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ORIGINAL RESEARCH

High Prevalence of Chronic Kidney Disease Among People Living with Hypertension in Rural Sierra Leone: A Cross-Sectional Study

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Introduction: Currently, there are no data on prevalence and associated risk factors of chronic kidney disease (CKD) among patients with hypertension in rural Sierra Leone.

Purpose: To estimate the prevalence and associated risk factors of CKD in rural Sierra Leone.

Patients and Methods: A cross-sectional study of hypertension patients aged between 18 and 75 years attending a non-communicable disease clinic at Koidu Government Hospital, Kono District, Sierra Leone was conducted between February and December 2020. Using systematic random sampling, a structured questionnaire, which comprised of questions on social demographic characteristics and past and current clinical history, was administered followed by measurement of creatinine and urinary protein and glucose. Estimated glomerular filtration rate (eGFR) was estimated using CKD-epidemiology formula without race as a factor. Baseline eGFR between 60–89 min/mL/1.73m^2 and <60 min/mL/1.73m^2 defined reduced eGFR and renal impairment, respectively. Estimated GFR less than 60 min/mL/1.73m^2 measured two times at least 3 months apart was used to define CKD.

Results: Ninety-six percent (n = 304) patients out of 317 patients were included in the study. Among all included patients, only 3.9% (n = 12) had eGFR of 90 min/mL/1.73m^2 and above. The prevalence of renal impairment and CKD was 52% (158/304, CI 46.2–57.7) and 29.9% (91/304, CI 24.8–34.5), respectively. In adjusted logistic regression analysis, currently taking herbal medications as treatment of hypertension (OR 4.11 (CI 1.14–14.80), p = 0.03) and being overweight and/or obese (OR 2.16 (CI 1.24–3.78), p < 0.001) was associated with CKD. Additionally, receiving some education was associated with a 48% (OR 0.52 (CI 0.29–0.91), p = 0.02) reduced likelihood of CKD.

Conclusion: The prevalence of renal impairment and CKD is high among hypertensive patients in rural Sierra Leone. CKD was associated with current history of taking herbal medications and being overweight and/or obese. Additionally, CKD was associated with reduced likelihood in patients who received some education.

Keywords: hypertension, non-communicable diseases, CKD, renal impairment, screening, Sierra Leone

Introduction

Chronic kidney disease (CKD) is one of the diseases with high morbidity and mortality worldwide.[1] In 2017 alone, over 697 million new cases were reported and 1.2 million people died due to CKD worldwide.[2] CKD was the 10th most common cause of death in 2020, and by 2040, CKD will be the fifth leading cause of years of life lost worldwide.[3,4] Low- and middle-income countries have disproportionately higher

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burden of CKD than high-income countries.[5,6] The higher burden of CKD in low- and middle-income countries is mainly as a result of high CKD prevalence accompanied by low CKD awareness, epidemiological transition with a rising burden of NCDs, and lack of policies and organized health systems aimed at addressing CKD burden.[7,8]

Chronic kidney disease burden is higher among people living with other non-communicable diseases (NCDs) like hypertension.[9–11] For example, the burden of CKD among hypertensive patients in Africa is reported at 35.6% by one recent study, twice as high as the prevalence in the general population.[12] Hypertension is an independent risk factor for CKD and quickens the progression of CKD to end-stage renal disease (ESRD).[13] Screening, early identification of CKD, subsequent management of CKD and control of hypertension is essential for reducing morbidity and mortality in hypertension patients.[14]

Management of CKD in general, and CKD in hypertensive patients specifically, is a challenge in low- and middle-income settings. In these settings, CKD screening is not routinely offered to patients with hypertension due to unavailability of screening tests, lack of organized systems for management of hypertension and other NCDs and limited funding for NCD care.[7] Additionally, lack of skilled staff to provide care, high cost of managing CKD, lack of infrastructure and absence of CKD in NCD policies and strategies contribute to challenges in managing CKD.[8,15] Dialysis and renal replacement therapy is frequently not available, hence patients with ESRD commonly have no access to these treatment modalities.[15–18]

As in many low and middle income countries, Sierra Leone is estimated to have a high burden of NCDs.[19] In 2016, NCDs contributed to 33% of all deaths.[20] Estimates by recent studies have shown that the prevalence of hypertension in people over 20 years of age is over 20% in Sierra Leone.[21–23] Although data is extremely limited, Global Burden of Disease estimates over half a million cases of CKD in 2017.[2] With evidence of hypertension as one of the strongest risk factor for CKD, management of hypertension should therefore include routine screening and treatment of CKD in Sierra Leone.[24,25]

Despite the inclusion of screening and treatment of hypertension at regional and district hospitals in Sierra Leone's package of essential health care, screening and management of CKD is not included in this package of care.[26,27] As far as we know, there is no published data on the prevalence of CKD in rural Sierra Leone to date. Currently, there is no public dialysis unit and renal replacement therapy is not available. As far as we are aware, only one private facility in capital city of Sierra Leone, Freetown, offers dialysis services and the cost is prohibitive for many patients with CKD. Therefore, early screening and management of CKD patients presents a unique opportunity to identify CKD patients and start early management to slow the progression to ESRD. CKD screening, which includes the measurements of creatinine, is feasible and relatively cheaper in low and middle-income countries.[6,28]

This study describes the prevalence and associated factors of CKD among hypertension patients in rural Sierra Leone. As far as we are aware, this is the first study to investigate CKD prevalence and provide evidence on the importance of screening for CKD in Sierra Leone.

Materials and Methods

Setting and Study Type

This is a cross-sectional study conducted at Koidu Government Hospital (KGH) in Kono District, Eastern Sierra Leone. Koidu Government Hospital, a Ministry of Health and Sanitation (MOHS) owned facility, is a secondary-level facility serving a catchment area of over half a million people and over 90 primary care facilities.[29] This 200-bed hospital offers in-patient services and outpatient services as well as other ancillary services which includes pharmacy, radiology and laboratory. At the hospital, some services are supported by a non-governmental organization called Partners In Health (PIH) Sierra Leone. In Kono district, 67% of the population lives in rural areas, and mining is the main source of income.[30] The study was conducted between February and December 2020.

Study Participants

The study included hypertensive patients receiving NCD services at KGH NCD clinic. KGH NCD clinic is an integrated outpatient clinic for the chronic management of patients with hypertension, diabetes, chronic heart disease, CKD, and other NCDs. It was established in February 2018, initially managing patients with hypertension and diabetes, before integrating with other NCDs in early 2019. In response to the high burden of hepatitis B, the clinic incorporated patients with complications of hepatitis B virus in its cohort in mid-2019.[31–33] The clinic is run by doctors, mid-level providers (known as Community Health Officers [CHOs]) and nurses. In

general, doctors manage patients with severe NCDs, CHOs manage non-severe NCD patients and nurses manage stable patients. Despite NCD care in Sierra Leone not included in the free health-care category, NCD services at KGH, including laboratory, pharmacy and radiology services, are provided free of charge with support from PIH.[34] For hypertension management in the NCD clinic, patients were enrolled in care if they had been diagnosed and are on medication for hypertension or if they are screened on the clinic day. During clinic screening, patients were enrolled if they had two blood pressure measurements ≥140/90 mmHg measured at least two minutes apart. We have recently described the enrollment and outcomes of hypertension patients in the first year of the clinic.[35]

Inclusion and Exclusion Criteria and Sample Size Calculations

In this study, we included hypertensive patients aged between 18 and 75 years receiving care at KGH NCD clinic. We excluded patients outside this age category, with pre-existing CKD, and patients with other diagnosis other than hypertension. Among the eligible hypertensive patients, we included patients that were able to give informed consent. We aimed to interview a minimum of 303 hypertensive patients. This was calculated based on CKD prevalence of 35.6% among hypertension patients in Africa, cumulative cohort of 2007 hypertension patients at KGH NCD clinic as of December 31, 2019 and a 5% margin of error.[12] We adjusted the sample size to 318 to account for a 5% non-response rate.

Data Collection Tools and Sampling

We developed a structured questionnaire consisting of social-demographic characteristics, medical history, family history and current management based on risk factors of CKD identified from relevant literature.[36–38] The questionnaire was administered in Krio, the commonest language spoken in Sierra Leone. Initially, the questionnaire was drafted in English. This was forward translated to Krio and backward translated to English by native Krio and English speakers to ensure no losses in translation. Finally, we pre-tested the questionnaire to ten patients to identify problematic questions, reduce measurements error and determine the best order of questions.

We used systematic random sampling to identify eligible patients on a clinic day. Initially, we randomly chose the first eligible patient to be enrolled between first and fifth patient using a random number generator. After the first patient eligible patients was identified, we enrolled every third patient.

Upon identification and enrollment, each eligible patient was interviewed by trained interviewer either before or after clinical consultation. The interview lasted at least 30 minutes. Anthropometric measurements and clinical information was obtained directly from patients' charts. The patients were then sent to KGH laboratory for collection of whole blood and urine samples for creatinine and urinary dipstick. For patients that required follow-up, we collected their contact details and were called using telephone for repeat tests after at-least 3 months from the enrollment date.

Measurements and Variables

The dependent variable was CKD. We used Kidney Disease: Improving Global Outcomes (KDIGO) definition of CKD defined as persistent estimated glomerular filtration rate (eGFR) of less than 60 mL/min/1.73m^2 for more than 3 months.[39] We used CKD epidemiology (CKD-Epi) formula without race to calculate eGFR. We used the CKD-Epi formula without race as some studies have shown this to be the better formula for African populations.[40–42] Estimated GFR of less than 60 mL/min/1.73m^2 on one occasion was regarded as renal impairment. Estimated GFR was categorized based on KDIGO classification.[39] Independent variables collected included:

1. Social-demographic characteristics: age (in years), gender (male or female), education level (never educated or some education), occupation (none, employed, farmer) and marital status (not married or married/cohabiting).
2. Medical history: years living with hypertension (0 to 2 years and over 2 years), years enrolled in the NCD clinic due to hypertension (Less than 12 months, 12 or more months), family history of hypertension (no, yes, I do not know), family history of CKD (no, yes, I do not know), history of smoking (yes or no), current or past alcohol drinking (yes or no), history of co-morbidities (diabetes, heart failure, HIV, stroke), intake of non-prescribed medications for hypertension (yes or no), past history of herbal medication used to treat hypertension (yes or no), current use of herbal medication for hypertension (yes or no), use of intake non-steroidal

anti-inflammatory drugs (NSAIDs) (yes, no, or do not know) and addition of salt in diet (yes or no).

3. Clinical observation and measurements. We used the patient charts to obtain the following measurements:
   a. The number of antihypertensive medications prescribed and document if Angiotensin Converting Enzyme (ACE) inhibitors and NSAIDs were prescribed on the current clinic visit.
   b. Body Mass Index (BMI). We calculated BMI based on current weight (in kilograms) and last known height (in meters). BMI was categorized as normal (18.5-<25 kg/m^2), underweight (below 18.5 kg/m^2), overweight (25.0-<30 kg/m^2) and obesity (30 kg/m^2 and above) as defined by World Health Organization.[43]
   c. Most recent systolic blood pressure (mmHg) and diastolic blood pressure (mmHg). Based on the clinical guidelines in use at the time, hypertension was classified as follows: normal/controlled (<140 and <90 mmHg), grade 1 (140–159 and/or 90–99 mmHg), grade 2 (160–179 and/or 100–109 mmHg) and grade 3 (≥180 and/or ≥110 mmHg).
   d. Most recent fasting blood glucose (in mg/dl).

The above variables were routinely performed and documented in medical charts by nurses, and/or CHOs and Doctors and were protocol based.[35] Additionally, we collected the following laboratory tests performed at the hospital laboratory by trained technicians:

(a) Creatinine (umol/l): A trained phlebotomist collected at least 3 millimeters of whole blood using aseptic technique for the measurement of creatinine. Creatinine was measured by HumaLyzer 3000 photometer by HUMAN Diagnostic Worldwide.[44] The photometer uses creatinine liquicolor for humalyzer 3000 to measure creatinine using kinetic and endpoint method (Jaffe).[45]

(b) Urine dipstick: At least 3 millimeters of fresh midstream urine was collected to measure urinary protein and glycosuria. Urine protein was categorized as negative and positive [combined +1, +2 and +3]) and glycosuria was categorized as negative and positive (combined +1, +2 and +3).

Urine dipstick and creatinine were measured using the manufacturer's standard operating protocols.

Data Management and Statistical Analysis

During study design phase, we planned to collect and analyze data on all variables of interest (see Supplementary Table 1). Since eGFR was used to measure CKD, we planned to exclude all participants without measurement of creatinine. For all other variables of interest, we aimed to analyze only the variables that have less than 5% of missing data, otherwise we planned to exclude variables with more than 5% missing data in our analysis. During data collection phase, all data were collected in paper-based questionnaires and were entered into Microsoft Excel 2016. Data cleaning and analysis was performed using STATA version 15.

We described patient baseline characteristics using descriptive statistics. To allow comparison between patients with and without CKD, we performed bivariate analysis for baseline demographic, history and clinical characteristics. For categorical variables, Chi^2 test and Fisher's exact test were used based on expected frequencies. For continuous variables, we used Student's *t*-test and Wilcoxon rank-sum test for normally distributed and non-normally distributed variable respectively.

To show association between CKD and some of the variables, we performed logistic regression analysis. Firstly, we conducted univariate logistic regression analysis between CKD and single predictor variables. This was followed by analysis with single predictors variables, with the addition of age and gender as adjusting variables (see Supplementary Material Table 2 for test of variable interaction). P <0.05 signified statistical significance.

Ethical Approval and Consent to Participate

We obtained informed consent from all the eligible patients. Initially, the data was not anonymized as we needed to collect the samples for creatinine test for patients with eGFR <60 mL/min/1.73m^2. After the collection of repeat tests, we created an anonymized dataset which was used to perform data cleaning and analysis. The study received ethical approval from Office of Sierra Leone Ethics and Scientific Review Committee and was conducted in accordance with the Declaration of Helsinki.

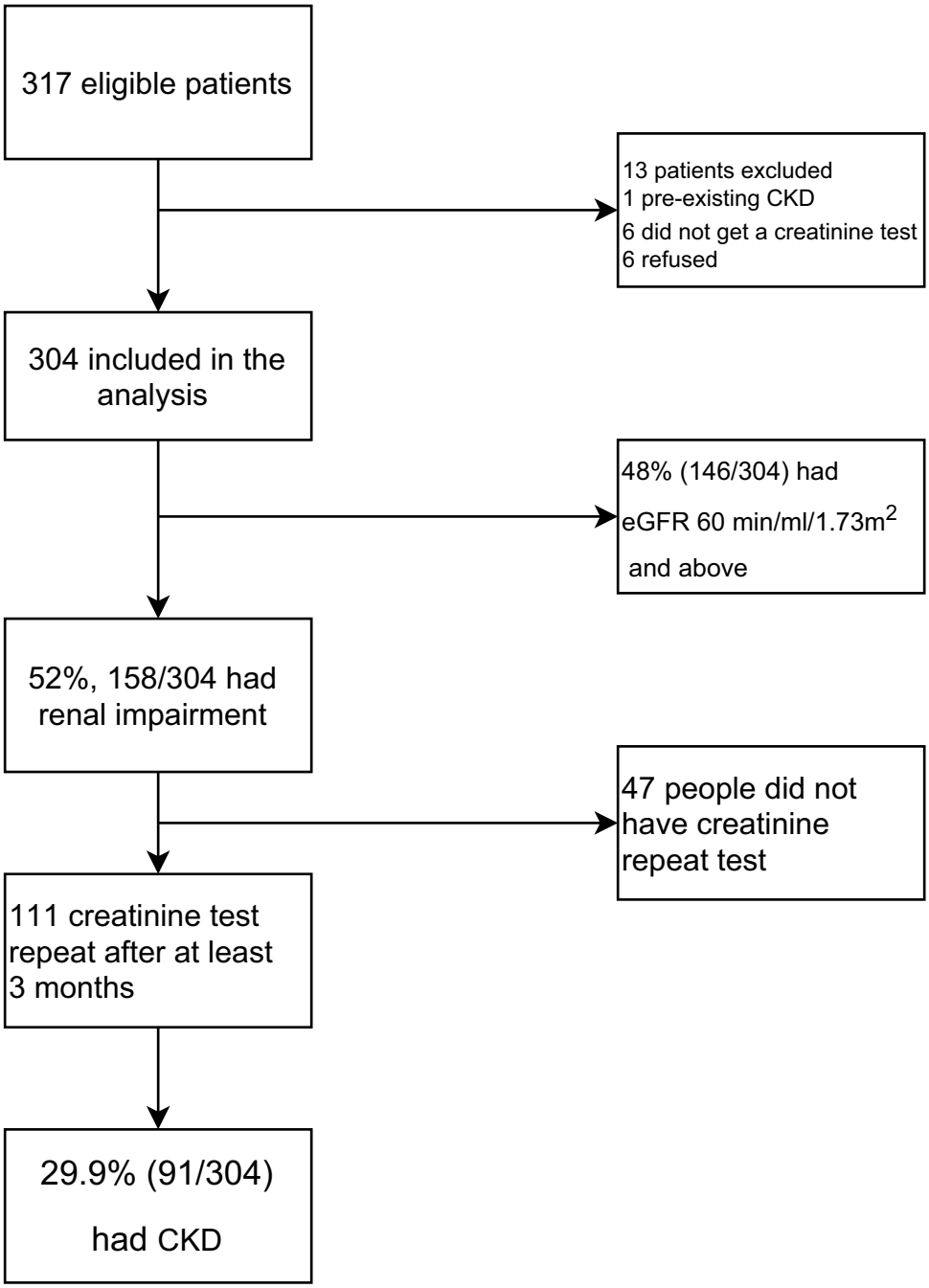

Figure 1 Hypertension patients screened for chronic kidney disease.
Notes: CKD was defined based on Kidney Disease: Improving Global Outcomes (KDIGO) guidelines: Persistent estimated glomerular filtration rate (eGFR) of less than 60 mL/min/1.73m^2 for more than 3 months. Estimated GFR of less than 60 mL/min/1.73m^2 on one occasion was regarded as renal impairment.
Abbreviations: CKD, chronic kidney disease; %, percentage.

Results

Baseline Characteristics of Hypertension Clients

We approached 317 eligible hypertension patients and included 304 (96%) in the final analysis (see Figure 1 and Table 1). Among the 304 patients, the majority of the patients had all the variables complete except for occupation (1.0% missing data), duration of care in the clinic (0.7% missing data), current number of antihypertensive drugs (0.3% missing data), median BMI/BMI category (2.6% missing data), proteinuria and glycosuria (0.7% missing data), and most recent diastolic blood pressure (0.3% missing data) (see Supplementary Table 1). We therefore included all the variables in our analysis as the

Table 1 Baseline Demographic and Clinical Characteristics of Hypertension Patients Included in the Study

Variable	Total (n = 304)	No CKD (n = 213)	CKD (n = 91)	P-value*
Median age-Median, IQR	55 (48–63)	55 (46–62)	60 (50–65)	**0.02**
Age category (years)-n,%				0.07#
18–29	5 (1.6)	5 (2.3)	0 (0.0)	
30–39	21 (6.9)	17 (8.0)	4 (4.4)	
40–49	63 (20.7)	45 (21.1)	18 (19.8)	
50–59	92 (30.3)	70 (32.9)	22 (24.2)	
60 and above	123 (40.5)	76 (35.7)	47 (51.6)	
Age less than 60	181 (59.5)	137 (64.3)	44 (48.3)	**0.009**
Age over 60	123 (40.5)	76 (35.7)	47 (51.7)	
Gender- n,%				
Male	97 (31.9)	76 (35.7)	21 (23.1)	**0.03**
Female	207 (68.1)	137 (64.3)	70 (76.9)	
Educational level-n,%				
Never educated	165 (54.3)	102 (47.9)	63 (69.2)	**0.001**
Some education	139 (45.7)	111 (52.1)	28 (30.8)	
Occupation-n,%				
None	114 (37.5)	75 (35.2)	39 (42.9)	0.3
Employed	132 (43.4)	93 (43.7)	39 (42.9)	
Farmer	55 (18.1)	42 (19.7)	13 (14.2)	
Missing	3 (1.0%)	3 (1.4)	0 (0.0)	
Marital status-n,%				
Not married	102 (33.6)	67 (31.5)	35 (38.5)	0.24
Married/cohabiting	202 (66.4)	146 (68.5)	56 (61.5)	
Years since hypertension diagnosis-n,%				
0–2years	169 (55.6)	124 (58.2)	45 (49.4)	0.16
Over 2 years	135 (44.4)	89 (41.8)	46 (50.6)	
Duration in the clinic (Months)-n,%				
Less than 12 months	170 (55.9)	129 (60.6)	41 (45.1)	**0.02**
More than 12 months	132 (43.4)	84 (39.4)	48 (52.7)	
Missing	2 (0.7)	0 (0.0)	2 (2.2)	
Family history of hypertension-n,%				
No	81 (26.6)	59 (27.7)	22 (24.2)	0.81
Yes	147 (48.4)	101 (47.4)	46 (50.5)	
Do not Know	76 (25.0)	53 (24.9)	23 (25.3)	

(*Continued*)

Table 1 (Continued).

Variable	Total (n = 304)	No CKD (n = 213)	CKD (n = 91)	P-value*
Family history CKD-n,%				
No	161 (53.0)	110 (51.6)	51 (56.0)	0.36#
Yes	9 (3.0)	5 (2.4)	4 (4.4)	
Do not Know	134 (44.0)	98 (46.0)	36 (39.6)	
History of smoking-n,%				
No	199 (65.5)	137 (64.3)	62 (68.1)	0.52
Yes	105 (34.5)	76 (35.7)	29 (31.9)	
History of alcohol intake-n,%				
No	205 (67.4)	140 (65.7)	65 (71.4)	0.33
Yes	99 (32.6)	73 (34.3)	26 (28.6)	
History of Diabetes-n,%				
No	270 (88.8)	191 (89.7)	79 (86.8)	0.47
Yes	34 (11.2)	22 (10.3)	12 (13.2)	
History of heart failure-n,%				
No	295 (97.1)	207 (97.2)	88 (96.7)	0.79#
Yes	8 (2.6)	5 (2.3)	3 (3.3)	
Do not Know	1 (0.30)	1 (0.5)	0 (0.0)	
Living with HIV-n,%				
No	299 (98.4)	211 (99.1)	88 (96.7)	0.16#
Yes	5 (1.6)	2 (0.9)	3 (3.3)	
History of previous stroke-n,%				
No	281 (92.4)	196 (92.0)	85 (93.4)	0.66
Yes	23 (7.6)	17 (8.0)	6 (6.6)	
Intake of non-prescribed medication for hypertension –n,%				
No	250 (82.2)	175 (82.4)	75 (82.4)	0.96
Yes	54 (17.8)	38 (17.6)	16 (17.6)	
Past Intake of herbal medications for hypertension-n,%				
No	247 (81.2)	174 (81.7)	73 (80.2)	0.76
Yes	57 (18.8)	39 (18.3)	18 (19.8)	
Current Intake of herbal medications for hypertension -n,%				
No	293 (96.4)	209 (98.1)	84 (92.3)	**0.02#**
Yes	11 (3.6)	4 (1.9)	7 (7.7)	
Use of non-steroidal anti-inflammatory drugs -n,%				

(*Continued*)

Table 1 (Continued).

Variable	Total (n = 304)	No CKD (n = 213)	CKD (n = 91)	P-value*
No	145 (47.7)	97 (45.5)	48 (52.7)	0.18
Yes	100 (32.9)	77 (36.2)	23 (25.3)	
Do not Know	59 (19.4)	39 (18.3)	20 (22.0)	
Normally add salt before eating-n,%				
Never	79 (26.0)	53 (24.9)	26 (28.6)	0.5
Eat salt	225 (74.0)	160 (75.1)	65 (71.4)	
Current number of anti-hypertensive drugs –n,%				
1	20 (6.6)	12 (5.6)	8 (8.9)	0.52
2	201 (66.1)	144 (67.6)	57 (62.6)	
3 or more	82 (27.0)	56 (26.3)	26 (28.5)	
Missing	1 (0.3)	1 (0.5)	0 (0.0)	
Current use of ACE Inhibitors-n,%				
No	199 (65.5)	141 (66.2)	58 (63.7)	0.68
Yes	105 (34.5)	72 (33.8)	33 (36.3)	
Currently taking NSAIDs-n,%				
No	261 (85.9)	182 (85.4)	79 (86.8)	0.75
Yes	43 (14.1)	31 (14.6)	12 (13.2)	
Median BMI (kg/m^2)-median, IQR	26.2 (22.4–30.5)	25.7 (21.9–30.1)	28.0 (24.0–31.0)	**0.008**[c]
BMI category (kg/m^2)-n,%				
Underweight (below 18.5 kg/m^2)	9 (3.0)	7 (3.3)	2 (2.2)	**0.02**[#]
Normal (18.5-<25 kg/m^2)	114 (37.5)	91 (42.7)	23 (25.3)	
Overweight (25.0-<30 kg/m^2)	88 (28.9)	54 (25.4)	34 (37.4)	
Obesity (30.0 kg/m^2 and above)	85 (28.0)	56 (26.3	29 (31.9)	
Missing	8 (2.6)	5 (2.3)	3 (3.2)	
Most recent systolic blood pressure (mmHg)-Median, IQR	158 (143–177)	158 (143–177)	158 (143–177)	0.78[c]
Most recent diastolic blood pressure (mmHg)-Median, IQR	99 (92–109)	99 (93–109)	98 (90–109)	0.22[c]
Most recent blood glucose (mg/dl)-Median, IQR	5.7 (4.9–7.2)	5.7 (4.9–7.2)	5.4 (4.8–6.8)	0.21[c]
Hypertension grade-n,%				
Normal (<140 and <90 mmHg)	39 (12.8)	26 (12.2)	13 (14.3)	0.88
Grade 1 (140–159 and/or 90–99 mmHg)	82 (27.0)	57 (26.8)	25 (27.4)	
Grade 2 (160–179 and/or 100–109 mmHg)	79 (26.0)	58 (27.2)	21 (23.1)	
Grade 3 (≥180 and/or ≥110 mmHg)	104 (34.2)	72 (33.8)	32 (35.2)	

Notes: *Chi^2 tests unless otherwise stated [#]Fishers exact test, [c]Wilcoxon rank-sum test. Bold P-value less than 0.05.

Abbreviations: CKD, chronic kidney disease; IQR, interquartile range; %, percentage; NSAIDs, non-steroidal anti-inflammatory drugs; n, number; BMI, body mass index; ACE, angiotensin converting enzyme.

Table 2 Laboratory Measurements

Laboratory Measurements	Total (n = 304)	No CKD (n = 213)	CKD (n = 91)	p-value*
Serum Creatinine (µmol/l)-Mean, SD	105.5, 35.2	100.0, 34.3	118, 33.9	**<0.001**[d]
Proteinuria-n,%				
Negative	264 (86.8)	189 (88.7)	75 (82.4)	0.31[#]
1+ or more	38 (12.5)	23 (10.8)	15 (16.5)	
Missing	2 (0.7)	1 (0.5)	1 (1.1)	
Glycosuria-n,%				
Negative	289 (95.1)	203 (95.3)	86 (94.5)	0.78[#]
1+ or more	13 (4.3)	9 (4.2)	4 (4.4)	
Missing	2 (0.6)	1 (0.5)	1 (1.1)	

Notes: *Chi square test unless stated [#]Fishers exact test, [d]Student's *t* test. Bold P-value less than 0.05 SD standard deviation. CKD was defined based on Kidney Disease: Improving Global Outcomes (KDIGO) guidelines: Persistent estimated glomerular filtration rate (eGFR) of less than 60 mL/min/1.73m^2 for more than 3 months. As such, only 111 patients (out of 158) with renal impairment had a repeat creatinine test and hence were included in the calculation of CKD. Estimated GFR of less than 60 mL/min/1.73m^2 on one occasion was regarded as renal impairment.
Abbreviations: CKD, chronic kidney disease; SD, standard deviation.

missing data in all the variables were below the 5% threshold.

The median age of eligible patients was 55 years (IQR 48–63 years) and over two-thirds were females (68.1%, n = 207). The median BMI was 26.2 kg/m^2 (IQR 22.4–30.5 kg/m^2) with over half of the patients being overweight or obese. Slightly over half of the patients had never received any education, two-thirds were married/ cohabiting and most were either farmers or were employed.

Over half of the clients (n = 169, 55.6%) had been diagnosed with hypertension within two years prior to the inclusion into this study and had been enrolled in the clinic for less than 12 months (55.9%, n = 170). Among existing comorbidities, 11.2% (n = 34), 7.6% (n = 23), 2.6% (n = 8) and 1.6% (n = 5) had been diagnosed with diabetes, stroke, heart failure and HIV, respectively. The median systolic blood pressure and diastolic blood pressure were 158 mmHg (IQR 143–177) and 99 mmHg (IQR 92–109), respectively. About 27% (n = 82) and 34.5% (n = 105) were on three or more antihypertensive drugs and ACE inhibitors, respectively.

Creatinine, Renal Impairment and Chronic Kidney Disease

The mean serum creatinine was 105.5 umol/l (standard deviation 35.2) and mean baseline eGFR was 60.6 min/mL/1.73m^2. 12.5% (n = 38) and 4.3 (n = 13) had proteinuria of at least 1+ and glycosuria of at least 1+, respectively (Tables 2 and 3).

Table 3 Distribution of Baseline eGFR Using KDIGO Guidelines

Estimated Glomerular Filtration Rate (min/mL/1.73m^2)	N (%)
Mean eGFR	60.6 (SD 15.7, range 12.7–128.2)
Normal eGFR (90 and above)	12 (3.9)
G2 60–89	134 (44.1)
G3a 59–45	122 (40.1)
G3b 44–30	29 (9.5)
G4 29–15	6 (2.0)
G5 <15	1 (0.3)

Abbreviations: eGFR, estimated glomerular filtration rate; KDIGO, Kidney Disease: Improving Global Outcomes; SD, standard deviation.

Based on KDIGO classification of eGFR, only 3.9% (n = 12) were within normal eGFR and the rest of the patients were within G2-G5 categories. The prevalence of renal impairment was 52% (158/304, CI 46.2–57.7%).

On follow-up of the patients, we were able to successfully re-test 111 patients (representing 70%) of 158 patients with renal impairment after at least 3 months (Table 3). Among this cohort, only 20 patients had eGFR which was 60 min/mL/1.73m^2 and above. The prevalence of CKD was 29.9% (91/304, CI 24.8–34.5%).

There were differences between patients with and without CKD on baseline characteristics. The median age for

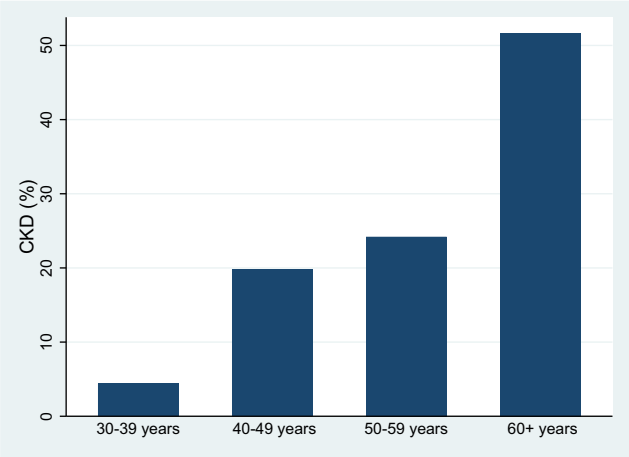

Figure 2 Chronic kidney disease categorized by age.
Note: There were no patients with CKD between 18 and 29 years old.
Abbreviations: CKD, chronic kidney disease; %, percentage.

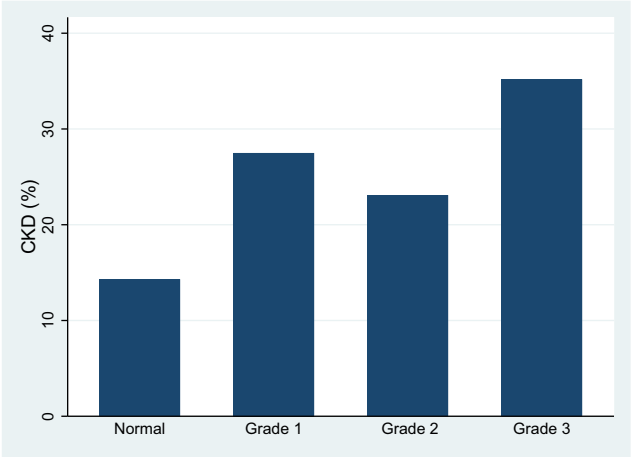

Figure 3 Chronic kidney disease and hypertension stages.
Note: Hypertension was classified as follows: normal/controlled (<140 and <90 mmHg), grade 1 (140–159 and/or 90–99 mmHg), grade 2 (160–179 and/or 100–109 mmHg) and grade 3 (≥180 and/or ≥110 mmHg).
Abbreviations: CKD, chronic kidney disease; %, percentage.

patients with CKD was 60 years (IQR 50–65 years) while median age was 55 years (IQR 46–62 years) in patients without CKD. The prevalence of CKD increased with age, with patients aged 60 years and above having the highest rates of CKD (51.7%, n = 47) (Figure 2). Additionally, CKD was more common in females than males (76.9% vs 23.1%, p = 0.03), was common in patients who are illiterate than patients who are literate (69.2% vs 30.8%, p = 0.01), and common in patients who were enrolled for over 12 months in clinic that less than 12 months in the clinic (52.7% vs 45.1%, p = 0.02). Furthermore, CKD was common in patients with a higher BMI. There were no statistically significant differences between patients who admitted taking herbal medication in the past, but significant differences were observed in patients who were taking herbal medication at the time of the study. In this cohort, only 12.8% (n = 39) of the patients had good hypertension control. CKD was lowest in patients with good control (14.3%) but increased to 35.2% in patients with grade 3 hypertension (Figure 3).

Factors Associated with Chronic Kidney Disease

Table 4 summarizes unadjusted and adjusted odds ratio of factors associated with CKD. Before adjusting for age and gender, there were statistically significant associations between CKD and advanced age, female gender, education level, longer duration in the clinic, current intake of herbal medication for hypertension treatment, and being overweight and/or obese. Age and female gender were associated with higher odds of CKD (OR 1.03 (CI 1.01–1.05) and 1.85 (CI 1.05–3.25)) respectively. Adjusting for age and gender, only education level, current intake of herbal medication for hypertension treatment, and being overweight and/or obese were associated with CKD. Adjusting for age and gender, receiving some education was associated with a 48% reduction in the likelihood of CKD (OR 0.52 (CI 0.29–0.91), p = 0.02). Currently taking herbal medications as treatment of hypertension was associated with four times the odds of having CKD (OR 4.11 (CI 1.14–14.80), p = 0.03). Finally, patients who were overweight and/or obese had more than two times the odds of having CKD (OR 2.16 (1.24–3.78), p = <0.001) in comparison to patient who had BMI less than 25 kg/m^2.

Discussion

Sierra Leone national NCD and Injury poverty commission, which was established in early 2018 by MOHS and its findings were published in late 2020, identified priority NCDs that required to be urgently addressed in order to reduce the morbidity and mortality of NCDs in Sierra Leone. Chronic kidney disease due to hypertension was included among 43 priority NCDs and injuries. Furthermore, the commission prioritized treatment of hypertension among CKD patients beginning from primary healthcare facilities.[26] Addressing morbidity and mortality of CKD due to hypertension goes beyond policy and strategies and requires understanding the prevalence and associated factors of CKD.[46] This is the first study to specifically investigate the burden of CKD in rural Sierra Leone.

Table 4 Associated Factors of Chronic Kidney Disease

Clinical History	Unadjusted Odds Ratio	P-value	Adjusted Odds Ratio[a]	P-value
Median age	1.03 (1.01–1.05)	**0.01**	-	-
Age category				
Less than 60 years	Ref	**0.01**	-	-
60 years and above	1.92 (1.17–3.17)		-	-
Gender				
Male	Ref		-	-
Female	1.85 (1.05–3.25)	**0.03**	-	-
Education level				
No education	Ref		Ref	
Some education	0.41 (0.24–0.69)	**0.001**	0.52 (0.29–0.91)	**0.02**
Occupation				
Not employed	Ref		Ref	
Employed	0.81 (0.47–1.38)	0.43	1.22 (0.67–2.22)	0.52
Farmer	0.60 (0.29–1.24)	0.17	0.62 (0.29–1.31)	0.21
Marital status				
Not married	Ref		Ref	
Married/cohabiting	0.73 (0.44–1.23)	0.24	1.15 (0.64–2.06)	0.64
Years since hypertension diagnosis				
0–2 years	Ref		Ref	
Over 2 years	1.42 (0.87–2.33)	0.16	1.44 (0.87–2.39)	0.16
Duration in the clinic				
Less than 12 months	Ref		Ref	
12 months and above	1.80 (1.09–2.96)	**0.02**	1.62 (0.97–2.70)	0.07
Family History of hypertension				
No	Ref		Ref	
Yes	1.22 (0.67–2.23)	0.51	1.45 (0.77–2.72)	0.25
Family History of Chronic Kidney Disease				
No	Ref		Ref	
Yes	1.73 (0.44–6.70)	0.43	2.38 (0.56–10.12)	0.24
History of Smoking				
No	Ref		Ref	
Yes	0.84 (0.50–1.42)	0.52	0.99 (0.56–1.74)	0.98
History of Alcohol intake				

(*Continued*)

Table 4 (Continued).

Clinical History	Unadjusted Odds Ratio	P-value	Adjusted Odds Ratio[a]	P-value
No	Ref		Ref	
Yes	0.77 (0.45–1.31)	0.33	0.95 (0.53–1.73)	0.88
History of Diabetes				
No	Ref		Ref	
Yes	1.32 (0.62–2.79)	0.47	1.36 (0.63–2.92)	0.44
History of heart disease				
No	Ref		Ref	
Yes	1.41 (0.33–6.03)	0.64	1.74 (0.40–7.63)	0.46
Living with HIV				
No	Ref		Ref	
Yes	3.60 (0.59–21.90)	0.17	4.46 (0.70–28.73)	0.11
History of stroke				
No	Ref		Ref	
Yes	0.81 (0.31–2.14)	0.66	0.70 (0.26–1.88)	0.48
Intake of non-prescribed medication for hypertension				
No	Ref		Ref	
Yes	0.98 (0.52–1.87)	0.96	0.95 (0.49–1.85)	0.88
Past Intake of herbal medications for hypertension				
No	Ref		Ref	
Yes	1.10 (0.59–2.05)	0.76	1.01 (0.53–1.92)	0.98
Current Intake of herbal medications for hypertension				
No	Ref		Ref	
Yes	4.35 (1.24–15.26)	**0.02**	4.11 (1.14–14.80)	**0.03**
Use of intake Anti-inflammatory drugs				
No	Ref		Ref	
Yes	0.60 (0.34–1.08)	0.09	0.61 (0.34–1.10)	0.1
Normally add salt before eating				
No	Ref		Ref	
Yes	0.60 (0.34–1.08)	0.09	0.83 (0.47–1.46)	0.52
Current number of anti-hypertensive Drugs				
1	Ref		Ref	
2	0.59 (0.23–1.53)	0.28	0.53 (0.20–1.42)	0.21
3 or more drugs	0.70 (0.23–1.53)	0.28	0.68 (0.24–1.93)	0.47

(*Continued*)

Table 4 (Continued).

Clinical History	Unadjusted Odds Ratio	P-value	Adjusted Odds Ratio[a]	P-value
Current use of ACE Inhibitors				
No	Ref		Ref	
Yes	1.11 (0.67–1.86)	0.68	1.10 (0.64–1.89)	0.72
Currently taking NSAIDS				
No	Ref		Ref	
Yes	0.89 (0.43–1.82)	0.75	0.90 (0.42–1.89)	0.77
BMI Category				
Less than 25	Ref		Ref	
Overweight/obesity	2.24 (1.31–3.84)	**<0.001**	2.16 (1.24–3.78)	**<0.001**
Most recent systolic blood pressure	1.00 (0.99–1.01	0.72	1.00 (0.99–1.01)	0.59
Most recent diastolic blood pressure	0.99 (0.97–1.01)	0.27	1.0 (0.98–1.01)	0.72
Most recent blood glucose	0.99 (0.92–1.08)	0.9	0.99 (0.91–1.07)	0.80
Proteinuria				
Negative	Ref		Ref	
1+ or more	1.64 (0.81–3.32)	0.17	1.69 (0.82–3.49)	0.16
Glycosuria				
Negative	Ref		Ref	
1+ or more	1.05 (0.31–3.5)	0.94	1.02 (0.29–3.56)	0.97
Hypertension grade				
Normal (<140 and <90 mmHg)	Ref			
Grade 1 (140–159 and/or 90–99 mmHg)	0.88 (0.39–1.98)	0.75	0.88 (0.38–2.02)	0.76
Grade 2 (160–179 and/or 100–109 mmHg)	0.72 (0.31–1.66)	0.45	0.74 (0.32–1.74)	0.49
Grade 3 (≥180 and/or ≥110 mmHg)	0.89 (0.40–1.95)	0.77	0.94 (0.42–2.12	0.89

Notes: [a]Adjusted by age, gender; bold P value less than 0.05.
Abbreviations: NSAIDs, non-steroidal anti-inflammatory drugs; ACE inhibitor, angiotensin converting enzyme; BMI, body mass index.

Screening for CKD allows for early identification of reduced GFR, renal impairment and CKD. This enables early management of these patients to prevent progression to ESRD.[8] Additionally, screening helps to increase awareness of CKD, as many patients in limited resource settings are not aware if they have been screened and/or they have CKD.[47,48] Finally, screening ensures avoidance of using medication that may lead to worsening of the function of the kidneys. In this study, 96% and 52% of the patients had a baseline eGFR within stage G2-G5 and G3-G5 eGFR categories respectively. This shows the value of screening as reduced eGFR can be identified early. As part of the protocol, patients in stage G3-G5 eGFR categories were contacted by phone to let them know the outcome of their tests. Additionally, all included patients received an explanation of their results during their clinic visits. This may have increased their awareness of reduced eGFR, renal impairment and CKD.

As the first study conducted in Sierra Leone, there is lack comparison of our study with other settings in Sierra Leone. However, CKD rates and risk factors can be compared with other countries in Africa.

The high prevalence of CKD reported in this study is similar to findings reported among hypertension patients in other settings.[48,49] For example, two recent reviews found the pooled CKD prevalence of 35.6% and 34% among hypertensive patients in Africa.[12,50] A recent study has suggested that west African countries has higher rates of CKD due to hypertension than other regions in Africa.[11]

Most of the patients in this study had uncontrolled hypertension, although hypertension stage was not associated with CKD in logistic regression analysis. Lower rates of hypertension control has been reported in other settings, for example in Nigeria where only 39.7% of inpatients had optimal blood pressure control.[51] Controlling hypertension is one of the strategies for slowing progression of CKD to ESRD. Moving forward, reasons for poor control should be identified and appropriate treatment should be instituted to ensure more patients have optimal blood pressure control.

Based on this study, plans are underway to include routine CKD screening, management and follow-up in our NCD clinic. This includes an annual CKD screening for patients that did not have CKD when we conducted the study. For the patients with CKD, enrollment in care and management, including for comorbidities, is essential to make sure we halt the progress to ESRD. Beyond Kono district, our findings warrant the development of a comprehensive program to screen, identify and manage CKD among hypertension patients in Sierra Leone. In the long term, there is need for the development of a CKD registry to monitor the burden of the disease. Advanced treatment options for the management of CKD, including dialysis and renal replacement therapy, will also need to be available in Sierra Leone. As an extension, it is necessary to conduct similar studies in urban areas, among the general population and other high risk groups like diabetes mellitus.

This study has found that CKD is associated with advanced age, female gender, no formal education and being overweight/obese. This is consistent with findings of other studies in Africa.[47,52–54] As CKD increases with age, where resources are limited, it will be prudent to start screening patients with advanced age first, before screening younger population. Although we did not explore why CKD is more likely to occur in female gender, we know that our sample was mainly female and this result may be due to selection bias.[55] To address the challenge with overweight and obese patients, screening for obesity, counselling on good dietary habits and regularly exercising and other ways of reducing obesity should be included to the health education that is provided in KGH NCD clinics.

Current intake of herbal medication for treatment of hypertension was one of the factors associated with CKD, and other studies has also found similar association between taking herbal medications and CKD.[47,56] Taking herbal medication may also be associated with acute kidney injury which may lead to CKD, interaction of herbal remedies with other medications and direct toxicity to the kidneys by some herbal medications.[57] There is a need to explore further on the types of herbal medications and identify if these medications predispose hypertension patients to CKD. Additionally, patient education on the dangers of harmful herbal medication needs to be intensified.

We noted several limitations to our study. Most of our participants were females and over one third of the participants were unemployed. Due to this selection bias, further studies should be designed with equal gender representation and consider CKD screening in occupation settings to identify and enroll more males in the studies. Due to its cross-sectional design, our study could not show causality and temporal associations between CKD and associated risk factors. We used CKD-EPI as it has been shown to better predict eGFR in Africa. However, no study has validated CKD-EPI or other creatinine formulas in Sierra Leone population. Although we aimed to re-test all patients with renal impairment, we could not find all the patients. Additionally, we could not collect data on why these patients did not come to clinic for re-testing. However, we know the study was conducted during coronavirus-19 pandemic, and this may have impacted the utilization of health services by hypertension patient. Further studies can explore reasons why we could not reach all patients and develop strategies that can guarantee the re-testing of all patients. Finally, we only used reduced GFR to define CKD, and did not use albuminuria, albumin to creatinine ratio, 24-hour urinary albumin, and abnormalities of the kidneys identified by ultrasound or renal biopsy to define CKD. We used urine dipsticks, which are less sensitive to lower levels of proteinuria, due to unavailability of more sensitive tests. Our study may therefore have underestimated the prevalence of CKD in this patient population.

Despite the limitations, we know this is the first study in Sierra Leone and can be used to provide evidence on CKD screening among hypertension patients. To Increase rigor of the study, we forward and backward translated our

questionnaire tool and used systematic random sampling to recruit study participants. Finally, we also used two measurements of creatinine measured at least three months apart to confirm CKD.

Conclusion

The prevalence of renal impairment and CKD is high among hypertensive patients in rural Sierra Leone. CKD was associated with advanced age, female gender, current history of taking herbal medications and with being overweight/obese. Additionally, receiving some education was associated with a 48% reduced likelihood of CKD. We recommend regular screening for CKD in Sierra Leone.

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Disclosure

The authors report no conflicts of interest in this work.

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