoxical relationship in type 1 diabetes. *J Clin Hypertens*. 2014;16:283–8.
33. Gois PHF, Souza ERM. Pharmacotherapy for hyperuricemia in hypertensive patients. *Cochrane Database Syst Rev*. 2017;(4):CD008652. doi:10.1002/14651858.CD008652.
34. Ma YC, Zuo L, Chen JH, Luo Q, Yu XQ, Li Y, et al. Modified glomerular filtration rate estimating equation for Chinese patients with chronic kidney disease. *J Am Soc Nephrol*. 2006;17(10):2937–44.
35. Khosla UM, Zharikov S, Finch JL, Nakagawa T, Roncal C, Mu W. Hyperuricemia induces endothelial dysfunction. *Kidney Int*. 2005;67(5):1739–42. doi:10.1111/j.1523-1755.2005.00273.x.

Author biography

Malika Noorjehan Samozai, Associate Professor

Rajashree Devarapalli, Professor

K Ranjith Babu, Assistant Professor https://orcid.org/0000-0003-1637-670X

Cite this article: Samozai MN, Devarapalli R, Babu KR. A study on association of serum uric acid and blood pressure in hypertensives at a tertiary care centre. *Indian J Clin Anat Physiol* 2021;8(4):264-268.