Original Article

Prevalence and correlates of chronic kidney disease in a group of patients with hypertension in the Savanah zone of Cameroon: a cross-sectional study in Sub-Saharan Africa

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Background: The prevalence of chronic kidney disease (CKD) is increasing worldwide due to an increase in the risk factors such as hypertension. The greatest burden is in low-income settings, coupled with late diagnosis and limited management resources. This work aimed at studying the prevalence and risk factors of CKD in a group of patients with hypertension in the Savanah zone in Sub-Saharan Africa (SSA).

Methods: We carried out a cross-sectional study between January and May 2016 in the regional Hospital of Garoua-Cameroon. Participants were adults ≥18 years of both sexes, who had a diagnosis of hypertension. Patients underwent a comprehensive clinical, biological, and electrocardiographic evaluation.

Results: A total of 400 patients with hypertension were included, of whom 132 (33%; 95% CI: 28.6–37.8%) were males. Their mean age was 54.16±11.17 years. Hypertension was controlled in 122 (30.5%; 95% CI: 26.2–35.2%) participants. Twelve percent had a positive urine dipstick for proteins. The mean glomerular filtration rate (GFR) was 75.27±24.87 mL/min/1.73m^2. The prevalence of CKD was seen in 129 (32.3%; 95% CI: 27.9–36.98) participants. Stage 3A was the most frequent (62.01%). The main comorbidities were anemia (44.5%), obesity (39.75%), diabetes (32%), consumption of traditional medicines (15.75%), and hyperuricemia (10.75%). After multivariate analysis, age >50 years (aOR: 1.75; 95% CI: 1.06–2.89; P=0.027), female sex (aOR: 2.21; 95% CI: 1.29–3.78; P=0.0035), obesity (aOR: 1.58, 95% CI: 1.01–2.44; P=0.026) and the hyperuricemia (aOR: 3.67; 95% CI: 1.78–7.58; P<0.001) were independently associated with CKD.

Conclusions: The prevalence of CKD in adults with hypertension was high. This was associated with age greater than 50 years, female sex, obesity and the hyperuricemia.

Keywords: Prevalence; chronic kidney disease (CKD); hypertension; Cameroon; Africa

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Introduction

Chronic kidney disease (CKD) is frequent worldwide, affecting one out of ten adults, and reaching up to one out of three after 70 years of age (1-4). The incidence and prevalence are increasing, with the greatest burden in low-income settings in sub-Saharan Africa (SSA), where the burden of hypertension, diabetes, and infectious diseases (main risk factors for CKD) are highest. Hypertension affects over 1 billion people worldwide, with over 25% of the adult population in SSA are having the disease (5,6). It is often under-diagnosed, under-investigated, and under-treated (7). Essential medicines to treat hypertension, and to slow down the progression of CKD are often not available and not affordable (8). In this setting, hypertension occurs earlier in life, with severe forms at presentation, and it is frequently associated with complications such as end-stage CKD (5,9). The inter-relationship between hypertension and CKD is triple. Hypertension is a cause, consequence, and a major factor in the progression of CKD (10). It is the main cause of CKD in SSA (11). As expected, the rate of CKD is highest in low-income settings like ours, due to the very high rates, and the interplay of the many risk factors of CKD. In a SSA setting, up to 50% of those receiving routine care for hypertension have CKD (12). For the same level of blood pressure (BP) as Caucasians, Africans with risk of hypertensive kidney disease have been shown to have a rapid deterioration of kidney function to End-Stage Renal Disease (ESRD) (10,13-15). This suggests a complex inter-relation between the genetic, social, and environmental factors. Data on the prevalence and determinants of CKD in patients with hypertension are lacking in SSA. Kaze *et al.* (12) identified age, adiposity, and severity of hypertension as determinants of CKD in a group of SSA (mainly Bantu and semi-Bantu) who live in the forest zones of Cameroon.

It is not certain whether the same risk factors can be extrapolated to the northern Savanah zones of the country, where they are mostly Sudanese with different behavioral patterns. Also, rural/urban differences, socio-economic status, presence of left ventricular hypertrophy (LVH) as determinants of CKD were not explored. This cross-sectional work aimed at studying further the prevalence and determinants of CKD in a genetically different people with hypertension in the Savanah zone of Cameroon.

Methods

Study design and setting

We carried out a cross-sectional study between January and May 2016 (5 months) in the city of Garoua, headquarter of the north region (Savanah zone) of Cameroon, central SSA. The population of this region is about 2 million inhabitants, and mainly made up of the Sudanese. The city of Garoua is cosmopolitan with other tribes being represented. This region is served by a regional hospital, which acts as the reference Hospital of the region.

Participants

These were consenting adults from the community, aged ≥18 years, of both sexes, who had an established diagnosis of hypertension for at least 1 month, with or without anti-hypertension treatment, and have lived in the region for at least 3 months (estimated time for acclimatization). Participants were invited via radio announcements and posters in the official and most spoken local language for a free health check, control and follow-up of high BP at the regional Hospital. We excluded those with non-hypertension related CKD, acute kidney injury, inter-current infection, malignancy, pregnant and menstruating women. The run-in period where all the participants were recruited (first visit) was 2 months. All participants retained for the study signed an informed consent form.

Variables

The main outcome measure was persistent significant renal function impairment (eGFR <60 mL/min/1.73m^2) and or active urine test (proteinuria) on urine dipstick after three months. During the first visit for each participant, we collected socio-demographic (age, sex, ethnicity, and residence), socio-economic data (Socio-economic status is the estimated monthly income: low ≤ €10, medium €10–20, high > €20), history of hypertension (duration and treatment), associated renal and vascular risk factors (diabetes, tobacco use, alcohol use, gout, family history, and nephrotoxic medicines), and comorbidities (HIV status, hepatitis, cancer). We then collected anthropometric data (weight, height, abdominal circumference), hemodynamic data (BP and pulse), and performed a resting 12-lead electrocardiography (ECG). Finally, we collected a fresh mid-stream urine sample for dip-stick tests, and blood for serum creatinine, blood glucose, hemoglobin, and uric acid levels. Those with abnormal serum creatinine and proteinuria were seen after 3 months (second visit) for control (BP, serum creatinine, and urine). Chronic kidney was diagnosed when there was persistence of any of the anomaly. Further care of the participants was arranged for

by the local nephrologist.

Data sources and measurements

The blood pressure was measured with an electronic device (Omron M3 Intellisene®) with a standard adult cuff, after 10 minutes of rest, in the sitting position, on both arms. Participants were not expected to have eaten, used tobacco products or stimulants. Two measures were taken each on both arms at 2 minutes interval, and the average recorded for each arm. BP was considered normalized when the SBP <140 mmHg and DBP <90 mmHg. The weight (kg) was measured with a Camry® scale in light clothing and no shoes, and the height (m) with a stadiometer. Participants were considered obese when the body mass index (BMI) was ≥30 kg/m^2. Resting 12-lead ECG was performed at room temperature using a Mac 500 GE machine, and the findings were read by an experienced Cardiologist. LVH was diagnosed using the Cornell index (RaVL + SV3 >28 mm in males and >20 mm in females). Fresh mid-stream urine sample was collected and tested for protein with a urine dip-stick (Comb 11®).

We semi-quantified urine protein as follows: + (0.3–0.9 g/L), ++ (1.0–2.9 g/L), +++ (3–9.9 g/L), and ++++ (≥10 g/L). Blood glucose was measured after an overnight fast (at least 8 hours) with an automatic glucose monitor (One-touch Ultra 2®) after a finger prick. Blood glucose was in the diabetes range if the glycemia was ≥1.26 g/L. Hemoglobin was measured using a hemoglobinometer (URTI 2®). Anaemia was present if the hemoglobin was <13 g/dL for males, and <12 g/L for females. Serum creatinine and uric were measured using the Jaffe colorimetric method. Hyperuricemia was present if serum uric acid was >70 mg/L in males and >60 mg/L in females. The Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation was used to estimate the glomerular filtration rate (eGFR) using serum creatinine as the substrate.

Bias

In order to minimize selection bias of participants, we proceeded by way of mass communication so as to touch people in the community who do not seek care at the hospital. However, the meeting point being the regional hospital might un-intentionally exclude some people with hypertension (aged, associated debilitating joint disorders, long distances). Co-morbid infectious conditions that can cause CKD were not screened efficiently (only based on participants' response).

Study size

We used the Stat-Calc option of the software Epi-Info to estimate the sample size for descriptive studies with a simple random sampling. With a prevalence of 49.7% of CKD in patients with hypertension in our setting (12), and an 80% power of detecting significant correlates of CKD, and an alpha error of 5%, the minimum size of the study was 384 participants with hypertension.

Quantitative variable

In order to study the correlates of CKD in this population, we grouped participants as having or not-having CKD according to eGFR and/or proteinuria. We also dichotomized all potential correlates (socio-economic, demographic, anthropometric, ECG, serum uric acid and hemoglobin levels).

Statistical methods

We used Epi-Info version 7 to analyze the data. We presented continuous variables as means (standard deviation), and discrete variables as proportions (95% confidence interval). We used the Student t-test to compare the means, and Chi squared test or Fischer exact test to compare proportions where appropriate. We carried out logistic regression analysis to study the predictors of CKD after adjusting for age and sex (for variables with P value ≤0.2 after univariate analysis). A P value <0.05 was considered statistically significant for the observed differences and associations.

Ethical statement

Ethical clearance was obtained from the ethical committee of the Faculty of Medicine and Biomedical Sciences of the University of Yaoundé 1. This work was carried out according to the declarations of Helsinki (16). We report this work according to the Standards for Reporting Epidemiological Studies (STROBE) checklist (17).

Results

Participants and descriptive data: a total of 400 participants fulfilled the inclusion criteria of the study. Socio-economic and demographic characteristics are shown in *Table 1*. Their mean age was 54.2±11.8 years, and ranged from 22 to

Table 1 Socio-economic and demographic characteristics of the study population

Variable	Frequency	Percentage [%, (95% CI)]
Sex (N=400)		
Male	132	33.0 (28.6–37.8)
Female	268	67.0 (62.3–71.4)
Ethnicity (N=380)		
Sudanese	344	90.5 (87.2–93.1)
Semi-bantou	22	5.8 (3.9–8.6)
Bantou	14	3.7 (2.2–6.1)
Residence (N=400)		
Urban	382	95.5 (93.0–97.1)
Rural	18	4.5 (2.9–7.0)
Socio-economic status (N=400)		
Low	157	39.2 (34.6–44.1)
Medium	231	57.8 (52.9–62.5)
High	12	3.0 (1.7–5.2)
Age range (years), (N=400)		
≤25	3	0.8 (0.3–2.2)
26–50	145	36.2 (31.7–41.2)
51–65	184	46.0 (41.2–50.9)
>65	68	17.0 (13.6–21.0)

92 years. There were 132 (33%; 95% CI: 28.6–37.8%) males, 344 (90.5%; 95% CI: 87.2–93.1%) Sudanese, and 382 (95%; 95% CI: 93.0–97.1%) urban dwellers. Most of the participants were aged in the 51–65 years age group. Treatment, complications, and control of hypertension is shown in *Table 2*. The mean duration of hypertension was 5.6±5.98 years, and ranged from 1 to 40 years. Calcium channel blockers (56.5%; 95% CI: 51.6–61.3%) and thiazide diuretics (31%; 95% CI: 26.7–35.7%) were the most frequently used anti-hypertensive medicines, mainly as monotherapy (69.8%; 95% CI: 65.1–74.1%).

Almost half of the participants (44%) used alternative medicines mainly as herbal products. The mean SBP was 149.9±19.3 mmHg (range: 100–228 mmHg), and the mean DBP was 94.4±27.7 mmHg (range: 60–120 mmHg). The BP was controlled in 122 (30.5%; 95% CI: 26.2–35.2%) participants, and 121 (30.25%; 955 CI: 25.8–35.1%) participants had complications related to hypertension (LVH

Table 2 Treatment and control of hypertension

Variable	Frequency (N=400)	Proportion [%, (95% CI)]
Type of anti-hypertensive medicine		
CCB	226	56.5 (51.6–61.3)
Thiazide diuretics	124	31.0 (26.7–35.7)
ACEIs	80	20.0 (16.4–24.2)
BB	42	10.5 (7.9–13.9)
ARA	23	5.8 (3.9–8.5)
Central anti-hypertensive	13	3.2 (1.9–5.5)
Number of anti-hypertensive medicines		
Monotherapy	279	69.8 (65.1–74.1)
Bitherapy	99	24.8 (20.8–29.2)
Tritherapy	20	5.0 (3.3–7.6)
More than 3 medicines	2	0.5 (0.1–1.8)
Alternative medicines		
Moringa	29	7.2 (5.1–10.2)
Garlic	45	11.2 (8.5–14.7)
Goriba	25	6.2 (4.3–9.1)
Prayers	47	11.8 (9.0–15.3)
Associated complications		
Stroke	54	13.5 (10.5–17.2)
Left ventricular hypertrophy	67	16.8 (13.4–20.7)
BP controlled		
Yes	122	30.5 (26.2–35.2)
No	278	69.5 (64.8–73.9)

CCB, calcium channel blockers; ACEIs, angiotensin converting enzyme inhibitors; BB, beta blockers; ARA, angiotensin II receptor antagonist; BP, blood pressure.

and history of stroke). Associated comorbidities and risk factors of CKD are shown in *Table 3*. The mean BMI was 29.7 kg/m^2 (range: 19–52 kg/m^2). The mean hemoglobin was 12.7±3.2 g/dL. The mean blood glucose was 1.58±2.35 g/L. The mean serum uric acid was 53.4±33.9 mg/L. Anaemia (44.5%; 95% CI: 39.7–49.4%), obesity (39.8%; 95% CI: 35.1–44.6%), and diabetes (32%; 27.6–36.7%) were the most frequent comorbidities. The use of tobacco

Table 3 Associated co-morbidities and risk factors of CKD

Variable	Frequency (N=400)	Proportion [%, (95% CI)]
Anaemia	178	44.5 (39.7–49.4)
Obesity	159	39.8 (35.1–44.6)
History of diabetes	128	32.0 (27.6–36.7)
Traditional medicines	63	15.8 (12.5–19.6)
Hyperuricemia	43	10.8 (98.1–14.2)
History of Gout	21	5.3 (3.5–7.9)
Tobacco use	3	0.8 (0.30–2.2)

CKD, chronic kidney disease.

Table 4 Stages of CKD according to eGFR and proteinuria

Grade (G)	eGFR	Proteinuria				Total [N=129, n (%)]
		Absent	+	++	+++	
G1	≥90	0	0	1	1	2 (1.6)
G2	60–89	0	6	4	2	12 (9.3)
G3a	45–59	65	9	6	0	80 (62.0)
G3b	30–44	11	8	4	1	24 (18.6)
G4	15–29	2	0	2	0	4 (3.1)
G5	<15	4	0	1	2	7 (5.4)

Values are presented as frequencies. CKD, chronic kidney disease; eGFR, estimate the glomerular filtration rate.

products was seen in 3 (0.8%; 95% CI: 0.26–2.2%) of the participants.

Outcome data

The occurrence and severity of CKD is shown in *Table 4*. CKD was seen in 129 (32.3%; 95% CI: 27.9–36.98%) participants. Proteinuria was seen in 47 (11.75%; 95% CI: 8.95–15.3%) participants (36.4% of CKD). Isolated proteinuria was seen in 14 (3.5%; 95% CI: 2.1–5.8%) participants (10.9% of CKD). Severe proteinuria (+++) was seen in 6 (1.5%; 0.69–3.2%) participants (12.8% of CKD). The mean eGFR was 75.3±24.9 mL/min/1.73 m^2 (range: 4.4–141 mL/min/1.73 m^2). An eGFR <60 mL/min/1.73 m^2 was seen in 115 (28.8%; 24.5–33.4%) participants (89.2% of CKD). Isolated low eGFR was seen in 82 (20.5%; 16.8–24.7%) participants (63.6% of CKD). The most frequent stage of CKD was G3aA0, seen in 65 (16.3%, 12.96–20.2) participants (50.4% of CKD).

Main results

The determinants of CKD are shown in *Table 5*. In univariate analysis, age age >50 years (OR: 1.81; 95% CI: 1.15–2.86; P=0.006), obesity (OR: 1.63; 95% CI: 1.4–1.98; P=0.026), and hyperuricemia (OR: 3.77; 95% CI: 1.96–7.24; P<0.001) were associated with CKD in hypertensive patients.

After multivariable analysis (adjusting for age and sex), age >50 years (OR: 1.75; 95% CI: 1.06–2.89; P=0.027), females (OR: 2.21; 95% CI: 1.29–3.78; P=0.003), obesity (OR: 1.58; 95% CI: 1.36–1.95; P=0.029) and hyperuricemia (OR: 3.67; 95% CI: 1.78–7.58; P<0.001) were independent risk factors of CKD in hypertensive patients.

Discussion

We carried out this cross-sectional study in the Savanah region of Cameroon-SSA with the aim of studying the prevalence and risk factors of CKD in patients with hypertension. In this group of people, one out of three patients with hypertension has CKD. Age, female sex, adiposity, and hyperuricemia were independently associated with CKD.

Our findings should be interpreted in the light of some limitations. The diagnosis of proteinuria was made using the semi-quantitative urine dipstick which could only detect macro-proteinuria or albuminuria (urine protein >300 mg/L). Cases with urine protein between 30 and 300 mg/L (early marker of CKD) were missed out. The urine albumin-creatinine ratio (ACR) could have been used to quantify urinary protein excretion more precisely, thereby identify more cases of CKD. Thus, our findings could be an under-estimate of CKD using the urinary protein excretion criteria. Also, other causes of CKD in our milieu such as infections were not systematically screened for, as hypertension could be a consequence of CKD in such group of people (10). This study focused on those with hypertension thus, the findings does not depict the burden of CKD in the community. Despite these limitations, this is the first study of the prevalence and risk factors of CKD in patients with hypertension living in the Savanah region of Cameroon. The climate and the ethnic group differ from the forest and littoral zones of southern part of the country.

The prevalence of CKD in this group of patients in

Table 5 Predictors of CKD in patients with hypertension adjusted for sex and age

Variable	Univariate		Multivariate	
	OR (95% CI)	P value	aOR (95% CI)	P value
Age >50 years	1.81 (1.15–2.86)	0.006	1.75 (1.06–2.89)	0.027
Female sex	1.41 (0.89–2.24)	0.082	2.21(1.29–3.78)	0.003
Sudanese ethnicity	0.76 (0.42–1.37)	0.224	NA	NA
Urban dweller	1.7 (0.54–5.27)	0.256	NA	NA
Low income status	0.72 (0.46–1.12)	0.089	0.71 (0.88–2.26)	0.145
Hypertension duration >5 years	1.14 (0.75–1.75)	0.533	NA	NA
Renin angiotensin system blockers	0.98 (0.61–1.59)	0.530	NA	NA
Anti-hypertensive medicines >2	1.21 (0.50–3.00)	0.671	NA	NA
Alternative medicine	1.22 (0.76–1.98)	0.234	NA	NA
History of stroke	0.95 (0.51–1.77)	0.516	NA	NA
Left ventricular hypertrophy	1.52 (0.89–2.62)	0.081	1.29 (0.71–2.33)	0.388
Uncontrolled hypertension	1.51 (0.94–2.40)	0.088	1.43 (0.85–2.38)	0.165
Obesity	1.63 (1.40–1.98)	0.026	1.58 (1.36–1.95)	0.029
History of diabetes	1.27 (0.81–1.99)	0.166	1.04 (0.63–1.70)	0.860
Tobacco use	1.05 (0.09–11.6)	0.690	NA	NA
History of gout	2.43 (1.00–5.88)	0.040	1.84 (0.66–5.12)	0.237
Herbal medicine use	1.06 (0.59–1.87)	0.473	NA	NA
Anaemia	0.81 (0.53–1.24)	0.200	0.81 (0.50–1.3)	0.397
Hyperglycemia	0.93 (0.58–1.50)	0.440	NA	NA
Hyperuricemia	3.77 (1.96–7.24)	<0.001	3.67 (1.78–7.58)	<0.001

CKD, chronic kidney disease; OR, odds ratio; aOR, adjusted odds ratio; NA, not applicable (P>0.2) in univariate; CI, confidence interval.

the Savanah zone was significantly lower than the 49.7% reported in the forest zone (12). Our participants were mainly Sudanese, compared to those in the forest zones who are mainly Bantu or semi-Bantu. Our study showed a non-significant lower risk of CKD in the Sudanese ethnic group. Ethnicity has been shown to play an important role in the genesis and aetiology of CKD in a group of Africans with mixt ancestry (18). However, our study was not sufficiently powered to answer this question. Also, it is not known whether the difference in climate or other possible causes of CKD could play a role in the disease burden. Beyond our borders, Sumaili *et al.* (19) and Osafo *et al.* (13) reported significantly higher rates of CKD in hypertensive patients in the forest zones of SSA. The prevalence of CKD is almost three times higher than that of the general community irrespective of the equation used (20-22). Similarly, we identified advancing age and adiposity as risk factors of CKD as reported in the African literature (12,13,19). We further identified female sex and hyperuricemia as risk factors of CKD. The relationship between CKD and female sex is not clear. Plausibly, this could indirectly be due to obesity (more frequent in women), a well-known risk factor for CKD (23). The mechanism is glomerular hyper-filtration with resultant albuminuria and eventual segmental glomerulosclerosis. Obesity can also act indirectly to cause CKD through hypertension and diabetes, which are classical risk factors of CKD (22).

Hypertension affects one out of three adults in Cameroon (6), with a certain degree of regional gradient. It is poorly diagnosed, under-investigated, and undertreated (7). Essential medicines

to treat hypertension and associated risk factors of CKD are largely not available and not affordable (8). This culminates to very few people with hypertension and related risks having their condition under control. Most patients were treated with calcium channel blockers as monotherapy, and only one out of three was controlled.

Only one out of four patients received the reno-protective blocker of the renin angiotensin system despite their very high risks. This is contrary to the guidelines (24). The mechanism of hyperuricemia and kidney damage is not clear despite the strong correlation between serum uric acid and renal resistive index (25). However, hyperuricemia is frequently seen in patients with hypertension and the metabolic syndrome which are classical risk factors of CKD (26).

Conclusions

This is the first study of the prevalence of CKD and its risk factors in patients with hypertension in the Savanah zone of Cameroon. At least one out of three patients with hypertension has CKD. Independent risk factors for CKD are age >50 years, female sex, obesity, and hyperuricemia. There is the need for targeting obesity and hyperuricemia so as to curb the burden of CKD in this group of patients. There is also the need to study the confounding effects of other possible causes of CKD such as infections.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: The study was approved by ethical committee of the Faculty of Medicine and Biomedical Sciences of the University of Yaoundé 1 (UY1/FMBS/006). All participants retained for the study signed an informed consent form.

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