

# The Relationship between Uric Acid and Hypertension in Adults in Fako Division, SW Region Cameroon

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## Abstract

Uric acid has been associated with hypertension in many studies involving different populations but little or no information was found on this association in a Cameroonian population. The aim of this study therefore was to correlate serum uric acid concentrations with blood pressure measurements in individuals who are hypertensive, pre-hypertensive and normotensive, and to investigate the possibility of existence of an association between uric acid levels and other risk factors for hypertension. A total of 297 adults from Fako Division participated in the study. Blood pressure, serum uric acid, fasting blood glucose (subjects with  $\geq 110$ mg/dl were excluded), lipids, body mass index and waist circumference were measured. Individuals who were pre-hypertensive had the highest mean uric acid concentration which was significantly higher than that for normotensives ( $P < 0.0001$ ). There was a significant positive correlation between uric acid with systolic and diastolic blood pressure ( $P < 0.0001$ ;  $P < 0.0001$ ), respectively. A significant positive correlation was also observed between serum uric acid levels with gender, age, triglycerides and life style patterns ( $P < 0.0001$ ). However, adjusting for these confounders did not change the increasing trend observed between serum uric acid with both systolic and diastolic blood pressure.

**Keywords:** Uric acid; Systolic blood pressure; Diastolic blood pressure; Triglycerides

## Introduction

Uric acid is a byproduct of purine metabolism produced in blood from endogenous purine (2/3) substances or from diet (1/3). Alcoholic and high-purine foods consumption, low water consumption and poorly exercising are contributing factors responsible for hyperuricemia. Its normal level in the body is  $< 7$  mg/dl in men and  $< 6$  mg/dl in women, based on the limits of solubility of the monosodium urate in serum at a temperature of  $36.8^{\circ}\text{C}$  [1]. The amount of urate in the body is affected by the balance of its production and excretion. Conditions associated with urate overproduction and reduced renal excretion also causes hyperuricemia. Urate overproduction, which is the primary mechanism for hyperuricemia in 10 percent of the general population, is seen in conditions with high cellular turnover, genetic errors, and tumor lysis syndrome. Inefficient urate excretion, which accounts for 90 percent of cases of hyperuricemia, occurs in renal insufficiency of any cause and with certain medications. Hyperuricemia is a level of uric acid in the blood that is abnormally high [2]. Men have a greater risk of developing hyperuricemia than women in all age groups, although the sex ratio tends to equalize with advancing age [3]. Hyperuricemia is becoming an increasing problem all over the world with a steady increase in its prevalence [4].

The association of hyperuricemia with hypertension has long been recognized with early investigators such as Frederick Mahomed [1], Alexander Haig [5], and Nathan Smith Davis [6,7], hypothesizing that uric acid might be a cause of hypertension or renal disease. Uric acid is thought to play a pathogenic role in hypertension mediated by several mechanisms such as inflammation, vascular smooth muscle cell proliferation in renal microcirculation, endothelial dysfunction and activation of the renin – angiotensin – aldosterone system [8-11]. Furthermore, studies have shown that in overweight and obese subjects, hyperinsulinemia secondary to insulin resistance may enhance the

reabsorption of uric acid and thus contribute to the association of hyperuricemia with hypertension [12]. The increasing prevalence of hypertension in Cameroon [13-15] coupled with the forecast that by the year 2020, non-communicable diseases such as cardiovascular diseases will be the major causes of morbidity and mortality in developing countries, accounting for almost four times as many deaths as from communicable diseases [16] warrant that weight be assigned to the individual risk factors of hypertension and the existence of any possible interaction between them as this will improve the efficiency of prevention strategies. However given that the results linking uric acid and hypertension are not entirely consistent [17,18], this study was carried out to investigate the relationship between uric acid and hypertension in Cameroonian adults.

## Methods

### Study population

The study participants constituted of individuals with hypertension (20 years and above) and apparently healthy people (20 years and above) who served as controls and consented to be part of the study.

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Sensitization was done through announcements in local churches and radio stations in the communities, asking willing participants to come to the health facilities (Limbe Regional Hospital and Buea Regional Hospital) following an overnight fast. The objectives, risk/benefits were explained, after which written informed consents were freely given by volunteers following a question/answer session. Volunteers were assisted to complete a structured questionnaire that contained information on general state of health, physical activity, smoking, alcohol consumption and dietary patterns. It was a cross-sectional study carried out from April 2011–September 2011. Ethical clearance was obtained from the Regional Delegation of Public Health in the SW Region Cameroon prior to the commencement of the research (Ref. Number: R011MPH/SWR/RDPH/FP-R /3909/74 of 20/07/2011). After seeking and obtaining informed consent from each participant. All participants were individually interviewed with a structured questionnaire and information on gender, age, weight, height, waist circumference, hip circumference, smoking status, physical exercise status and diet was recorded. Body mass index (BMI) and waist to hip ratio (WHR) determined. Fasting blood samples were then collected for the measurement of uric acid, glucose, lipids and creatinine. Individuals with a fasting plasma glucose  $\geq 110$  mg/dl, gout, history of cardiovascular or kidney disease, pregnant females and estimated glomerular filtration rate values out of the normal were excluded. Written consent was obtained from each individual before enrolment.

### Blood pressure measurement

Blood pressure was measured 3 times consecutively in the right arm placed at the heart level using an automatic blood pressure measuring device OMRON 907 (OMRON, Hoofddorp, The Netherlands) after the subjects had rested for at least 10 minutes in a sitting position. The measurements were taken 60 seconds apart and the average systolic and diastolic blood pressures were recorded and used for our analyses. Hypertension was defined as a systolic blood pressure  $\geq 140$  mmHg and or diastolic pressure  $\geq 90$  mmHg, Pre-hypertension as systolic pressure 120-139 mmHg and or diastolic pressure 80-89mmHg and normotension as systolic pressure  $<120$  mmHg and diastolic blood pressure as  $<80$  mmHg according to the seventh report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC-7) [19].

### Measurement of biochemical markers

Venous blood samples were drawn from all participants after an overnight fast (8-12 h) after which they were allowed to clot at room temperature for 1-3 h and the serum separated by centrifugation for 15 min at 3000 rpm. From these samples, uric acid, triglycerides, cholesterol, HDL- cholesterol and creatinine were measured. Glucose was measured from venous blood collected into a sodium fluoride tube. LDL-cholesterol was calculated using the Friedewald equation and the estimated glomerular filtration rate was calculated using the Croft-Gault formula [20]. All biochemical assays were analyzed enzymatically on a spectrophotometer (Fortress Diagnostics) alongside human control sera.

### Statistical analyses

Statistical analyses were performed using SPSS Statistics 17.0 (SPSS Inc., Chicago, USA). Statistical results are presented as mean  $\pm$  standard deviation. The significance of differences in prevalence were explored using Pearson's Chi-square test whereas the differences in group means were assessed using Student's *t*-tests or analyses of variance (ANOVA) with Post Hoc Turkey. The levels of correlation between variables

were determined by calculating Pearson's correlation coefficients (*r*). A difference or correlation giving a P-value  $\leq 0.05$  was considered statistically significant.

## Results

### General characteristics of study population

The main clinical and anthropometric characteristics of the study population are represented in Supplementary Table 1. A total of 297 individuals 20 years and above from Fako Division, South-West Region were recruited for this study. It was made up 169 (56.9%) females and 128 (43.1%) males. These participants were divided according to their blood pressure status into hypertensive, pre-hypertensive and normotensive. Ninety seven (32.7%) of the study participants were hypertensive, 101 (34%) were found pre - hypertensive and 99 (33.3%) normotensive. The mean age of study participants was  $41.95 \pm 14.83$  years (range: 20-76 years) and mean BMI  $26.41 \pm 4.80$  kg/m<sup>2</sup> ( $17-44$  kg/m<sup>2</sup>) 169 (56.9%) were females. The mean systolic blood pressure was  $127.84 \pm 22.33$ (mmHg) with a range of 80-195 mmHg and the mean diastolic pressure was  $80.44 \pm 15.59$ (mmHg) with a range of 50-146 mmHg. The average uric acid concentration was  $5.84 \pm 2.18$  mg/dl (1.6-11. 92 mg/dl).

### Association between uric acid and hypertension

Supplementary Table 2 displays the prevalence of uricaemia with blood pressure category. One hundred and eighty seven (63%) of the total population had a normal uric acid (UA) concentration. Of this number, 47 (48.5%) were hypertensive, 51 (50.5%) pre-hypertensive and 89 (89.9%) normal. Ninety eight (33%) of total population had a high (UA) concentration, with 48 (49.5%) being hypertensive, 50 (49.5%) and pre-hypertensive. No body with a normal BP had a high UA concentration. 12(4%) people had low UA concentration, with 2(2.1%) being hypertensive and 10(10.1%) normal. There was a significant association in the prevalence UA concentration with BP category ( $\chi^2=80.166$ ;  $p<0.0001$ ).

Subjects were then placed in serum uric acid quartiles and their mean systolic and diastolic blood pressures compared. The mean levels of SBP (Systolic Blood Pressure) and DBP (Diastolic Blood Pressure) increased along with elevated levels of SUA (Supplementary Table 3).

### Association between uric acid and other hypertension risk factors

The association between uric acid and other risk factors of hypertension was analyzed. It was observed that there was a significant positive association between uric acid and triglycerides, smoking ( $r=0.377$ ;  $P<0.0001$ ), physical exercise ( $r=0.274$ ;  $P<0.0001$ ) and alcohol consumption ( $r=0.391$ ;  $P<0.0001$ ). Age showed a significant negative correlation with uric acid ( $r=-0.147$ ;  $P=0.011$ ) (Supplementary Table 4).

## Discussion

Hypertension is an increasingly important medical and public health issue worldwide, affecting approximately one billion individuals [19]. As a major risk factor for cardiovascular and renal morbidity and mortality, hypertension is one of the leading contributors to global disease burden, with its current prevalence in many developing countries, particularly in urban societies already as high as those seen in developed countries [21]. To be able to curb this rising prevalence it is necessary to study the individual risk factors and the possible existence

of interaction between them. Evidence from a number of studies [22-24] suggest that uric acid be added to the list of conventional risk factors of hypertension like obesity [25,26], age [27,28] renal disease [10,29], diabetes mellitus [30,31]. Uric acid has been implicated in hypertension through the probable role it is thought to play in mediating hypertension via mechanisms like inflammation, vascular smooth muscle cell proliferation in renal microcirculation, endothelial dysfunction and activation of the rennin – angiotensin – aldosterone system [8]. Given that not all epidemiological studies support uric acid as an independent risk factor for hypertension [18] coupled to the little or no information on the relationship between uric acid and hypertension in Cameroon was the reason why this study was carried out.

We found a significant independent association between uric acid with both systolic and diastolic blood pressure; an increase in both systolic and diastolic blood pressure was also marked by a corresponding increase in serum uric acid concentration. This is in conformity with several studies [8,22-24] wherein a similar trend was reported. There was a significant negative correlation between uric acid and age. This is in line with results from other studies [32,33]. Uric acid has been suggested to play a role in the pathogenesis of early onset hypertension [29] but the levels may tend to dampen with age where stiffening of the aorta, activation of the renin-angiotensin system and renal vasoconstriction have a role to play [24]. This may be the probable reason why those with pre-hypertension who were averagely younger had a higher mean UA concentration than hypertensive participants. However, Teng et al. [24] reported a contrary result wherein uric acid was associated with the risk of hypertension in the elderly. We also observed a significant correlation between uric acid and triglycerides. Triglycerides have been linked to insulin resistance which promotes hypertension through renal tubular sodium reabsorption, augmentation of the sympathetic nervous system reactivity and activation of the renin-angiotensin system [34]. Given that uric acid can also induce the Renin-angiotensin system it is possible that they both have an additive effect on the blood pressure response. Furthermore, we observed that people who smoked had a significantly higher mean uric acid concentration compared to those who did not, contrary from the results of a previous study [35]. The decrease of uric acid in smokers can be explained by the inactivation of xanthine oxidase by cyanide, which is eliminated as thiocyanate [35]. Nevertheless, there is some evidence that the increase of plasma uric acid is protective against the cardiovascular diseases, since uric acid acts as an endogenous antioxidant. Therefore, high plasma uric acid concentrations might be protective in situations characterized by an increase of cardiovascular risk and oxidative stress, such as smoking [36] a possible reason for the high uric acid concentration observed among smokers. In the same light, the high uric acid concentration observed in people who exercised could be because of its antioxidant property thus the raised levels to probably protect against exercise oxidative stress.

In conclusion we observed a significant positive association between uric acid with both systolic and diastolic blood pressure after controlling for confounding factors. The association was most evident in people with hypertension. We also observed a significant negative association between uric acid and age on hypertension.

## Limitations

First this was a cross-sectional study and so does not permit us to make any inference on the causal relationship between uric acid and

hypertension. Second given that blood pressure was only measured during one visit it is possible that some individuals were misclassified owing to the white coat effect. Third the limited sample size also limited the power of the analysis. It will be good for this study to be repeated with a larger sample size.

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