

Prevalence and Associated Factors of Diabetic Kidney Disease in Senegalese Patients: A Cross-Sectional Study in Saint-Louis

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Abstract

Introduction: Diabetes is a leading cause of chronic kidney disease in the world. During the next decade, its burden is expected to increase in Africa with potential complications such as chronic kidney disease. However, epidemiology and risk factors of diabetic kidney disease are poorly described at population level. This study aimed to determine prevalence of diabetic kidney disease (DKD) in adult diabetics living in Saint-Louis, northern Senegal. **Methods:** A cross-sectional study including diabetic patients followed-up aged ≥ 18 years during a five-year period (2013-2018) in Saint-Louis. Clinical and biological parameters were collected during annual community-based mass screening. Diabetes was defined as fasting blood glucose ≥ 1.26 g/L confirmed by a second lab dosage. DKD was defined as persistence of albuminuria ≥ 30 mg/24h and/or estimated glomerular filtration rate (eGFR) < 60 mL/min/1.73m². Data were analyzed with Stata 12.0. **Results:** We included a total of 1310 diabetic patients among whom 3.7% (95% CI = 1.4% - 9.8%) presented DKD. Their mean age was 46.2 ± 11.8 years and sex-ratio was 0.7. Micro-albuminuria and macro-albuminuria were present respectively in 59.2% and 18.4% of patients with DKD and half of them had a normal eGFR. Before the survey 89.8% of patients with DKD were not aware of their renal disease and only four of them had seen a nephrologist. After multivariate analysis, age (OR = 1.5; 95% CI = 1.1 - 3.4), duration of diabetes (OR = 1.2; 95% CI = 1.6 - 4.4) and hypertension (OR = 2.5; 95% CI = 1.4 - 4.6) were associated with the presence of DKD in diabetic patients while no significant association was not found with gender, blood glucose level, smoking and familial history.

Conclusion: DKD is a frequent complication in diabetic adult population living in Saint-Louis. Early detection and management should be promoted in order to prevent progression to end-stage renal disease.

Keywords

Diabetes, Kidney Disease, Epidemiology, Saint-Louis

1. Introduction

Diabetic kidney disease (DKD) is a major complication of type 2 diabetes, characterized by elevated urinary albumin excretion rate, hypertension and/or a declining renal function that can lead to end-stage renal disease (ESRD). Currently diabetes is the world leading cause of ESRD undergoing dialysis treatment [1].

The rapid growth of DKD is due to the progression of type 2 diabetes epidemic combined with an increase in the life span of diabetic patients due to a better management of acute fatal complications [2]. This trend of increase in the proportion of chronic kidney disease attributable to diabetes is observed in both developed and developing countries [3].

During the next decade, the burden of diabetes is expected to increase in Africa with potential micro-angiopathic complications such as DKD and cardiovascular disease (CVD) that are the main causes of death [4].

Literature review

However, the epidemiology of DKD is still unknown at population level. This study aimed to describe the prevalence of diabetic kidney disease in adult population of Saint-Louis region (northern Senegal).

2. Patients and Methods

We performed a cross-sectional survey including diabetic patients aged ≥ 18 years and recruited during community-based screening organized during five consecutive years of celebrating the World Diabetes Day (2013-2018) in Saint-Louis, northern Senegal. Clinical and biological parameters were collected using a questionnaire. Interviews combined with clinical examination and point-of-care tests (fasting blood glucose with Accucheck® device, urine albumin using Multistick Pro®). All cases with elevated finger glycemia or albumin positive urine dipsticks were completed by laboratory analyses at university hospital. Other biochemical tests included serum creatinine and total cholesterol. Diabetes was defined as fasting blood glucose ≥ 1.26 g/L controlled by the lab test. Diabetic kidney disease was defined as presence of persistent micro- or macro-albuminuria (urine albumin-to-creatinine ratio ≥ 300 mg/g) and/or estimated glomerular filtration rate (eGFR) < 60 mL/min/1.73m² using the MDRD equation [5].

Statistical analysis was performed with Stata 12.0. Baseline clinical and biological characteristics of patients with and without DKD were compared using

the unpaired Student's *t* test for continuous variables, and χ^2 test for proportions. Logistic regression analysis was used to identify factors associated with DKD. The models included variables that were a priori known to be potential determinant of nephropathy, or that were found to be significantly different at baseline when we compared the two groups. For all statistical tests, we considered a significance level of $p \leq 0.05$.

3. Results

Among a total of 1310 diabetic patients included, 3.7% (95% CI = 1.4% - 9.8%) presented overt DKD. Diabetic kidney disease prevalence was higher in men (4.3%) compared to women (3.4%) and showed an increasing trend with age (**Figure 1**). Their mean age was 46.2 ± 11.8 years and sex-ratio was 0.7. Micro-albuminuria and macroalbuminuria were present respectively in 59.2% and 18.4% of patients with DKD. Two of them had nephrotic range proteinuria. About half of patients with DKD had a normal eGFR and 20% had stage 4 - 5 chronic kidney disease (**Figure 2**). The main characteristics of participants with and without DKD are presented in **Table 1**.

Before the survey was conducted, 89.9% of patients were not aware of their kidney problem and only four of them had consulted a nephrologist and were treated with renin-angiotensin-aldosterone system (RAAS) inhibitors.

Univariate analysis identified age, gender, diabetes duration, hypertension, abdominal obesity and presence of familial history as significantly associated with DKD (see **Table 2**). Neither smoking nor level of glycated hemoglobin (HbA_{1c}) was associated with occurrence of DKD.

After multivariate logistic analysis, only age, diabetic duration and hypertension remained significantly associated with DKD (see **Table 3**). The strongest risk factor was hypertension that multiplied risk of DKD by 2.5. Of note, any significant association was not found between DKD and gender, physical activity, smoking and familial history.

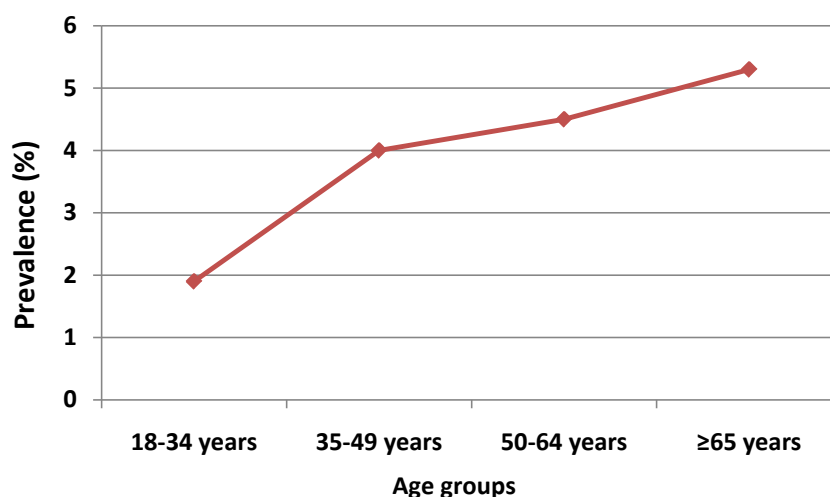


Figure 1. Prevalence of diabetic kidney disease across age groups.

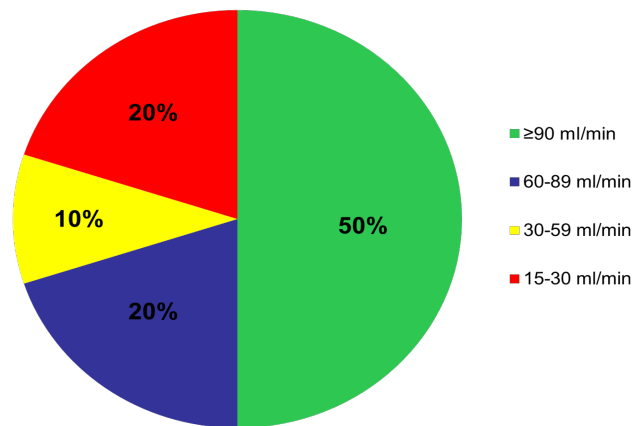


Figure 2. Glomerular filtration rate levels among patients with diabetic kidney disease.

Table 1. Baseline characteristics of diabetics with and without diabetic kidney disease.

	Normal kidney function (n = 1261)	Diabetic kidney disease (n = 49)
Age (years)	37.8 ± 14	41.6 ± 18
Gender (% male)	44.1	51.6
Familial history of DKD	10.3	44.9
Duration of diabetes (years)	9.7 (3 - 25)	15.8 (5 - 23)
Smokers (%)	3.8	4.6
Physical inactivity (%)	51.5	53.1
Prevalence of retinopathy (%)	33.3	77.5
Systolic BP (mm Hg)	133.6 ± 18.9	133 ± 17
Diastolic BP (mm Hg)	80.6 ± 9.4	80 ± 9
Glycated hemoglobin (%)	6.3 ± 2.5	9.1 ± 2.8
Fasting glycemia (g/l)	1.2 (0.7 - 1.9)	1.3 (0.8 - 1.5)
Estimated GFR (ml/min/1.73m ²)	88.9 ± 21.3	64 ± 18.9

4. Discussion

4.1. DKD Prevalence

A global picture of DKD is not clearly shaped because high quality data from many countries are scarce. In the United Kingdom Prospective Diabetes Study, the prevalence rate of nephropathy in types 2 diabetic patients was 30.8% [6].

In the sub-Saharan region reported data are more heterogeneous because of different definitions and methods used in studies. A systematic review showed that overall prevalence of kidney disease varied from 11% to 83.7% with albuminuria incidence of 94.9% after 10 years follow-up [7]. One study in Tanzanian patients found that 83.7% of diabetic patients attending a tertiary hospital presented an eGFR ≤ 60 ml/min/1.73m² [8]. In this study, we found lower prevalence of kidney disease but this can be explained by the difference between our

Table 2. Univariate analysis of factors associated with DKD.

Variables	OR	95% CI	p-value
Age (years)			<0.01
18 - 49	1		
≥50	2.46	1.80 - 3.38	
Gender			0.05
Female	1		
Male	1.54	1.11 - 3.42	
Diabetes duration (years)			<0.01
<10	1		
≥10	2.04		
Familial history of DKD			0.02
No	1		
Yes	1.83	1.15 - 4.28	
Smoking			0.18
No	1		
Yes	1.30	0.43 - 5.01	
Physical inactivity			0.35
No	1		
Yes	1.02	0.54 - 1.51	
Hypertension			<0.01
No	1		
Yes	1.96	1.21 - 6.99	
Waist circumference (cm)			0.05
<88	1		
≥88	1.54	1.09 - 4.39	
Body Mass Index (kg/m ²)			0.27
<25	1		
25 - 29.9	1.98	0.70 - 5.36	
≥30	1.55	0.68 - 2.81	
Total cholesterol (g/L)			0.61
<2	1		
≥2	1.72	0.92 - 4.25	
Glycated haemoglobin (%)			0.36
<7	1		
7 - 8	1.29	0.59 - 3.80	
>9	1.07	0.60 - 2.53	

DKD = diabetic kidney disease; OR = odds ratio; CI = confidence interval.

Table 3. Factors associated with diabetic kidney disease (multivariate regression).

Variables	OR	95% CI	P value
Age	1.5	1.1 - 3.4	0.01
Gender	0.7	0.2 - 5.6	0.57
Familial history of DKD	1.2	0.8 - 3.5	0.09
Duration of diabetes	1.2	1.6 - 4.4	0.03
Hypertension	2.5	1.4 - 4.6	0.04
Abdominal obesity	1.0	0.4 - 2.9	0.22
Smoking	0.9	0.5 - 3.8	0.48
Glycated haemoglobin	0.56	0.4 - 4.7	0.77

DKD = diabetic kidney disease; OR = odds ratio; CI = confidence interval.

population and the other studies that are in majority hospital-based including patients with more advanced disease. One study in Benin including 300 type 2 diabetics found 7.7% of patients with eGFR < 60 ml/min/1.73m² [9].

About 2.8% of diabetic patients included in this study presented with albuminuria between 30 and 300 mg/24h. Micro-albuminuria was reported in 27% in Oman [10], 22% in Bahrain [11], 21.2% in Yemen [12], 16.1% in Iraq [13]. In the African continent, prevalence of micro-albuminuria among type 2 diabetics is variable but higher with 23% in Tunisia [14], 34.2% in Egypt [15], 44% in Sudan [16], and 45.8% in Tanzania [8].

In general, the reported higher incidence of renal complications in African diabetic patients compared to western countries is not clearly demonstrated as there is an important heterogeneity in published data depending on the study population, the methods used to define or assess diabetic kidney disease and the duration of observation period [7]. A systematic review describing CKD epidemiology in sub-Saharan Africa found a prevalence ranging from 4% to 24% among diabetic population [17].

4.2. DKD Associated Factors

Duration of diabetes, high blood pressure, advancing age, obesity and poor glycaemic control were the identified risk factors of DKD in our patients.

The existence of a positive family history of DKD or high blood pressure had been identified in many studied as a major risk factor to develop renal among diabetic patients [18] [19] [20]. Genetic studies found many SNPs variants that might explain the familial clustering of DKD and difference between ethnic groups [21]. Patients presenting some variants of the ACE gene (double deletion allele DD) show a faster progression of diabetic nephropathy even though this polymorphism does not influence retinopathy [22].

Beyond genetic background that increases susceptibility to DKD several environmental factors may play a more important role in occurrence and progression of the disease. Low socioeconomic level, poor hyperglycemic control,

hypertension, obesity, high protein diet, smoking and early life conditions were found to be associated with occurrence of DKD [23]. Hypertension had been extensively reported as a progression factor to ESRD but it can also be a confounding cause of kidney disease in diabetic patients [24] [25].

Early glycemic control is one of the main targets in primary prevention of diabetic nephropathy [4] [26] but other determinants of DKD are more controversial.

In an observational study of type 1 diabetic patients with a median follow-up of 9 years study, only smoking and baseline urinary albumin excretion rate were identified as predictors of progression from normo-albuminuria to micro-albuminuria or macro-albuminuria [27].

After high blood pressure, duration of diabetes was the second most powerful risk factor for DKD in our study. Compared with participants with duration of diabetes < 10 years, those with duration of diabetes \geq 10 years had a 20% more chance of developing kidney disease. Duration of disease and bad of control of glycemia are well known risk factors of micro-albuminuria and overt nephropathy in diabetic patients [7] [11] [28]. However, in this study HbA1C level was not significantly associated presence of DKD probably because of the cross-sectional design that did not allow a good follow up of glycemia level.

Studies demonstrated that control of these risk factors with prescription of RAAS blockers can slow GFR decline and reduce all-cause mortality by half in diabetic patients [29]. However, early initiation of RAAS blockers in type 1 diabetes patients without micro-albuminuria did not show any substantial renal benefit [30]. In type 2 diabetes, several studies have the efficacy of RAAS inhibition to improve renal outcomes but data are strong enough to recommend RAAS inhibitors in absence of hypertension or albuminuria [31] [32].

New therapeutic molecules such as sodium-glucose co-transporter 2 (SGLT2) inhibitors, glucagon-like peptide-1 (GLP-1) agonists and aldosterone antagonists have demonstrated interesting results in reduction of renal and cardiovascular outcomes and will probably be widely used in management of DKD [33]. Finally, like in many chronic diseases, management of diabetic patients should not be restricted to one parameter or organ because there are various clinical, biological and socio-demographical determinants that may influence the outcomes. Building an integrated healthcare system with multidisciplinary management could help to achieve this goal [1] [3]. In such perspective, general practitioners or primary healthcare workers should have a central role for curative and preventive care activities.

4.3. Limitations

The cross-sectional design of our study represents a limitation. One reason of the lack of precision in diagnosis of kidney disease in diabetic patients is due to the observational and descriptive nature of the majority of community-based studies that does not allow a complete and adequate workup to identify the type of kidney injury.

Kidney function was not measured 3 months later to ascertain chronicity of the disease and to roll out acute kidney injuries. Also, interpretation of associations found might be misleading as the study was descriptive.

5. Conclusion

Kidney disease is frequent among diabetic adult population living in Saint-Louis. The most common clinical presentation is hypertension with albuminuria. Patients' awareness is low and may contribute to late diagnosis and referral. To avoid complications that are particularly costly to manage, a lot of efforts should be made at primary care level to promote integrated programs for screening, early detection and management of diabetes and its complications including renal disease.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Annex: Data Collection Questionnaire

Patient's ID: ___/___ Date of birth: ___/___/___ Address: _____
 Phone: _____ Date of inclusion: | ___ | ___ | - | ___ | ___ | - | ___ | Time: ____
 Questionnaire N°: | ___ | ___ | - | ___ | ___ | Survey site _____ Investigator ID: _____

SOCIO-DEMOGRAPHICAL DATA

Marital status: _____; Disease awareness (before current survey): _____
 Occupation: _____; Diabetes duration (since diagnosis): _____ years

MEDICAL PAST

MEDICAL:

- Hypertension Diabetes Overt nephropathy Proteinuria Repeated UTI
 Other diabetic cases in the family (_____)
 Physical activity Smoking

SURGICAL:

- Chirurgie autres que césarienne (Préciser _____)

GYNECO-OBSTETRICAL (if female):

- Number of pregnancies _____ Gestational diabetes Preeclampsia Abortion
 Fœtal macrosomia C section delivery (indication? _____)

ONGOING TREATMENTS:

- Dietary measures (_____) Oral antidiabetics (_____)
 Insuline (_____) Phytotherapy (_____)
 Other medications (_____)

CLINICAL EXAMINATION

General appearance _____; Edema _____; Skin dehydration : _____
 Vital signs: T ___ C; BP ___/___ mm·Hg; Pulse ___ bpm; RF ___ cycles/min; Weight ___ kg; Height ___ cm;
 Waist circumference ___ cm; Hip circumference ___ cm
 Urinary strips: Proteins ___ Glucose ___ Blood ___ Leucocytes ___ Nitrites ___ Gravity ___

BIOLOGICAL TESTS

Fasting blood glucose: _____ g/l; HbA1C: _____ %
 Hb _____ g/dl; Serum creatinine _____ mg/l; UAE _____ g/24 h