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Prevalence and risk factors for chronic kidney disease in general population of Yopougon (Côte d'ivoire); a cross-sectional study

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ABSTRACT

Introduction: Chronic kidney disease (CKD) is rising sharply worldwide due to the increased prevalence of its risk factors.
Objectives: To assess the prevalence of CKD and identify its associated factors in general population of Yopougon (Côte d'ivoire).
Materials and Methods: This is a descriptive cross-sectional study conducted from 24th to 26th May 2016 in Yopougon municipality, which included each participant attending our blood collection center voluntarily. CKD was defined by the presence of urinary abnormality and/or an estimated glomerular filtration rate (GFR) below 90 mL/min/1.73 m^2. GFR was estimated with the MDRD, CKD-EPI and Cockcroft-Gault formulas.
Results: We included 510 participants with average age of 43±14.5 years and female predominance (sex ratio: 201/309 = 0.65). Comorbidities such as hypertension (47.1%), obesity (22.7%), hypercholesterolemia (12.5%), HIV infection (7.1%) and diabetes 3.6%) were found. The prevalence of CKD was 13% according to the MDRD formula, 11.2% according to CKD-EPI formula and 23.4% according to Cockcroft-Gault formula. In multivariate analysis, factors such as female gender (odds ratio [OR] = 1.15; 95% CI=1.07-1.23, P = 0.0001), obesity (OR = 2.04; 95% CI = 1.26-3.30; P = 0.004) and hypertriglyceridemia (OR = 1.95, 95% CI = 1.05-3.59, P = 0.039) were associated with CKD.
Conclusion: The prevalence of CKD is high. Obesity, just like the usual risk factors, must be managed for the prevention of CKD. The Cockcroft-Gault formula should no longer be used to estimate the GFR in the general population.

Implication for health policy/practice/research/medical education:
Our study shows that factors associated with CKD in the general population are obesity, female gender and age. The prevalence of CKD is overestimated when the GFR is estimated using the Cockroft-Gault equation, due to the high prevalence of obesity. This equation should no longer be used to estimate the GFR in the general population of Yopougon.
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Introduction

Chronic kidney disease (CKD) is a major cause of global morbidity and mortality. In global burden of disease study (2013), 956 200 people were estimated to have died of CKD, showed a 134% increase from 1990 (1,2). This is one of the highest rates among the top causes of death. Furthermore, even in the early stages of CKD, the risk of fatal and non-fatal cardiovascular events attributable directly to renal disease increases substantially (1). Moreover, more than 1.4 million people with end-stage renal disease worldwide are estimated to receive renal replacement therapy with dialysis or transplantation, with 8% annual growth (3).
Several epidemiological studies based on the Kidney Disease Outcomes Quality Initiative (K/DOQI) guidelines, showed a prevalence that is very variable from one region to another and sometimes, from one study to

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another in the same region. In a study conducted in six regions of the world, the prevalence CKD was estimated to be 14.3% in general population and 36.1% in high-risk populations (4). The differences across countries and regions may reflect the racial, ethnic and environmental diversity, in addition to inequalities in access to healthcare due to the differences in health systems. In 2010, the prevalence of CKD in subjects aged 20 years and older was 10.4% for men and 11.8% for women (5). This prevalence varied according to income level. Thus, in high-income countries, the prevalence of CKD was 8.6% for men and 9.6% for women. In low- and middle-income countries, it was 10.6% for men and 12.5% for women.

In sub-Saharan Africa, the overall prevalence of CKD was 13.9%. The prevalence was 12.4% in urban areas and 16.5% in rural areas (6). There is also variability among African countries. There are data in Côte d'Ivoire, but these are hospital data and relate only to chronic renal failure (CRF), i.e. the advanced stage of CKD. These data show that, the prevalence of CRF shifted from 5.8% to 7.5% in the Department of Internal Medicine, Treichville Teaching Hospital (7). However, there is no data available in the general population.

Objectives

This study aims to assess the prevalence of CKD in the urban general population of Côte d'Ivoire and to identify its associated risk factors.

Patients and Methods

Study type and site

This is a cross-sectional study conducted in three days in Yopougon municipality. This municipality, located in Abidjan district, is the most populated in Cote d'Ivoire. Three various sites well attended by the population of Yopougon were identified as data collection sites.

Study population

Anyone aged 18 and older, living in Côte d'Ivoire and attending our blood collection center was included. Participants under 18 years or with reported CRF, pregnancy and any hematuria during their menstrual cycle were not included to the study.

Study implementation

One week before the start of activities, adults were informed and mobilized by community representatives. Messages were sent on the local community radio station for the mobilization of the population.

For each patient included, the following data were collected using a standardized survey form, consisted of socio-demographic data (date of birth, sex and occupation), clinical data (past- medical history, weight, height and urine strips), and laboratory data (fasting capillary blood glucose, serum creatinine, total cholesterol, triglycerides and HDL cholesterol).

For the urine strip test, we used MultistixR 10-parameter strips. The test was performed immediately after collecting midstream urine specimens. Abnormalities such as proteinuria and hematuria were investigated. The appearance of at least two plus (+ +) for albuminuria and/or hematuria without associated leukocyturia was considered a positive test.

Definitions

CKD is defined according to the K/DOQI guidelines (8). Our reference formula was the simplified MDRD (Modification in Diet of Renal Disease) formula. Glomerular filtration rate (GFR) was also estimated using the Cockroft-Gault (CG) and CKD epidemiology collaboration (CKD-EPI) formulas. As per K/DOQI guidelines, CKD is classified as stage 1 if GFR ≥90 mL/min/1.73 m^2 with urine abnormality, as stage 2 if GFR is between 60 and 89 mL/min/1.73 m^2, as stage 3 if GFR is between 30 and 59 mL/min/1.73 m^2, as stage 4 if GFR is between 15 and 29 mL/min/1.73 m^2, and as stage 5 if GFR <15 mL/min/1.73 m^2. Serum creatinine was measured using the Jaffe's method.

According to the World Health Organization (WHO) criteria (9), blood pressure was measured using a digital sphygmomanometer on the right arm of seated participant after at least a 5-minute rest. Blood pressure was measured twice and the averages were used in all analysis. Hypertension is defined as systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure ≥90 mm Hg or normal blood pressure in people on antihypertensive therapy (10). Diabetes is defined as fasting blood glucose higher than 126 mg/dL or normal blood glucose in a participant on anti-diabetic therapy (11). Obesity is confirmed based on a body mass index greater than 30 kg/m^2.

Statistical analysis

Data were entered into an Excel database and then analyzed using the SPSS software version 22. Quantitative variables were described in terms of means ± standard deviations (SDs) when their distribution was normal or in terms of medians and percentiles otherwise. In univariate analysis, the proportions of qualitative variables were compared across male and female participants using the chi-square test or Fisher's exact test. As regards the quantitative variables, the means were compared using the analysis of variance (ANOVA) test. Relative quantitative variables were transformed into categorical variables according to pathological norms. Qualitative or categorical variables with $P<0.20$ were included in a logistic regression model. The association between the variable and the various parameters was measured by the odds ratio (OR). The threshold of $P<0.05$ was considered significant.

Ethical issues

This research was performed following the Declaration of Helsinki and its latter amendments. Participants gave their written and informed consent to participate in the study by completing the consent form. This signed form was required prior to data collection. This study received

approval from the National Research Ethics Committee of Côte d'Ivoire (# 031/MSLS/CNER-kp).

Results

Our study included 510 participants, 309 of which were female and 201 were male (sex ratio: 0.65). The mean age was 43.7 ± 14.5 years and all age groups were represented in this population (Table 1). The average age of female subjects was 42.2 ± 13.4 years versus 45.7 ± 15.7 years for male subjects ($P = 0.01$). In addition, the proportion of subjects ≥65 years was 2.3% in the female group versus 11.4% in the male group with a significant difference (OR = 2.06, 95% CI = 1.64-2.60, $P = 0.001$) (Table 1).

Co-morbidities such as hypertension (47.1%), obesity (22.7%), HIV infection (7.1%) and diabetes (3.8%) were found. The proportion of obese subjects was 30.6% in the female group versus 10.2% in the male group with a significant difference (OR = 1.50, 95% CI = 1.33-1.70; $P = 0.0001$). Similarly, the proportion of hypertriglyceridemia was significantly higher in the female group (14.9%) than in the male group (8.9%) (OR = 1.21, 95% CI = 1.02-1.44; $P = 0.032$).

According to the MDRD formula, the prevalence of CKD was 13%. This was 11.2% according to the CKD-EPI formula and 23.5% according to the CG formula. The GFR was between 60-90 mL/min/1.73 m^2 in 11.2% of subjects. It was between 30-60 mL/min/1.73 m^2, in 0.89%. Accordingly GFR between 15-30 mL/min/1.73 m^2 was in 0.44% and finally GFR <15 mL/min/1.73 m^2 was seen in 0.44 %(using MDRD formula) (Table 1). Furthermore using CKD-EPI formula, GFR between 60-90 mL/min/1.73 m^2 was in 9.1% of subjects, GFR between 30-60 mL/min/1.73 m^2 was in 1.1% of cases, GFR between 15-30 mL/min/1.73 m^2 detected in 0.4% of participants and finally GFR <15 mL/min/1.73 m^2 was found in 0.44% of individuals. Finally GFR between 60-90 mL/min/1.73 m^2 was in 19.6% of subjects, GFR between 30-60 mL/min/1.73 m^2 was found in 1.1% of subjects, and GFR

Table 1. General characteristics of population by gender

	Total (n = 510)	Male (n = 201)	Female (n = 309)	*P* value	OR (95% CI)
Age (y)					
Mean	43.7±14.5	45.7±15.7	42.2±13.4	0.010	
<25	9.2% (47/510)	10% (20/201)	8.7% (27/309)	0.37	1.08 (0.76-1.54)
25-35	18.2% (93/510)	16.9% (34/201)	19.1% (59/309)	0.30	1.05 (0.89-1.25)
35-45	22% (112/510)	23.9% (48/201)	20.7% (64/309)	0.23	1.11 (0.87-1.42)
45-55	15.9% (81/510)	14.4% (29/201)	16.8% (52/309)	0.27	1.07 (0.89-1.28)
55-65	19% (97/510)	21.9% (44/201)	17.2% (53/309)	0.11	1.19 (0.92-1.53)
≥65	5.9% (30/510)	11.4% (23/201)	2.3% (7/309)	0.0001	2.06 (1.64-2.60)
Co-morbidities					
Hypertension	47.1% (239/507)	50.5% (101/200)	45% (138/308)	0.12	1.14 (0.92-1.42)
Diabetes	3.8% (19/500)	5.6% (11/200)	2.6% (8/303)	0.07	0.68 (0.40-1.16)
HIV	7.1% (36/508)	5.5% (11/200)	8.1% (25/308)	0.17	1.15 (0.92-1.45)
Inherited kidney disease	8.2% (42/510)	8% (16/201)	8.4% (26/309)	0.49	0.96 (0.64-1.44)
Obesity	22.7% (114/503)	10.2% (20/196)	30.6% (94/307)	0.0001	1.50 (1.33-1.70)
Hypercholesterolemia	12.5% (62/495)	8.9% (17/192)	14.9% (45/303)	0.032	1.21 (1.02-1.44)
Hypertriglyceridemia	3.6% (17/468)	4.4% (8/181)	3.1% (9/287)	0.31	0.85 (0.51-1.16)
Proteinuria ≥++	10.1% (51/506)	12% (24/200)	8.8% (27/306)	0.15	0.86 (0.66-1.13)
Hematuria ≥++	7.5% (38/506)	5% (10/200)	9.2% (28/306)	0.05	1.24 (101-1.52)
Average creatinine (mg/dL)	0.78±0.66	0.87±0.99	0.72±0.28	0.012	
GFR/MDRD					
≥90	87% (388/446)	94.2% (179/190)	81.6% (209/256)	0.0001	2.43 (1.41-4.18)
60-90	11.2% (50/446)	4.2% (8/190)	16.4% (42/256)	0.0001	1.44 (1.25-1.67)
30-60	0.9% (4/446)	0.5% (1/190)	1.1% (3/256)	0.48	1.24 (0.70-2.19)
15-30	0.4% (2/446)	-	0.7% (2/256)	0.36	1.65 (1.54-1.77)
<15	0.4% (2/446)	1% (2/190)	-	0.15	2.55 (2.29-2.84)
GFR/CKD-EPI					
≥90	88.8% (397/447)	96.3% (184/191)	83.2% (213/256)	0.0001	3.08 (1.96-4.83)
60-90	9.1% (41/447)	2% (4/191)	14.4% (37/256)	0.0001	1.55 (1.37-1.76)
30-60	1.1% (5/447)	0.5% (1/191)	1.5% (4/256)	0.34	0.50 (0.08-2.92)
15-30	0.4% (2/447)	-	0.7% (2/256)	0.36	1.65 (1.54-1.77)
<15	0.4% (2/447)	1% (2/191)	-	0.15	2.55 (2.29-2.84)
GFR/CG					
≥90	76.5% (339/443)	77.7% (146/188)	75.7% (193/255)	0.35	1.33 (0.79-1.14)
60-90	19.6% (87/443)	18.6% (35/188)	20.3% (52/255)	0.47	1.02 (0.77-1.35)
30-60	1.1% (5/443)	0.5% (1/188)	1.5% (4/255)	0.34	1.32 (0.85-2.06)
15-30	0.4% (2/443)	-	0.7% (2/255)	0.36	1.65 (1.54-1.77)
<15	0.4% (2/443)	1% (2/188)	-	0.15	2.55 (2.29-2.84)

between 15-30 mL/min/1.73 m^2 was detected in 0.4% of cases and finally GFR <15 mL/min/1.73 m^2 detected in 0.44%, by CG formula (Table 1).

Patients with CKD had an average age of 45.5 ± 13 years versus 43±14.8 years in the group without CKD (P = 0.34). In the group with CKD, the female gender accounted for 81% and the male sex accounted for 19%. The most commonly observed age groups were 35-45 years, 45-55 years and 55-65 years (Table 2). The leading co-morbidities were hypertension (51.7%), obesity (36.2%), diabetes (6.8%) and HIV infection (3.4%) in the group with CKD. The proportion of women was significantly higher in the group with CKD than in the group without CKD (OR = 1.15, 95% CI = 1.07-1.23, P = 0.001), as were the proportions of obesity (OR = 2.04, 95% CI = 1.26-3.30; P = 0.004) and hypertriglyceridemia (OR = 1.95; 95% CI = 1.05-3.59; P = 0.03). In multivariate analysis, factors such as age ranging from 45 to 55 years (OR = 2.09, 95% CI = 1.10-3.97; P = 0.024), female sex (OR = 3.01, 95% CI = 1.54-5.85; P = 0.001), obesity (OR = 2.29, 95% CI = 1.29-4.06; P = 0.005) and hypertriglyceridemia (OR = 2.24, 95% CI = 1.03-4.86; P = 0.04) were associated with CKD in our study population (Table 3).

Discussion

The high prevalence of CKD in urban population was reported in similar proportions in studies conducted in sub-Saharan Africa (12-15). The authors reported a high prevalence of factors such as hypertension, diabetes, and long-term administration of herbal medicines and street drugs. These factors were identified as predictors of CKD (6,16). According to Seck et al, hypertension and age were associated with CKD (12).

The prevalence of CKD was variable depending on the equation used to estimate the GFR. It was lower with using the CKD-EPI equation and higher when used the CG equation as demonstrated by Kaze et al in Cameroon (15). However, assessment of GFR by CG was higher in our study than that mentioned above (14%), probably because of the high proportion of obesity associated with CKD in our population. Considering the GFR <60 mL/min, the proportion of CKD was virtually identical, regardless of the equation. Therefore, GC equation should no longer be used to estimate the GFR in the Ivorian general population. Moreover, the ethnicity factor of these equations increasingly raises questions. For example, a recent study conducted in the Ivorian population revealed that in African black subjects, the performance of the MDRD and CKD-EPI equations is significantly better in the general population without the currently recommended "African-American" factor. The "African-American" ethnicity factor appears to be inadequate for GFR estimation and should not be used for West-African black populations (17).

Obesity was identified as a predictor of CKD (15). Our population consisted mostly of female subjects. Furthermore, the proportion of obesity and hypertriglyceridemia was significantly higher in female subjects. In sub-Saharan Africa, obesity and dyslipidemia are more common in women than in men (18,19). Several studies have reported that overweight and obesity are associated with an increased incidence of CKD (20,21). This association appears to be stronger in diabetic patients with CRF but also significantly higher in non-diabetic patients with end-stage CRF (22). Obesity results in complex metabolic abnormalities that have wide-range effects on kidneys. The exact mechanisms whereby obesity may worsen or cause CKD remain unclear. Obese individuals are exposed to comorbid factors such as diabetes or hypertension. There are also the effects of adiposity that could directly affect the kidneys, by the endocrine activity of the adipose tissue with production of

Table 2. Characteristics of population with or without CKD in univariate analysis

	With CKD (n = 58)	Without CKD (n = 388)	*P* value	OR (95% CI)
Male	19% (11/58)	46.1% (179/388)	0.0001	0.38 (0.16-0.59)
Female	81% (47/58)	53.9% (209/388)	0.0001	1.15 (1.07-1.23)
Age (y)				
<25	6.9% (4/58)	10.6% (41/388)	0.27	0.71 (0.27-1.87)
25-35	13.8% (8/58)	20.4% (79/388)	0.15	0.70 (0.34-1.42)
35-45	25.9% (15/58)	24.2% (94/388)	0.44	1.20 (0.69-2.07)
45-55	20.7% (16/58)	16.2% (63/388)	0.10	1.95 (1.16-3.28)
55-65	20% (12/58)	21.4% (83/388)	0.53	1.08 (0.59-1.95)
≥ 65	8.6% (5/58)	6.5% (25/388)	0.34	1.47 (0.63-3.40)
Co-morbidities				
Hypertension	51.7% (30/58)	45.8% (210/458)	0.33	1.15 (0.71-1.85)
Diabetes	6.8% (4/58)	3.8% (15/386)	0.16	1.86 (0.75-4.61)
HIV	3.4% (2/58)	7.8% (30/386)	0.18	0.46 (0.11-1.80)
Inherited KD	10.3% (6/58)	9.3% (36/386)	0.36	1.25 (0.57-2.74)
Obesity	36.2% (21/58)	20.2% (79/386)	0.004	2.04 (1.26-3.30)
Hypercholesterolemia	8.6% (5/58)	12.2% (47/386)	0.39	0.81 (0.36-1.81)
Hypertriglyceridemia	6.8% (5/58)	3.1% (12/386)	0.039	1.95 (1.05-3.59)

Abbreviations: KD, kidney disease; HIV, human immunodeficiency virus.

Table 3. Risk factors for CKD in multivariate analysis

Variables	*P* value	OR	95% CI	
			Lower	Higher
Female	0.001	3.01	1.54	5.85
Age ≥65 years	0.37	-	-	-
Age 45-55 years	0.024	2.09	1.10	3.97
Diabetes	0.19			
Obesity	0.005	2.29	1.29	4.06
hypertriglyceridemia	0.042	2.24	1.03	4.86

adiponectin, leptin and resin. These abnormalities include development of inflammation, abnormal lipid metabolism, activation of the renin-angiotensin-aldosterone system, and increased production of insulin and insulin resistance (23). These various effects result in specific renal pathologic changes. This may explain the increased risk of CKD observed in obese patients. Obesity, just like the usual risk factors such as hypertension, diabetes and HIV infection, thus appears to be a risk factor for CKD. In our context, the fight against obesity forms part of the overall prevention of the cardiovascular risk. In high-income countries, the populations' mentalities have changed a lot. Play areas for practicing sports are crowded on weekends. As for people living in low-income populous areas, they indulge in their favorite leisure activity, i.e. football. Women remain sedentary due to lack of adequate fitness centers for them. It is at this level that awareness must be further raised to reduce substantially the proportion of obese individuals.

Conclusion

The prevalence of CKD is high in our study. The CG formula should no longer be used to estimate the GFR in the general population. Factors such as female sex, obesity and hypertriglyceridemia were associated with CKD. Obesity, just like the usual risk factors such as hypertension, diabetes and HIV infection, should be managed to prevent this disease in our country. Mass awareness campaigns and education sessions on healthy lifestyle are required for the population.

Study limitations

Our study has limitations that must be considered when interpreting the results. The cross-sectional nature of the study and the determination of serum creatinine by the Jaffe method are limitations.

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Authors' contribution

KHY made a substantial contribution to the conception, design, analysis and interpretation of data. He was also involved in drafting the manuscript and revising it critically for important intellectual content. SDK, SPD, MAM and MCG collected data. SS and DAG revised the manuscript critically for important intellectual content. All authors read and approved the final paper.

Conflicts of interest

The authors declare no conflict of interest.

Ethical considerations

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors.

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