Chronic Kidney Disease Epidemiology in Northern Senegal
A Cross-sectional Study

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Special Report

Chronic kidney disease (CKD) is an emerging worldwide epidemic but few data are available in African populations. This study assessed prevalence of CKD in adults living Saint-Louis, northern Senegal. In a population-based survey between January and May 2012, 1037 adults living in Saint-Louis were assessed. Sociodemographical, clinical, and biological data were collected during household visits. Glomerular filtration rate was estimated using the 4-variable Modification of Diet in Renal Disease equation. Factors associated with CKD were identified by multivariate regression analysis. The mean age of participants was 47.9 ± 16.9 years. The majority of the participants lived in urban areas (55.3%) and had school education (65.6%). The overall prevalence rates of hypertension, diabetes mellitus, and obesity were 39.1%, 12.7%, and 23.4% respectively. Prevalence of CKD was 4.9% (95% confidence interval, 3.5% to 6.2%) and 0.9% had an estimated glomerular filtration rate less than 30 mL/min/1.73 m^2. Before the study, 23% of the patients were aware of their disease. In multivariable logistic analysis, presence of CKD was significantly associated with hypertension and age. This study shows that CKD is frequent in adult population of Northern Senegal. A kidney health program is urgently needed to reduce the disease burden in both urban and rural areas.

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INTRODUCTION

Chronic kidney disease (CKD) represents one of the greatest public health challenges in the 21st century.[1,2] It has a major impact on healthcare costs and world productivity, particularly in low-income countries.[3] In Africa, though we assist to a rising awareness of health authorities about CKD burden, prevention and management programs are still difficult to elaborate because of the scarcity of epidemiological data at population level.[3,4] Most of the current data come from nephrology departments in specialized hospitals in large cities, and there is very little information in rural populations.[5] This study aimed to assess prevalence of CKD in urban and rural areas of Saint-Louis, northern region of Senegal.

MATERIALS AND METHODS

We performed a community-based cross-sectional survey in Saint-Louis (northern region of Senegal). All individuals aged 18 years and older, living in Saint-Louis more than 3 months were eligible to participate in the study. A two-stage cluster sampling method was used to select a representative sample of adults living in urban and rural areas. We firstly selected 17 localities as clusters (9 urban areas and 8 rural areas). Then, we randomly took a number of households proportionally to population size of each locality (data available from the National Agency of Statistics and Demography at http://www.ansd.sn). From each household, a maximum of 2 participants were recruited. By considering an α error of 0.05 and a power β of

80%, the required sample size was 855 individuals, and we added a 20% attrition rate to get a final sample of 1026 participants.

Data were collected on-site during house-to-house visits that were conducted between 7 AM and 12 AM or at the nearest health center when patients did not live far away from this facility. During the house visit, researchers took one blood and one urine samples for laboratory tests.

A modified version of the World Health Organization STEPwise questionnaire was pre-tested and validated before its use to collect data. Researchers assisted by medical students, trained nurse practitioners, and community health workers had to fill the data collection form, to document the sociodemographic status (age, sex, marital status, education, profession, and education level), personal and family health history (regarding particularly hypertension, diabetes mellitus, stroke, heart disease, and kidney disease), and lifestyle (nutritional habits, physical activity, and smoking and alcohol consumption) of each participant. History of nephrotoxic medications (nonsteroidal anti-inflammatory drugs and traditional herbs) was also assessed.

Anthropometric measurements (weight, height, and waist and hip circumference) were performed using standard methods and calibrated devices. Serum total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, and triglyceride levels were measured with colorimetric method. Obesity was defined using International Diabetes Foundation cutoffs.[6] Blood pressure was measured twice at 5-minute intervals by a semi-automatic sphygmomanometer and the mean of the two readings was calculated. If the difference between the readings was greater than 10 mm Hg, a third measurement was performed. Hypertension was defined as a systolic blood pressure of 140 mm Hg or more, diastolic blood pressure of 90 mm Hg, any prescription of antihypertensive medication in the past 2 weeks, or any self-reported history of hypertension.[7] Fasting blood glucose was measured with a glucose oxidase method. Diabetes mellitus was defined as a fasting blood glucose level of 1.26 mg/dL and higher, prescription of hypoglycemic agents despite fasting plasma glucose, or any self-reported history of diabetes.[6] Physical inactivity was defined as less than 30 minutes of moderate activity per week or less than 20 minutes of vigorous activity 3 times per week, or the equivalent.

Serum creatinine was measured with Jaffe kinetic method and glomerular filtration rate (GFR) was estimated with the Modification of Diet in Renal Disease equation.[8] Urinary albumin excretion was first screened using Multistick Pro strips. Positive cases were confirmed by a quantitative nephelometric dosage in the 24-hour urine output. Chronic kidney disease was defined according to National Kidney Foundation classification.[9]

The study was approved by the National Committee for Ethics in Health Research. A free consent form had to be signed by participants to give their approval before data collection. All participants were personally informed of their screening results and those with abnormal values were referred to a specialist for further exploration and treatment.

Statistical analyses were performed using the Stata (version 12.0, StataCorp LP, College Station, TX, USA). Continuous variables were presented as mean ± standard deviation and categorical variables as percentage. Comparison of proportions and means were done using the Pearson chi-square test or the Student *t* test as appropriated. Multivariable regression analysis was used to identify clinical and biological parameters associated with CKD. A *P* value less than .05 was considered significant.

RESULTS AND DISCUSSION

A total of 1047 individuals were interviewed and 1037 had a complete questionnaire and were kept in the study (response rate of 99%). Fifty-three percent of them lived in urban areas and 60% were female. The age ranged from 18 to 87 years old. Table 1 presents demographic, clinical, and biological characteristics of participants according to their living areas. Compared to the rural population, participants from urban cities were older, more educated, more active, and more likely to be women. One participant out of 10 reported a relative with a history of kidney disease. Cardiovascular risk factors such as hypertension, diabetes mellitus, and obesity were frequent among the whole population with a significantly higher prevalence in individuals living in urban areas (Table 1).

Overall, the adjusted prevalence of CKD in the total population was 6.1% (95% confidence interval

Table 1. Demographic and Clinical Characteristics of Participants*

Characteristic	All Participants (n = 1036)	Urban Areas (n = 578)	Rural Areas (n = 458)	*P*
Mean age, y	48.0 ± 16.9	51.6 ± 15.7	43.5 ± 17.2	.001
Age groups				
18 to 34 years	25.6	16.0	37.8	
35 to 49 years	25.3	26.1	24.2	
50 to 60 years	23.6	28.0	18.1	
> 60 years	25.5	29.9	19.9	.001
School education	60.7	63.4	55.6	.03
Familial history of renal	10.4	5.4	15.0	.003
Tobacco use	4.2	5.2	2.8	.09
Alcohol use	4.5	1.5	8.5	< .001
Physical inactivity	58.1	55.3	61.7	.047
Mean systolic blood pressure, mm Hg	131.0 ± 22.0	131.33 ± 21.0	130.5 ± 21.0	.001
Mean diastolic blood pressure, mm Hg	86.3 ± 16.9	87.9 ± 15.7	84.3 ± 18.1	.007
Hypertension	39.1	43.3	33.8	.002
BMI, kg/m^2	26.3 ± 6.8	27.9 ± 7.3	24.3 ± 5.5	< .001
Waist circumference, cm	90.6 ± 16.1	94.4 ± 15.6	86.0 ± 15.6	< .001
Obesity, ≥ 30 kg/m^2	23.4	33.8	10.2	< .001
Mean cholesterol, g/L	2.18 ± 0.49	2.25 ± 0.54	2.10 ± 0.44	< .001
Mean fasting blood glucose, g/L	1.08 ± 0.62	1.12 ± 0.60	1.03 ± 0.65	.02
Diabetes	12.7	14.6	10.3	.04
Mean serum creatinine, mg/dL	1.04 ± 0.44	1.01 ± 0.47	1.06 ± 0.40	.03
Mean estimated glomerular filtration rate, mL/min	90.6 ± 23.8	89.7 ± 22.8	91.7 ± 24.9	.20
Albuminuria, >1 g/L	5.3	4.3	6.6	.18

*Values are percentages for categorical parameters and mean ± standard deviation for continuous variables.

between 4.7% and 7.6%) with 3.5% of individuals presenting with albuminuria greater than 1 g/L. Chronic kidney disease prevalence in women (5.7%) was lower than in men (6.9%). A linear increase with age was found in CKD prevalence (*P* = .03). In the subgroup of people aged greater than 60 years, 14.3% presented CKD (Figure 1).

The participants living in rural areas showed a similar prevalence of CKD compared to those from urban cities (7.6% and 5.0%, respectively; *P* = .08) even though early stages 1 and 2 were more frequent in urban areas (Figure 2). Eighty-three percent of people with CKD in rural areas and 62.7% in urban areas were not aware of their disease before the study.

In the univariable analysis, CKD was significantly associated with hypertension, obesity, physical activity, a family history of kidney disease, and age group (Table 2). In multivariable regression analysis, only age and high blood pressure remained significantly associated with CKD, while diabetes, family history, and obesity failed to reach statistical significance (Table 3).

This study is the first one that assessed the burden of CKD in a sample of Senegalese population, particularly for the early stages (1 and 2), which are often not seen by specialists at hospital.[10] Senegalese population has increased to about 13 million people with a gross domestic product of

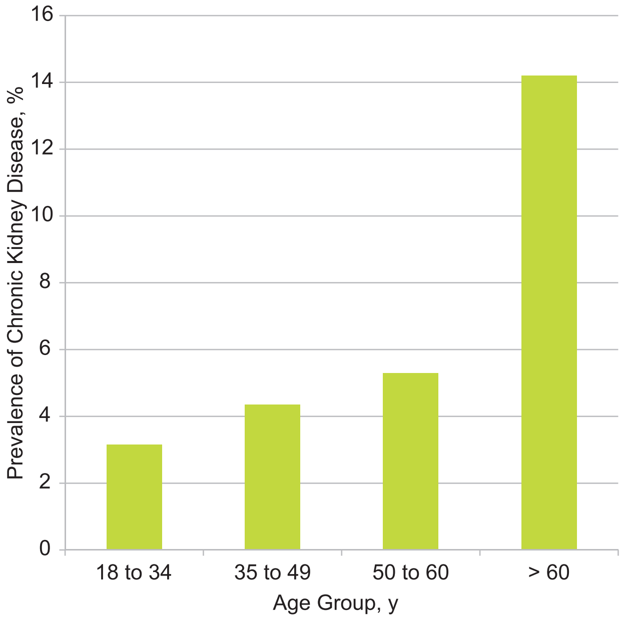

Figure 1. Prevalence of chronic kidney disease according to age groups.

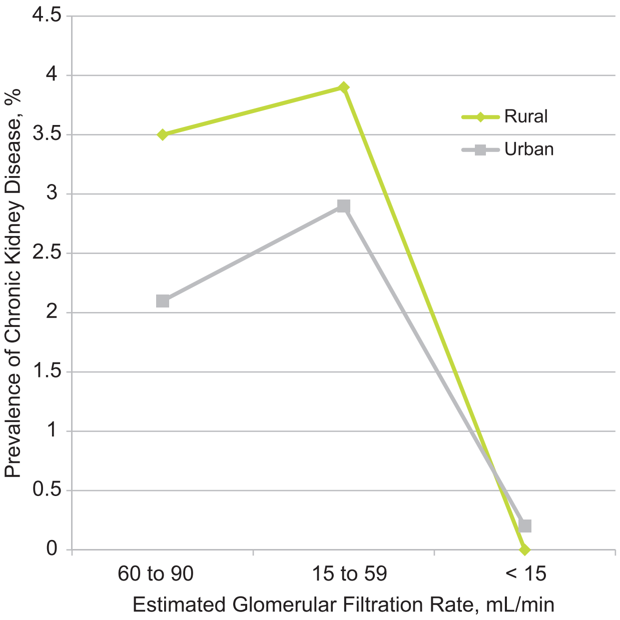

Figure 2. Level of glomerular filtration rate in urban and rural population.

Table 3. Multivariate Regression Analysis of Factors Associated With Chronic Kidney Disease*

Parameter	Odds Ratio	95% Confidence Interval	*P*
Hypertension	1.12	1.02 to 1.23	.02
Age group	1.03	1.00 to 1.06	.02
Diabetes	0.80	0.25 to 2.51	.70
Obesity	0.77	0.24 to 2.46	.66
Family history of kidney disease	1.43	0.38 to 5.33	.60
Urban residence	0.34	0.13 to 0.87	.02
School education	0.85	0.33 to 2.19	.74

*n =324; pseudo R^2 = 0.106

US$ 1196 per inhabitant.[11] Currently, 11 dialysis units are offering treatment just a few proportions of CKD patients needing renal replacement therapy. In the sub-Saharan region, a recent meta-analysis reported a CKD prevalence of 13.9%, but there are many variations between countries and within the same countries.[1]

In sub-Saharan Africa, epidemiology of CKD in general population is difficult to estimate because of possible confounding due to low study quality and methods used to define CKD.[1] Community-based studies are very scarce and most of previously reported data come from hospital records.[2,3] The prevalence of CKD in our population was lower than that in previous reports from community-based studies in Ghana (13.2%) and Kinshasa (12.4%).[5,12] This study also confirmed the increase of CKD prevalence with age already described in other populations.[1,3] A recent study in southern Iran population found a CKD prevalence of 11.6%, and in particular, 34.4% in people aged older than 60 years.[13]

As expected, our results found less than one quarter of CKD patients who were aware of their disease particularly in rural areas were education level is lower and people do not easy access to healthcare services. Similar low rates of awareness had been commonly reported in other populations and even health workers.[14,15] More efforts are needed to sensitize governments and populations about the disease burden.[1] CKD risk factors like high blood pressure, diabetes, obesity, and abdominal obesity were frequent among participants. However, only age and hypertension independently correlated with CKD. Some risk factors like infections, genetic predispositions, and environmental or herbal toxins were not evaluated in this study but they might play a prominent role in African populations.[16,17]

Interestingly, 1 CKD patient out of 9 in our study was detected at early stages where therapeutic interventions are most efficient.[4,10] In developing countries, diagnosis of patients at end-stage renal disease has a limited interest

Table 2. Univariable Analysis of Relationship Between Chronic Kidney Disease and clinical factors in Urban And Rural Populations

	Urban Areas			Rural areas		
Parameter	Odds Ratio	95% Confidence Interval	*P*	Odds Ratio	95% Confidence Interval	*P*
Age group	1.32	1.05 to 2.87	.01	1.06	0.62 to 1.51	.44
Male sex	0.64	0.57 to 9.68	.55	1.16	0.52 to 1.35	.21
School education	0.99	0.76 to 2.54	.17	0.06	0.01 to 13.32	.78
Physical activity	0.58	0.07 to 0.90	.04	0.76	0.82 to 1.51	.30
Obesity	1.33	1.15 to 3.98	.02	0.91	1.02 to 1.51	.17
Hypertension	2.85	1.11 to 15.70	.01	1.23	1.00 to 10.18	.04
Diabetes	1.78	0.56 to 29.21	.47	1.62	1.12 to 8.46	.05
Family history of kidney disease	1.66	1.07 to 4.23	.05	1.28	0.88 to 6.34	.73

because a few proportions of them will have access to renal replacement therapy with a lot of difficulties.[18] In order to achieve long-term reduction of CKD morbidity and mortality, early detection and prevention at population level are the best cost-effective strategy, because conservative treatment has limited public health impact.[4,19] Developed countries spend 2% to 3% of their health expenditures for management of end-stage renal disease patients who represent less than 0.03% of patients.[20] The situation is probably worse in low-income countries where healthcare expenditure is often very low and the majority of end-stage renal disease patients die because of dialysis inaccessibility.[3]

This study has many limitations due to its cross-sectional design, and therefore, inferences about causality or direction of association should be made with caution. Nevertheless, it gives an insight on the epidemic of CKD in the northern region of Senegal. More longitudinal studies are urgently needed to produce reliable data about CKD incidence, prevalence, risk, and progression factors in sub-Saharan African populations.[1,3] Integrating CKD in other chronic diseases programs could be an interesting approach to increase coverage of screening and awareness in populations. However, mass screening might not be beneficial from a public health perspective because of potential overdiagnosis of cases that will undergo unnecessary investigation or referral to secondary care and the high cost for the healthcare system.[21] Also, cost-effectiveness of current preventive interventions should be assessed in relation to the local socioeconomic context particularly in rural areas.[1,4]

This study shows a high prevalence of CKD in northern region of Senegal. Rate of awareness is very low among populations and associated risk factors are hypertension and aging. A program targeting prevention and early detection of CKD is urgently needed to reduce the disease burden in both urban and rural areas.

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CONFLCIT OF INTEREST

None declared.

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