HEALTH RESEARCH IN AFRICA
High Quality Research with Impact on Clinical Care

Research Article

Clinical and Epidemiological Profile of Chronic Kidney Disease in Patients with Type 2 Diabetes au Cameroun

Profil Epidémiologique et Clinique de la Maladie Rénale Chronique chez les Diabétiques de Type 2 in Cameroon

Teuwafeu Denis Georges [1,2], Mbeleg Madeleine Dorcas Ornella[1], Balepna Jean Yves[3,4], Ronald Gobina Mbua [1], Mafouk Fopa Dianna Fontania[1], Tsague syntiche [1,2], Ivan Nkeng[3], Folong Kamta[3], Halle Marie-Patrice [5]

Affiliations
1- Faculty of health Sciences, University Of Buea, Cameroon
2- Triad Research Foundation
3- Hopital Laquintinie Douala
4- Faculty of Medicine and pharmaceutical Sciences, University Of Dschang, Cameroon
5- Faculty of Medicine and Pharmaceutical Sciences, University of Douala, Cameroon

Corresponding Author
Teuwafeu Denis Georges
Lecturer in Internal Medicine and Nephrology, Faculty of Health Sciences, University of Buea, P.O Box 63 Buea, Cameroon
Tel (+237) 699961884
E-mail: d.teuwafeu@yahoo.com

Mots clés : Maladie rénale chronique, diabète sucré, prévalence
Key words: Chronic Kidney Disease, Diabetes Mellitus, Prevalence

Article history
Submitted: 4 July 2024
Revisions requested: 7 September 2024
Accepted: 15 September 2024
Published: 27 September 2024

ABSTRACT

Introduction. Despite chronic kidney disease (CKD) being a major problem in Type 2 diabetes mellitus (T2DM), only a few studies have addressed CKD among patients with T2DM in Cameroon. The aim of our study is to determine the clinical and epidemiological profile of chronic kidney disease in patients with type 2 diabetes. **Methods.** This was a hospital-based cross-sectional study conducted over a period of three months from February to April 2022 on all type 2 diabetic patients at the Buea Regional Hospital and Laquintinie Hospital Douala. edical records were checked for the patients to assess for serum creatinine. CKD was staged according to the 2012 Kidney Disease Improving Global Outcomes Framework (KDIGO) guideline. Statistical significance was set at $p<0.05$. **Results.** A total of 391 type 2 diabetic patients were screened for CKD. The mean age was 59.62 years, for a sex ratio of 0,49. The overall prevalence of CKD was 27.9 %. Based on KDIGO classification. 76% of CKD patients were between stages 3-5. Among our patients, 76% had renal impairment (eGFR< 60ml/min/1.73m2) and 77% (84) had albuminuria. On multivariate analysis, albuminuria (aOR: 0.09, CI (0.05-0.16), $p<0.01$) was a risk factor for CKD. **Conclusion.** The prevalence of CKD in T2DM patients was high due to the fact that ¾ of our patients had albuminuria which was a risk factor for CKD. This result highlights the need of regular screening for kidney disease among diabetic patients to prevent progression to CKD.

RESUME

Introduction. Bien que l'insuffisance rénale chronique (IRC) soit un problème majeur dans le diabète sucré de type 2 (DT2), seules quelques études se sont intéressées à l'IRC chez les patients atteints de DT2 au Cameroun. Le but de notre étude est de déterminer le profil clinique et épidémiologique de l'insuffisance rénale chronique chez les patients atteints de diabète de type 2. **Méthodologie**. Il s'agit d'une étude transversale en milieu hospitalier menée sur une période de trois mois, de février à avril 2022, sur tous les patients diabétiques de type 2 à l'hôpital régional de Buea et à l'hôpital Laquintinie de Douala. Le stade de la maladie rénale a été déterminé selon la directive KDIGO (Kidney Disease Improving Global Outcomes Framework) de 2012. La signification statistique a été fixée à $p<0,05$. **Résultats**. Au total, 391 patients diabétiques de type 2 ont fait l'objet d'un dépistage de l'IRC. L'âge moyen était de 59,62 ans, pour un sex-ratio de 0,49. La prévalence globale de l'IRC était de 27,9 %. Sur la base de la classification KDIGO. 76 % des patients atteints d'IRC se situaient entre les stades 3 et 5. Parmi nos patients, 76% présentaient une insuffisance rénale (DFGe< 60ml/min/1.73m2) et 77% (84) une albuminurie. En analyse multivariée, l'albuminurie (aOR : 0.09, CI (0.05-0.16), $p<0.01$) était un facteur de risque de l'IRC. **Conclusion.** La prévalence de l'IRC chez les patients DT2 était élevée car ¾ de nos patients présentaient une albuminurie qui était un facteur de risque d'IRC. Ce résultat souligne la nécessité d'un dépistage régulier des maladies rénales chez les patients diabétiques afin de prévenir l'évolution vers l'IRC.

HIGHLIGHTS

What is known of the subject

Despite chronic kidney disease (CKD) being a major problem in type 2 diabetes mellitus (T2DM), only a few studies have addressed CKD among patients with T2DM in Cameroon.

The aim of our study

Clinical and epidemiological profile of chronic kidney disease in patients with T2DM.

Key Results

1. A total of 391 type 2 diabetic patients were screened for CKD. The mean age was 59.62 years, for a sex ratio of 0,49.
2. The overall prevalence of CKD was 27.9 %.
3. Based on KDIGO classification, 76% of CKD patients were between stages 3-5. Among our patients, 76% had renal impairment (eGFR< 60 ml/min/1.73 m2) and 77% had albuminuria.
4. On multivariate analysis, albuminuria (aOR: 0.09, CI (0.05-0.16), p<0.01) was a risk factor for CKD.

Implications for future practices and policies

There is a need of regular screening for kidney disease among T2DM patients to prevent progression to CKD.

INTRODUCTION

Diabetes Mellitus (DM) is known as one of the most rapidly increasing chronic diseases in the world, with type 2 diabetes mellitus(T2DM) accounting for 90% (1). The World Health Organization (WHO) predicted that the number of people living with this disease would reach 221 million by 2010 and will further increase to 300 million by 2025 with the majority of new cases occurring in Asia and Africa (2). Chronic kidney disease (CKD) is a long-term complication of DM (3) and is a public health problem worldwide that is associated with considerable morbidity and mortality (4, 5). Globally the number of patients with CKD is rising (6) with its prevalence estimated to be 8–16% worldwide (7) and 13.9% in sub-Saharan Africa (SSA) (8). In Cameroon its prevalence ranges between 11 and 14.2% (9) in 2019, T2DM became the 2nd leading cause of CKD and CKD-related death and is gradually becoming the main cause of CKD in less economically advanced countries (10). Patients with T2DM in developing countries with a duration of diabetes greater than 10 years are 4 times more likely to have micro albuminuria and also have kidney failure as a major cause of death (11). Diabetic kidney disease occurs in 20-40% of diabetic patients globally (12), it was thought to be more frequent in Africa as compared to those in the developed country due to poor sensitization, delayed diagnosis, limited screening and resources for diagnosis, inadequate treatment at an early stage, and poor glycaemic control (13). Annual screening for CKD in diabetic patients is initiated at the time of diagnosis for T2DM [14] as this would allow immediate intervention. These along with strict control of blood glucose will diminish the progression of kidney disease (14, 15). A study done in 2021 by Mbanya et al., revealed that improvement must be done in screening and treatment for kidney disease in patients with diabetes attending non-nephrology clinics in LMICs (16). Although the prevalence of CKD in Africa is quite known, the growing burden, risk factors, and pattern of CKD among T2DM patients are not well explored in LMICs. In Africa, the overall prevalence of CKD in the diabetic population has been reported to fluctuate between 11% and 83% (17). Despite CKD being a major problem in diabetes, only a few studies have been carried out on CKD among patients with T2DM in Cameroon.

PATIENTS AND METHODS

Study design and population

This was a hospital-based cross-sectional study conducted over a period of three months (February to April 2022). The Population was all type 2 diabetic patients at the Buea Reginal Hospital and Laquintinie Hospital Douala visiting the diabetic unit and seen at the specialist consultation during the study period. A consecutive sampling method was used.

Study area

These two hospitals were chosen because they served as reference centres for the management of diabetic patients for the Littoral and south west regions of Cameroon and both hospitals have are running a diabetes clinic. The diabetes and hypertension clinic of laquintinie hospital Douala is headed by an endocrinologist, the working team is made up of 4 endocrinologist and 3 nurses. They receive at least 20 patients every day from Monday to Friday from 8am- 3pm. It also has The Clinical Biology unit which is divided into 7 subunits including the central laboratory further divided into subunits including the biochemistry's where we tested for serum creatinine. The facility has well-equipped laboratories carrying out a wide range of analyses, and is also endowed with qualified medical biologists, laboratory technicians and assistant. The Diabetes clinic of Buea regional Hospital is run by general practitioners and six nurse assistants. It has a visiting endocrinologist who visit the centre twice a month. There are an average of 500 registered patients and they receive about 40 patients a week. Their main outpatient clinic day is Tuesday. These patients receive educational teachings concerning their health, complications of diabetes and diet. The hospital has a well-equipped and SANAS' accredited laboratory where all patients are directed for their laboratory investigations.

Data collection tools and procedure

All study participants received a participant information sheet and signed a consent form. Data were entered in a structured questionnaire following a one-on-one interview with the patient and medical records were checked to assess previous serum creatinine levels to set a baseline creatinine value. The most recent but more than three months values were taken. Patients with no creatinine in their medical records were actively screened for serum creatinine. All diabetic patients were screened for albuminuria. Blood pressure was measured using an electronic sphygmomanometer. BMI was calculated as weight divided by height squared (kg/m2). Three millilitres of fresh blood was collected from every selected patient in a dried tube Samples were transported

into to the laboratory. The measurements of concentrations were done using the Jaffe's method for serum creatinine. On the same day of the recruitment of the patient freshly voided urine was collected in a clean, dried, and sterile container with no preservative. Then, urine albumin was determined by using dipstick (COMBINA 14S, Human). The presence of albumin in the urine (from +1 to +4) was defined as albuminuria.
The eGFR was calculated using the MDRD formula based on the serum creatinine, CKD was defined as having an eGFR < 60ml/min/1.73m2 or proteinuria for at least 3months. The pattern of CKD was described based on the presence or absence of albuminuria. Diabetic patient with pregnancy, urinary tract infection and glycosuria, fever, acute heart failure, and jaundice were excluded.

Data management and analysis

We used the Statistical Package for Social Sciences version 26 for analysis. Categorical variables were summarized using counts and percentages and presented using bar and pie charts. Continuous variables were summarized using means, standard deviations, medians, and interquartile ranges where necessary. Bivariate analyses by Chi-square tests for the categorical variables and t-tests for continuous variables as appropriate. Stepwise binary logistic regression was used to select and estimate the association between elevated serum creatinine and mortality. A p value < 0.05 was considered statistically significant.

Ethical considerations

The study was approved by the Institutional Review Board of the Faculty of Health Sciences, University of Buea (2022/350-01/UB/SG/IRB/FHS). All patients signed the inform concern. To ensure patient confidentiality, patient information was coded. The questionnaire was checked daily to ensure the correct entry of information. Data were entered daily into a computer, whose password was known just by the investigator. The questionnaires were locked up in a safe, accessible only to the investigator. The study received administrative authorization from the directors of hospitals included in the study and ethical approval from the ethical review board of the faculty of health sciences university of Buea.

RESULTS

A total number of 410 participants with T2DM were approached during the study period. Of which, 4.7 % (n=19) of patients were excluded from the study (Figure 1). The reasons for exclusion were; refused to consent (n=10) and (n=9) had fever and urinary tract infection.

Socio-demographic and clinical characteristics of the study population.

The mean age of the participants was 59.62±11.6 years. Most of the participants 218 (55.8%) were aged ≥ 60 years old. There was a female predominance 262 (67%) and only 8.4% (33) did not have formal education (Table 1). Among the study participants, 210 (53.7%) had hypertension, 164 (41.9%) had albuminuria and 267 (64.3%) had some degree of obesity. The majority of the participants had never smoked 347(95.7%), 349 (89.3%) doesn't consume alcohol, and 280 (71.6%) had diabetes for more than 10 years (Table 2). Prevalence, pattern and stage of CKD amongst T2D Patients. Of the 391 T2DM participants, 109 had CKD giving a prevalence of 27.9 %. Albuminuria of any degree was present in 84 (77%) patients. Among the 109 participants diagnosed with CKD, 13(12%) had advanced CKD (stage IV and V) (Table 3).

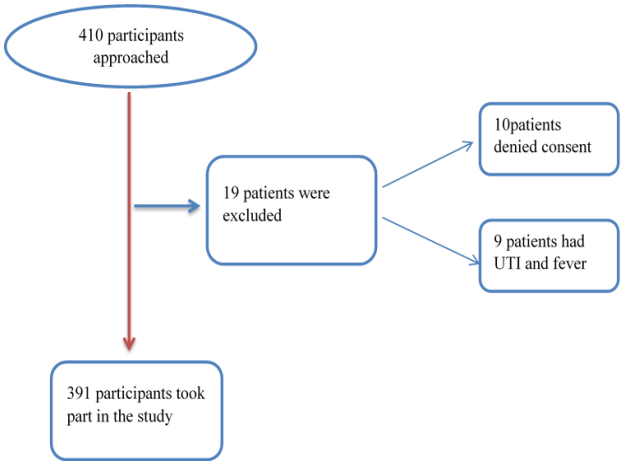

Figure 1. flow chart of the recruitment.

Table1. Socio demographic characteristics of the study population (N=391)

Variables	N	%
Age group (years		M±SD (59.62±11.66)
< 60	173	44.2
≥ 60	218	55.8
Sex		
Female	262	67.0
Male	129	33.0
Occupation		
Employed	116	29.7
Retired	146	37.3
Student	2	0.5
Unemployed	127	32.5
Marital status		
Divorced	13	3.3
Married	244	62.4
Single	32	8.2
Widowed	102	26.1
Level of education		
No education	33	8.4
Primary	149	38.1
Secondary	169	43.2
Tertiary	40	10.2

Table 2. Clinical characteristics of the study population (N=391)

Variables	Population	Percentage
BMI (Kg/m^2)		
< 25	124	31.7
[25-30[	134	34.3
≥30	133	34.0
Systolic BP		
< 140mmHg	216	55.2
≥ 140 mmHg	175	44.8
Diastolic BP		
< 90mmHg	252	64.5
≥ 90 mmHg	139	35.5
Hypertension		
No	210	53.7
Yes	181	46.3
Smoking		
No	374	95.7
Yes	17	4.3
Alcohol		
No	349	89.3
Yes	42	10.7
FBS		
< 150 md/dl	209	53.5
≥ 150 md/dl	182	46.5
Duration T2DM		
< 10 years	280	71.6
≥ 10 years	111	28.4

Table 3. The stages of CKD in patients with Type 2 Diabetes. (n=109)

Stages	eGFR	N	%
Grade 1	≥90+ Albuminuria	10	9.2
Grade 2	60-89.9 + Albuminuria	16	14.7
Grade 3a	45-59.9	45	41.2
Grade 3b	30-44.9	25	22.9
Grade 4	15-29.9	11	10.2
Grade 5	<15	2	1.8

Factors associated with CKD among Type 2 Diabetes Mellitus

After bivariate analysis (Table 4), the multivariate logistic regression analysis showed that, albuminuria (aOR: 0.09, p<0.001) was independently associated with CKD (Table 5). Factors associated with albuminuria among Type 2 Diabetes Mellitus. The bivariate analysis revealed that elevated FBS and age was significantly associated with albuminuria (Table6). In multivariate logistic regression elevated FBS (aOR: 4.24, p= 0.007) and older age (aOR: 0.31, p= 0.033) was found to increase the risk of developing albuminuria (Table 7).

Table 4. Factors associated with CKD among T2DM

Variables	CKD		COR	CI	P-Value
	No	Yes			
Age (Years)					
< 60	127	46	1		0.348
≥ 60	155	63	1.12	0.71-1.75	
Sex					
Female	190	72	1		0.446
Male	92	37	0.94	0.59-1.50	
Systolic BP (mmHg**)**					
< 140	163	53	1		**0.064**
≥ 140	119	56	1.44	0.92-2.25	
Diastolic BP(mmHg**)**					
< 90	184	68	1		0.339
≥ 90	98	41	1.13	0.71-1.79	
Smoking					
No	271	103	1		0.326
Yes	11	6	0.69	0.25-1.93	
Alcohol					
No	253	96	1		0.379
Yes	26	13	0.84	0.44-1.69	
FBS (md/dl)					
< 150	155	54	1		**0.197**
≥ 150	127	55	1.24	0.79-1.93	
Albuminuria					
Positive	80	84	1		**<0.001**
Negative	202	25	0.11	0.07-0.19	
Duration of DM (Years)					
< 10	204	76	1		0.346
≥ 10	78	33	1.13	0.69-1.8	

Table 5. Independent variables associated with CKD with T2DM patients

Variables	CKD		AOR	CI	P-Value
	No	Yes			
Albuminuria					
Positive	80	84	0.09	0.05 -0.16	<0.001
Negative	202	25			
Fasting blood sugar (md/dl**)**					
< 150	155	54	0.66	0.38-1.13	0.135
≥ 150	127	55			
Systolic BP (mmHg)					
< 140	163	53	1.41	0.85-2.35	0.775
≥ 140	119	56			

Table 6. Factors associated with Albuminuria

Variables	Albumineria		COR	CI	P-value
	Yes	No			
BMI (Kg/m^2)					
< 25	25	12	1		
[25-30[	32	8		0.18-2.74	0.218
≥30	27	5		0.64-1.79	
Systolic BP (mmHg**)**					
< 140	43	10	1		0.226
≥ 140	41	15		0.34-3.71	
Diastolic BP (mmHg**)**					
< 90	53	15	1		0.478
≥ 90	31	10	0.83	0.23-2.99	
Smoking					
No	78	25	1		0.201
Yes	6	0	>1.9	0.33-1.93	
Alcohol					
No	74	22	1		0.614
Yes	10	2	0.52	0.93-2.93	
FBS (md/dl)					
< 150	35	19	1		0.002
≥ 150	49	6	0.22	0.08-0.62	
Age group					
< 60	40	6	1		0.029
≥ 60	44	19	2.87	1.04-7.92	
Sex					
Female	53	19	1		0.170
Male	31	6	0.58	0.17-1.92	
Duration DT2 (Years)					
< 10	58	18	1		0.494
≥ 10	26	7	0.49	0.12-1.97	

Table 7. Independent factors associated with Albuminuria

Variables	Albuminuria		AOR	CI	P-value
	Yes	No			
Sex					
Female	53	19			0.342
Male	31	6	1.70	0.56-5.07	
Fasting blood sugar (md/dl)					
< 150	35	19			0.007
≥ 150	49	6	4.24	1.49-12.08	
Age group (years)					
< 60	40	6			0.033
≥ 60	44	19	0.31	0.10-0.91	

DISCUSSION

This hospital-based cross-sectional study was carried out to determine the prevalence of CKD, its associated factors and describe the pattern of CKD in patients with T2DM in Cameroon.

Prevalence of CKD and its stages in patients with T2DM

In this study, the prevalence of CKD amongst T2DM was 27.9%. This was similar to that found by Van de Meer *et al.* in Netherland (18) and Poncelas *et al.* in Spain (15) who both reported a prevalence of 27%. Our prevalence was high compare to the prevalence of CKD in the general population which ranges from 11%-14.2%. National Kidney Foundation estimates that 20- 40% of T2DM patients will eventually suffer from CKD. Higher prevalence was found in studies done in, Cameroon 70.8% (17) Tanzania 83.7% (8). These discrepancies across different settings may be due to the fact there was a difference in the definition of CKD adopted, also some studies included both type 1 and type 2diabetes which was not our case. Furthermore, the study design may contribute to the differences we conducted a cross-sectional study and we may not have captured all patients with CKD. Another reason may be that we recruited patients only in the diabetic unit and not in the nephrology unit where they are referred after the diagnosis of CKD. Therefore all of this could underestimate the prevalence. Based on KDIGO classification. 76% of CKD patients were between stages 3-5. CKD is a silent disease and reveals itself only at the later stages, diminished eGFR is associated with increased global mortality (15). However, this was higher than some studies done among diabetic Cameroonians, Tanzanians, Ethiopians who reported a prevalence between 21-25% (8, 16, 19). The difference with janmohamed's study in Tanzania (2) is that they used the Cockcroft-gault equation to estimate the GFR. Authors have reported the character of this equation to underestimate normal and high GFR compared to MDRD (20). Moreover, the difference in the prevalence with the Cameroonian studies could be explained by the fact that they had a smaller sample size compared to ours which could underestimate the prevalence. In our study we found out that 77% of CKD patients had albuminuria. This was similar to a study done by Janmohammed *et al* in Tanzania who reported a prevalence of 80% (2), albuminuria is a factor of initiation and progression of CKD. An increase in urinary albumin independently increases the cardiovascular mortality of patients with T2DM (21). However, Poncelas *et al* in Spain, Mbarawa *et al* in Cameroon reported a prevalence of 16% and 33% respectively (15, 17). The disparity in the prevalence of albuminuria among studies could be due to different techniques of sample collection, and methods used to determine albuminuria. These studies used the urinary albumin creatinine ratio (UARC) as the method; this was not our case where urine dipstick was used. This may have overestimated the prevalence. Despite this, the results show an important presence of albuminuria in the diabetic population in our country. Hence monitoring of albuminuria is crucial in the diabetic population to permit early diagnosis and reduce the progression of the disease. After multivariate analysis elevated FBS (aOR= P=0.03) was found to be associated with albuminuria. This was the same in a study done by penno et al (22). According to Alicic *et al* poor glycemic control is an independent predictor of progression to the development of albuminuria and/or ESRD, hence intensive blood glucose control early in the course of disease exhibits a lasting favourable effect on the risk of developing the disease (23). Older age was significantly associated with albuminuria. This was consistent with similar studies (5,8,15,24) who reported that older age was an independent factor for albuminuria; as age increases there is progressive loss of nephrons. Longer duration of diabetes even though not statistically significant in our study has been reported in others to be an associated factor of albuminuria (21). The disparity between our studies may be due to the fact that most of their patients had longer duration of diabetes which was not the same in our case. According to our study presence of albuminuria ($p<0.01$) was a risk factor for CKD. This was similar to the study done in Ethiopia, Palestine, and Spain (1, 5, 15). Pima et al reported that albuminuria is an early sign of kidney damage (11) and accelerates kidney disease progression to ESRD promoting the loss of kidney function and scarring. So, early screening should be performed to delay the progression of renal disease (16). A longer duration of diabetes was not found to be associated with CKD. This was not the case with several studies (7, 8, 14, 25) which reported that there was a greater chance of developing CKD after a longer duration of diabetes (5). So early diagnosis reduces the rate of progression of renal diseases (26) . This difference may be explained by the fact that more than half of our patients had lesser duration of diabetes than in other studies.

CONCLUSION

We found out that the prevalence of CKD in T2DM patients was high at 27.9%. Three out of four patients had albuminuria which was a risk factor for CKD. This result highlights the need of regular screening for kidney disease among diabetic patients to prevent progression to CKD.

Limitations

We used dipstick to measure urine albumin, we were unable to calculate the UACR to determine albuminuria. Only albuminuria and creatinine were used as markers of kidney function.

Funding

None

Authors' contributions

HMP, TDG, and MMDO were entirely responsible for the conception and design of the study. HMP, TDG, BJY,RGM,TS, FK, HMP designed data collection tools,

collected and monitored data collection for the whole trial, cleaned, analysed, and interpreted the data, and drafted the manuscript. HMP, TDG, BJY, RGM and MMDO revised the paper and had the final manuscript. All authors read and approved the final manuscript

Competing interests

The authors declare that they have no competing interests.

REFERENCES

1. Nazzal Z, Hamdan Z, Masri D, Abu-Kaf O, Hamad M. Prevalence and risk factors of chronic kidney disease among Palestinian type 2 diabetic patients: a cross-sectional study. *BMC Nephrol*. 2020; 21(1):484.
2. Janmohamed MN, Kalluvya SE, Mueller A, Kabangila R, Smart LR, Downs JA, Peck RN. Prevalence of chronic kidney disease in diabetic adult out-patients in Tanzania. *BMC Nephrol*. 2013; 14(1):183.
3. Feteh VF, Choukem SP, Kengne AP, Nebongo DN, Ngowe-Ngowe M. Anemia in type 2 diabetic patients and correlation with kidney function in a tertiary care sub-Saharan African hospital: a cross-sectional study. *BMC Nephrol*. 2016; 17(1):29.
4. Halle MP, Takongue C, Kengne AP, Kaze FF, Ngu KB. Epidemiological profile of patients with end stage renal disease in a referral hospital in Cameroon. *BMC Nephrol*. 2015; 16(1):59.
5. Debele GR, Hajure M, Wolde HF, Yenit MK. Incidence and Predictors of Chronic Kidney Disease among Diabetes Mellitus Patients: A Retrospective Follow-Up Study at a Tertiary Health-Care Setting of Ethiopia. *DMSO*. 2021; 14:4381–90.
6. Hamer RA, El Nahas AM. The burden of chronic kidney disease. *BMJ*. 2006; 332(7541):563–4.
7. Murton M, Goff-Leggett D, Bobrowska A, Garcia Sanchez JJ, James G, Wittbrodt E, Nolan S, Sörstadius E, Pecoits-Filho R, Tuttle K. Burden of Chronic Kidney Disease by KDIGO Categories of Glomerular Filtration Rate and Albuminuria: A Systematic Review. *Adv Ther*. 2021; 38(1):180–200.
8. Geletu AH, Teferra AS, Sisay MM, Teshome DF. Incidence and predictors of chronic kidney diseases among type 2 diabetes mellitus patients at St. Paul's Hospital, Addis Ababa, Ethiopia. *BMC Res Note*s. 2018; 11(1):532.
9. Aseneh JB, Kemah BLA, Mabouna S, Njang ME, Ekane DSM, Agbor VN. Chronic kidney disease in Cameroon: a scoping review. BMC Nephrol. 2020; 21(1):409.
10. Deng Y, Li N, Wu Y, Wang M, Yang S, Zheng Y, Deng X, Xiang D, Zhu Y, Xu P, Zhai Z, Zhang D, Dai Z, Gao J. Global, Regional, and National Burden of Diabetes-Related Chronic Kidney Disease From 1990 to 2019. *Frontiers in Endocrinology*. 2021;12:809.
11. Rotchford AP, Rotchford KM. Diabetes in rural South Africa--an assessment of care and complications. *S Afr Med J*. 2002; 92(7):536–41.
12. Seck SM, Doupa D, Ahou S, Gueye S, Engerran M, Gueye L. Prevalence and Associated Factors of Diabetic Kidney Disease in Senegalese Patients: A Cross-Sectional Study in Saint-Louis. *Open Journal of Nephrology*. 2020 22;10(1):23–33.
13. Noubiap JJN, Naidoo J, Kengne AP. Diabetic nephropathy in Africa: A systematic review. 6(5):16.
14. Diabetes, Chronic Kidney Disease and Special Populations. National Kidney Foundation. 2015.
15. Rodriguez-Poncelas A, Garre-Olmo J, Franch-Nadal J, Diez-Espino J, Mundet-Tuduri X. Prevalence of chronic kidney disease in patients with type 2 diabetes in Spain: PERCEDIME2 study. 2013; 8.
16. Mbanya JC, Aschner P, Gagliardino JJ, İlkova H, Lavalle F, Ramachandran A, Chantelot JM, Chan JCN. Screening, prevalence, treatment and control of kidney disease in patients with type 1 and type 2 diabetes in low-to-middle-income countries (2005–2017): the International Diabetes Management Practices Study (IDMPS). *Diabetologia*.2021; 64(6):1246–55.
17. Mbarawa Marat KI, Marcelin G, Marcel T. Prevalence of Chronic Kidney Disease and dyslipidaemia in diabetic patients in Buea, South-West of Cameroon. JMPR. 2019; 3.3
18. van der Meer V, Wielders HPM, Grootendorst DC, de Kanter JS, Sijpkens YW, Assendelft WJ, Gussekloo J, Dekker FW, Groeneveld Y. Chronic kidney disease in patients with diabetes mellitus type 2 or hypertension in general practice. *Br J Gen Pract*. 2010 Dec 1; 60(581):884–90.
19. Rajput R, Kumar KMP, Seshadri K, Agarwal P, Talwalkar P, Kotak B, Raza A, Vasnawala H, Kumar A. Prevalence of Chronic Kidney Disease (CKD) in Type 2 Diabetes Mellitus Patients: START-India Study. *J Diabetes Metab*. 2017; 08(02).
20. Ibrahim MMK, Acha AE, Shey ND, Jelil NA, Clement ANJ. Prevalence and Biomarkers of Diabetic Kidney Disease in Diabetic Patients on Treatment in Buea and Ngaoundere, Cameroon. *American Journal of Bioscience and Bioengineering*. 2020; 8(5):84.
21. Al-Salman RA, Al-Basri HA, Al-Sayyad AS, Hearnshaw HM. Prevalence and risk factors of albuminuria in Type 2 diabetes in Bahrain. *J Endocrinol Invest*. 2009; 32(9):746–51.
22. Penno G, Solini A, Bonora E, Fondelli C, Orsi E, Zerbini G, Trevisan R, Vedovato M, Gruden G, Cavalot F, Cignarelli M, Laviola L, Morano S, Nicolucci A, Pugliese G. Clinical significance of nonalbuminuric renal impairment in type 2 diabetes. *Journal of Hypertension*. 2011; 29(9):1802–9.
23. Alicic RZ, Rooney MT, Tuttle KR. Diabetic Kidney Disease. *Clin J Am Soc Nephrol*. 2017; 12(12):2032–45.
24. van der Meer V, Wielders HPM, Grootendorst DC, de Kanter JS, Sijpkens YW, Assendelft WJ, Gussekloo J, Dekker FW, Groeneveld Y. Chronic kidney disease in patients with diabetes mellitus type 2 or hypertension in general practice. *Br J Gen Pract*. 2010 Dec 1; 60(581):884–90.
25. Charles F, Alexandra K, Konstantinos I, Pavlos D, Manolis K, Kiriakos D. Microvascular Complications of Type 2 Diabetes Mellitus. *Current Vascular Pharmacology*. 2020; 18(2):117–24.
26. McFarlane P, Gilbert RE, MacCallum L, Senior P. Chronic Kidney Disease in Diabetes. *Canadian Journal of Diabetes*. 2013; 37:S129–36.