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Hyperuricaemia and its Relations with Serum Lipid Abnormalities in Untreated, Newly Diagnosed Adult Nigerian Hypertensive Patients

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Authors' contributions

This work was carried out in collaboration between all authors. Author AJF designed the study, wrote the protocol, executed the research and wrote the first and subsequent drafts of the manuscript. Author OAB managed the literature, reviewed and reconstructed the manuscript. Authors OGO and ABO were supervisors for the research and contributed in all stages of the work. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aims: To determine the prevalence of hyperuricaemia in adult Nigerians with untreated newly diagnosed hypertension and to evaluate its relations with serum lipid abnormalities.
Study Design: Cross-sectional study.
Place and Duration of Study: General Out-patient Department, Medical Out-patient Department and Emergency Room of the University of Ilorin Teaching Hospital, Ilorin, Nigeria between May 2007 and October 2007.
Methodology: One hundred and fifty (150) untreated newly diagnosed hypertensive patients 18 years and above and one hundred and fifteen (115) age and sex-matched normotensive individuals were recruited into the study. Thorough clinical evaluation and laboratory investigations were done for both patients and controls including serum uric acid and serum lipid profile.

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Atherogenic ratio (Total cholesterol/Low density lipoprotein-cholesterol) was calculated for both patients and controls.

Results: Of the one hundred and fifty newly diagnosed hypertensive patients, 52 (34.7%) were males and 98 (65.3%) females, with a range of 19-85 years and a mean age (±SD) of 50.4±12.3 years. Among the normotensive controls, 49 (42.6%) were males and 66 (57.4%) females with range of 23-80 years and a mean (±SD) of 50.7±12.7 yrs. Mean serum UA in hypertensive patients and normotensive controls was 0.4±0.1 mmol/l and 0.3±0.1 mmol/l respectively. Hyperuricaemia was found in 36.7% of hypertensive patients and 17.4% of normotensive controls (P<0.001). Serum UA was significantly higher in hypertensive patients than in normotensive controls (P<0.0001). Among hypertensive patients high TC and high LDL-c were the most prevalent types of serum lipid abnormalities. There was a significant positive correlation between serum UA and TG (r=0.21, P = 0.01).

Conclusion: The study shows that hyperuricaemia and serum lipid abnormalities are prevalent among adult Nigerians with hypertension. There was a significant correlation between serum uric acid and serum triglyceride. This study recommends routine measurement of serum uric acid in both newly diagnosed hypertensive patients as well as those on antihypertensive drugs.

Keywords: Hyperuricaemia; serum lipid abnormalities; hypertension; adult Nigerians.

1. INTRODUCTION

Systemic hypertension (HT) is a common disease globally, with populations of African descent being most prone to its complications [1-5]. In 2010, HT was the commonest of the three leading risk factors for global disease burden [6]. The reason for the enormous burden of HT has been reported in numerous studies, showing that it is strongly associated with overall cardiovascular risk [6-8]. HT contributes to both cardiovascular and cerebrovascular endpoints, including heart failure (HF), myocardial infarction (MI) and stroke and it accounts for 16.5% of all deaths including 51% of deaths due to strokes and 45% of deaths due to coronary artery disease (CAD) [7,8]. The prevalence of HT has been increasing globally and it has been estimated that it will increase to 29.2% by 2025 [2]. In Nigeria, studies have reported prevalence varying from 12% to 36.6% [9-13]. HT is implicated in 35% of all atherosclerotic cardiovascular events, including over 40% of all cases of HF [14-17]. In the US, 33.0% of adults aged 20 years and older have HT. African American adults have among the highest prevalence of HT (44%) in the world [18]. The Framingham and other epidemiological surveys as well as experimental studies have shown that hyperuricaemia (HU) and serum lipid abnormalities are not only associated with HT, they significantly increase the risk for cardiovascular disease and complications [17,19,20].

HT is a multifactorial and polygenic disorder in which the interaction between several candidate genes and environmental factors play a role. Some polymorphisms have been linked to HT. The recent genome-wide analysis of the Framingham Heart Study 100 K Project showed an association between elevated diastolic blood pressure (DBP) and the rs10491334 T/C single-nucleotide polymorphism (SNP) of the human CaMKIV gene (CaMK4) suggesting a role for this kinase in the regulation of vascular tone [21]. Also, angiotensin converting enzyme (ACE) *DD* gene polymorphism has been found to be associated with increased risk for HT [22]. It has been proposed that HU is one of the independent risk factors for cardiovascular disease in patients with HT, HF and diabetes mellitus (DM) [23-30]. Also, studies have shown increased risk of cardiovascular events in individuals with elevated serum triglyceride (TG), elevated serum LDL-cholesterol (LDL-c) or low HDL-cholesterol (HDL-c) either singly or in combinations [17,31-34]. Although, there are documented epidemiological, pathophysiological and clinical behavioral peculiarities of HT in people of African descent, there are a few reports about serum UA and serum lipid abnormalities in untreated newly diagnosed adult Nigerian hypertensive patients. The objective of the study was to determine the prevalence of HU in adult Nigerians with untreated newly diagnosed HT and to evaluate its relations with serum lipid abnormalities.

2. MATERIALS AND METHODS

2.1 Study Design and Study Site

The study was a cross sectional study done at the General Out-patient Department (GOPD), Medical Out-patient Department (MOPD) and Emergency Room (ER) of the University of Ilorin Teaching Hospital, Ilorin, in the North Central geopolitical zone of Nigeria between May 2007 and October 2007.

2.2 Ethical Considerations

The study protocol was approved by the Ethics and Research Committee of the hospital, and both oral and written consent was obtained from all the participants.

2.3 Study Participants

One hundred and fifty (150) untreated newly diagnosed hypertensive patients 18 years and above and one hundred and fifteen (115) age and sex-matched normotensive individuals were recruited into the study. Excluded from the study were participants with significant history of alcohol ingestion; on drugs such as lipid lowering drugs, uricosuric agents, antituberculosis and antiretroviral drugs; cancer patients taking or not taking cytotoxic drugs; patients with renal impairment; and DM.

2.4 Clinical Evaluation, Measurements and Definitions

All participants had a detailed history and a thorough physical examination, including anthropometry. Each participant's height in meters was determined using Marsden's Stadiometer with maximum height of 2 meters. The measurement was performed to the nearest 0.1 cm. Weight in kilogram was determined using Detecto electrical column scale; model CN 20 with 180 kg capacity. The body weight was measured to the nearest 0.1kg and the body mass index (BMI) (Kg/m^2) [35] was determined by dividing the weight (Kg) by the square of the height (m). The waist circumference (WC) (cm) was measured with a tape at the umbilical level on the bare abdomen, and the hip circumference (HC) (cm) measured at the external margins of the anterior superior iliac spines and waist/hip (WHR) ratio was determined [36]. Abdominal/central obesity was defined as WHR: > 1.0 (men), > 0.9 (women), WC: > 102 cm (40 in) > 88 cm (35 in) in women. Overweight and obesity were also defined as: BMI ≥ 25 kg/m^2 and ≥ 30 kg/m^2respectively.

Blood pressure was measured using mercury column sphygmomanometer (Accosson) and a cuff of appropriate size (25 cm x 12 cm). A standardized protocol was followed, in which systolic (SBP) and diastolic blood pressure (DBP) was measured on the right arm after at least 5 min of rest. Two consecutive measurements were obtained 5 minutes apart and the average was obtained. Phase I Korotkoff sound was used for SBP and phase V for the DBP. HT was defined as SBP ≥140 mmHg and/or DBP ≥90 mmHg, or use of antihypertensive drugs [37-40].

2.5 Serum Uric Acid Measurement

Serum uric acid level was estimated at the Chemical Pathology laboratory of the hospital using Fe (III) reduction direct method with Intraseries and Interseries Variation Coefficient of 2.09% and 2.38% respectively and Recovery of 96.6%.HU was defined as serum UA level > 0.42 mmol/L for males and > 0.36 mmol/L for females.

2.6 Serum Lipids and Other Laboratory Measurements

Venous blood samples were collected from the study participants for fasting serum lipids assay. Serum total cholesterol (TC) was estimated using enzymatic colorimetric test, CHO-PAP Method; serum TG and HDL-c were estimated using GPO-PAP method and Dextransulphate– Mg (II) method. Serum LDL-c was calculated using:

Friedewald formula (38): LDL-c (mmol/l) = TC (mmol/l) – HDL-c (mmol/l) – (TG (mmol)/ 2.2).

Venous blood samples were also collected for electrolytes panel and blood glucose estimation.

Serum lipid abnormalities were defined as elevated serum TC ≥ 5.2 mmol/l (≥200 mg/dl);elevated serum LDL-c ≥ 3.37 mmol/l (130 mg/dl); elevated serum TG ≥ 1.7 mmol/l (≥150 mg/dl); and low serum HDL-c <0.9 mmol/l (35 mg/dl) for males and < 1.0 mmol/l (39 mg/dl) for females.

Atherogenic ratio (AR) was defined as TC/HDL-c and values >5 identified as higher risk of cardiovascular disease.

2.7 Data Analysis

Data obtained was analyzed using EPI – INFO version 6.04 and Statistical Package for Social Sciences (SPSS) version 14 computer software packages. Results for continuous variables were expressed as mean±SD and proportions as percentages. The Chi square (X^2), with Yate's correction where applicable, was used to determine the statistical significance of categorical variables between the different groups. Student's t – test was used to assess the significance between means of two groups. Pearson's correlation coefficient was used to assess the correlation between measured variables. Cross-tabulation was performed to investigate the associations of different variables with serum uric acid. $P \leq 0.05$ was considered statistical significance.

3. RESULTS

Of the one hundred and fifty newly diagnosed hypertensive patients, 52 (34.7%) were males and 98 (65.3%) females, with a range of 19-85 years and a mean age (±SD) of 50.4±12.3 years. Among the normotensive controls, 49 (42.6%) were males and 66 (57.4%) females with range of 23-80 years and a mean (±SD) of 50.7±12.7 yrs. Hypertensive patients were subdivided into two groups based on gender and the mean age for males and females was 51.0±12.7 yrs and 50.1±12.1 yrs respectively. No statistical difference was observed in the mean ages (p = 0.67). Tables 1 shows educational and marital status of the patients and controls. Table 2 highlights the clinical characteristics of the patients and the controls. Mean serum UA in hypertensive patients and normotensive controls was 0.4±0.1 mmol/l and 0.3±0.1 mmol/l respectively. HU was found in 36.7% of hypertensive patients and 17.4% of normotensive controls (p<0.001). Serum UA was significantly higher in hypertensive patients than in normotensive controls (p<0.0001). Among hypertensive patients, males had higher mean serum UA (0.4±0.1 mmol/L) than females (0.3±0.1 mmol/L) (p = 0.01). Mean SBP and DBP was 175.2±24.0 mmHg and 106.0±16.4 mmHg respectively in the hypertensive patients, 119.8±9.1 mmHg SBP and 78.2±8.3 mmHg DBP in the normotensive controls (p<0.0001 SBP, p<0.0001 DBP). Seventy six percent of hypertensive patients had stage 2 HT (JNC 7 classification [34]. Mean serum TC was statistically higher in hypertensive patients (5.1±1.1 mmol/l) than in normotensive controls (3.6±1.5 mmol/) (p<0.001). Also the LDL-c was significantly higher in hypertensive patients (3.1±1.1 mmol/L) than in normotensive controls (2.2±1.0 mmol/L) (p<0.001). Other findings about serum lipid profile in patients and controls are shown in Table 3. The prevalence of serum lipid abnormalities is highlighted in Table 4.

Among hypertensive patients high TC and high LDL-c were the most prevalent types of serum lipid abnormalities. Fifty eight (38.7%) and 52 (34.7%) hypertensive patients had high TC and high LDL-c respectively. In normotensive controls, 11.3% had high TC (p<0.001), while 10.4% had high LDL-c (p<0.001). Hypertriglyceridemia was the least common form of serum lipid abnormalities among hypertensive patients occurring in 4.7% of them. Thirty-four hypertensive patients (22.7%) and four normotensive controls (3.4%) had HU in combination with one or more components of serum lipid abnormalities (p<0.0001).

Table 5 shows the Pearson's correlation between serum UA and serum lipids variables. There was a significant positive correlation between serum UA and TG(r=0.21, P = 0.01).There was a negative correlation with age TC (r= -0.12, p = 0.13), LDL-c (r = -0.11, p = 0.17), HDL-c (r = -0.06, p = 0.48) and AR (r = - 0.02, p = 0.83). Table 6 shows the Pearson's correlation between UA and other variables.

4. DISCUSSION

The prevalence of HU among hypertensive patients was found to be 36.7%. This is not far from40% reported by Abengowe [28] but higher than findings (5-33%) reported among Caucasians [38-41]. About nineteen percent (19.1%) of normotensives had HU. Consistent with other reports [42-45], the mean serum UA was significantly higher in males than in females in both hypertensive patients (p = 0.02) and normotensive controls (p = 0.004). This difference is thought to reflect the different hormonal status of men and women. Indeed, renal excretion of UA is reduced by androgens and increased by estrogens [45,46].

Table 1. Educational and marital status of patients and controls

	Hypertensive patients (n=150) (%)	Normotensive controls (n=115) (%)	X^2	P value
Educational status				
No education	34(22.6)	25(21.7)	0.03	0.86
Primary	46(30.7)	21(18.3)	5.30	0.02
Secondary	41(27.3)	13(11.3)	10.31	0.001
Post-secondary	29(19.4)	56(48.7)	25.76	<0.001
Marital status				
Single	12(8.0)	17(14.8)	3.07	0.3
Married	78(52.0)	63(54.8)	0.20	0.004
Widowed	40(26.7)	22(19.1	2.06	<0.001
Divorced	20(13.3)	13(11.3)	0.25	<0.001

Table 2. Clinical characteristics of hypertensive patients and normotensive controls

Variables	Hypertensive patients				Normotensive controls			
	Males (52)	Females (98)	Total (150)	P value	Males (49)	Females (66)	Total (115)	P value
Age (yrs)	51.0±12.7	50.1±12.1	50.4±12.3	0.67	50.8±15.8	51.4±16.3	50.7±12.7	0.81
BMI(kg/m^2)	25.6±5.5	27.9±5.7	27.2±15.8	0.02*	23.2±4.1	23.4±4.4	23.3±4.2	0.76
SBP(mmHg)	177.2±26.9	174.1±22.4	175.2±24.0	0.45	118.4±9.9	120.6 ±9.8	119.8±9.0	0.24
DBP(mmHg)	108.8±16.8	104.5±16.1	106.0±16.4	0.13	77.8±9.4	77.6±7.5	78.3±8.3	0.90
WC (cm)	92.3±14.9	94.2±11.6	93.4±12.9	0.37	83.0±12.0	83.2±12.7	83.1±12.3	0.93
WHR	1.01±0.1	0.96±0.1	0.98±0.1	0.0001*	0.97±0.1	0.94±0.1	0.96±0.1	0.002*
Fundoscopy	51.9%	29.6%	38.0%	0.007*	6.1%	3.0%	4.4%	0.73
Serum UA (mmol/l)	0.4±0.1	0.3±0.1	0.4± 0.1	0.01*	0.3±0.2	0.3±0.1	0.3±0.1	0.004*
FBS(mmol/l)	4.4±0.7	4.2±0.9	4.2±0.9	0.39	4.7±1.0	4.4±1.4	4.5±1.2	0.29
Serum Cr (µmol/l)	94.7±15.3	90.3±22.7	95.4±15.3	0.31	96.8±13.8	92.8±21.9	94.2±19.0	0.36

**Differences are statistically significant; Fundoscopy - ≧ grade 2 hypertensive retinopathy; BMI – body mass index; SBP – systolic blood pressure; DBP – diastolic blood pressure; WC – waist circumference; WHR – waist/hip ratio.; FBS-fasting blood sugar; Cr-creatinine; UA-uric acid*

In this study, there was a nonsignificant negative correlation between age and serum UA, though this is at variance with previous studies in which HU correlated with age [47], but similar to that found in the Framingham Heart study [48]. A strong correlation between serum UA and central obesity was also found in this study which is consistent with findings by previous researchers [49]. No correlation between SBP and DBP, and serum UA was found in both sexes. This is at variance with the report by Johans et al. [25], in which a standard deviation increment in serum UA was associated with an increase in SBP of 0.6 mmHg and an increase in DBP of 0.3 mmHg. This difference may be due to the relatively smaller number of hypertensive patients employed in this study, and also because they were not followed up long enough in order to observe a linear relationship in increment in both blood pressure and serum UA.

The finding of a negative though non-significant correlation between serum UA and TC, AR and LDL-c is puzzling; meaning that HU may have some beneficial effects after all. Though this is contrary to previous studies which have found HU to be a cardiovascular risk factor, Ariel et al. [50] and other authors [51,52] have hypothesized that diuretic-induced HU may indeed have some beneficial effects because of its antioxidant effects. It is however difficult to conclude from this study that the HU seen in hypertensive subjects may be beneficial since they were not on diuretics.

Table 3. Serum lipid characteristics of hypertensive patients and normotensive controls

Variables	Hypertensive patients				Normotensive controls			
	Males (n=52)	Females (n=98)	Total (n=150)	P value	Males (n=49)	Females (n=66)	Total (n=115)	P value
TC(mmol/l)	5.1±1.0	5.1±1.2	5.1±1.1	0.92	3.6±1.4	3.6±1.6	3.6±1.5	0.88
TG(mmol/l)	1.3±0.6	1.2±0.5	1.2±0.5	0.56	1.4±0.8	1.4±0.9	1.1±0.5	0.68
LDL(mmol/l)	3.1±1.1	3.2±1.2	3.1±1.1	0.71	2.2±0.9	2.2±1.0	2.2±1.0	0.90
HDL(mmol/l)	1.4±0.5	1.5±0.6	1.5±0.6	0.88	1.4±0.4	1.5±0.4	1.4±0.4	0.09
TC/HDL(AR)	2.4±1.4	2.8±2.5	2.7±2.2	0.36	1.8±1.2	1.6±0.9	1.9±1.1	0.24

**Differences are statistically significant; TC – total cholesterol; TG – triglyceride; LDL-c – low density lipoprotein-cholesterol; HDL-c –high density lipoprotein-cholesterol; AR – atherogenic ratio*

Table 4. Prevalence of serum lipid abnormalities among hypertensive patients and normotensive controls

Variables	Normotensives (n=115) (%)	Hypertensives (n=150) (%)	p - value
* TC	11.3	38.7	<0.0001
*TG	11.4	13.3	0.62
*LDL	10.4	34.7	< 0.0001
$^{+}$HDL	13.6	11.3	0.53
AR	0.9	4.7	0.049

*p≤0.05, *High, $^{+}$Low, AR = atherogenic ratio*

Table 5. Pearson's correlation between serum UA and serum lipids variables in hypertensive patients

Serum lipids variables	R	P value
TC	-0.12	0.13
TG	0.21*	0.01
LDL-c	-0.11	0.17
HDL-c	-0.06	0.48
AR	-0.01	0.88

**Correlation is significant at the 0.05 (2-tailed), r = correlation coefficient; p≤0.05, TC-total cholesterol; TG-triglycerides; LDL-c-low density lipoprotein-cholesterol; HDL-c-high density lipoprotein-cholesterol; UA-uric acid*

Table 6. Pearson's correlation between serum UA and other variables in hypertensive patients

Variables	R	P value
Age	-0.02	0.83
BMI	-0.03	0.70
WC	0.20*	0.01
WHR	0.03	0.72
SBP	0.01	0.86
DBP	0.11	0.20
FBS	0.15	0.11
CR	-0.01	0.92

**Correlation is significant at the 0.05 (2-tailed), r = correlation coefficient; p≤0.05, BMI – body mass Index; SBP – systolic blood pressure; DBP – diastolic, blood pressure; WC – waist circumference; WHR – waist/hip ratio.; FBS-fasting blood sugar; Cr-creatinine*

Hypertensive patients had a significantly higher TC and LDL-c than controls. This increase can be an integral component of the metabolic disorder associated with HT [53,54]. In this study 38.7% of subjects had high TC compared with 11.3% of normotensive controls. Likewise 34.6% of hypertensive patients had high LDL-c compared to 10.4% of normotensive controls. These figures are similar to the findings (43.4%) in Ibadan, Nigeria [55]. Serum TG correlated with serum UA. This data confirms the well known association of hypertriglyceridemia with HU [56,57], which was found in about 75% of gouty patients [58] as well as in patients with HT [59]. However no correlation was found between serum UA and BMI, WHR, TC, LDL-c, HDL- c, AR, serum urea and serum creatinine. This is at variance with many studies that have found correlation between serum UA and these parameters [3,12,60,61]. No concrete explanation could be given for this difference. However the finding of large number of hypertensive patients with high serum UA and components of dyslipidemia suggests that hypertensive patients with HU may be at risk of increased metabolic morbidity (dyslipidemia) than their counterparts without HU.

The mean value for HDL – cholesterol in this study approximates other published values from this hospital [56,62]. It is however insignificantly higher in females than in males. Estrogen is known to have a positive correlation with plasma

levels of HDL-c [63] and the fact that a larger proportion of hypertensive patients studied (tabs 5 and 6) are pre-menopausal, it is not surprising that females had higher HDL-c than males; this is also reflected in normotensive controls. Mean HDL – c in hypertensive patients was not significantly different from that in the normotensive group. This is in consonance with the values obtained by Isezuo and Omotoso [62]. The mean TC among hypertensive patients in this study is very close to that obtained in hypertensive patients studied for risk factors for cardiovascular diseases in Ilorin, Nigeria by Okesina et al. [54] and Opadijo et al. [30].

The mean values of AR, TC, TG and LDL-c in this study were lower than those observed in Caucasians while the mean HDL-c in this study is higher than that observed in Caucasians [24, 64]. The finding of low HDL-c in only 13.6% and 11.3% of hypertensive patients and normotensive controls respectively is of great significance in terms of sudden death due to coronary heart disease in people of African descent. Africans are generally protected when compared with Caucasians due to low levels of cigarette smoking, especially in women; reduced intake of fat, low cholesterol levels as well as racial factor [65]. Even though it is obvious that the prevalence of coronary artery disease (CAD) in people of African descent is steadily increasing because of adoption of Western lifestyles, trends in urbanization, acquisition of technology and the increasing numbers of tertiary health care institutions, yet the incidence of coronary heart disease in people of African descent is still low when compared with Caucasians [65]. This situation has been described as puzzling. It was noted that the various risk factors for coronary heart disease are exerting influence in a far less noxious manner in Africans than is the case in most Western population [66].

It is not established in this study whether HU is a risk factor on its own requiring treatment, an innocent by stander merely reflecting an adverse risk factor pattern, or a major endogenous antioxidant. This could be viewed in line with the Framingham heart study [42] that concluded that an elevated serum UA level is not causally associated with increased risk for CAD, death from cardiovascular disease, or death from all causes.

5. CONCLUSION

The study shows that HU and serum lipid abnormalities are prevalent among adult Nigerians with HT. There was a significant correlation between serum UA and TG which is known to be associated with other components of metabolic syndrome and is also a risk factor for CAD as reported in epidemiologic and interventional studies. This study recommends that a large prospective study should be carried out in Nigeria to establish the significance of serum UA as a cardiovascular disease risk factor among people of African descent. It also recommends routine measurement of serum UA in both newly diagnosed hypertensive patients as well as those on antihypertensive drugs.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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