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ORIGINAL ARTICLE

Prevalence and determinants of chronic kidney disease in urban adults' populations of northern Cameroon

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Abstract

Background Chronic kidney disease (CKD) is a major health problem with growing prevalence in sub-Saharan Africa.
Aim Assess the prevalence and determinants of CKD in Garoua and Figuil cities of the North region of Cameroon.
Methods A cross-sectional survey was conducted from January to June 2018 in the two cities, using a multi-level cluster sampling. All adults with low estimated glomerular filtration rate (eGFR) (< 60 ml/min/1.73 m^2) by Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation and/or albuminuria (≥ 30 mg/g) were reviewed three months later. Logistic regression models (accounting for the sampling strategy) were used to investigate the predictors of the outcomes.
Results A total of 433 participants were included, with a mean age (95%CI) of 45.0 (43.4–46.6) years, 212 (48.7%) men, 294 (67.9%) from Garoua and 218 (45.6%) with no formal education. Risk factors for chronic nephropathy were highly prevalent including longstanding use of street medications (52.8%), herbal medicines (50.2%) and non-steroidal anti-inflammatory drugs (50%), alcohol consumption (34.4%), hypertension (33.9%), overweight/obesity (33.6%), hyperuricemia (16.8%), smoking (11.3%) and hyperglycemia (6.5%). The prevalence of CKD was 11.7% overall, 10.7% in Garoua and 13% in Figuil participants. Equivalents figures for CKD G3-5 and albuminuria were 2.8%, 2.0% and 4.5%; and 9.1%, 9.3% and 8.5%, respectively. History of diabetes, increase systolic blood pressure, hyperglycemia and hyperuricemia were predictors of CKD.
Conclusion The prevalence of CKD is as high in these northern cities as previously reported in southern cities of Cameroon, driven mostly by known modifiable risk factors of chronic nephropathy.

Keywords Chronic kidney disease · Albuminuria · CKD-EPI equation · Cameroon

Abbreviations

ACR	Albumin/creatinine ratio
BMI	Body mass index
CI	Confidence Interval
CKD	Chronic kidney disease

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CKD-EPI	Chronic kidney disease epidemiology collaboration
CRF	Chronic renal failure
DBP	Diastolic blood pressure
eGFR	Estimated glomerular filtration rate
HDL	High-density lipoprotein
LDL	Low-density lipoprotein
SSA	Sub-Saharan Africa
SBP	Systolic blood pressure

Background

Chronic kidney disease (CKD) is a major health problem with a growing prevalence worldwide [1, 2]. Studies have revealed the high prevalence and progression rates of CKD among higher risk groups such as people of African ethnicity, with a prevalence of CKD in Africa at 15.8% compared with the world average of 13.4%. Figures are even much higher in some segments of the African population including people living with hypertension, diabetes and HIV infection [1–8]. In most Sub-Saharan Africa (SSA) countries, due to low awareness of the disease and challenges to access healthcare, CKD rapidly progresses to end-stage kidney disease requiring renal replacement therapy, with only 1.5% of patients in need accessing such therapy, and mainly dialysis [9, 10].

Central African region has the second-highest prevalence of CKD in SSA after West Africa, with the prevalence ranging from 10 to 14.1% in the general population [3, 11–13]. Available population-based data on CKD in Cameroon originate from the southern part of the country where Bantou people are the dominant ethnic group; and may not reflect the patterns in northern regions where Peulh are the dominant population. In order to have a broader picture of CKD in Cameroon, we here report on the prevalence and determinants of CKD in Garoua and Figuil cities of the north region.

Methods

Study setting and design

Data collection for this cross-sectional survey took place between January to June 2018, in Garoua and Figuil, two cities of the North Region of Cameroon, with predominantly Peulh population. Garoua, the administrative capital of both Benoue division and North region, has a population of approximately 568,760 inhabitants distributed across two health districts, namely Garoua I and II, each with 6 health areas. The population of Garoua I has been estimated at 272,461 inhabitants from 54,492 households, while that of Garoua II has been estimated at 296,299 inhabitants across 59,260 households. Garoua adult population comprises students, traders, civil servants, private and parastatal companies' workers mainly from the cotton development company (SODECOTON®). Figuil is the capital of eponym subdivision in the Mayo Louti division. It has an estimated population of 123,517 inhabitants distributed in the Figuil health district across 11 health areas and 24,703 household. The adult population comprises essentially private-sector workers from two companies: CHAUX ROCA® is specialised in the production of marble, calcium carbonate, slake lime and gravel of granite while CIMENCAM® produces cement, aggregate and concrete. This study was approved by the Cameroon National Ethics Committee, and all participants provided a written informed consent before enrolment.

Sampling procedures

The sample size was estimated assuming a 10% prevalence (P) of CKD among urban adults in Cameroon based on the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation [11], a precision (I) of 2%, a correction factor (K) for the cluster effect of 2, and a confidence interval of 1.96. Using these assumptions, a minimum of 432 subjects (N) were required, by applying the following formula $N = [(Z\alpha /2)^2 PQ/ I^2] \times K$. We used a multi-level cluster sampling approach whereby the health area was the first level and the household the second level. The number of participants to be recruited was equally distributed across health districts, giving a ratio of 144 participants per district. This number was then divided by the number of health areas per health district, to give a ratio of 24 participants per health area of the Garoua health district and 14 participants per health area of the Figuil health district. We determined the sampling interval by dividing the number of household in the health area by the number of participants to be recruited in that health area, assuming a maximum of 2 adults per household. The first household to be included and selection approach mirrored those used during national immunization days. Potential adult participants were sensitized to the survey through their district council, community leaders, posters, leaflets and words of mouth. For household included in the survey, all adults were further explained the purpose of the study and received a health promotion campaign on communicable and non-communicable diseases. Thereafter, a maximum of two adults (20 years and above) who have been residing in the household for at least three month were randomly selected from the household to take part in the survey. The random selection was done by blindly picking two names from a small bag. When there was only one adult or in case of non-response, the study team moved to the next household to repeat the procedure and recruit the remaining participants. Were excluded from the survey, people with serious mental or physical impairment (limb

amputation or paralysis in particular), pregnant women or lactating mother and people with simultaneous leucocyturia and urine nitrites.

Data collection

Final year undergraduate medical student collected data between 8 and 12 am during household surveys and only from participants who provided written informed consent. Biological samples including urine and blood specimens were collected from 8 and 9 a.m. During face-to-face interview with participants, the scope of data collected included socio-demographic information (age, gender, education and occupation), and clinical information including personal history of diagnosed conditions (hypertension, diabetes, dyslipidaemia, gout and infectious diseases such as HIV, hepatitis B and C), lifestyles (alcohol consumption and smoking), use of nephrotoxins (herbal and street medicines), anthropometric (weight, height and waist girth) and blood pressure measurements. Blood pressure (BP) measurement followed to the World Health Organization (WHO) guidelines [14], and used an automated device (OMRON HEM705CP, Omron Matsusaka Co, Matsusaka City, Mie-Ken, Japan). BP was measured on both arms, while the participant was comfortably sitted, had been at rest for 30 min or more, and had consumed no tea, coffee or smoked cigarette within the preceding hour. The standard 23 × 12 cm cuff or larger size cuff for obese individuals was used. The average of three consecutive BP measurements from the arm with the higher values was used in all analyses.

A 50 ml clean container was used to collect the midstream second-morning urine for dipstick, creatinine and albumin tests. After an overnight fast of 8 h or more, a 3 ml of whole blood was also collected from the antecubital vein for serum creatinine, uric acid, lipid profile (including total and high-density lipoprotein (HDL) cholesterol, triglycerides) and fasting glycemia. Fasting glycemia and dipstick urine tests were done at the site of sample collection. The remaining sample was transported in ice to the Garoua Regional Hospital's laboratory for further processing and analyses. The CombiScreen 7SL PLUS 7 test strips (Analyticon Biotechnologies AG, D-35104 Lichtenfeis, Germany) were used for urine dipstick tests. Fasting glycemia was acquired using the One Touch Ultra® easy reader® (LifeScan Europe, Cilag GmbH International, Zug, Switzerland). Serum and urinary creatinine measurements were based on the kinetic modification of the Jaffé reaction with a Human visual spectrophotometer (Human Gesellschaft, Biochemica und Diagnostica mbH, Wiesbaden, Germany) implemented on a Beckman creatinine analyzer (Beckman CX systems instruments, Anaheim, CA, USA). Urinary albumin was measured using pyrogallol red-molybdate complex with Teco diagnostics tests (Teco Diagnostics**,** Anaheim, CA, USA). Lipid profile [serum Triglycerides (TG), total (TC) and HDL cholesterol (HDL-C)] measurement used the enzymatic colorimetric methods, while low-density lipoprotein cholesterol (LDL-C) was calculated from the Friedwald's equation as LDL-C = TC – (HDL-C + TG/5) [15–17].

All participants with a positive dipstick [protein (≥ traces), blood, leucocytes], and/or a fasting glycemia of at least 126 mg/dl (for those without prior diabetes), were offered confirmation tests two weeks later. For a participant with positive dipstick on the repeated test and/or estimated glomerular filtration rate (eGFR) < 60 ml/min/1.73 m^2 using CKD-EPI formula, the chronicity of the condition was confirmed 3 months later via repeated tests. For persistent proteinuria (≥ traces) 3 months later, a urinary albumin/creatinine ratio (ACR) was performed.

Definitions and calculations

We calculated the body mass index (BMI, kg/m^2) as weight (kg)/height (m)*height (m), and ranked participants as a normal weight for $20 \le BMI < 25$ kg/m^2, overweight for $25 \le BMI < 30$ kg/m^2 or obese for $BMI \ge 30$ kg/m^2. Hypertension was diagnosed in the presence of systolic (SBP) ≥ 140 mmHg and/or a diastolic blood pressure (DBP) ≥ 90 mmHg on two consecutive occasions two weeks apart, or ongoing use of BP-lowering medications. The 24-h albuminuria was estimated from Albumin/Creatinine ratio (mg/g). Estimated glomerular filtration rate (eGFR, mL/min) was based on the CKD-EPI (Chronic Kidney Disease Epidemiology Collaboration) equation [18]. Serum creatinine from Jaffe reaction (SCr_{Jaffe}) was converted to standardized serum creatinine ($SCr_{Standardized}$) to be used in CKD-EPI formula, via the formula $SCr_{Standardized} = 0.95*SCr_{Jaffe} – 0.10$ [19]. CKD was defined by the persistence after 3 months of albuminuria (ACR ≥ 30 mg/g) and/or low eGFR (< 60 ml/min/1.73 m^2) following the Kidney Disease: Improving Global Outcomes (KDIGO) guidelines [20]. Thereafter, CKD was classified into GFR and albuminuria categories. GFR categories of CKD included: G1 (eGFR ≥ 90); G2 (eGFR: 60 – 89); G3a (eGFR: 45–59); G3b (eGFR: 30–44); G4 (eGFR: 15–29) and G5 (eGFR < 15). Albuminuria categories of CKD were: A1 (< 30 mg/g); A2 (30–300 mg/g) and A3 (> 300 mg/g). Diabetes mellitus was diagnosed in the presence of fasting glycaemia ≥ 126 mg/dl on two consecutive occasions, or the use of blood glucose control agents. Hyperuricemia was defined as serum uric acid level ≥ 7.0 mg/dl or use of uric acid lowering drugs. Dyslipidaemia was defined by total cholesterol (≥ 200 mg/dl) and/or triglycerides (≥ 150 mg/dl) and/or HDL cholesterol (< 40 mg/dl) and/or LDL cholesterol (≥ 130 mg/dl) or use of lipids lowering agents [21].

Statistical analysis

Data were analysed using the SAS/STAT v9.4 software for Windows® (SAS Institute Inc., Cary, NC, USA). The survey analysis procedures (*'proc surveymeans', 'proc surveyreg' and 'proc surveylogistic')* were applied to account for the multilevel sampling design of the sample collection and sampling weights. Results are reported as means, counts and percentages and the accompanying 95% confidence intervals. The Taylor series linearization method was used to estimate the sampling error. To compare qualitative variables across groups, we used the Rao-Scott design-adjusted chi-square test. This test accounts for the sample design and allows inference to be made for the study population. Age and sex-adjusted logistic regression models were used to investigate the predictors of CKD. A p-value < 0.05 was used to indicate statistically significant results.

Results

Baseline characteristics of the study population by sex and location

As presented in Table 1, 433 participants were included with a mean age (95% CI) of 45.0 (43.4–46.6) years, 212 (48.7%)

Table 1 Baseline clinical and biological characteristics by location

Characterisitics	Overall	Garoua	Figuil	p	p sex*residence
n (%)	433 (100)	294 (67,9)	139 (32,1)		
Age, years (95% CI)	45.0 (43.4–46.6)	44.5 (42.5–46.4)	46.1 (43.1–49.1)	0.358	0.223
Men, *n*; % (95% CI)	212; 48.7 (40.4–56.9)	133; 44.3 (35.8–52.9)	79; 58.2 (48.3–68.1)	0.0004	NA
Achieved education, *n*; % (95% CI)				0.967	801
Never	218; 45.6 (35.9–55.2)	156; 46.5 (33.8–59.2)	62; 43.5 (32.2–54.8)		
Primary	111; 26.5 (22.9–30.0)	73; 26.1 (21.0–31.2)	38; 27.2 (24.3–30.1)		
Secondary	90; 25.0 (18.0–31.9)	56; 24.4 (16.0–32.9)	34; 26.1 914.4–37.9)		
University	14; 3.0 (1.4–4.6)	9; 2.9 (0.6–5.2)	5; 3.1 (1.3–5.0)		
History of renal disease, *n*; % (95% CI)	2; 0.5 (0.0–1.6)	2; 0.8 (0.0–2.2)	0	NA	0.112
History of hypertension, *n*; % (95% CI)	46; 12.0 (8.8–15.2)	31; 12.8 (8.5–17.0)	15; 10.3 (7.8–12.9)	0.219	0.390
History of gout, *n*; % (95% CI)	6; 1.8 (0.2–3.3)	4; 1.9 (0.0–3.9)	2; 1.5 (0.1–2.9)	0.726	< 0.0001
History of diabetes, *n*; % (95% CI)	7; 2.9 (0.9–4.8)	5; 3.5 (1.0–6.0)	1; 0.8 (0.0–1.7)	0.042	0.050
Use of anti-inflammatory drugs, *n*; % (95% CI)	209; 50.0 (36.9–63.1)	128; 46.3 (30.2–59.0)	81; 61.8 (44.5–79.0)	0.049	0.323
Tobacco use, *n*; % (95% CI)	52; 11.3 (6.3–16.3)	33; 9.7 (4.2–15.2)	19; 14.9 (7.1–22.8)	0.173	< 0.0001
Alcohol use, *n*; % (95% CI)	142; 34.4 (22.6–46.2)	62; 24.3 (16.8–31.8)	80; 55.9 (34.8–77.1)	< 0.0001	0.009
Longstanding use of herbal medicine, *n*; % (95% CI)	199; 50.2 (41.2–59.2)	124; 46.6 (36.6–56.6)	75; 57.9 (40.2–75.5)	0.247	0.008
Longstanding use of street medications, *n*; % (95% CI)	214; 52.8 (41.9–63.6)	135; 48.7 (35.7–61.8)	79; 61.7 (43.8–79.6)	0.219	0.300
Body mass index, kg/m^2 (95% CI)	23.8 (23.0–24.6)	24.2 (23.1–25.0)	23.0 (22.5–23.6)	0.056	0.807
BMI ≥ 25, *n*; % (95% CI)	126; 33.6 (25.0–42.2)	92; 37.2 (26.7–47.7)	34; 25.8 (20.1–31.4)	0.0004	0.066
Waist girth, cm (95% CI)	86 (84–88)	87 (84–89)	84 (83–85)	0.079	0.790
Systolic blood pressure, mmHg (95% CI)	131 (129–133)	131 (128–134)	131 (127–135)	0.989	0.103
Diastolic blood pressure, mmHg (95% CI)	84 (83–86)	84 (82–85)	86 (83–89)	0.190	0.536
Hypertension, *n*; % (95% CI)	137; 33.9 (30.0–37.8)	93; 34.7 (29.7–39.7)	44; 32.3 (27.0–37.6)	0.479	0.682
Fasting glycemia, g/l (95% CI)	0.92 (0.89–0.95)	0.94 (0.91–0.98)	0.88 (0.86–0.91)	0.011	0.589
Hyperglycaemia, n; % (95% CI)	34; 6.5 (3.6–9.6)	30; 8.0 (4.1–11.9)	4; 3.3 (1.0–5.5)	0.009	0.734
Mean uricemia, mg/l (95% CI)	57.1 (54.2–59.9)	57.8 (54.3–61.3)	55.4 (51.0–59.8)	0.389	0.006
Hyperuricemia, *n*; % (95% CI)	74; 16.8 (11.6–22.0)	58; 19.2 (13.3–25.4)	16; 11.2 (6.0–16.3)	0.004	0.040
HDL cholesterol, g/l (95% CI)	0.29 (0.27–0.31)	0.30 (0.27–0.33)	0.26 (0.24–0.28)	0.043	0.630
Total cholesterol, g/l (95% CI)	1.65 (1.59–1.71)	1.68 (1.59–1.77)	1.60 (1.55–1.66)	0.164	0.063
LDL cholesterol, g/l (95% CI)	1.07 (1.02–1.12)	1.05 (0.98–1.12)	1.11 (1.07–1.16)	0.112	0.237
Triglycerides, g/l (95% CI)	1.16 (1.11–1.20)	1.19 (1.14–1.23)	1.08 (1.02–1.14)	0.007	0.334
Dyslipidaemia, *n*; % (95% CI)	397; 93.1 (89.9–96.4)	271; 94.4 (90.5–98.3)	126; 90.3 (88.0–92.5)	0.029	0.171

95% CI 95% confidence interval

men, 294 (67.9%) from Garoua and 218 (45.6%) with no formal education. In all, 107 (25.4%) participants had kidney function tests abnormalities and repeated tests 3 months later to confirm the chronicity in 73 (68.2%) with albuminuria, 26 (24.3%) with eGFR below 60 ml/min/1.73m^2 and 8 (7.5%) with both.

Only few participants knew their status as having hypertension (12%), diabetes (2.9%), gout (1.8%) and renal diseases (0.5%). Risk factors for chronic nephropathy were highly prevalent including longstanding use of street medications (52.8%), herbal medicines (50.2%) and non-steroidal anti-inflammatory drugs (50%), alcohol consumption (34.4%), hypertension (33.9%), overweight/obesity (33.6%), hyperuricemia (16.8%), smoking (11.3%), and hyperglycaemia (6.5%), Table 1. Dipstick abnormalities were proteinuria (17.4%), hematuria (6.5%) and leucocyturia (6%). In all, 148 (32%) and 34 (9.4%) participants had eGFR between 60–90 and below 60 ml/min/1.73 m^2, respectively, Table 2.

By city, Figuil participants were predominantly female, less overweight/obese and diabetic, and more hematuric, alcohol and non-steroidal anti-inflammatory users (all $p < 0.049$). Sex and city differences were apparent regarding the distribution of history of diabetic and gout, eGFR, uricemia, and consumption of alcohol, tobacco and herbal medicines (all $p < 0.05$ for sex*residence interactions), Tables 1 and 2.

Prevalence and correlates of persistent albuminuria, CKD G3-5 and chronic kidney disease

The prevalence of CKD was 11.7% overall, 10.7% in Garoua and 13% in Figuil participants. Equivalents figures for CKD G3-5 and albuminuria were 2.8%, 2.0% and 4.5%; and 9.1%, 9.3% and 8.5%, respectively. There was a statistically significant higher prevalence of albuminuria in Garoua compare to Figuil ($p = 0.049$) and no difference by the city for prevalent CKD and CKD G3-5 (both $p > 0.05$). There was significant gender*city interaction in the prevalence of CKD and CKD G3-5 (both $p < 0.024$), but not for albuminuria, Table 2.

The prevalence of CKD varied by status for hypertension, hyperglycaemia and hyperuricemia (all $p < 0.01$), while CKD G3-5 varied by age, status for higher total cholesterol and hyperuricemia (all $p < 0.033$), and prevalent albuminuria varied by status for hypertension, hyperglycaemia and hyperuricemia (all $p < 0.042$), Table 3

Table 2 Kidney function tests and urine profile by location at baseline and after three months

Characteristics	Overall	Garoua	Figuil	*p*	*p* sex*residence
n (%)	433	294	139		
Dipstick abnormalities, *n*; % (95% CI)					
Proteinuria	81; 17.4 (12.9–21.9)	56; 17.8 (12.3–23.4)	25; 16.4 (8.7–24.1)	0.746	0.733
Hematuria	32; 6.5 (3.5–9.5)	20; 5.4 (2.4–8.4)	12; 9.0 (4.6–13.5)	0.04	0.738
Leucocyturia	28; 6.0 (3.5–8.4)	21; 6.5 (3.2–9.7)	7; 4.9 (2.4–7.5)	0.399	0.574
Serum creatinine 1 stand, mg/l (95% CI)	10.4 (9.5–11.3)	10.7 (9.5–11.8)	9.9 (8.7–11.1)	0.377	0.870
eGFR CKD-EPI 1, (ml/min/1.73 m^2) (95% CI)	96.4 (89.8–101.9)	93.4 (85.9–100.9)	102.9 (94.7–111.1)	0.091	0.007
Stages of eGFR, CKD-EPI 1 (ml/min/1.73 m^2) *n*; % (95% CI)					
> 90	251; 58.6 (47.9–69.3)	154; 52.7 (40.5–64.8)	97; 71.5 (61.9–81.1)	< 0.0001	< 0.0001
60–90	148; 32.0 (23.7–40.3)	117; 37.1 (28.1–46.2)	31; 20.9 (13.2–28.6)		
< 60	34; 9.4 (5.1–13.7)	23; 10.2 (4.3–16.1)	11; 7.6 (4.0–11.1)		
Initial proteinuria and/or low eGFR (CKD-EPI), *n*; % (95% CI)	107; 25.4 (19.7–31.1)	73; 26.7 (19.8–33.7)	34; 22.6 (14.3–30.8)	0.402	0.944
Persisting albuminuria, *n*; % (95% CI)	42; 9.1 (5.1–13.0)	29; 9.3 (4.0–14.6)	13; 8.5 (3.5–13.5)	0.049	0.363
Serum creatinine 2 stand (*N* = 107), mg/l (95% CI)	12.5 (10.9–14.0)	12.0 (10.4–13.6)	14.4 (12.8–16.1)	0.049	0.744
eGFR CKD-EPI 2 (*N* = 107), (ml/min/1.73 m^2) (95% CI)	80.8 (73.8–87.8)	83.2 (74.8–91.5)	72.4 (63.6–81.1)	0.071	0.418
Chronic renal failure eGFR (CKD-EPI) (ml/min/1.73 m^2), *n*; % (95% CI)	15; 2.8 (1.1–4.5)	8; 2.0 (0.02–4.0)	7; 4.5 (2.2–6.7)	0.083	0.011
Chronic kidney disease (CKD-EPI), *n*; % (95% CI)	55; 11.7 (7.1–15.7)	35; 10.7 (4.7–16.6)	20; 13.0 (7.6–18.4)	0.570	0.024

CKD-EPI Chronic kidney disease epidemiology collaboration, *eGFR* Estimated glomerular filtration rate

Table 3 – Characteristics by status for persistent albuminuria, and chronic kidney disease overall and G3-5

Variables	Persistent albuminuria			Chronic kidney disease G3-5			Chronic kidney disease overall		
	No	Yes	*p*	No	Yes	*P*	No	Yes	p
n	391	42		418	15		378	55	
Sex (Men), *n*; % (95% CI)	193; 48.6 (40.3–56.9)	19; 49.4 (31.8–67.0)	0.915	206; 48.8 (40.2–57.4)	6; 42.7 (7.8–77.5)	0.735	188; 48.9 (40.0–57.7)	24; 46.9 (28.9–64.9)	0.835
Garoua residency, *n*; % (95% CI)	265; 68.5 (39.1–97.9)	29; 70.5 (42.5–98.6)	0.825	286; 69.2 (40.6–97.8)	8; 49.9 (10.3–89.5)	0.083	259; 69.2 (40.1–98.4)	35; 64.3 (34.0–94.6)	0.570
Age, years (95% CI)	45.2 (43.4–47.1)	42.4 (37.5–47.3)	0.319	44.6 (43.0–46.1)	59.1 (51.5–66.7)	0.0006	44.8 (43.0–46.6)	46.2 (41.4–51.1)	0.592
History of hypertension, n; % (95% CI)	39; 11.3 (8.0–14.7)	7; 18.5 (4.3–32.7)	0.235	42; 11.7 (8.6–14.9)	4; 21.8 (0.0–45.4)	0.250	35; 11.0 (7.8–14.1)	11; 20.1 (7.6–32.6)	0.070
History of diabetes, *n*; % (95% CI)	7; 3.2 (1.1–5.2)	0	NA	7; 3.0 (1.0–4.9)	0	NA	7; 3.3 (1.2–5.3)	0	NA
History of gout, *n*; % (95% CI)	6; 1.9 (0.3–3.6)	0	NA	5; 1.8 (0,2–3.3)	1; 1.2 (0.0–4.0)	0.736	5; 2.0 (0.2–3.7)	1; 0.3 (0.0–0.9)	0.055
Tobacco use, *n*; % (95% CI)	47; 11.2 (6.4–16.0)	5; 12.2 (0.0–24.5)	0.852	49; 10.8 (5.9–15.7)	3; 29.0 (0.0–65.3)	0.125	45; 11.0 (6.2–15.8)	7; 13.9 (2.1–25.7)	0.514
Alcohol use, *n*; % (95% CI)	128; 34.1 (21.5–46.7)	14; 37.2 (24.8–49.5)	0.669	136; 33.9 (22.2–45.6)	6; 53.3 (20.7–85.9)	0.155	123; 33.7 (21.3–46.1)	19; 39.5 (25.1–53.8)	0.409
Longstanding use of herbal medicine, *n*; % (95% CI)	181; 50.7 (41.4–60.0)	18; 45.2 (21.4–69.0)	0.642	194; 50.6 (41.6–59.6)	5; 35.7 (9.7–61.7)	0.234	176; 50.8 (41.5–60.2)	23; 44.9 (24.8–65.1)	0.556
Use of anti-inflammatory drugs, *n;* % (95% CI)	190; 50.8 (38.1–63.6)	19; 41.2 (19.9–80.1)	0.187	203; 49.9 (36.8–63.0)	6; 51.4 (21.1–81.7)	0.913	185; 50.9 (38.2–63.6)	24; 42.5 (22.4–62.6)	0.189
Use of street medications, *n*; % (95% CI)	193; 53.4 (43.1–63.6)	21; 46.9 (24.2–69.5)	0.433	208; 52.9 (41.9–63.9)	6; 48.6 (24,6–72.6)	0.709	189; 53.8 (43.5–64.0)	25; 45.1 (25.4–64.7)	0.201
Systolic blood pressure, mmHg (95% CI)	131 (128–132)	139 (128–150)	0.115	131 (128–133)	138 (126–150)	0.248	130 (127–132)	139 (130–148)	0.061
Diastolic blood pressure, mmHg (95% CI)	84 (82–850	93 (85–101)	0.042	84 (83–86)	83 (79–88)	0.632	84 (82–85)	91 (85–98)	0.054
Hypertension, *n*; % (95% CI)	118; 32.5 (28.5–36.6)	19; 48.0 (33.8–62.3)	0.024	130; 33.8 (29.8–37.9)	7; 37.4 (13.0–61.9)	0.765	112; 32.4 (28.3–36.4)	25; 46.2 (35.0–57.4)	0.010
Body mass index, kg/m^2 (95% CI)	23.8 (23.0–24.6)	23.9 (21.6–26.2)	0.896	23.8 (22.9–24.7)	23.6 (21.9–25.3)	0.860	23.8 (22.9–25.0)	24.0 (22.2–25.8)	0.719
Body mass index $\geq$ 25, *n*; % (95% CI)	114; 33.0 (25.0–41.0)	12; 39.6 (15.7–63.6)	0.493	297; 66.2 (57.4–74.9)	10; 73.7 (55.0–92.4)	0.432	269; 66.9 (58.8–75.1)	38; 62.0 (42.3–81.6)	0.530
Waist girth, cm (95% CI)	86 (84–88)	87 (82–93)	0.526	86 (84–88)	89 (83–95)	0.286	86 (84–88)	88 (84–93)	0.240
Fasting glycemia, g/l (SD)	0.91 (0.88–0.93)	1.08 (0.85–1.32)	0.131	0.92 (0.89–0.95)	0.88 (0.81–0.95)	0.218	0.91 (0.88–0.93)	1.04 (0.84–1.24)	0.184

Table 3 (continued)

Variables	Persistent albuminuria			Chronic kidney disease G3-5			Chronic kidney disease overall		
	No	Yes	*p*	No	Yes	*P*	No	Yes	p
Hyperglycemia, *n*; % (95% CI)	27; 4.8 (1.9–7.8)	7; 23.4 (5.0–41.9)	0.001	33; 6.6 (3.6–9.5)	1; 5.2 (0.0–16.2)	0.808	27; 5.0 (2.0–8.0)	7; 18.7 (3.5–33.9)	0.010
Hyperuricemia, *n*; % (95% CI)	62; 15.3 (11.0–19.7)	12; 31.4 (14.0–48.9)	0.002	67; 16.0 (11.3–20.7)	7; 43.6 (10.1–77.1)	0.010	56; 14.7 (10.5–18.9)	18; 32.8 (16.7–48.9)	0.0001
HDL cholesterol, g/l (95% CI)	0.29 (0.27–0.31)	0.27 (0.23–0.32)	0.494	0.29 (0.26–0.31)	0.28 (0.24–0.32)	0.777	0.29 (0.27–0.31)	0.27 (0.24–0.31)	0.416
Total cholesterol, g/l (95% CI)	1.64 (1.58–1.70)	1.70 (1.55–1.84)	0.425	1.65 (1.58–1.71)	1.78 (1.65–1.91)	0.033	1.64 (1.58–1.70)	1.71 (1.57–1.84)	0.262
LDL cholesterol, g/l (95% CI)	1.08 (1.03–1.12)	1.06 (0.95–1.18)	0.765	1.07 (1.02–1.12)	1.13 (0.99–1.27)	0.403	1.08 (1.03–1.12)	1.07 (0.96–1.18)	0.920
Triglycerides, g/l (95% CI)	1.15 (1.11–1.19)	1.19 (1.10–1.29)	0.314	1.15 (1.11–1.20)	1.25 (1.06–1.44)	0.270	1.15 (1.11–1.19)	1.21 (1.10–1.31)	0.184
Dyslipidemia,, *n; %* (95% CI)	357; 92.8 (89.3–96.3)	40; 96.4 (91.0–100.0)	0.904	383; 93.1 (89.8–96.4)	14; 94.0 (82.9–100)	0.879	345; 92.8 (82.2–96.4)	52; 95.7 (90.7–100.0)	0.384

95% CI 95% confidence intervals

Predictors of chronic kidney disease in age, sex and residence adjusted logistic

In age, sex and city adjusted logistic regressions, predictors of CKD were increased systolic blood pressure [OR 1.02 (95%CI 1.00–1.04) per mmHg higher SBP, $p=0.032$], hyperglycaemia [4.73 (1.24–18.08), $p=0.025$] and hyperuricaemia [3.12 (1.58–6.16), $p=0.002$]. There was a borderline association between hypertension and the presence of CKD. However, age, sex and residence did not affect the prevalence of CKD, Table 4

Table 4 - Predictors of chronic kidney disease in age, sex and residence adjusted logistic regressions

Variables	Chronic kidney disease	
	OR (95%CI)	*p*
Sex (men)	1.01 (0.98–1.03)	0.777
Residency (Garoua)	0.89 (0.39–2.03)	0.580
Age, per years	0.79 (0.34–1.86)	0.606
History of hypertension	2.05 (0.86–4.90)	0.100
Tobacco use	1.33 (0.59–3.00)	0.475
Alcohol use	1.26 (0.64–2.50)	0.490
Longstanding use of street medications	0.67 (0.36–1.25)	0.197
Use of herbal medicine	0.75 (0.33–1.74)	0.492
Use of anti-inflammatory drugs	0.65 (0.34–1.23)	0.175
Systolic blood pressure, mmHg	1.02 (1.00–1.04)	0.032
Diastolic blood pressure, mmHg	1.02 (0.96–1.08)	0.563
Hypertension	1.89 (0.98–3.65)	0.058
Body mass index ≥ 25 kg/m^2	1.25 (0.57–2.73)	0.559
Hyperglycemia	4.73 (1.24–18.08)	0.025
Hyperuricemia	3.12 (1.58–6.16)	0.002
Dyslipidemia	1.76 (0.51–6.04)	0.354

Discussion

This study on the prevalence and determinants of CKD in urban adult populations of northern Cameroon revealed a prevalence of 11.7%, with sex differentials across cities. Prevalent CKD was driven by known modifiable risk factors for chronic nephropathy including hyperglycaemia, high blood pressure, and hyperuricemia.

The prevalence of CKD observed in these northern cities of Cameroon was similar to those previously reported in the southern parts of the country despite differences in population characteristics, sociocultural background and lifestyles [11, 12]. The prevalence of CKD in our study was also in keeping with prevalence rates across SSA as reported in recent systematic reviews and meta-analysis on the topic [2, 3]. The high prevalence of CKD in this setting, likely driven by known risk factors for chronic nephropathy, could be explained by participant's low awareness of their status for those risk factors, and accordingly low exposure to primary CKD prevention measures. Furthermore, the

epidemiological transition in the country is associated with the growing prevalence of non-communicable diseases and persistent infectious diseases which contribute to the burden of CKD [22–24]. The potential contribution of chronic tubulo-interstitial nephropathy can also be suggested. Indeed, agricultural workers like those of SODECOTON® are predisposed to CKD of unknown cause whereas people working in a hot climatic environment rich in marble, calcium carbonate, slake lime, gravel of granite, cement, aggregate and concrete like in Figuil could develop chronic tubulo-interstitial nephropathy [25]. However, the prevalence of CKD in this study is lower compared to studies performed in sugarcane farming populations of El Salvador and Nicaragua [26, 27]. This invites a systematic screening of CKD in such populations; those with urinalysis abnormalities should undergo kidney biopsy for appropriate diagnosis and timely management of the disease.

We found that 2.8% of study participants presented CKD G3-5 with higher prevalence observed in Figuil. This prevalence was similar to previous reports in the country, despite the higher frequency of risk factors for chronic nephropathy in apparently healthy populations [11, 12]. The presence of CKD G3-5 was associated with advanced age, higher total cholesterol and hyperuricemia. As previously mentioned, this could be related to low awareness of such factors as also reported elsewhere and then lack of appropriate management [24]. This implies a regular screening of these factors in such populations especially in the elderly and their optimal control to prevent the progression to end-stage renal disease. Moreover, a sensitization campaign to raise awareness, educate on the risk of anti-inflammatory drugs and obesity, increase treatment adherence and improve the control rate of these factors should be implemented in this setting.

Nearly one out of ten participants had albuminuria which was associated with higher systolic blood pressure, hypertension, hyperglycaemia and hyperuricemia. These factors could lead to albuminuria either by hyperfiltration or secondary to glomerular lesions, inviting early screening and initiation of nephroprotection measures [28, 29].

Strengths and limitations

The main limitation of this study was the lack of screening for infectious disease such as HIV and hepatitis B and C which are endemic in this setting and well-known risk factors of CKD. It was also difficult to assess the socioeconomic status of participants from the monthly income which was not regular and not suitable for analysis; however, the higher level of illiteracy may correlate with lower socio-economic status which is a risk factor of CKD. This study is the first of our knowledge on the epidemiology of CKD in the northern part of the country with predominantly peuhl populations. We used up-to-date guidelines for populations screening, as done in previous studies in the country [11, 12].

Conclusion

We observed a high prevalence of CKD in northern Cameroon, similar to figures reported in the southern part of the country, driven mostly by known modifiable risk factors for chronic nephropathy. This indicates the importance for a regular and systematic screening of these factors and their optimal control as well as screening for prevalent CKD to allow early initiation of nephroprotective measures to slow the progression of the disease where present. Locally relevant population-based strategies should also be developed and implement to improve population levels of common risk factors for CKD in this setting. Along these lines, the national plan against CKD which is currently under development makes provision for annual screening of high-risk people across the country and their education for the appropriate use of drugs and the bodyweight control.

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Availability of data and materials Data and materials are available with corresponding author which is the principal investigator. They can be consulted at anytime upon request. However, the ethical clearance and the inform consent form did mention that patient data could be share to a third party.

Declarations

Conflicts interests The authors report no conflicts of interest.

Consent for publication All authors gave their approval for publication

Ethics approval and consent to participate This study was approved by the Cameroon National Ethics Committee and all participants provided a written informed consent before enrolment.

References

1. World Kidney Day. World kidney day: FAQS. http://www.worldkidneyday.org/faqs (accessed date: 15th August 2019).

2. Hill NR, Fatoba ST, Oke JL, Hirst JA, O'Callaghan CA, Lasserson DS, Hobbs FD. Global prevalence of chronic kidney disease - a systematic review and meta-analysis. PLoS ONE. 2016;11(7):e0158765.
3. Kaze AD, Ilori T, Jaar BG, Echouffo-Tcheugui JB. Burden of chronic kidney disease on the African continent: a systematic review and meta-analysis. BMC Nephrol. 2018;19(1):125.
4. Kaze FF, Kengne AP, Magatsing CT, Halle MP, Yiagnigni E, Ngu KB. Prevalence and determinants of chronic kidney disease among hypertensive cameroonians according to three common estimators of the glomerular filtration rate. J Clin Hypertens (Greenwich). 2016;18(5):408–14.
5. Hamadou B, Boombhi J, Kamdem F, Fitame A, Amougou SN, Mfeukeu LK, Nganou CN, Menanga A, Ashuntantang G. 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. Cardiovasc Diagn Ther. 2017;7(6):581–8.
6. FolefackKaze F, Kengne AP, Pefura Yone EW, NdamFemben NS, Ashuntantang G. Renal function, urinalysis abnormalities and correlates among HIV-infected Cameroonians naive to antiretroviral therapy. Saudi J Kidney Dis Transpl. 2013;24(6):1291–7.
7. Kaze FF, Kengne AP, Atanga LC, Monny Lobe M, Menanga AP, Halle MP, Chetcha Chemegni B, Ngo Sack F, Kingue S, Ashuntantang G. Kidney function, urinalysis abnormalities and correlates in equatorial Africans with sickle cell disease. Clinical Kidney J. 2012;6(1):15–20.
8. Sumaili EK, Cohen EP, Zinga CV, Krzesinski JM, Pakasa NM, Nseka NM. High prevalence of undiagnosed chronic kidney disease among at-risk population in Kinshasa, the Democratic Republic of Congo. BMC Nephrol. 2009;10:18.
9. Anand S, Bitton A, Gaziano T. The gap between estimated incidence of end-stage renal disease and use of therapy. PLoS ONE. 2013;8(8):e72860.
10. Ashuntantang G, Osafo C, Olowu WA, Arogundade F, Niang A, Porter J, Naicker S, Luyckx VA. Outcomes in adults and children with end-stage kidney disease requiring dialysis in sub-Saharan Africa: a systematic review. Lancet Glob Health. 2017;5(4):e408–17.
11. Kaze FF, Halle MP, Mopa HT, Ashuntantang G, Fouda H, Ngogang J, Kengne AP. Prevalence and risk factors of chronic kidney disease in urban adult Cameroonians according to three common estimators of the glomerular filtration rate: a cross-sectional study. BMC Nephrol. 2015;16:96.
12. Kaze FF, Meto DT, Halle MP, Ngogang J, Kengne AP. Prevalence and determinants of chronic kidney disease in rural and urban Cameroonians: a cross-sectional study. BMC Nephrol. 2015;16:117.
13. Sumaili EK, Krzesinski JM, Zinga CV, Cohen EP, Delanaye P, Munyanga SM, Nseka NM. Prevalence of chronic kidney disease in Kinshasa: results of a pilot study from the Democratic Republic of Congo. Nephrol Dial Transplant. 2009;24(1):117–22.
14. Chalmers J, MacMahon S, Mancia G, Whitworth J, Beilin L, Hansson L, Neal B, Rodgers A, Ni Mhurchu C, Clark T: 1999 World Health Organization-International Society of Hypertension Guidelines for the management of hypertension. Guidelines subcommittee of the World Health Organization. *Clin Exp Hypertens* 1999, 21(5–6):1009–1060.
15. Allain CC, Poon LS, Chan CS, Richmond W, Fu PC. Enzymatic determination of total serum cholesterol. Clin Chem. 1974;20(4):470–5.
16. Fossati P, Prencipe L. Serum triglycerides determined colorimetrically with an enzyme that produces hydrogen peroxide. Clin Chem. 1982;28(10):2077–80.
17. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem. 1972;18(6):499–502.
18. Levey AS, Stevens LA, Schmid CH, Zhang YL, Castro AF 3rd, Feldman HI, Kusek JW, Eggers P, Van Lente F, Greene T, *et al*. A new equation to estimate glomerular filtration rate. Ann Intern Med. 2009;150(9):604–12.
19. Rule AD, Bailey KR, Schwartz GL, Khosla S, Lieske JC, Melton LJ 3rd. For estimating creatinine clearance measuring muscle mass gives better results than those based on demographics. Kidney Int. 2009;75(10):1071–8.
20. K/DIGO Guidelines. Definition and classification. Kidney Int Suppl 2013, 3(1):19–62.
21. Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report. Circulation 2002, 106(25):3143–3421.
22. Marshall SJ. Developing countries face double burden of disease. Bull World Health Organ. 2004;82(7):556.
23. Ataklte F, Erqou S, Kaptoge S, Taye B, Echouffo-Tcheugui JB, Kengne AP: Burden of Undiagnosed Hypertension in Sub-Saharan Africa: A Systematic Review and Meta-Analysis. *Hypertension* 2014.
24. Katte JC, Dzudie A, Sobngwi E, Mbong EN, Fetse GT, Kouam CK, Kengne AP. Coincidence of diabetes mellitus and hypertension in a semi-urban Cameroonian population: a cross-sectional study. BMC Public Health. 2014;14:696.
25. Johnson RJ, Wesseling C, Newman LS. Chronic Kidney Disease of Unknown Cause in Agricultural Communities. N Engl J Med. 2019;380(19):1843–52.
26. Torres C, Aragon A, Gonzalez M, Lopez I, Jakobsson K, Elinder CG, Lundberg I, Wesseling C. Decreased kidney function of unknown cause in Nicaragua: a community-based survey. Am J Kidney Dis. 2010;55(3):485–96.
27. Peraza S, Wesseling C, Aragon A, Leiva R, Garcia-Trabanino RA, Torres C, Jakobsson K, Elinder CG, Hogstedt C. Decreased kidney function among agricultural workers in El Salvador. Am J Kidney Dis. 2012;59(4):531–40.
28. Anders HJ, Huber TB, Isermann B, Schiffer M. CKD in diabetes: diabetic kidney disease versus nondiabetic kidney disease. Nat Rev Nephrol. 2018;14(6):361–77.
29. Anders HJ. 2018 update in basic kidney research: fibrosis, inflammation, glomerular filtration and kidney disease progression. Nephrol Dial Transplant. 2019;34(5):719–23.