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Prevalence of chronic kidney disease in Kinshasa: results of a pilot study from the Democratic Republic of Congo

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Abstract

Background. The burden of chronic kidney disease (CKD) in sub-Saharan Africa is unknown. The aim of this study was to investigate the prevalence and the risk factors associated with CKD in Kinshasa, the capital of the Democratic Republic of Congo (DRC).

Methods. In a cross-sectional study, 503 adult residents in 10 of the 35 health zones of Kinshasa were studied in a randomly selected sample. Glomerular filtration rate was estimated using the simplified Modification of Diet in Renal Disease Study equation (eGFR) and compared with the Cockcroft–Gault equation for creatinine clearance. The associations between health characteristics, indicators of kidney damage (proteinuria) and kidney function (<60 ml/min/1.73 m^2) were examined.

Results. The prevalence of all stages of CKD according to K/DOQI guidelines was 12.4% [95% confidence interval (CI), 11.0–15.1%]. By stage, 2% had stage 1 (proteinuria with normal eGFR), 2.4% had stage 2 (proteinuria with an eGFR of 60–89 ml/min/1.73 m^2), 7.8% had stage 3 (eGFR, 30–59 ml/min/1.73 m^2) and 0.2% had stage 5 (eGFR < 15 ml/min/1.73 m^2). Hypertension and age were independently associated with CKD stage 3. The prevalences of major non-communicable diseases considered in this study were 27.6% (95% CI, 25.7–31.3%) for hypertension, 11.7% (95% CI, 10.3–14.4%) for diabetes mellitus and 14.9% (95% CI, 13.3–17.9%) for obesity. Hypertension was also independently associated with proteinuria.

Conclusion. More than 10% of the Kinshasa population exhibits signs of CKD, which is affecting adults in their productive years. Risk factors for CKD, including hypertension, diabetes and obesity, are increasing. These alarming data must guide current and future healthcare policies to meet the challenge raised by CKD in this city and hopefully in the whole country.

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Keywords: chronic kidney disease; diabetes mellitus; equation (Cockcroft–Gault; MDRD); hypertension; prevalence

Introduction

Chronic kidney disease (CKD) represents a global public health problem both in developed and in developing countries [1]. The prevalence of CKD has been reported mainly in Western countries. In the USA [2,3], the third National Health and Nutrition Examination Survey (NHANES III) estimated that the prevalence of CKD has recently risen from 11% between 1988 and 1994 up to 13% between 1999 and 2004. The prevalence of CKD is 16% in Australia [4], 10.1% in Singapore [5] and 3.3% in Italy [6]. Almost all the available data of CKD in developing countries [7,8] come from individual nephrologists working in tertiary care referral hospitals. This fact is well illustrated by our recent report of increasing number of admissions for end-stage renal disease (ESRD) in the Democratic Republic of Congo (DRC) [8]. Although such observations may probably reflect an ascertainment bias [9], nonetheless, severe CKD is immediately ominous in the DRC and in neighbouring countries where many affected patients are neither detected nor properly managed at an early stage [10]. Treatments for ESRD are prohibitively expensive. Chronic renal failure is thus a significant cause of death. Earlier interventions for CKD are likely to be beneficial [1,10]. Unfortunately, the lack of quantitative knowledge of CKD prevalence hinders the adoption of appropriate preventive measures that may be useful. Moreover, traditional cardiovascular risk factors, such as hypertension and diabetes, are associated with CKD and becoming more common in developing countries. An estimated 250% increase of the burden of diabetes and cardiovascular disease is expected by year 2030 in sub-Saharan Africa [11]. Despite these overwhelming facts, CKD has not received much attention from health organizations.

In recent years, new guidelines have been published by the National Kidney Foundation's Kidney Disease

Outcomes Quality Initiative (K/DOQI) to help the detection and management of CKD [12,13]. To the best of our knowledge, there are no available published data based on these guidelines from sub-Saharan countries.

We have undertaken this study in order to establish baseline data on the prevalence of CKD, and other major chronic non-communicable disease (CND) such as hypertension, diabetes and obesity in the Congolese population of Kinshasa. Socio-demographic features and clinical parameters were also assessed.

Subjects and methods

Study design and population

The present cross-sectional study is the first part of a larger ongoing epidemiological survey on CKD and associated risk factors 'Prévalence, détection précoce et prévention des maladies rénales chroniques et facteurs de risque associés (PDMRA) en RDC', carried out between 24 November and 23 December 2006. The selected urban population came from Kinshasa city, home of ∼7 million people. Ten of its thirty-five health zones were studied randomly. Because of the lack of population registries, sampling was adapted to the administrative organization of the city, which is subdivided into health zones [14].

We used a multistage sampling [15] among the units of the survey as follows: the health zone (first degree), the health area (second degree), the street (third degree), the inhabited parcel (fourth degree) and the household (fifth degree). Where there were several households in the single selected parcel, only one household was randomly drawn and then only one subject ≥20 years old was picked at random. The proportion of the participants varied according to the health zone. This study was approved by the Provincial Medical Inspection of Kinshasa.

Screening examinations and data collection

Based on the assumption that ∼11% of individuals would have all stages of CKD, ∼418 subjects were required to reach this prevalence with the error estimate of 3% [16]. We had planned for 550 subjects but 9% denied participation. Except for five individuals, no more information could be drawn from nonresponders. Finally, 503 subjects were interviewed and examined. Three of them declined blood testing. The final sample size thus encompassed 500 participants.

All participants provided informed written consent before enrolment. They were visited twice at home by trained volunteers who recorded general information on demographic data, diet, smoking, alcohol consumption, indigenous herbal drug use and birth weight knowledge. Data about family relatives of first degree and medical history for kidney disease, hypertension, diabetes and current treatment were also recorded. Body weight, height and waist circumference were measured.

Blood pressure was measured twice in the right or left arm using a calibrated sphygmomanometer (WelchAllyn, Germany) at the heart level. Hypertension was defined by a systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg (namely unknown hypertensive) and/or concomitant use of antihypertensive medications by self-report (known hypertensive) [17].

The body mass index (BMI) was calculated from the measured height (in metres) and weight (in kilograms) and categorized as not obese (<25 kg/m^2), overweight (25–29.9 kg/m^2) or obese (≥30 kg/m^2) according to the 2000 WHO criteria [18].

The diagnosis of diabetes was established after two fasting glucose values of ≥126 mg/dl (namely unknown diabetic) using fingertip blood (Accutrend glucometer) and/or concomitant use of antidiabetic medications by self-report (known diabetic).

The participants were also asked to collect a urine sample to detect proteins by the urinary strips 'Uric 8V'. Female subjects were instructed to void a random urine specimen, remote from menstrual periods. Pregnant women were excluded. Because microalbuminuria and the ratio of albumin to creatinine (ACR) were not available and urine dipstick provides only a semi-quantitative estimation of the severity of proteinuria, kidney damage in stage 1 and 2 CKD in our study was identified as 24-h urinary protein ≥300 mg per day.

Serum creatinine and proteinuria were carried out according to the kinetic Jaffe (semi-automated polyphotometer, Visual Biomérieux) and Esbach methods, respectively. These tests were performed in the laboratory of the Belgian medical centre of Kinshasa 'CMK'. For estimated glomerular filtration rate (eGFR) determination, the abbreviated equation from the Modification of Diet in Renal Disease (MDRD) study was used. We have calibrated 35 creatinine results measured with the Jaffe method against a traceable isotope dilution mass spectrometry (IDMS) enzymatic method (creatinine +, Roche enzymatic diagnostics) at the University Hospital of Liège. Recalibrated serum creatinine values were thereafter computed for each participant, and the new MDRD study equation was used for estimation of the eGFR as $175 \times (\text{serum creatinine level [mg/dl]})^{-1.154} \times (\text{age [years]})^{-0.203}$ [19]. For women and blacks (all patients in our study), the product of this equation was multiplied by a correction factor of 0.742 and 1.21, respectively. The Cockcroft–Gault (CG) estimate of creatinine clearance [20] was calculated as $[(140 - \text{age}) \times \text{weight}]/[72 \times (\text{serum creatinine in mg/dl})] \times 1$ (or 0.85 if female).

The K/DOQI guidelines [12] for definition and classification of CKD were used in the present study. In brief, the CKD stages are defined as follows: stage 1, proteinuria ≥300 mg per day with an eGFR >90 ml/min/1.73 m^2; stage 2, proteinuria ≥300 mg per day with an eGFR of 60–89 ml/min/1.73 m^2; stage 3, an eGFR of 30–59 ml/min/1.73 m^2; stage 4, an eGFR of 15–29 ml/min/1.73 m^2 and stage 5, an eGFR <15 ml/min/1.73 m^2.

The term chronic renal failure or CKD 3+ refers to an eGFR <60 ml/min/1.73 m^2. All stages of CKD included both kidney damage (early stage of CKD, 1 and 2) and chronic renal failure (CKD 3 or worse).

Statistical analysis

Results are presented as number and percentage or mean ± SD. Two-sample Student's *t*-test and chi-squares were

used for comparison of means and proportion, where appropriate.

The participant with an eGFR <30 ml/min/1.73 m^2 ($n = 1$) was excluded from the logistic regression analysis. The outcome under analysis was the presence of CKD, defined as above. Exposure variables that were considered included gender, age, smoking, herbal drug use, BMI, diabetes mellitus, pulse pressure and hypertension. Categories of age were divided as follows: 20–39, 40–59, 60–69 and ≥70 years. The crude (unadjusted) relationships between the exposure variables and the presence or absence of CKD were examined in univariate logistic regression analyses. Multivariate stepwise logistic regression analysis was then done to evaluate the simultaneous effects of various exposure variables, with adjustment for the potential confounding effects of other factors. The odds ratio (OR) and 95% confidence intervals were also obtained. The above approaches were applied separately to the MDRD formula-based results for CKD stage 3 and for proteinuria. Except chi-squares, all data analysis and calculations were performed by using the standard statistical package (SPSS Inc., Chicago, IL, USA; version 10.1). Chi-squares were made in the dialog box using MedCal version 9.1.01, 2005. A P-value <0.05 indicated statistical significance.

Results

Characteristics of the study population

The general characteristics of the study population are summarized in Table 1.

Their age ranged between 20 and 79 years (mean 38.6 ± 14.4). There were 206 males and 297 females. A history of hypertension, diabetes, renal disease, smoking and the use herbal remedies was recorded in 15.7%, 2%, 0.4%, 10.7% and 28.0% of participants, respectively.

Table 1. Characteristics of the study population

Clinical features	$n = 503$	%
Gender		
Male	206	41.0
Female	297	59.0
Age (mean ± SD) (years)	38.6 ± 14.4	
Age range (years)	20–79	
20–39 (years)	292	58.1
40–59 (years)	156	31.0
60–69 (years)	33	6.6
≥70 (years)	22	4.4
History of hypertension	79	15.7
History of renal disease	2	0.4
Smoking currently or formerly	54	10.4
Herbal remedies use currently	141	28.0
Physical inactivity	40	8.0
Family history of hypertension (first degree)	311	61.8
Family history of diabetes mellitus (first degree)	149	29.6

Values expreesed as number and proportions in parentheses or mean ± SD, as appropriate.
SD, standard deviation.

Table 2. Prevalence of CKD in Kinshasa (DRC)

Stage	MDRD (ml/min/1.73 m^2) $n = 500$	Cockcroft–Gault (ml/min) $n = 500$
1	10 (2.0)	7 (1.4)
2	12 (2.4)	11 (2.2)
3	39 (7.8)	75 (15.0)
4	0	1 (0.2)
5	1 (0.2)	1 (0.2)
All stages CKD	62 (12.4)	95 (19.0)
CKD 3+ (eGFR <60 ml/min/1.73 m^2)	40 (8.0)	77 (15.3)
Proteinuria (≥300 mg/day)	25 (5)	
Proteinuria dipstick (Uric 8V)	90 (18)	

Values are number and propotions (%) given in parentheses.
MDRD, Modification of Diet in Renal Disease; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

Prevalence of CKD and associated related risk factors

Table 2 shows the prevalence of CKD. Depending on the method used to estimate the eGFR, 12.4% (95% CI, 11.0–15.1%) to 19% (95% CI, 17.3–22.3%) had all stages of CKD. However, awareness of CKD was very low (3.2%).

According to the MDRD study and CG formulas, 7.8% (95% CI, 7.6–8.1%) to 15% (95% CI, 13.4–18.1%) had chronic renal failure (CKD stage 3), respectively. For both formulas, the ages of patients with CKD stage 3 were similar (mean 53.9 ± 13 versus 53.6 ± 15.7 years, $P > 0.05$).

Lower body weight explained some of the higher prevalence of CKD stage 3 according to the CG equation. The prevalence of early stages 1 [2.0%; (95% CI, 1.4–3.1%)] and 2 [2.4%; (95% CI, 1.8–3.5%)] was almost 10 times greater than that of stage 5 CKD (0.2%).

Twenty-four-hour quantitative proteinuria of >300 mg/day was found in 5%.

Stratified by age groups of 20–39, 40–59, 60–69 and ≥70 years, the prevalence of all stages of CKD defined by the MDRD study formula in the study population was 1.4%, 13.5%, 30.3% and 22.7%, respectively. According to the CG formula, the prevalence of all stages of CKD, stratified by the same age groups, was 5.2%, 18.7%, 57.6% and 63.6%, respectively (data not shown). From this, there appears to be a linear rise in rates of CKD with increasing age in our study population. As illustrated in Figure 1, there is a distinct overrepresentation of CKD in younger people in the DRC cohort, in contrast to the US cohort, where CKD appears to predominate in older, rather than younger subjects. This difference in distribution is highly significant for the two middle age ranges 40–59 and 60–69 ($P < 0.01$).

Risk factors associated with stage 3 CKD and proteinuria are described in Table 3. In univariate analysis, the risk factors significantly associated with stage 3 CKD according to the MDRD study formula were age (unadjusted OR 6.2; 95% CI 2.7–14.3; $P < 0.001$), hypertension (unadjusted OR 3.05; 95% CI 1.5–5.9; $P < 0.001$) and pulse pressure (unadjusted OR 2.8; 95% CI 1.4–5.6; $P < 0.004$). On the other hand, the risk factors significantly associated with proteinuria were age (unadjusted OR 3.8; 95% CI 1.3–10.9; $P < 0.01$), hypertension (unadjusted OR 7.5; 95% CI 3.0–18.4; $P < 0.0001$) and herbal remedy use (unadjusted OR 2.9; 95% CI 1.3–6.5; $P < 0.01$).

In multivariate analysis, hypertension (adjusted OR 2.1, 95% CI 1.06–4.5; $P = 0.03$) and age (adjusted OR of 4.2, for the age range of <65 and ≥65 years, $P < 0.001$) were independently associated with CKD stage 3. Hypertension (adjusted OR 6.8, 95% CI 2.6–17.2; $P < 0.001$) was also independently associated with proteinuria.

Prevalence of other CND

The prevalence of hypertension was 27.6% (95% CI, 25.7–31.3%), and that of diabetes mellitus was 11.7% (95% CI, 10.3–14.4%). There was a 14.9% (95% CI, 13.3–17.9%) prevalence of obesity (Table 4).

Table 4. Prevalences of other major non-communicable diseases in Kinshasa (DRC)

Other major non-communicable diseases	$N = 503$	%
Hypertension	139	27.6
Known	79	15.7
Unknown	60	11.9
Diabetes mellitus	59	11.7
Known	10	2.0
Unknown	49	9.7
Overweight (25–29.9 kg/m^2)	102	20.3
Obesity (≥30 kg/m^2)	75	14.9

Values are number and proportions given in parentheses.

Discussion

Our study documents for the first time the burden of the CKD in Kinshasa. Using the recommended protocols of the Kidney Disease Improving Global Outcomes (KDIGO) initiative [21], CKD in this study averages 12.4–19% depending on the method used to estimate GFR. The difference between the prevalence of CKD according to both (MDRD study versus CG) formulas may probably result from the body weight measurement, a variable that is not included in the MDRD study eGFR equation. Further, the CG equation was initially developed in Caucasian men. Since the MDRD study formula has been adequately validated in African Americans with kidney disease [22], extrapolation to black Africans appears justified. Hence, we considered only the results based on the MDRD study formula.

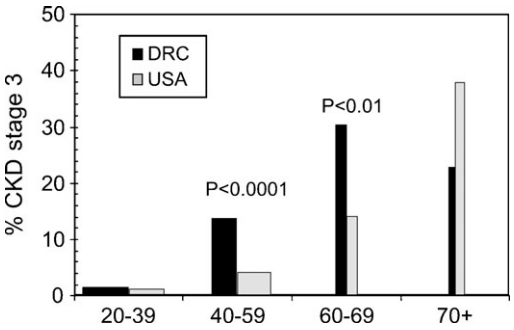

Fig. 1. The prevalence of CKD stage 3, according to age range and country. The data for the USA are taken from Coresh *et al*. [3]. The width of the columns is proportional to the percentage of subjects in that age bracket, by cohort. There is a distinct overrepresentation of CKD in younger people in the DRC cohort, in contrast to the USA cohort, where CKD is more prevalent in older, rather than younger subjects. This difference in distribution is highly significant for the two middle age ranges ($P < 0.01$, chi-square).

In our survey, roughly one person out of eight is affected by all stages of CKD.

This value is higher than the 3.3% found in Italy [6], similar to 12.7% in Norway [23], but lower than the value of 16% in Singapore [4]. Comparisons between studies are of course fraught with difficulty as the definitions and the criteria of selection may substantially differ. Nonetheless, our results are similar to those recently reported by Coresh *et al*. in the USA [3]. Yet when one considers the increasing prevalence of known and unknown risk factors for CKD, it appears likely that in Kinshasa, the occurrence of CKD stage 3 or worse will increase to rates beyond those in the USA. Moreover, had we used the spot microalbuminuria or ACR, the prevalence of CKD at the early stage (1 and 2) would probably be even higher in the DRC cohort.

The higher CKD prevalence observed in middle-aged adults in the DRC compared to the USA is not due to the presence of only black Africans in our cohort. That is because the CKD prevalence data for NHANES III show a lower prevalence of CKD in blacks compared to whites [3]. The greater prevalence of CKD in black adults aged <70 years in Kinshasa compared to that in the USA may have specific causes that require closer scrutiny.

Table 3. Odds ratio of risk factors associated with CKD (univariate and multivariate analysis) in Kinshasa

Risk factors	OR (univariate analysis)	95% CI	*P*-value	OR (multivariate analysis)	95% CI	*P*-value
CKD stage 3 (MDRD study)						
Hypertension versus no	3.05	1.5–5.9	0.001	2.1	1.06–4.5	0.03
Pulse Pressure >60 mmHg versus <60 mmHg	2.8	1.4–5.6	0.004	1.2	0.4–3.1	0.6
≥65 years versus <65 years	6.2	2.7–14.3	<0.001	4.2	1.7–10.4	0.001
24-h quantitative proteinuria (>300 mg/24 h)						
Hypertension versus no	7.5	3.0–18.4	<0.001	6.8	2.6–17.2	<0.001
≥65 years versus <65 years	3.8	1.3–10.9	0.01	1.6	0.5–5.0	0.3
Herbal remedies use	2.9	1.3–6.5	0.009	2.2	0.8–5.6	0.07

OR, odds ratio; MDRD, Modification of Diet in Renal Disease; CI, confidence interval; CKD, chronic kidney disease; PP, pulse pressure.

In this survey, we found a very low occurrence rate of ESRD. This is not in contradiction to our finding of a high rate of CKD in this city. That is because the prevalence of ESRD is influenced by both the number of new patients requiring renal replacement therapy (RRT) (incidence) and the number of deaths. Indeed, incidence reflects typically the interaction of genetic and environmental factors as well as the efficacy of primary health care services, while mortality depends on the availability of RRT [24].

Many people with ESRD in the DRC die of uraemia because only a few of them can afford peritoneal dialysis as the RRT available in that country [8,10]. In addition, those patients who do not progress to ESRD had an increased risk of death from cerebrovascular and heart disease. Another potential explanation for high rates of CKD compared to ESRD would be the slowing of CKD so that people do not reach ESRD as reported in Norway by Hallan *et al*. [23]. However, such is not the case in DRC, where recent experience [25] in secondary healthcare reveals that many Congolese patients are neither detected nor adequately managed at an early stage and are not referred to the sole renal unit existing in this country.

Among several possible explanations for the higher prevalence of CKD in Kinshasa, we can suggest genetic, intrauterine, economic and manpower factors. Although most of our study population did not have birth certificates or knowledge of weight at birth, it is known that low birth weight (LBW) is common in Africa, as it is among African Americans [26]. An additional explanation for CKD in the DRC is the increased burden of CND (such as hypertension, diabetes, obesity) and the persistence of poverty-related diseases (malaria, tuberculosis, HIV infection and the current resurgence of leprosy, trypanosomiasis, filariosis and schistosomiasis), all factors playing an important role in the development of kidney diseases [8,24]. But this study did not address the specific causes of CKD in individual subjects. Also, appropriate management of these patients is adversely impacted by economic problems in general and civil war and lack of manpower in particular [7,10].

As expected [2,3], hypertension and age were independently associated with CKD. Hypertension is injurious to the kidney and leads to renal disease. Hypertension is also a common pathway of renal disease for which it is hard to distinguish between cause and end result [27].

Ageing is well known as a risk factor for CKD. But subjects with CKD in the present study are relatively young, as has been noted in most developing countries [7,8]. In contrast, the USDRS [28] and the NHANES III [2,3] data show that CKD or ESRD in the USA is strikingly a disease of older people. This difference in distribution is highly significant mainly for the two middle age ranges. This has distinct economic effects, because CKD can thus cause death or disability to wage earners in the DRC.

The cause for this discrepancy remains unknown, but might be due to different risk factors leading to CKD or to the different population age distribution of the sample geographical area. For example, the more developed regions show much higher proportions of persons aged 65 years or more, these older people being as much as one-fifth of the population. In less-developed parts of the world, $<10\%$ of the population is in the >65 age range [29]. Nonetheless, because the difference of the CKD prevalence in the middle age groups in the DRC compared to that in the USA is a percentage, and not an absolute number, it may not merely depend on a difference in the population pyramid.

Another preventable risk factor for CKD is the use of herbal remedies, which was found in this survey in univariate analysis but not in multivariate analysis. Several compelling studies [30,31] demonstrated renal toxicity and other adverse effects of traditional herbal remedies. Further, histopathological and toxicological studies are recommended in order to establish the causal relationship and specific component(s) of the culprit products.

Another important finding of this study is the determination of the real extent of the major CND such as hypertension, diabetes and obesity. These are possibly modifiable risk factors for CKD. Indeed, the prevalence of hypertension in our study was as high as 27.6% and similar to the prevalence of 28.3% found in Ghana [32]. These values are much higher than the 14% reported previously in this country by M'Buyamba in 1987 [33] and in Nigeria as well as 16.9% in Cameroon [34], but a bit lower than the value of 32.6% for blacks in the USA [34].

One of the consequences of adoption of a Western lifestyle in Africa is an increased prevalence of hypertension from past historical levels when these levels were probably much lower. It has been estimated that cardiovascular disease will become the leading global cause of death and disability in the very near future [11].

Over the past 40 years, the prevalence of diabetes has also increased significantly in Kinshasa.

According to the epidemiological study of the 1960s, the proportion of diabetes among hospital patients was 0.012%. It was 7% in another epidemiologic survey in 2000 [35] and it is now 11.7% in our study. At the same time, the prevalence of obesity has increased from 9% in 2000 [35] to 14.9% at present. This increasing prevalence of diabetes and of obesity will probably impact on future rates of CKD in the DRC.

However, some limitations exist in this study: it is cross-sectional with only one measure (for serum creatinine, proteinuria and blood pressure), it has a relatively small size and it relies on both MDRD study and CG equations, the validation of which is lacking among the African population as well as in the non-CKD population [36].

Despite possible methodological limitations, this study emphasizes that CKD and associated risk factors such as hypertension, diabetes and obesity are highly prevalent in Kinshasa, while awareness of renal disease is very low. This work confirms hypertension and age as significant CKD risk factors. However, large prospective studies in this country are needed to improve the precision of these preliminary data and so to develop adapted preventive strategies.

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