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CHRONIC KIDNEY DISEASE IN AFRICA: A SYSTEMATIC REVIEW

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ABSTRACT

While increasing attention is being paid to the rising prevalence of non-communicable diseases in
Africa, there remains little focus on the risk posed by chronic kidney disease (CKD). This
systematic review assesses the CKD burden among the general population and high-risk groups on
the entire African continent.

We searched the MEDLINE and PUBMED databases for articles published between January 1st, 1995 and September 25th, 2014 by sensitive search strategies focusing on CKD surveys at the community level and in high risk groups. In total, 6163 references were evaluated, of which 6050 articles were excluded because they did not meet the inclusion criteria. Thus, 113 studies were included in the final analysis.

In the community-level studies, based on available medium and high quality studies, the pooled prevalence of CKD in Africa was 9.4% (95% CI: 9.1-9.7%). Central region had the highest prevalence (16.4%), followed by West/Central-West (16.1%), Southern (12.1%), South-East (11.0%), North-East (7.7%), and North (4%) Africa. The prevalence in sub-Saharan Africa (based on medium and high quality studies) was 15.3%, i.e. Close to that in a previous meta-analysis by Stanifer et al. (13.2%). The pooled prevalence of CKD in the high risk groups was 4.4% (95% CI: 4.1-4.5%) in HIV (based on available medium and high quality studies), 37.7% (95%CI: 35.9-39.6%) in diabetes [based on all available studies which are of low quality except one of medium quality] and 35.0% (95 % CI: 33.5%-36.6%) in patients with hypertension (based on all available studies which are of low quality except two of medium quality)

In Africa, the burden of CKD attributable to high risk conditions such as hypertension and diabetes is of the same order or greater than that seen in economically developed Western countries.

Strengths and limitations of the study

- There is increasing attention on chronic non-communicable diseases in Africa but information on chronic kidney disease (CKD) is sparse and mainly limited to sub-Saharan Africa where the average prevalence was estimated to be of the same magnitude or even higher than in most Western countries.
- In this systematic review we assessed the CKD burden among the general population and high-risk groups on the entire African continent.
- The quality of the included articles was assessed based on standard criteria dealing with clinical trials, diagnostic studies, and observational studies. The articles were assessed based on the subject sampling and precision, sampling technique, response rate, and exclusion rate.
- No meta -analysis was conducted in this review due to the huge discrepancy in the definition
 used to identify CKD, the methods of creatinine measurement, urine protein assessment, and
 in the quality of the reporting.

INTRODUCTION

Chronic kidney disease (CKD) is an emerging global public health problem[1]. The disease is a component of a new epidemic of chronic conditions that replaced malnutrition and infection as leading causes of mortality during the twentieth century[2]. Age-standardized death rates due to CKD have increased during the last 23 years. CKD has shifted from the 36th cause of death in 1990 to the 19th cause in 2013[3]. The worldwide increase in CKD and kidney failure-necessitating renal replacement therapy (RRT) -and the high rate of cardiovascular mortality and morbidity attributable to CKD are poised to reach epidemic proportions over the next decade. CKD complications represent a considerable burden on global health care resources and only a small number of countries have sufficiently robust economies to meet the challenge posed by this disease. Socioeconomic differences in health exist and individuals of lower socioeconomic status (SES) have a higher risk for mortality and morbidity compared with those of higher SES[4]. A change in the global approach to CKD from the treatment of ESRD to intensive primary and secondary prevention is therefore considered an absolute public health priority[5]. Africa is the second largest continent in the world, with a population of over 1 billion; 961.5 million people live in sub-Saharan Africa and 195 million in Northern Africa[6]. Africa now faces the dual challenge of infectious illnesses and chronic diseases. Africa's chronic disease burden is secondary to various factors, including increased life expectancy, changing lifestyle practices, poverty, urbanization and globalization[7]. The burden of CKD on the entire continent remains underestimated due to a lack of epidemiological information on the problem of kidney disease in different African countries. There exists only a single systematic review conducted in sub-Saharan Africa which concluded that CKD is a prevalent and potentially escalating disease across sub-Saharan Africa, with both communicable and non-communicable risk factors[8]. Strategies aimed at managing CKD epidemics in Africa critically depend on a reliable assessment of the burden of the problem and the establishment of affordable early detection programs. Previous studies reported the

- prevalence of CKD among the general population or the specific prevalence of this condition in
- 2 diseases that are recognized as drivers of renal damage (e.g., diabetes mellitus). These estimates
- 3 have varied across studies due to differences in the methods of Glomerular Filtration Rate (GFR)
- 4 measurement, background risk (general population vs. high risk groups), or demographic
- 5 characteristics (e.g., age, gender)[9].
- With this background in mind, this review aimed to increase the systematic information on the
- burden of CKD in the general population and high risk groups of the entire African continent and
- 8 provide an estimate of the prevalence of CKD in different regions of Africa.

9 MATERIALS AND METHODS

Data source and search strategy

- We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)
- Guidelines [10]. A systematic literature search was performed in the PubMed and OVID-MEDLINE
- databases by two authors (DB and SA) to identify articles reporting epidemiology data on CKD in
- the adult population in any geographic area of the African continent. This employed focused, highly
- sensitive search strategies (S1 Table). The search covered the time frame from January 1st, 1995 to
- September 25th, 2014. Papers without language and study design restrictions were located and
- screened. References from relevant studies were screened for supplementary articles.

Study selection and data extraction

- 19 Titles and abstracts were screened independently by two authors (SA and GD), who discarded
- studies that were not relevant to the topic. Case reports, reviews, editorials, letters, and studies
- 21 focusing on African-Americans not living on the African continent, conducted entirely among
- children, or dealing with acute kidney injury or kidney transplantation were excluded. Two authors
- 23 (SA, ED) independently assessed the retrieved abstracts and the full texts of these studies to
- determine eligibility according to the inclusion criteria. Disagreements were resolved through
- discussion and consensus, or through consultation with a third reviewer (DB), who solved these

differences based on study judgments. Furthermore, screening of reference lists of all of the retrieved studies was conducted to check for relevant articles, and a supplementary scan of the reference lists of the systematic reviews was performed to identify any additional studies. Data were extracted from full-text articles and registered using a specifically designed form. These data included study design, geographical area, sample size, the definition of CKD used, prevalence of CKD, age, gender, GFR measurement, type of creatinine assay, proteinuria, the method of outcome assessment and associated comorbidities such as diabetes mellitus and hypertension. Data extraction was performed by one reviewer (SA) and independently verified by another reviewer (DB).

Data extraction and analysis

Studies were categorized according to the reference population as follows: 1) studies dealing with the general population and 2) studies focusing on particular diseases such as diabetes, hypertension, lupus and HIV or settings, e.g., hospital-based surveys and occupational studies.

Information on the assessment of kidney function was collected, including: the equation adopted for GFR estimation ((Cockroft-Gault(CG), Modification of Diet in Renal Disease (MDRD), Chronic Kidney Disease-Epidemiology Collaboration (CKD-EPI)), the type of creatinine assay (Jaffe, standardized or unknown), and the type of proteinuria or albuminuria assay used (semi-quantitative assessment by urinary strips or quantitative in urine samples or 24 h collection). When the study included two or three GFR equations, we defined the CKD prevalence based on the CKD-EPI equation whenever this information was provided. Otherwise, we considered the MDRD equation and lastly the CG equation. In the case of ethnicity correction[11]; we included the equation which corrected for ethnicity. Information on the definition of CKD used in each study was also included ((either the internationally accepted definition as Kidney Disease Improving Global Outcomes (KDIGO), or other ways of defining CKD)).

Quality assessment

Two independent authors (SA and DB) appraised each article and assessed its quality based

- on standard criteria described into details in previous methodology reviews dealing with clinical
- 2 trials[12], diagnostic studies[13], and observational studies[14]. The articles were assessed based
- on the subject sampling and precision, sampling technique, response rate, and exclusion rate

Statistical analyses

The principal demographic and clinical data for each study were summarized as the mean and standard deviation or as absolute number and percentage, as appropriate. The age range in each study was also recorded. The pooled prevalence rate of CKD was expressed as a point estimate and 95% CI. No meta-analysis was conducted in this study. Data were appropriately presented for different populations (general population and CKD patients). The patients' data were stratified by the type of underlying condition, i.e., hypertension, diabetes mellitus, HIV, or systemic lupus erythematosus. All calculations were conducted using SPSS for Windows, version 21, Chicago, Illinois, USA.

RESULTS

Search results

The flow diagram of the selection process is depicted in (Fig. 1). In total, 6145 potentially relevant references were initially retrieved. Eighteen additional citations were found through a personal search. By screening titles and abstracts, a total 5890 citations were excluded because of search overlap, dealing with the wrong population (African American, AKI, cancer or post-transplant patients), or not providing actual data on CKD. Review articles, case reports, editorials, or letters were also excluded. Amongst the 273 studies selected for full text examination, 160 were excluded because they dealt with a population different from that specifically targeted in this systematic review, such as paediatric populations (81 studies), transplant patients (n=30), or others (n=46) (e.g., Africans living in non-African countries), or because only narrative data were provided (n=12). A total 113 articles were therefore reviewed in detail and included in the analysis. The main characteristics of these studies are summarized in Table 1.

Study characteristics

Amongst the 113 studies reviewed, 17 were general population studies (Table 2). Ninety-six studies focused on selected groups, of which 27 included HIV patients (Table 3), 14 studied diabetic patients (Table 4), seven included hypertensive subjects (Table 5) and eight were conducted in other populations (Table 6), including one study in lupus patients[15], two in specific occupational settings (silica exposure[16] and exposure to the nephrotoxic hair-dye, paraphenylenediamine[17]) and five studies in family practice[18-20] or hospital-based[21] surveys. Forty studies conducted among CKD patients (S2 Table)[22-61].

The studies that were included covered all regions of Africa. The highest number of the studies came from the Western macro-area (n=38), followed by the Eastern macro-areas (n=19). Eighteen studies were retrieved from the Northern Africa, seventeen from the Southern Africa, and ten studies from the Central macro-area. The lowest number of studies was from the Central Western macro-area (n=8). Three studies were conducted in both the Eastern and Southern regions.

Assessment of kidney function impairment

Urinary markers for kidney disease were assessed in fifty-four (74%) among seventy-three studies conducted in the general population, high risk groups, occupational or hospital-based studies. Proteinuria was assessed by a semi-quantitative method (urinary strips) in twenty studies[18,20, 62-79]. Sixteen studies used dipstick with confirmation by quantitative methods, nine of which used dipsticks to identify proteinuria/albuminuria with confirmation by 24-hour proteinuria[19,80-87] whereas seven studies used dipstick with confirmation by the protein-to-creatinine ratio or albumin-to-creatinine ratio[88-94]. Quantitative methods for the assessment of proteinuria/albuminuria (24-hour proteinuria or albuminuria, PCR, immunoassay, or ACR) were applied in seventeen studies[15, 21, 95-109]. In one study, the method of proteinuria assessment was not mentioned[110].

Serum creatinine was measured in sixty studies (82%). The Jaffe assay was used in eighteen

studies[65, 68, 70, 72, 73, 76, 80, 85, 88, 94, 104, 106, 111-116] whereas the IDMS-calibrated method was used in six studies [11, 20, 96, 110, 117, 118]. In five studies, both the Jaffe assay and the calibrated serum creatinine were used [19, 81, 82, 89, 119]. In the remaining thirty-one studies provided no information on the method of creatinine measurement 15, 18, 21, 67, 69, 71, 74, 75, 77-79, 83, 84, 87, 92, 95, 97-102, 105, 107, 120-126]. With respect to the formula used for estimating GFR, the MDRD equation was used in nineteen studies [18-20, 68, 80, 88, 89, 94-96, 101, 102, 106, 110, 115, 117, 118, 120, 125] and the CG equation was used in thirteen[15, 65, 71, 76-78, 83, 85, 98, 104, 112, 114, 123]. The other thirteen studies used both the CG and the MDRD equations [67, 69, 70, 73-75, 81, 82, 84, 113, 116, 122, 124], whereas six studies estimated GFR by the CG, MDRD, and the CKD-EPI methods[11, 72, 92, 111, 119, 121].

Definition of CKD

Thirteen studies defined the presence of CKD as an eGFR below 60 ml/min/1.73 m²[11, 70, 94, 96, 98, 115, 117, 118, 120, 122-125], with chronicity confirmed by repeated testing in four other studies[111-114]. Moreover, fifteen studies reported CKD prevalence based on eGFR below 60 ml/min/1.73 m² and/or the presence of proteinuria or albuminuria[18, 20, 65, 67, 72-74, 76, 82, 83, 88, 89, 92, 101, 110]. Proteinuria/albuminuria was used alone to identify CKD in eleven studies[62-64, 66, 77, 90, 91, 93, 103, 108, 109]. KDIGO staging[127] of CKD was used in eleven studies[19, 68, 69, 75, 80, 81, 95, 102, 104, 106, 119]. The serum creatinine level (either doubling, or an increase above a certain threshold) was considered to be a marker of the presence of CKD in four studies[79, 87, 100, 126]. In fifteen studies, the definition of CKD was either not mentioned or was defined in various ways, including personal history, Creatinine Clearance (CrCl) ≤50 ml/min, clinical manifestations, the presence of albuminuria, elevated serum creatinine, and the average of two measurements of eGFR < 90 ml/min/1.73 m²[15, 21, 71, 78, 84-86, 97, 99, 105, 107, 116, 121, 128, 129].

Paper quality

- 2 Paper quality was high in eight studies [19, 64, 80, 81, 88, 89, 95, 119]. Twenty-one studies were
- of medium quality[11, 20, 62, 63, 66-68, 71, 72, 93, 94, 96, 108, 110, 112-114, 118, 120, 121, 124].
- 4 The rest of the studies were of low quality.

Prevalence of CKD

- Based on the prevalence of eGFR <60 ml/min/1.73m² and/or the presence
- albuminuria/proteinuria (the current definition of CKD by KDIGO)[127] reported in the 14
- 8 medium-high quality studies in **Table 2** the pooled prevalence of CKD in the general population
- 9 in Africa was 9.4% (95% CI: 9.1-9.7%). The highest prevalence was reported in the Central
- region (16.4%), followed by West/Central-West (16.1%), Southern (12.1%), South-East (11.0%),
- North-East (7.7%), and North (4%) Africa (Fig. 2). The pooled prevalence in Sub-Saharan Africa
- was 15.3% (95% CI: 14.6- 16.00 %).
- Among HIV patients (**Table 3**), the pooled prevalence of CKD (estimated as above on the
- basis of the KDIGO definition in the nine medium quality studies in the same table) was 4.4% (95%)
- 15 CI: 4.1-4.5%). Based on the treatment status, the prevalence of renal dysfunction was 4.7% (95 %
- 16 CI: 4.5- 4.9%) among HIV patients not receiving treatment while the prevalence was 6.0% (95 %
- 17 CI: 5.5-6.5%) among HIV patients on anti-retroviral therapy .The Central macro-area recorded the
- highest prevalence of CKD among HIV patients (39%), followed by the West/Central-West (38%),
- 19 South-East (5.0%), and South (3.0%) macro-areas.
- Among diabetic patients (**Table 4**, 14 all studies are of low quality except for one with
- 21 medium quality), the pooled prevalence of CKD by the KDIGO definition was 37.7% (95%CI:
- 22 35.9-39.6%). The highest prevalence was in the South-East (55.1%), followed by the South
- 23 (47.5%), West/Central-West (34.1%), Central (21.2%), and North (18.6%) Africa.
- The pooled prevalence of CKD among hypertensive patients (**TABLE 5**, 7 studies; all of
- low quality except for two with medium quality) by KDIGO criteria was 35.0% (95 % CI: 33.5%-

1 36.6%). The highest prevalence was reported in the West/Central-West (39.4%) followed by South (25.4%) Africa. No data were found for other African macro-areas.

Among other patient populations (studies reported in Table 6), almost three quarters of the lupus patients had CKD (prevalence=72.0%) based on low quality study[15]. Hospital-based surveys revealed that (the calculation was based on **the total prevalence** reported from all studies including three of high-medium quality and 2 of low quality in the same table)more than one third of patients attending either primary care centres or tertiary hospitals had CKD (pooled prevalence= 35.5%, 95% CI: 33.7-37.2%). The study (low quality) conducted among hairdressers exposed to paraphenylenediamine[87] reported that 26.4% of these subjects had renal impairment. Of note, 100% of silica-exposed workers experienced proteinuria (reported from low quality study)[109].

The prevalence of CKD was variable based on definition used to diagnose CKD. Based on medium-high quality studies; CKD had a 4 % prevalence (95% CI: 3.8- 4.2%) in population studies defining this disease as an eGFR below 60 ml/min/1.73 m²[11, 94, 96, 118, 120, 124]. When CKD was diagnosed based on eGFR below 60 ml/min/1.73 m² and/or the presence of proteinuria or albuminuria[20, 67, 72, 88, 89, 110]; the prevalence was 4.1 % (95 %CI: 3.8-4.5). The prevalence of CKD was 23.0 % (95% CI: 22.0- 24.0%) in studies where the disease was defined on the basis of proteinuria[62-64, 66, 93, 108]. When KDIGO definition (i.e. by combining the eGFR and proteinuria/albuminuria) was used[19, 68, 80, 81, 95, 119], the prevalence of CKD was 16.1% (95% CI: 15.1-17.2%)

Causes of CKD

- Forty studies were conducted specifically to clarify the underlying cause of CKD [22-61]. (S2
- 22 Table) The diagnosis was biopsy-proven in sixteen studies[24, 30, 32, 34-36, 39, 45, 46, 49, 51, 54,
- 23 58-61]. Diabetic nephropathy was the leading cause of CKD (19.1%), followed by hypertensive
- nephrosclerosis (13.2%), chronic glomerulonephritis (12.9%), tubulo-interstital/obstructive (3.4%),
- lupus nephritis (2.1%), and polycystic kidney disease (2%). In nine studies, the diagnosis remained
- 26 undetermined (2.5%). (Fig. 3)

DISCUSSION

This systematic review focuses on the burden of CKD on the entire African continent. We assessed 113 papers published between January 1st, 1995 until September 25th, 2014, reporting the epidemiology of CKD in the general population and in specific chronic conditions in Africa. The differences in the methods adopted to define the prevalence of CKD (creatinine measured by various techniques, estimated GFR, dipstick and albuminuria/proteinuria measurements, either timed or every 24 h), in addition to differences in sample size, demographics, and clinical characteristics, is an objective and significant limitation in this systematic review for making accurate estimates of the prevalence of CKD in African countries. Furthermore, only five studies[69,111-114] assessed the KDIGO chronicity criterion, which is a fundamental element of the current definition of CKD by this organization. Thus, estimates in this review should be seen as a pragmatic attempt to evaluate the dimension of CKD as a public health issue on the African continent. CKD is now considered to be an important component of the epidemic of non-communicable diseases in economically developed and developing countries alike. In a seminal meta-analysis published in 2014 Stanifer et al.,[8] for the first time drew attention to the public health relevance of CKD in the sub-Saharan Africa, a vast area comprising 85% (947.4 million) of the whole African population[8]. In the present systematic review, the lowest prevalence of CKD (4%) was reported in the Northern Africa macro-area; including Egypt, Libya, Tunisia, Algeria, Morocco, the Western Sahara, and Mauritania, and the highest (16.4%) was observed in Central Africa, which includes Angola, Cameroon, Central African Republic, Chad, Democratic Republic of the Congo, Republic of the Congo, Equatorial Guinea, Gabon, Sao Tome and Principe. The average prevalence of in the entire African continent was 9.4%. In sub-Saharan Africa in Stanifer's meta-analysis, the prevalence of CKD was 13.2%[8], which is close to that reported in the same area in our review (15.3%). Among the general population of economically developed countries,

CKD has a 13.6% prevalence in the USA[130]. In Europe, the reported prevalence is lower and more homogenous, being 8.9% in the Netherlands, 6.8% in Italy, 5.2% in Portugal, 4.7% in Spain, and 3.3% in Norway[131]. CKD prevalence in some Asian countries was higher than the estimates in the USA and in Europe, being 17.5% in Thailand[132], 15% in India[133], 13% in Japan[134], 11.9% in Taiwan[135], and 9.9% in China[136]. Overall, the estimated prevalence of CKD at the general population level in African countries appears to be comparable and possibly even higher than that reported in other continents. This may be at least in part due to the low quality data for the prevalence of CKD in Africa related to poor sampling techniques, unreliable kidney function measurements, and the different definitions used.

In our review, the prevalence of CKD in surveys based on hospitals or primary care centres (35.5%) is close to that in Swiss primary care centres (36%)[137].

Poverty-related factors such as infectious diseases secondary to poor sanitation, inadequate supply of safe water, environmental pollutants and high concentrations of disease transmitting vectors continue to play an important role in the development of CKD in low-income countries. Although rates of diabetic nephropathy are rising, chronic glomerulonephritis and interstitial nephritis are among the principal causes of CKD in many countries[138].

In Africa, infectious diseases such as HIV, bilharziasis, malaria, hepatitis B and C represent an almost unique cluster of risk factors responsible for CKD[139]. HIV/AIDS is pandemic in Africa, with a prevalence ranging from 0.5% in Senegal[140] to 27.4% in Swaziland[141]. The global success in bringing effective antiretroviral treatment (HAART) to HIV-infected patients in Africa has determined the emergence of chronic medical illnesses such as HIV-related CKD[142]. Up to 50% of kidney diseases in HIV-infected persons result from a wide array of non-HIV-associated nephropathy (HIVAN) pathologies, ranging from glomerulonephritis to diabetic nephropathy [143]. We found that 4.2% of HIV patients complained of renal dysfunction. This figure is lower than that reported in economically developed countries such as France, USA, China, Spain, and Brazil[144-148]. Variation in the proportion of HIV patients affected by CKD depends

on the heterogeneity in the definition used to determine renal dysfunction, the proportion of the study population on HAART, diverse ethnicities, and the associated comorbidities. Furthermore, differences in HIV clades or strains in African patients[149] and genetic factor [150] may influence the replication capacities within the isolated renal reservoir and thus lead to a diversity in clinical presentations[70].

Regarding systemic autoimmune diseases such as lupus, a study conducted among lupus patients from Senegal showed that almost three quarters (71.0%) the patients with this disease had evidence of renal involvement[15]. This isolated figure is higher than that reported in other countries[151-153].

Even though there are no sufficient data to precisely reconstruct historical trends, the profile of CKD causes has changed during the last decades. Interstitial nephritis and glomerulonephritis were the main causes of CKD in North Africa[154] and CKD was principally caused by chronic glomerulonephritis and hypertension in East and Tropical Africa[155 156]. Today, the spectrum of causes of CKD in Africa is dominated by diabetes mellitus and hypertension. We found that the prevalence of diabetic and hypertensive nephropathies as a cause of CKD (19.1% and 13.2%, respectively) exceeded that caused by chronic glomerulonephritis (12.9%).

Our review has both strengths and limitations. The major strengths include a thorough systematic search of electronic databases and the inclusion of all comprehensive studies with a transparent assessment of CKD prevalence by two independent reviewers. The fact that our literature search was limited to PubMed and Medline OVID but did not include the African Index Medicus, like it was done by Stanifer in the meta-analysis of CKD in sub-Saharan Africa [8], is a limitation of our study. Because there was a huge discrepancy in the definitions used to identify CKD, the methods of creatinine measurement, urine protein assessment, and in the quality of the reporting, we decided to adopt an inclusive strategy. Our primary interest was to identify all studies conducted among different population groups in Africa providing information on CKD and to reconstruct a tentative scenario of the epidemiological dimension concerning disease in the entire

African continent. Methodological limitations notwithstanding this review compiled estimates suggesting that the CKD burden in Africa is at least as concerning as that in economically-developed countries. The lack of a consistent definition of CKD makes it difficult to compare the burden of CKD across studies in various countries. Moreover, the failure to demonstrate chronicity when defining CKD is a common limitation of studies investigating CKD prevalence in Africa. It was reported that a single test in time has an extremely poor positive predictive value for confirmation of CKD compared to repeated testing 3 months later. Failure to repeat testing may lead to a significant overestimation of CKD prevalence and underestimation of the burden of CVD in CKD[157]. The CKD-EPI formula was applied in only six studies[11, 72, 92, 111, 119, 121]. Similar limitations were found for proteinuria and albuminuria.

In conclusion, CKD in Africa appears to be at least as common as in other continents and as such, it constitutes a true public health priority. Targeted screening of high-risk groups (including those with hypertension, diabetes mellitus, HIV patients and persons with occupational exposures) should likely be instituted as the first step in kidney disease prevention whenever and wherever affordable and feasible. Education to increase awareness of CKD among healthcare workers and patients, and the promotion of healthy life styles, should be engrained in preventive programs. The treatment of hypertension and diabetes mellitus are of obvious relevance. Nurses and other health workers should be trained to manage these conditions at the local level if we are to curb the incidence of CKD and to avert the added burden of CKD complications to diabetes, hypertension, and infectious diseases, the deadly trio of risk factors underlying the CKD epidemic in Africa.

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- SA, DB, and CZ: conceptualized and designed the study. 3
- SA, GD, and ED: participated in revising the articles included in the review and retrieved the 4
- necessary information. 5
- DB and GT: supervised the data capture and analysis. 6
- 7 SA, DB, and GT: analysed and interpreted the data.
- e data
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 ead and approved ti. SA, DB, and CZ: drafted and critically revised the manuscript. 8
- All of the authors read and approved the final manuscript. 9

10 11

Table 1: Characteristics of the study population included in the analysis

Study population	Number of the studies	Study characteristics
General population	17	N=22652, age ranging from
		12 to 95 years; 48% males
Diabetic patients	14	N=2629, age ranging from
		14 to 90 years; 44% males
Hypertensive patients	7	N=3625, age ranging from
		19 to 90 years; 44% males
HIV patients	27	N= 57779, age ranging
		from 13 to 74 years; 64%
		males
Occupational group	2	N= 153, age ranging from
		22 to 59 years; one study
		only enrolled females and
		the other principally
		enrolled males
Family practice patients	5	N= 2645, age ranging from
		20-74 years, 44% males
Lupus patients	1	N= 43, age ranging from 6
		to 55 years, 7% males
CKD patients	40	N = 32440, age ranging
		from 12 to 90 years, 58%
		males

Table 2: Studies on CKD among the general population

Study ID	Year, Country, Region	Location	N	Population Characteristic	Definition of CKD	Method of outcome assessment	Type of creatinine assay	Proteinuria	CKD prevalence	Quality assessme nt
0 1 Abdelsatir S[128] 3 4	2013 Sudan North- east	All village inhabitants	389	Age (years): 41 ± 15 Male gender: 16.2% HTN: 39.6%, DM: 17% BMI category: (kg/m²) <18: 6.2%, 18-24.9: 65.8%, 25-29.9: 20.2 %, ≥30: 7.8%	Not identified, personal history	Personal history	Not mentioned	Not measured	Total prevalence (as reported): 6.40%	Low
5 6 Fatiu A[62] 9 0	2011 Nigeria West	Market population	286	Age (years): 49.5 ± 5.7 Male gender: 9.8% HTN: 37.7% BMI (kg/m²): 26.76 ± 5.28 <20 kg/m²: 7.4% 20-25 kg/m²: 33.4% > 25 kg/m²: 59%	Proteinuria ≥ +1	Midstream urine sample was tested by urinary strip	Not measured	29.70%	Total prevalence (based on proteinuria prevalence): 29.7%	Medium
1 2 Traore M[63]	1998 Mali West	All Household population of the villages	1098	Age (years): 30±12 Male gender: 52%	Proteinuria ≥ +1	Microhaematuria and proteinuria by urinary strip	Not measured	40.80%	Total prevalence (based on proteinuria prevalence): 40.80%	Medium
4	2013 South Africa South	Bellville town inhabitants	1202	Age (years): 52.9 ±14.8 Male gender: 24.7% SBP: 125±20 DBP: 76 ±13 DM: 26.4% BMI: 29.9 ±7.2	eGFR<60 ml/min	4 variables: MDRD, CG, CKD-EPI	Standardized creatinine assay	Not measured	Prevalence of stages 3-5: 7.4% (based on CKD- EPI with ethnicity correction)	Medium
9 0 1 2 Seck SM[80] 4	2014 Senegal West	Two stage cluster sampling of Urban and rural inhabitants of Saint- Louis	1037	Age (years): 48.0 ± 16.9 Male gender: 40% HTN: 39.1% DM: 12.7% BMI: 26.3 ± 6.8 kg/m ²	KDIGO	Albuminuria by urinary strips. Positive samples were confirmed by 24-hour albuminuria, eGFR by 186 MDRD	Kinetic Jaffe	5.3% albuminuria >1 g/l	Total prevalence: 6.1%	High
6 7 8 9 Pruijm M[95] 0 1	2007 Seychelle s Southeast	a random sex- stratified and age- stratified sample inhabitants of	1255	Age (years): range, 25-64 Male gender: 46%	KDIGO	Quantitative microalbuminuria by ACR, eGFR using MDRD	Not mentioned	11.4% microalbuminuria, 0.7% macroalbuminuria	Total prevalence: 15.3% Prevalence of stages 3–4 CKD 3.2%.	High

. Г			Sevchelle								
5			,								
3 4 5	Sumaili EK[81]	2009 Congo Central	Multistage sampling of residents of Kinshasa	500	Age (years): 38.6 ± 14.4 Male gender: 41% HTN: 27.6% DM: 11.7% BMI category: $25-29.9$ kg/m ² : 20.3% ≥ 30 kg/m ² : 14.9%	KDIGO	Proteinuria by urinary strip and 24-hour proteinuria, eGFR by CG and 175MDRD	Kinetic Jaffe and IDMS-calibrated	18% proteinuria by dipstick 5% (≥300 mg/day)	Total prevalence: MDRD 12.4% CG 19% Prevalence by stage (MDRD) Stage 1: 2% Sage 2: 2.4% Stage 3: 7.8% Stage 4:0 Stage 5: 0.2%	High
6 7 8 9 9 9 1 1 2 2 3 4 25	Matsha T[120]	2014 South Africa South	All residents of Cape-Town	320	Age (years): mean, 56.4 (55.1–57.6, 95% CI) Male gender: 22% SBP: 124.7 (122.8– 126.7, 95% CI)mmHg DBP: 75.5 (74.2–76.7, 95% CI) mmHg BMI: 31.9 (31.2–32.7, 95% CI) kg/m² Mean eGFR at baseline: 68.6±16.7 ml/min/1.73 m²	eGFR< 60 ml/min/ 1.73 m ²	eGFR- 186MDRD (4 variables)	Not mentioned	Not measured	Total Prevalence 28.9% Prevalence by categories eGFR>90 ml/min/1.73m ² :9.4% eGFR60- 90 ml/min/1.73m ² : 58.7% eGFR30-60 ml/min/1.73m ² : 28.1% eGFR<30 ml/min/1.73m ² : 0.9%	Medium
6 7 8	Sumaili EK[64]	2008 Congo Central	All Residents of Kinshasa	3018	Age (years): 44.3 ±15.3 Male gender: 59% HTN: 18% DM: 4%	Proteinuria ≥ +1	Proteinuria by urinary strip	Not assessed	17.1%	Total prevalence (based on proteinuria prevalence): 17.1%	High
9	Egbi OG[65]	2014 Nigeria Central- West	All Civil servants in Bayelsa	179	Age (years): 45.2 ± 10.3 Male gender: 53.1% SBP: 128.5 ± 17.5 mmHg DBP: 81.8 ± 13.2 mmHg	eGFR <60 ml/min/1.73 m ² and/or presence of proteinuria of at least +1 on dipstick urinalysis	Proteinuria by urinary strip, eGFR by CG equation standardized for body surface area (BSA)	Kinetic Jaffe	5.6%	Total prevalence: 7.8% Prevalence by stage Stage 1:3.4% Stage 2: 2.2% Stage 3: 2.2% None in stage 4 or 5	Low
5 6 7 8 9	Oluyomb o R[88]	2013 Nigeria Central- West	Multistage sampling of Households of Ilie	454	Age (years): 45.8 ± 19.0 Male gender: 43% HTN: 20.4% DM: 0.6%	eGFR <60 ml/min and/or macroalbuminuria (ACR>300 mg/g or dipstick proteinuria)	Proteinuria by urinary strip, negative cases were estimated for albumin creatinine ratio, eGFR by 186 MDRD	Kinetic Jaffe	Macroalbuminuria in 8.9%	Prevalence by stage Stage 1: 2.4% Stage 2: 4.1% Stage 3: 11.8% Stage 4: 0.5%	High
0 1 2	Eastwood J[119]	2010 Ghana West	Inhabitants of 12 villages	944	Age (years): 54.7±11.2 Male gender: 38% SBP:125.5±26.0 mmHg	KDIGO	175MDRD, CG, CKD-EPI	Kinetic Jaffe and calibrated IDMS		Total Prevalence (based on CKD-EPI and ethnicity correction) :	High

				DBP: 74.4 13.6 mmHg DM: 4% BMI: 21.1 ±4.2 kg/m ²					MDRD: 1.6% (7.2 % without ethnicity correction; CKD-EPI 1.7% (4.7% without ethnicity correction), CG 21.0%.	
Gouda Z[96]	2011 Egypt North	Community based in Al- Buhayrah governorate	417	14.29 Male gender: 43.2% HTN: 25.20% DM: 10.6%	eGFR <60 ml/min/1.73 m ²	Quantitative assessment of urinary ACR, eGFR by 175 MDRD	IDMS-calibrated	10.6% microalbuminuria	Total prevalence 18%	Medium
Ayodele OE[66]	2011 Nigeria West	People at a major trade center, the public servant secretariat and the state broadcastin g station	586	Age (years): 42.4±11.2 Male gender: 61.4 % HTN: 16.4% DM: 3.8% BMI: 25.9±5.4 kg/m ²	proteinuria ≥+1	Proteinuria by urinary strip	Not assessed	2.50%	Total prevalence (based on proteinuria): 2.50%	Medium
Abu- Aisha H[67]	2009 Sudan Northeast	Pilot survey of police housing complex	273	Age (years): 34.3±12 Male gender: 49.1% HTN: 27% DM: 5.1%	eGFR <60 ml/min/1.73 m ² and or proteinuria	Proteinuria by urinary strip, 175MDRD, CG	Not mentioned	5.30%	Total prevalence (MDRD) 7.7% [11% by CG] Prevalence by stage Stage 1 or 2: 4.7% Stage 3:2.6% Stage 4: 0 Stage: 0.4%	Medium
Gharbi M[89]	2012 Morocco North	Stratified random sampling of population in two towns	10524	Age (years): range, 25-70 Male gender: (50%), HTN: 16.7%	eGFR < 60 ml/ min/1.73 m² or macroalbuminuria or dipstick abnormalities (proteinuria ≥ ++ 1 or haematuria: ≥ ++1) or diabetes type 1 associated with microalbuminuria	175 MDRD, microalbuminuria and proteinuria by urinary strip and ACR	Kinetic Jaffe and IDMS	microalbuminuria (30-299 mg/l): 5.26%	Total prevalence 2.90%	High
CU O[117]	2014 Nigeria West	All attendees to lectures of the Ebreime Foundation for the elderly,	170	Age (years): 68.1±7.7 Male gender: 67.1%	eGFR<60ml/min/1.73 m ²	175 MDRD	IDMS calibrated		Total prevalence: 43.50%, (all cases were at stage 3)	Low
	Ayodele OE[66] Abu-Aisha H[67] Gharbi M[89]	Ayodele OE[66] Abu- Alisha H[67] Gharbi M[89] CU Egypt North 2011 Nigeria West 2029 Morocco North 2012 Morocco North	Gouda Z[96] Ayodele North Al-Buhayrah governorate People at a major trade center, the public servant secretariat and the state broadcastin g station Abu-Aisha H[67] Abu-Aisha Northeast Gharbi M[89] CU O[117] Abu-Aisha Northeast Abu-Aisha Northeast Abu-Aisha Northeast Abu-Aisha Northeast Abu-Aisha Northeast All attendees to lectures of the Ebreime Foundation for the	Gouda Z[96]	DM: 4% BMI: 21.1 ±4.2 kg/m²	DM: 4% BMI: 21.1 ±4.2 kg/m²	DM: 4% BM: 21.1 ±4 2 kg/m²	DM. 4% BMI: 21.1 ±4.2 kg/m² BMI: 23.1 ±4.2 kg/m² Age (years): 39.12 ± 14.29 Age (years): 42.4±11.2 Age (years): 43.4±12 Age	Community Comm	DM: 48 DM: 21.1 = 4.2 kg/m² DM: 20.1 DM: 48 DM: 21.1 = 4.2 kg/m² DM: 20.1 DM: 48 DM: 21.1 = 4.2 kg/m² DM: 20.1 DM: 47 CM: 47 C

HTN: hypertension, DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault, CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration



Table 3: Studies on CKD among HIV patients

	Year,	Location					Method of	Creatinine			Quality
	Country,						outcome	assay			assessment
Author	Region		N	Study group	Population characteristics	Definition of CKD	assessment		Proteinuria	CKD prevalence	
		ART clinic at						Kinetic		Total prevalence (CKD-	Low
		the regional						Jaffe		EPI): 10.2%	
		hospital			Age (years): HAART-					HAART naive: 8.7%	
					naïve (33.42 ± 0.88) , On					CG, 9.1% MDRD, 8.7%	
				HIV (276	HAART (36.91 ± 0.77)					CKD-EPI	
	2013,			HAART-naïve	Male gender: HAART-					On HAART: 14.5% CG,	
	Ghana,			patients	naive (28.3%), On	eGFR < 60 mL/min/1.73	CG, 186 MDRD,			12.6% MDRD, 12.6%	
Wkba O[111]	West		442	166 on HAART)	HAART (22.3%)	m^2 for > 3 months	CKD-EPI		Not measured	CKD-EPI	
		Three			Age (years): 36.8 (32-	9)		Kinetic			Medium
		centeres in			42.2)			Jaffe			
		Uganda and			Male gender: 35%						
		Zimbabwe			SBP: median:110	eGFR<60 ml/min/1.73					
	2011,				(IQR:100-120) mmHg	m^2 on ≥ 2 consecutive					
	Uganda,				DBP: median:70 (60-80)	visits 80 days apart or					
	Zimbabwe,			HIV-infected	mmHg	confirmed 25% decrease					
	East and			patients initiating	BMI: 21.1 (19.1–23.6)	if eGFR <60 ml/min/1.73				Total prevalence : 7.2%	
Stöhr W[112]	South		3316	ART	kg/m ²	m ² at baseline	CG		Not measured		
	2008,	Three			Age (years): 36.8 (32-	eGFR<60 ml/min 1.73 m ²		Kinetic			Medium
	Uganda,	centeres in			42.2)	on ≥2 consecutive		Jaffe		Total prevalence (
	Zimbabwe,	Uganda and		HIV-infected	Male gender: 35%	occasions >80 days apart				MDRD):3.1%,	
Stöhr W[113]	East and	Zimbabwe	3316	patients on ART	SBP: median:110	or confirmed 25%	186 MDRD, CG		Not measured	CG 7.4%	

DBP: median:70 (60-80) m/min/1.73 m² at mmflg RMI categories: <18.5 kg/m²: 18% 18.5 - <25 kg/m²: 18% 25-30 kg/m²: 4% Not Median: 12% 230 kg/m²: 4% Age (years): 40.1 (33-46.5) Male gender: 9.7% HTV: clinic DM: 2% DM: 1.7% DM: 1.7% DM: 1.7% DM: 1.7% DM: 1.7% Proteinuria ≥ 4 DM: 1.7% DM: 1.7% DM: 1.7% Proteinuria ≥ 5 Proteinuria by wrinary strip and measured Proteinuria by wrinary strip and measured DM: 1.0w Total prevalence (DM: 1.7% DM: 1.7% DM: 1.7% DM: 1.7% DM: 1.7% DM: 1.7% Proteinuria ≥ 30 mg/dl ACR Proteinuria 2+1: 41.3% 41.3 % 41.3 %		South				(IQR:100-120) mmHg	decrease if eGFR <	<60					
BMI categories:						DBP: median:70 (60-80)	ml/min/1.73 m ²	at					
Cailhol J [69] Southeast Outpatient HIV-linice HIV-infected BMI: median: 21.8 (19.3-24.2) kg/m² KDIGO BMI: measured HIV-infected HIV-infected BMI: 22.3 ± 3.8 kg/m² urinary strip or urinary strip and Proteinuria by urinary strip and Proteinuria based on proteinuria);						mmHg	baseline						
18.5 - 25 kg/m² : 66% 25 - 30 kg/m² : 12% ≥ 30 kg/m² : 4% Not Total prevalence Low						BMI categories:							
25-30 kg/m²: 12% ≥ 30 kg/m²: 4% Dutpatients HIV clinic Age (years): 40.1 (33- 46.5) Male gender: 9.7% HIN-infected BMI: median: 21.8 (19.3- 24.2) kg/m² KDIGO 186MDRD						<18.5 kg/m ² : 18%							
Dutpatients HIV clinic Dutpatient HIV clinic Dutpatient HIV clinic Dutpatient HIV clinic HIV clinic HIV clinic Dutpatient HIV clinic Dutpatient HIV clinic Congo. HIV clinic HIV clinic HIV clinic HIV clinic HIV clinic Congo. HIV clinic HIV clinic HIV clinic HIV clinic Congo. HIV clinic HIV clinic Congo. HIV clinic HIV clinic Congo. Congo. HIV clinic Congo. HIV clinic Congo. Congo. HIV clinic Congo. Congo. HIV clinic Congo. Congo						18.5- <25 kg/m ² : 66%							
Outpatients HIV clinic Age (years): 40.1 (33-46.5) Male gender: 9.7% Burundi, Burundi, Burundi, Cailhol J [69] Southeast Outpatient HIV clinic Age (years): 40.1 (33-46.5) Male gender: 9.7% DM: 2% BMI: median: 21.8 (19.3-2.8 (19.3-4.5) Mode and patients Age (years): 40.1 (33-4.5) Male gender: 9.7% DM: 2% BMI: median: 21.8 (19.3-4.5) Mode and patients Age (years): 40.1 (33-4.5) Male gender: 9.7% DM: 2% BMI: median: 21.8 (19.3-4.5) Mode and patients Age (years): 40.1 (33-4.5) Mode and patients Age (years): 40.1 (33-					14	25-<30 kg/m ² : 12%							
HIV clinic Age (years): 40.1 (33-46.5) Male gender: 9.7% HIV-infected BMI: median: 21.8 (19.3-24.2) kg/m² Age (years): 40.1 (33-46.5) Male gender: 9.7% HIV-infected BMI: median: 21.8 (19.3-24.2) kg/m² Age (years): 40.1 (33-46.5) Male gender: 9.7% Burundi, Burundi, Cailhol J [69] Southeast Outpatient HIV clinic Age (years): 40.1 (33-46.5) Male gender: 9.7% DM: 2% BMI: median: 21.8 (19.3-24.2) kg/m² KDIGO REMORD Not measured HIV clinic Male gender: 27.8% HTN: 46.8% HTN: 46.8% DM: 1.7% Proteinuria by urinary strip or urinary strip and Proteinuria by Total prevalence (BMI: 22.3 ± 3.8 kg/m² Urinary strip or urinary strip and Proteinuria by mentioned (MDRD): 45.7% GG: 46.5% Prevalence by Stages (using MDRD) Stage 1: 30.2% Stage 2: 13.5% Stage 2: 13.5% Stage 2: 13.5% Stage 3: 2% Stage 4 & 5: no patients Low HIV-infected BMI: 22.3 ± 3.8 kg/m² Urinary strip or urinary strip and Proteinuria by mentioned (MDR): 45.7% Frevalence by Stages (using MDRD) Stage 1: 30.2% Stage 4 & 5: no patients Low HIV-infected BMI: 22.3 ± 3.8 kg/m² Urinary strip or urinary strip and Proteinuria by mentioned Proteinuria by urinary strip and						$\geq 30 \text{ kg/m}^2 : 4\%$							
Age (years): 40.1 (33-46.5) Male gender: 9.7% HIV-infected BMI: median: 21.8 (19.3-24.2) kg/m² Cailhol J [69] Southeast 300 patients 24.2) kg/m² KDIGO 186MDRD 6.10% Stage 4 & 5: no patients Outpatient HIV clinic Age (years): 40.0 ± 10.7 Male gender: 27.8% HTN: 46.8%. DM: 1.7% Proteinuria by urinary strip, CG, 186MDRD 6.10% Stage 4 & 5: no patients Not measured measured measured measured hTN: 46.8%. DM: 1.7% Proteinuria≥ +1 by Proteinuria by urinary strip and Proteinuria based on proteinuria):			Outpatients							Not		Total prevalence	Low
Age (years): 40.1 (33- 46.5) Male gender: 9.7% HTN: 2.7% DM: 2% Burundi, Burundi, Cailhol J [69] Southeast Outpatient HIV clinic Outpatient HIV clinic Masimango Congo, HIV-infected BMI: 22.3 ± 3.8 kg/m2 DM: 1.7% Proteinuria by urinary strip or urinary strip and Proteinuria by urinary strip and Proteinuria by urinary strip and Proteinuria by urinary strip and Proteinuria by urinary strip and Proteinuria by urinary strip and Proteinuria by urinary strip and Proteinuria by urinary strip and Proteinuria by urinary strip and Proteinuria by urinary strip and Proteinuria by Urinary strip and Proteinuria by Urinary strip and Proteinuria by Urinary strip and Proteinuria by Urinary strip and Proteinuria by Urinary strip and Proteinuria by Urinary strip and Proteinuria by Urinary strip and Proteinuria by Urinary strip and Proteinuria by Urinary strip and Proteinuria by Urinary strip and			HIV clinic			80				mentioned		(MDRD): 45.7%	
A6.5) Male gender: 9.7% HIV: 2.7% Stage 1: 30.2% Stage 2: 13.5% Stage 2: 13.5% Stage 3: 2%						CA						GG: 46.5%	
HTN: 2.7% DM: 2% Proteinuria by Stage 1: 30.2% Stage 2: 13.5% Stage 3: 2% Stage 4 & 5: no patients Duty clinic HIV clinic HIV clinic Male gender: 27.8% HTN: 46.8% Duty clinic HIV-infected BMI: 22.3 ± 3.8 kg/m2 Urinary strip or Urinary strip and Proteinuria Duty clinic Du						Age (years): 40.1 (33-						Prevalence by Stages (
DM: 2% Burundi, Burundi, Cailhol J [69] Southeast Outpatient HIV clinic Masimango Congo, DM: 2% BMI: median: 21.8 (19.3- 24.2) kg/m² KDIGO Proteinuria by urinary strip, CG, Stage 2:13.5% Stage 3: 2% Stage 3: 2% Stage 4 & 5: no patients Age (years): 40.0 ± 10.7 Male gender: 27.8% HTN: 46.8%. DM: 1.7% Proteinuria≥ +1 by Proteinuria by measured Proteinuria by measured Total prevalence (BMI: 22.3 ± 3.8 kg/m² urinary strip or urinary strip and Proteinuria by measured						46.5) Male gender: 9.7%						using MDRD)	
Burundi, Cailhol J [69] Southeast Outpatient HIV-infected BMI: median: 21.8 (19.3- 24.2) kg/m² KDIGO 186MDRD 6.10% Stage 3: 2% Stage 3: 2% Stage 3: 2% Stage 4 & 5: no patients Low Male gender: 27.8% HTN: 46.8%. DM: 1.7% Proteinuria≥ +1 by Proteinuria by Masimango Congo, HIV-infected BMI: median: 21.8 (19.3- 24.2) kg/m² KDIGO 186MDRD Not measured Total prevalence (based on proteinuria):						HTN: 2.7%						Stage 1: 30.2%	
Cailhol J [69] Southeast 300 patients 24.2) kg/m² KDIGO 186MDRD 6.10% Stage 4 & 5: no patients Outpatient HIV clinic Age (years): 40.0 ± 10.7 Male gender: 27.8% HTN: 46.8%. DM: 1.7% Proteinuria≥ +1 by Proteinuria by Masimango Congo, HIV-infected BMI: 22.3 ± 3.8 kg/m² urinary strip or urinary strip and Proteinuria based on proteinuria):		2011,				DM: 2%			Proteinuria by			Stage 2:13.5%	
Outpatient HIV clinic Age (years): 40.0 ± 10.7 Male gender: 27.8% HTN: 46.8%. DM: 1.7% Proteinuria≥ +1 by Proteinuria by Masimango Congo, HIV-infected BMI: 22.3 ± 3.8 kg/m2 urinary strip or urinary strip and Proteinuria Proteinuria Proteinuria Proteinuria Proteinuria Proteinuria Proteinuria		Burundi,			HIV-infected	BMI: median: 21.8 (19.3-			urinary strip, CG,			Stage 3: 2%	
Male gender: 27.8% HIV clinic Male gender: 27.8% HTN: 46.8%. DM: 1.7% Proteinuria≥ +1 by Proteinuria by Masimango Congo, HIV-infected Male gender: 27.8% HTN: 46.8%. DM: 1.7% Proteinuria≥ +1 by Proteinuria by Urinary strip or urinary strip and Proteinuria based on proteinuria):	Cailhol J [69]	Southeast		300	patients	24.2) kg/m ²	KDIGO		186MDRD		6.10%	Stage 4 & 5: no patients	
HTN: 46.8%. DM: 1.7% Proteinuria≥ +1 by Proteinuria by Proteinuria by HIV-infected BMI: 22.3 ± 3.8 kg/m2 urinary strip or urinary strip and Proteinuria Proteinuria by Proteinuria by Based on proteinuria):			Outpatient			Age (years): 40.0 ± 10.7				Not			Low
2014, DM: 1.7% Proteinuria≥ +1 by Proteinuria by			HIV clinic			Male gender: 27.8%				measured			
Masimango Congo, HIV-infected BMI: 22.3 ± 3.8 kg/m2 urinary strip or urinary strip and Proteinuria based on proteinuria):						HTN: 46.8%.							
		2014,				DM: 1.7%	Proteinuria≥ +1	by	Proteinuria by			Total prevalence (
MI[90] Central 235 patients albuminuria ≥30 mg/dl ACR ≥+1: 41.3% 41.3 %	Masimango	Congo,			HIV-infected	BMI: $22.3 \pm 3.8 \text{ kg/m2}$	urinary strip	or	urinary strip and		Proteinuria	based on proteinuria):	
	MI[90]	Central		235	patients		albuminuria ≥30 mg/dl		ACR		≥+1: 41.3%	41.3 %	
2008, Three Untreated HIV- age(years): 36.8 (IQR: eGFR<60 ml/min 1.73 m ² Kinetic Total prevalence: 7% Medium		2008,	Three		Untreated HIV-	age(years): 36.8 (IQR:	eGFR<60 ml/min 1.73	m ²		Kinetic		Total prevalence: 7%	Medium
Reid A[114] Uganda, centeres in 3316 infected patients 32.0–42.2) male gender: on ≥2 consecutive CG Jaffe Not measured	Reid A[114]	Uganda,	centeres in	3316	infected patients	32.0–42.2) male gender:	on ≥2 consecut	ive	CG	Jaffe	Not measured		

	Zimbabwe,	Uganda and		undergoing ART	35%	occasions >80 days apart					
	East and	Zimbabwe		intake	SBP: median:110 (IQR:	or confirmed 25%					
	South				100-120) mmHg	decrease if eGFR <60					
					DBP: median:70 (IQR: 60-	ml/min/1.73 m ² at					
					80) mmHg	baseline					
					BMI: median, 21.1						
					(IQR:19.1–23.6) kg/m ²						
		HIV		A	Age (years): 37 (range 16–			Not			Low
	2009,	outpatient			70 years)			measured			
	South	clinic at		HIV-infected	Male gender: 38%	Proteinuria ≥ +1 by	Proteinuria by			Total prevalence (
	Africa,	Johannesburg		naïve ART	DM: 4.6% among group	urinary strip or	urinary strip and		43.7% had	based on proteinuria	
Fabian J[91]	South	Hospital	578	patients	with microalbuminuria	albuminuria ≥30 mg/dl	PCR		proteinuria	prevalence): 43.7%	
		All				9,		IDMS-			Medium
		consenting						calibrated			
		individuals									
		residing in				(0)					
		every		1202 HIV-	Age (years): HIV-ve, 28						
		household in		infected patients	(IQR: 24-35), HIV+ve: 30						
	2010,	50 Rakai		and 664 HIV -ve	(IQR: 25-36)					Total prevalence among	
	Uganda,	District		age- and sex-	Male gender: HIV-ve:	eGFR< 60ml/min/1.73				HIV+ve : 0.7%	
Lucas G[118]	East	communities	1960	matched controls	(38.7%), HIV+ve (36.4%)	m^2	MDRD		Not measured		
		Primary			Age (years): 30 (IQR: 27-			Not		Total prevalence	Medium
		health care		HIV-infected	35)			mentioned		(CKD-EPI with	
	2011, sub-	units		patients before	Male gender: 30%	CrCl <50 ml/min	CG,186 MDRD,			coefficient for black	
Jao J[121]	Saharan,		2495	ART	BMI:22.8 (IQR: 20.4–		CKD-EPI		Not measured	race): 2.5%	
	l					i .					

					$25.6) \text{ kg/m}^2$					CG: 3.4%	
										(MDRD with coefficient	
										for black race): 2.5%	
		Consecutive						Kinetic		Total prevalence :	Low
		HIV patients					proteinuria by	Jaffe and		20.5%	
		from clinic		HIV-infected	Age (years): 43 ± 9		dipstick and 24-	IDMS		3% of the patients had	
	2012	nom chine				CED < (0 ml/min/1/22		IDIVIS		_	
	2012,			(ART	Male gender: 23%	eGFR< 60 ml/min/1.73	hour proteinuria,			eGFR< 60 ml/min/1.73	
	Congo,			treated=264)	Hypertension: 13%	m ² / or proteinuria defined	eGFR by MDRD,			m ² by MDRD	
Longo A[82]	Central		300	(ART naïve =36)	$BMI:24 \pm 5 \text{ (kg/m}^2$	as 1+ or greater	CG		20.50%		
		HIV clinic				eGFR <60 ml/min/1.73	Proteinuria by	Not			Low
					Age (years): 38 (32-45)		urinary strip,	mentioned			
	2013,			HIV-infected	Male gender: 33%	m^2 ; or proteinuria $\geq +1$	ACR, PCR, eGFR				
	Ghana,			patients starting	BMI: 20.3 (IQR: 17.6-	(confirmed by uPCR >	by CG, MDRD,			Total prevalence (CKD-	
Sarfo F[92]	West		3137	ART	22.7) kg/m ²	45 mg/mmol)	CKD-EPI			EPI):13.8%	
		Electronic				3//)	Not			Low
		medical						mentioned			
		records of				•					
		patients from									
		18 sites									
	2011,	throughout			Age (years): 35.5 (29.3-		•			Total prevalence	
	Cameron,	Western		HIV patients	44.0)	eGFR<60 ml/min/1.73				(MDRD): 9.4%	
Gupta S[122]	Central	Kenya	7383	without ART	Male gender: 26.9%	m ²	CG, MDRD			CG: 20.2%	
Ekat	2013,	Ambulatory		Newly diagnosed	Age (years): 38.84 (IQR:	eGFR< 60		Kinetic		Total prevalence :8.5%	Low
MH[115]	Congo,	Treatment	562	HIV patients	33.18-46.23)	ml/min/1.73m ²	186MDRD	Jaffe	Not measured		
		l		<u> </u>						l	l

	Central	Center			Male gender: 33.9%						
					BMI: 20.31 (IQR: 17.97-						
					22.89) kg/m ²						
		Academic						Kinetic			Low
		Model for the						assay			
		Prevention									
		and			Age (years): 35.0 (range,		proteinuria by				
		Treatment of			19–60)		urinary strip, CG,				
Wools-	2007,	HIV/AIDS		HIV-infected	Male gender: 32.1%		full and		6.2%		
Kaloustian	Kenya,	(AMPATH)		patients naive to	SBP: 104.7 (range, 80-		abbreviated		(proteinuria	Total prevalence	
K[70]	East	clinic	373	ART	140) mm/Hg	CrCl<60 ml/min/1.73 m ²	MDRD		≥1+)	:11.50%	
		Consecutive			Age (years): 35.80 ± 10.01			Not			Medium
		HIV/AIDS			Male gender: 48.5%			mentioned			
		outpatient			Hypertension: 13.2%	albuminuria +1 on at					
		clinic			BMI categories:	least two occasions (4			21.9%		
	2008,				<19.0 kg/m ² : 59.2 %	weeks apart) and or	Proteinuria or		nephrotic	Total prevalence :38 %	
	Nigeria,			HIV-infected	19-25 kg/m ² : 37.5%	serum creatinine >1.5	albuminuria by		range	Among patients; 8.8%	
Emem C[71]	West		400	patients	>25 kg/m ² : 3.3%	mg/dl	urinary strip, CG		proteinuria	had CrCl <15 ml/min.	
		Community			Age (years): 34 (IQR: 30-			Kinetic		Total prevalence among	Medium
		based			39) HIV +ve/43 (IQR:34-			Jaffe		HIV +ve:9%	
					50) HIV -ve				(9% among	2.7% had eGFR< 60	
					Male gender: 0		proteinuria by		HIV +	ml/min/1.73 m ²	
	2011,			677 HIV-	Hypertension: HIV+ve:	eGFR<60 ml/min/1.73	urinary strip,		and7.2%	CKD prevalence among	
	Rwanda,			infected and 214	4.8%/ HIV-ve: 8.3%	m ² / or proteinuria +1 or	eGFR by MDRD,		among non-	HIV-ve: 7.2%	
Wyatt C[72]	East		891	HIV-uninfected	BMI (kg/m²): HIV+ve:	greater	CKD-EPI, CG		infected)	1.5% had eGFR< 60	

					20.9 (IQR: 19.0–23.3)/					ml/min/1.73 m ²	
					HIV-ve: 20.5 (IQR: 18.5-						
					23.3)						
		HIV clinic of				The presence of		Kinetic			Low
	2013,	Yaoundé		All newly		proteinuria +1 or more	Proteinuria by	Jaffe		Total prevalence :36%	
	Cameron,	general		diagnosed HIV-		and eGFR< 60 ml/min	urinary strip,			Among patients; 3% had	
FolefackKaze	Central -	hospital		infected patients	Age (years): 35±10.7	based on the average of	eGFR by CG, 175			eGFR< 60 ml/min/1,73	
F[73]	West		104	naïve to HAART	Male gender: 32%	eGFR by 2 equations	MDRD		36%	m^2	
		ART clinic in				any proteinuria (≥+1);		Not			Low
		a central			S ₀	heavy proteinuria (≥+2);		mentioned			
		hospital in			6/4/S	any proteinuria (≥+1)					
		Malawi				with renal dysfunction (e					
						GFR <60 ml/min/1.73					
						m ²) and heavy proteinuria					
						(≥+2) with renal					
						dysfunction (CrCl < 60					
						mL/minute) and				Total prevalence:	
				Consecutive	Age (years): 34.3 ± 9.3 ;	the absence of any	Proteinuria by			23.3%	
	2011,			newly referred	Male gender: 43.5%	alternative cause for renal	urinary strip,			Among patients with	
	Malawi,			HIV-infected	HTN: 11.2%	dysfunction or	eGFR by CG and			proteinuria; 5.3% had	
Struik G[74]	Southeast		526	patients on ART	DM: 0.8%	proteinuria.	MDRD		23.3%	CrCl< 60 ml/minute	
		National					Serum creatinine	Not			Low
	1998,	Central			Age(years): 22±4		measurement and	mentioned	Proteinuria		
Attolou	Benin,	hospital		HIV-infected	Male gender: 68 %	Proteinuria > 0.5 g/24 hrs	24-hour		>0.5 g/24 hrs	Total	
V[97]	West		92	patients		and SCr>14 mg/l	proteinuria		in 23.33%	prevalence:27.16%	

Low
Low
-
Low

		infections						Not			Low
		unit of the						known			
		Jos								Total prevalence among	
	2003,	University		Consecutive 79						AIDS group:51.80%	
Agaba	Nigeria,	Teaching		AIDS patients					25% (AIDS	CKD prevalence among	
EI[129]	West	Hospital	126	and 57 controls		Not known	Not known		group)	control group: 12.2%	
		Outpatient					Proteinuria by	Not			Low
		clinics					urinary strip and	mentioned		Total prevalence :	
	2011,			HIV-infected		CrCl < 60 ml/min.	24-hour			45.9%	
	Zimbabwe,			patients naïve to		Proteinuria ≥ +1 and/or	proteinuria, eGFR			Among patients; 7.50%	
Fana GT[83]	South		159	ART	CA	PCR > 20 mg/mg	by CG		45.90%	had CrCl< 60 ml/min	
		Medical			Age (years): 31(range,13-	Microalbuminuria >		Not			Low
		center			63)	urinary protein 30 and		mentioned			
					Male gender: 25%,	300 mg/24 h.					
					Proteinuria -ve:	A cut-off serum					
					117±14/70±9	creatinine level of 250	Proteinuria by				
	2006,				Microalbuminuria:	mmol/l was used to	urinary strip and				
	South				121±15/81±10	exclude those patients	24-hour			Total prevalence (
	Africa,			HIV patients not	Macroalbuminuria:	with advanced	proteinuria, CG			based on proteinuria):	
Han TM[84]	South		615	on ART	120±12/74±11	nephropathy	and MDRD		6%	6%	
	2008,	Home-Based						Kinetic			Low
	Uganda,	AIDS Care		HIV patients	Age (years): 39 (median)			Jaffe			
Peters P[116]	East		508	starting HAART	Male gender: 41%	CrCl of 25–50 ml/min	CG, 175 MDRD		Not measured	Total prevalence: 20%	
	2011,	Clinics		199 HIV +ve and	Age (years): HIV+ve (27	Proteinuria (PCR > 200	Proteinuria by	Not	HIV+ve:	Total prevalence among	Medium
Jao J [93]	Cameroon,		389	190 HIV -ve	(IQR: 24- 31)),	mg/g)	urinary strip and	measured	39.2%	HIV+ve (based on	

	Central			pregnant women	HIV-ve (27 (IQR: 22 -		PCR		HIV-ve: 20.9%	proteinuria): 39.2%	
					31))						
					Male gender: 0						
		Outpatient					Proteinuria and	Not			Low
		clinics					albuminuria by	mentioned			
	2011,	4		HIV-infected	Age (years): 36.1 ±7.9		urinary strip		36%		
Msango	Tanzania,			patients naïve to	Male gender: 35%		eGFR by CG,		proteinuria ≥	Total prevalence:	
L[75]	East		355	ART	BMI (kg/m ²): 21.3 ±3.8	KDIGO	MDRD		+1	85.6%	
		primary		Consecutive 238				Not			Low
		healthcare		pregnant women,	Age (years): pregnant, 28			mentioned			
		clinic		1014 non-	(IQR: 25–32), men, 37						
	2013,			pregnant, 609	(IQR: 32-45), women, 33						
	South			men; HIV-	(IQR: 28–39)						
	Africa,			infected patients	Male gender: 33%		Absolute Scr and			Total prevalence: 5.8%	
Myer L[123]	South		1861	eligible for ART		CrCl< 60ml/min	CG		Not measured		
	2008,	Clinic		HIV-infected,	Age (years): normal CrCl,		7	Not			Medium
	Zambia,			ART-naïve	33.7±7.9, decreased CrCl,		Absolute Scr,	mentioned		Total prevalence	
Mulenga	South			adults initiating	38.5±9.9	· ·	eGFR by CG and			(MDRD): 3.2%	
L[124]			25249	treatment	Male gender: 39.7%	CrCl< 60 ml/min	MDRD		Not measured	:	

HTN: hypertension, DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, HAART: highly active antiretroviral therapy,

ART: antiretroviral therapy, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault, CKD-EPI: Chronic Kidney Disease Epidemiology

Table 4: Studies on CKD among diabetic patients

	Year,	Location		Study			Method of	Creatinine			Quality
Study ID	Country		N	group	Population Characteristics	Definition of CKD	outcome		proteinuria	CKD prevalence	assessment
	, Region						assessment	assay			
Janmohamed MN[76]	2013, Tanzania, East	diabetes mellitus clinic of Bugando Medical Centre in Mwanza	369	Consecuti ve diabetic patients	Age (years): 54 (IQR: 45-62) Male gender: 46.6% HTN: 57.5% BMI (kg/m²): 25.6 (IQR: 22.6-29.6) Duration of DM (years): 6(3-11) 93.8% type 2 DM 6.2% type 1DM	eGFR ≤60 ml/min/1.73 m² or evidence of kidney damage (microalbuminuria or overt proteinuria).	Microalbumin uria, proteinuria by urinary strips, eGFR by CG	Kinetic Jaffe	Overt proteinuria (34.1%), microalbuminuria(45.8%)	Total prevalence:83.7%	Low
Wanjohi FW[77]	2002, Kenya, East	Outpatient diabetic clinic at Kenyatta National Hospital	100	Consecuti ve type 2 diabetic patients	Age (years): 53.7 ±9.3 Male gender: 37% HTN: 50% BMI (kg/m²): 27.8±6.0 Duration of DM (months): 10.3±7.5	Albuminuria > 20 mg/ L	Albuminuria by urinary strip, CG	Not mentioned	26% had albuminuria	Total prevalence(based on albuminuria): 26%	Low

Bouzid C[98]	2011, Tunis, North	nutrition	689	diabetic patients from computeri zed hospital	Age (years): 60±11 Male gender: 39% HTN: 84.6% (renal insufficiency), 57.2% (no renal disease) Duration of DM (years): 11±8	eGFR<60 ml/min	CG, 24-hour proteinuria	Not mentioned	10.1% macroalbumnuria, 13% microalbuminuria	Total prevalence:	Low
Zajjari Y[99]	2012, Morocco, East	Military	16	Type 2 diabetic patients	Age (years): 60 (IQR: 47-79) Male gender: 81.3% HTN: 56.3% Duration of DM (years): 6.5 (IQR: 1-39)	Not mentioned	24-hour proteinuria, serum creatinine, renal biopsy	Not mentioned	Not mentioned	Total prevalence :68.8%	Low
Choukem SP[78]	2012, Cameroon, Central - West	Two main referral centres	420	diabetic patients	Age (years): 56.7 ±9.9 Male gender: 49% HTN: 50% BMI (kg/m²): 28.5 ±5.2 Duration of DM (years): 4 (IQR: 1-9)	The presence of positive proteinuria with or without low CrCl < 90 ml/min/1.73 m ²	Proteinuria by urinary strip/eGFR by CG	Not mentioned		Total prevalence:	Low
Keeton G[100]	2004, South Africa, South	Groote Schuur Hospital Outpatients Diabetic Clinic or the Somerset Hospital	59	Consecuti ve type 2 diabetic patients	Age (years): 62 ± 9.4 Male gender: 36% BMI (kg/m ²): (31 ± 6) Duration of DM (years): 17 (Range: 14 -33)	Double Scr level	Proteinuria by ACR, and serum creatinine	Not mentioned		Total prevalence: 66.1%	Low

		Outpatie	ents									
		Basic	Health		73 type 2	Age (mean ±SE in years):						Low
		Group	of		diabetic	59.3 ±1.1						
		Sousse			patients	Male gender: 35%						
					and 42	SBP (mean ±SE mmHg):		Measurement				
	2012,				healthy	136.3 ±3.1	Microalbuminuria (defined as <	of				
BouAziz[101]	Tunisia,			115	volunteers	DBP (mean ±SE): 76.8	2.8 g/mmol for women and < 2.3	microalbuminu	Not		Total prevalence:	
	North					±1.9	for men) and eGFR≤60	ria, eGFR by	mentioned		11%	
						BMI (mean \pm SE in kg/m ²):	ml/min/1.73 m ²	MDRD				
						30.5± 0.7						
						Duration of DM (years):						
						10.6 ±1						
		Referral			Medical	Age (years): 58 ±10.4		Microalbumin				Low
		general			records of	Male gender: 35.7%		uria (>20 mg/L				
Katchunga	2010,	hospital			type 2	HTN: 59.2%		and <200	Not		Total prevalence:	
P[102]	Congo,			98	diabetic	BMI (kg/m ²): 25.2± 4.7	KDIGO	mg/L)	mentioned		66%	
	Central				patients	Duration of DM (years):		eGFR by				
						17.3 ±8.5		MDRD				
		National			Type 1	Age (years): 53.3(range,					Tetal and 1	Low
	2001 5	Universi	ity		and 2	21-90)		241	N		Total prevalence (
Djrolo F[103]	2001, Benin,	hospital	centre	152	diabetic	Male gender: 65.8%	Presence of proteinuria	24-hour	Not	28%	based on	
	West				patients	Duration of DM (years):		proteinuria	measured		proetinuria level):	
						<1 – 16 or more					28%	
Balogun	2011,	Tertiary		40	Randomly	Age (years): 59.4 ± 11.25		Proteinuria by	Jaffe	82.5%	Total prevalence:	Low
WO[85]	Nigeria,	hospital		40	selected	Male gender: 37.5%	not mentioned	urinary strip	method	macroalbuminuria	90%	

Mafundikwa A [86]	West 2007, Zimbabwe, South	Diabetic clinic	75	diabetic patients Consecuti ve Insulindependent diabetic patients	HTN: 45% No available data	No available data	and 24 hrs, eGFR by CG Proteinuria by urinary strips and 24-hour proteinuria		Overt proteinuria 21%. Microalbuminuria 12%.	Total prevalence:	Low
Lutale J [104]	2007, Tanzania, East	Outpatient diabetic clinic	204	Type 1 and 2 diabetic patients	45% type 1 DM 55% type 2DM Age (years): type 1, 21(14– 44.8), type 2, 53 (23.5–85) Male gender: 55% HTN: 42% BMI (kg/m²): 19.3 ± 3.8 (type 1), 27.8 ± 4.8 (type 2) Duration of DM (years): 3(Range: 0-25)	KDIGO	Quantitative assessment of albuminuria, CrCl by CG	Kinetic Jaffe	Type 1: microalbuminuria was 12.1% and macroalbuminuria 1.1 %. Type 2: microalbuminuria 9.8% Macroalbuminuria 7.2%	Total prevalence: 18.5% 4.6% of Type 1 patients and 22% of Type 2 had eGFR < 60 ml/min/1.73 m ²	Low
Gill G [105]	2008, Ethiopia, East	Diabetic clinic at Mekelle Hospital	105	All diabetic patients	Age (years): 41±16 Male gender: 70% HTN: 5% BMI (kg/m²): 20.6±5.4 Duration of DM (years): 7±6	Nephropathy was considered present if the urinary ACR was >25.0mg/mmol and retinopathy was present. Microalbuminuria was diagnosed if the ACR was >2.5 and <25.0mg/mmol in men and >3.5 and	ACR, Scr	Not mentioned	51% microalbuminuria	Total prevalence : 53%,	Low

		<25.0mg/mmol in women.	
Makulo R [94] Community based Congo, Central	DM, 148 impaired fasting Male ge SBP (m) DBP (m)	Urinary albumin by urinary strip and ACR, and and	the had

HTN: hypertension, DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault, CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration

Table 5: Studies on CKD among hypertensive patients

1		0112		nyper tensive	Pwww						
Study ID	Year Country Region	Location	N	Study group	Population characteristics	Definition of CKD	Method of outcome assessment	Creatinine	Proteinuria	CKD prevalence	Quality assessment
Osafo C	2011 Ghana Central- West	four polyclinics	712	Hypertensive patients	Age (years): 59 (range,19–90) Male gender: 21.3% DM: 14.7% SBP (mmHg): 150 (range,100–280) DBP (mmHg): 90 (range, 60–160) BMI (kg/m²): 29.7 (range,12.2–67.4) BMI categories (kg/m²): <25: 22.3% 25-29.9: 26% >30: 45.7%	KDIGO	Proteinuria by PCR (men>0.3 women>0.2 mg/mg) eGFR by MDRD	Kinetic Jaffe	28.90%	Total prevalence: 46.90% Prevalence by stage: Stage 1-2: 19.1% Stage 3-5: 27.8%	Low
Ajayi S	2014 Nigeria West	Tertiary health centre	628	diabetic patients	Age (years): 49.71±13.22 Male gender : 49% DM: 8.6% SBP (mmHg): 135.9 ± 27.4 DBP (mmHg): 87.0 ± 16.3 BMI (kg/m²): 27.8 ± 8.7	eGFR <60 mL/min/1.73 m ²	eGFR by MDRD	Not mentioned	Not measured	Total prevalence: 38.5%	Low
Lengani A[107]	2000 Burkina Faso West	department of Cardiology or Internal	342	Hypertensive patients	Age (years): 50.6 ±13.8 Male gender: 58%	Serum creatinine \geq 650 µmol/l and or blood urea >=35 mml/l plus long	scr, 24-hour proteinuria	Not mentioned		prevalence: 50.8%	Low

		medicine				history with clinical					
						manifestations					
Nwankwo E[126]	2006 Nigeria West	University of Maiduguri Teaching Hospital	185	All hospitalized hypertensive patients	Age (years): 44.6 ± 14.9 Male gender: 49%	Scr >135 μmol/l	Measurement of Scr	Not mentioned	Not measured	Total prevalence: 45.50%	Low
Rayner B[108]	2006 South Africa South	100 General practice centres	1091	Random hypertensive patients	Age (years): >=35 years Male gender: 48.5% BMI: 23.6% of the patients had a normal BMI 41.9% were overweight and 34.2% were frankly obese	30	assessment of	not measured	21.3% microalbuminu ria 4.1% macroalbumin uria	Total prevalence (based on albumnuria): 25.4%	Medium
Plange-Rhule J [79]	1999 Ghana Central-West	Komfo Anokye Teaching Hospital	448	Hypertensive patients	Age (years): 50.5 ±13.0 Male gender: 36% SBP (mmHg): 165.0 ±27.8 DBP (mmHg): 101.9 ±17.9	Plasma creatinine ≥140mol/l	Proteinuria by urinary strips and serum creatinine	Not mentioned	25.50%	Total prevalence: 30.2%	Low
Addo J[110]	2009 Ghana Central-West	seven central government ministries in Accra	219	Hypertensive patients	Age (years): 50.4± 6.6 years Male gender: 64% SBP (mmHg):156.0 ±21.5 DBP (mmHg): 95 ±13 BMI (kg/m²): 27.5 ± 5.4	Persistent proteinuria on Urinalysis in the absence of urinary tract infection and/or impaired GFR<60 ml/min/ 1.73 m ²	Proteinuria and eGFR by MDRD	Enzymatic assessment	13.4%	Total prevalence: 13.4% 4.1% had eGFR< 60 ml/min/1.73 m²	Medium



Table 6: Studies on CKD among other populations

Study ID	Year Country Region	Location	Study group	Population Characteristics	Definition of CKD	Method of outcome assessment	Creatinine assay	Proteinuria	CKD prevalence	Quality assessment
E.F K [15]	2013 Senegal West	Nephrology department of the Aristide Le Dantec University Hospital Center.	Lupus patients	Age (years): 32.9 Male gender: 7% HTN: 30%	Proteinuria > 0.5 g/ 24 hours with or without hematuria/ renal insufficiency/ abnormal renal biopsy	24-hour proteinuria and eGFR by CG	Not mentioned	51%	Total prevalence: 72%	Low
Abd ElHafeez S[68]	2009 Egypt North	The Nephrology department at the Main Alexandria University 400 hospital	Consecutive sampling of relatives of ESRD patients	Age (years): 35.2±11.6 Male gender: 50.8% HTN: 60% DM: 11.5% BMI: 28.5±5.89 kg/m ²	KDIGO	Proteinuria by urinary strips, 186 MDRD	Kinetic Jaffe	21.3%	Total prevalence 57% Prevalence by stage: Stage 1: 9% Stage 2: 44% Stage 3: 4% Stage 4: 0.3%	medium
ElSharif M[18]	2013 Sudan	Primary 252 health care	Patients attending the primary	Age (years): 43.35± 12.80 Male gender: 16%	eGFR of < 60 mL/min/	Proteinuria by urinary strip and eGFR by MDRD	Not mentioned	24.21%	Total prevalence:	Low

Northeast		health care facilities	HTN: 10%	1.73 m ² with or				10.32%	
			DM: 5.95%	without proteinuria.					
			BMI (kg/m ²): 28.67 ± 6.43						
			BMI categories (kg/m²):						
			<18: 2.38%						
			>25.13: 71.83						
	Family	Newly registered patients		Persistently					Medium
	practice clinic	who attended the Family		abnormal ACR				Total	
		Practice Clinic	Age (years): 50.52 + 13.03	irrespective of GFR				prevalence:	
2000			Male gender: 27.2%	level or persistent				14.4%	
	250		32% elevated SBP, 30%	eGFR < 60	Proteinuria by urinary	Standardized	14.40/	10.4% had	
	250		elevated DBP	mL/min/1.73 m ²	strip, eGFR by MDRD	IDMS	14.4%	persistent	
west			DM: 6%	irrespective of the				eGFR< 60	
			Obesity: 32%	presence or absence				ml/min/1.73	
				of Kidney damage				m ²	
				after 3 months					
2009 Congo Central	Primary and secondary health care	At risk population randomly selected	Age (years): 53.9 ± 15.5 Male gender: 43% HTN: 58.2% DM: 54.5% Obesity: 16%	KDIGO	Proteinuria by urinary strip, 24-hour proteinuria, 175 MDRD	Kinetic Jaffe	19%	Total prevalence: 36% Prevalence by stage stage 1: 4.2%, stage 2: 6.1%, stage 3: 18.3%, stage 4: 1.9%, stage 5: 5.7%	High
	2009 Nigeria West	Family practice clinic 2009 Nigeria West Primary and secondary health care 2009 Congo 527	Family practice clinic who attended the Family Practice Clinic West Primary and secondary health care 2009 Congo 527	DM: 5.95% BMI (kg/m²): 28.67 ± 6.43 BMI categories (kg/m²):	DM: 5.95% BMI (kg/m²): 28.67 ± 6.43 BMI categories (kg/m²):	DM: 5.95% BMI (kg/m²): 28.67 ± 6.43 BMI categories (kg/m²): 418: 2.38% 25.13: 71.83 Persistently abnormal ACR irrespective of GFR level or persistent eGFR 4260 Nigeria West Primary and secondary health care Primary and secondary health care Age (years): 53.9 ± 15.5 Male gender: 43% HTN: 58.2% DM: 54.59% Age (years): 53.9 ± 15.5 Male gender: 43% HTN: 58.2% DM: 54.59% KDIGO Proteinuria by urinary without proteinuria. Without proteinuria. Without proteinuria. Persistently abnormal ACR irrespective of GFR level or persistent eGFR 600 Male gender: 27.2% Male gender: 43% HTN: 58.2% Male gender: 43% HTN: 58.2% KDIGO Proteinuria by urinary strip, 24-hour proteinuria. Proteinuria by urinary strip, 24-hour proteinuria. Proteinuria by urinary strip. 24-hour proteinuria. Proteinuria by urinary strip. 24-hour proteinuria. Proteinuria by urinary strip. 32-hour proteinuria. Proteinuria by urinary strip. 32-hour proteinuria. Male gender: 43% HTN: 58.2% DM: 45.45% KDIGO Proteinuria by urinary strip. 24-hour proteinuria. Proteinuria by urinary strip. 32-hour proteinuria.	DM: 5.95% BMI (kg/m²): 28.67 ± 6.43 BMI (categories (kg/m²): 48: 2.38% 25.13: 71.83 Persistently abnormal ACR abnormal ACR practice clinic Newly registered patients who attended the Family Practice Clinic Age (years): 50.52 ± 13.03 Male gender: 27.2% 32% elevated SBP, 30% elevated DBP DM: 6% clevated DBP DM: 6% irrespective of the presence or absence of Kidney damage after 3 months Primary and secondary health care Primary and secondary health care Age (years): 53.9 ± 15.5 Male gender: 43% HTN: 58.2% DM: 43.5% KDIGO Proteinuria by urinary skimette Jaffe Kimette Jaf	DM: 5.95% BMI (kg/m²): 28.67 ± 6.43 BMI categories (kg/m²):	DM: 5.95% BMI (kg/m²): 28.67 ± 6.43 BMI categories (kg/m²): 48: 2.38% 25.13: 71.83 Persistently abnormal ACR irrespective of GFR level or persistent of Elevated DBP West West Primary and secondary health care 2009 Congo Congo Congo Central Central At risk population randomly selected Age (years): 53.9 ± 15.5 Male gender: 32.9% blessity: 16% Age (years): 53.9 ± 15.5 Male gender: 42.9% blessity: 16% Molecular of DBP DM: 6% Age (years): 53.9 ± 15.5 Male gender: 42.9% blessity: 16% WDIGO DM: 9% DM: 9% Proteinuria by urinary irrespective of the presence of absence of Kidney damage after 3 months Embedding and secondary blessity: 18.2% Age (years): 53.9 ± 15.5 Male gender: 43% HIN: 82.2% DM: 43.4% DM: 43.4% DM: 54.5% DM: 43.4% DM: 43.4% DM: 54.5% DM: 43.5% DM: 43.5% DM: 43.5% DM: 43.5% DM: 43.5% SIBOR Without proteinuria. Wersistently abnormal ACR irrespective of GFR by MDRD IDMS Total prevalence by stage stage at 4.2%, stage 4.1.9%, st

van Rensburg B [21]	2010 South Africa South	Tertiary hospital	1216	New patients referred to the Renal Unit	Age (years): 39.6 ± 15.9 Male gender: 51.1% HTN: 13.2% DM: 10.8%	Elevated SCr(>130 µmol/L) and small kidneys on imaging without evidence of reversible causes		Not mentioned	16.7% proteinuria >3.5 g/dl	Total prevalence: 37.9%	Low
Hamdouk M[87]	2011 Sudan Northeast	hairdressing saloons	72	Hairdressers	Age (years): 40±8 Male gender: 0% Hypertension: 19.4%	Scr level≥2 mg/dl	Proteinuria by urinary strip and 24 hrs Scr measurement and renal biopsy	Not mentioned	26.4% had albuminuri	Total prevalence: 26.4% 14% had Scr ≥2 mg/dl	Low
EL-Safty I[109]	2003 Egypt North	male workers attending the out-patient clinic of the Health Insurance Organization	81	Male workers attending the out-patient clinic of the Health Insurance Organization Workers (29 non- silicotics, 24 silicotics and 28 referent)	Age (years): 39.83±7.27 Male gender: 100% Hypertension: 19.4%	Elevated proteinuria	Assessment of proteinuria quantitatively	Not measured	93% among non-silica exposed 100% silica exposed	among those with	Low

HTN: hypertension, DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, MDRD: Modification of Diet in Renal Disease,

CG: Cockroft Gault, CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration

Titles and legends

Fig. 1 Flow diagram of the study selection

Fig. 2 Prevalence of CKD among entire general population

Fig. 3 Main causes of CKD

Supporting information

S1 Table: Search strategy adopted in PubMed and Ovid MEDLINE

S2 Table: Studies among CKD patients

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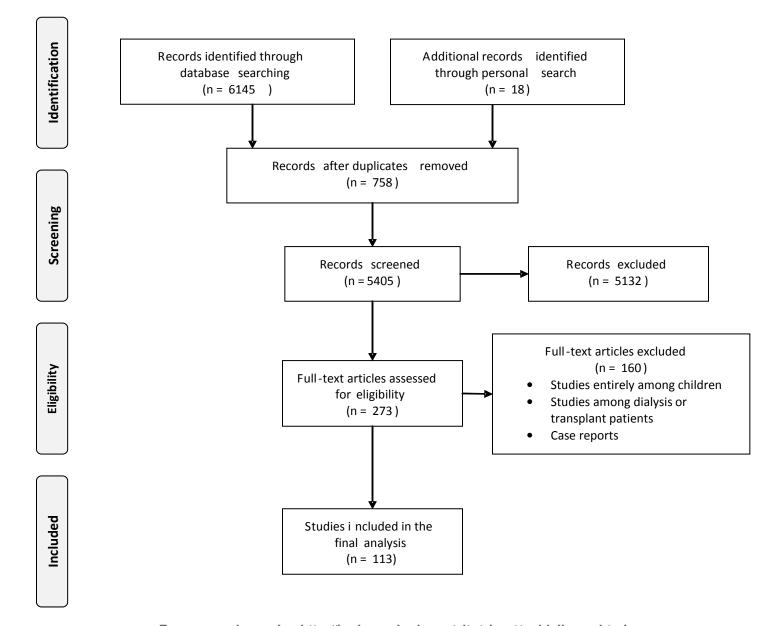
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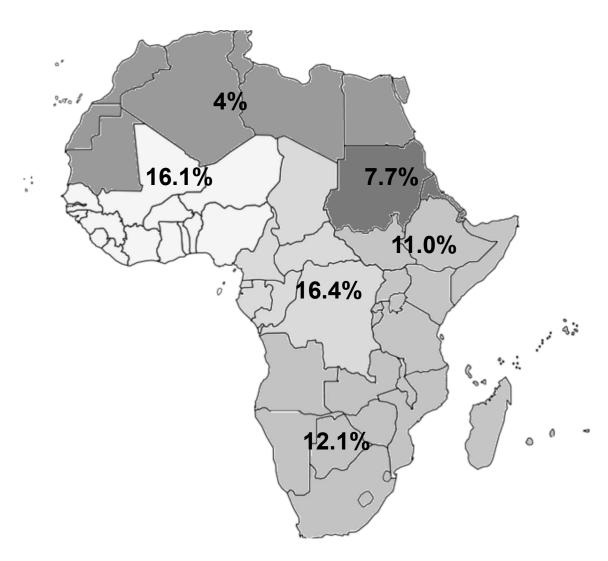
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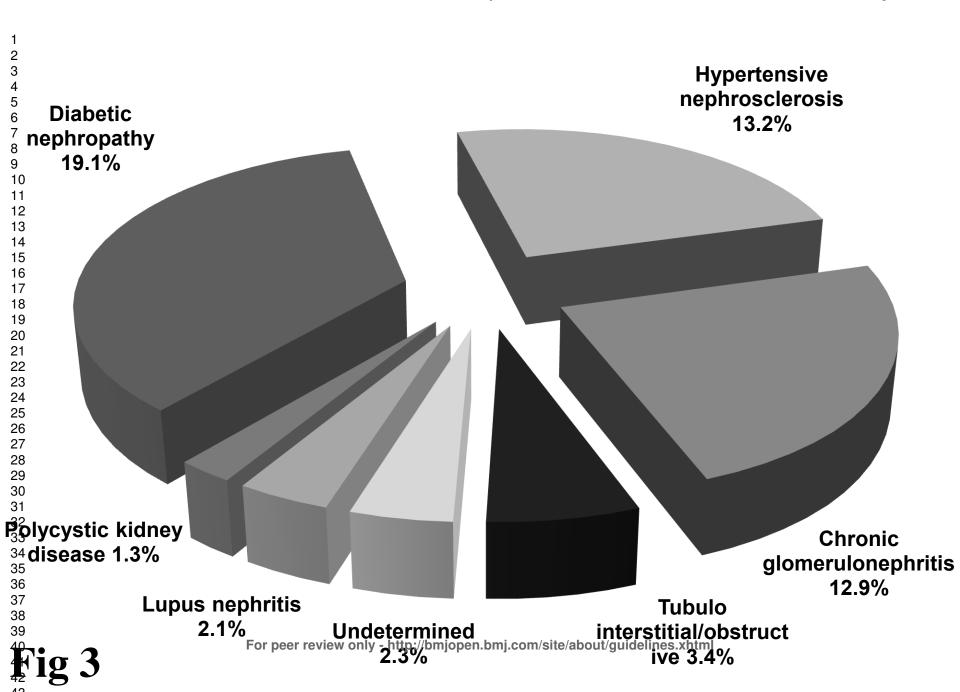
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S1 Table. Search strategy adopted in PubMed and Ovid MEDLINE

- 1. exp Renal Dialysis/
- 2. (hemodialysis or haemodialysis).tw.
- 3. (hemofiltration or haemofiltration).tw.
- 4. (hemodiafiltration or haemodiafiltration).tw.
- 5. dialysis.tw.
- 6. (CAPD or CCPD or APD).tw.
- 7. Renal Insufficiency/
- 8. Kidney Failure/
- 9. exp Renal Insufficiency, Chronic/
- 10. Kidney Diseases/
- 11. Uremia/
- 12. (end-stage renal or end-stage kidney or endstage renal or endstage kidney).tw.
- 13. (ESRF or ESKF or ESRD or ESKD).tw.
- 14. (chronic kidney or chronic renal).tw.
- 15. (CKF or CKD or CRF or CRD).tw.
- 16. (predialysis or pre-dialysis).tw.
- 17. ur?emi\$.tw.
- 18. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17
- 19. afric\$.ti,ab,kw,tw,mp.
- 20. 18 and 19

S2 Table: Studies among CKD patients

Study ID	Year Country Region	N	Population Characteristic	biopsy	causes of CKD
El Khayat S ¹⁴	2013, Morocco, North	134	Age(years): 54.4±18.1 Male gender: 58.65%	no	Tub.int: 9.7% DN: 44% H.scl: 11.2% Ch.GN: 3.7%
Seck S ¹⁵	2013, Senegal, West	60	Age (years): 70.5±54.6 Male gender: 52% HTN: 20% SBP (mmHg): 167 ± 78 DBP (mmHg): 95 ± 55 DM: 18%	no	DN: 25% H.scl: 30%
Seck S ¹⁶	2008, Senegal, West	118	Age (years): 39.28±16.4 Male gender: 56% SBP (mmHg): 160±15 DBP (mmHg): 90±15	yes	Tub.int: 12% H.scl: 20% Ch.GN: 35%
Bourquia A ¹⁷	2002, Morocco, North	420	Age (years): 46±3 Male gender: 52%	no	PKD: 3%
Ouattara B ¹⁸	2011, Ivory Coast, West	301	Age (years): 44±10 Male gender: 56% HTN: 33.5% DM: 12.3%	no	Tub.int: 10.3% DN: 9.65% Ch.GN: 17% undetermined: 29.2%
Lengani A ¹⁹	1997, Burkina Faso, West	174	Age (years): 36±15 Male gender: 63% HTN: 64.9%	no	Tub.int: 16.1% Ch.GN: 42.5% PKD: 16.1% undetermined: 14.4%
Afifi A ²⁰	2005, Egypt, North	220	Not known	no	DN: 28.2% H.scl: 25.5% obstructive: 5.9%
Diouf B ²¹	2000, Senegal, West	261	Age (years): 44(range:15-88) Male gender: 46%	no	DN: 20.5% H.scl: 34.23%

					Ch.GN: 15%
Niang A ²²	2008, Senegal, West	258	Age (years): 28 (range:15-79) Male gender: 75% HTN: 12.2%	yes	FSGS: 42% Tub.int: 10%
Sabi K A	2011, Togo, West	398	Age (years): mean: 42.6 Male gender: 57%	not known	Tub.int: 20.9% Ch.GN: 40.2%
Ulasi I ²⁴	2010, Nigeria, West	1538	Age (years): 42.55±15.43 Male gender: 65% HTN: 17.2% DM: 11.8%	yes	FSGS: 40.5% H.scl: 17.2%
AbdErrahim E ²⁵	2001, Tunis, North	299	Age (years): 38.3±14.6 Male gender: 69%	no	DN: 20.3%
Abdou N ²⁶	2003, Senegal, West	115	Age (years): 28 (IQR:5-60) Male gender: 56%	yes	FSGS: 67% MGN: 12.5% DN: 23.5% SLE: 55% undetermined: 7%
Afifi A ²⁷	2004, Egypt, North	3172	Age (years): 56.5±29.2	yes	DN: 14.5%
Afifi A ²⁸	1999, Egypt, North	4905	Age (years): 45.6±14.2 Male gender: 62.4%	yes	DN: 8.9% H.scl: 28% obstructive: 15% PKD: 3% undetermined: 16.2%
Agaba EI ²⁹	2009, Nigeria, West	130	Age (years): 41±16 Male gender: 68%	no	DN: 17.5% H.scl: 29.7% Ch.GN: 45.6%
Alashek W ³⁰	2012, Libya, North	2417	Age (years): 49 (range: 36-61) Male gender: 58%	no	DN: 13.3% H.scl: 26.1% Ch.GN: 41.2%
Alasia D ³¹	2012, Nigeria, West	320	Age (years): 46.2±17.6 Male gender: 63% SBP (mmHg): 171.2±31.9 DBP(mmHg): 102.5±27.4	yes	DN: 13.4% H.scl: 42.8% obstructive: 14.9% SLE: 1% Ch.GN: 15.9% undetermined:

					9.5%
Alebiosu C	2006, Nigeria, West	153	Age (years): 39.6±14.8 Male gender: 59% HTN: 38.5% SBP (mmHg): 167.3±15.5 DBP (mmHg): 106±28.9 DM: 13.1%	no	Tub.int: 2.2% H.scl: 31.1% Ch.GN: 43.7%
Amira CO ³³	2012, Nigeria, West	201	Age (years): 47.5±15.7 Male gender: 56.2 HTN: 42.8% DM: 13.4%	no	DN: 16.1% H.scl: 7.6% Ch.GN: 1.8% PKD: 2.9%
Arogundade FA ³⁴	2011, Nigeria, West	760	Age(years): 36 (range:15-90) Male gender: 70.3% HTN: 72.4% SBP (mmHg): 160 (range:120 – 270) DBP (mmHg): 100 (range:50 – 209)	no	FSGS: 79.2%
Counil É ³⁵	2008, Tunis, North	6397	Age (years): 51.4±18.0 Male gender: 56.5%	no	DN: 14.7% H.scl: 52.8% PKD: 17.2%
Chijioke A ³⁶	2012 , Nigeria ,West	116	Age (years): Male: 50.89±13.43 and Female: 48.22±14.70 Male gender: 61.2% SBP(mmHg): 153.41±27.12 DBP (mmHg): 93.92±17.19	no	Tub.int: 17.1% Ch.GN: 36%
Madala ND ³⁷	2014, South Africa, South	302	Age (years): 47.1±17.0 Male gender: 45% SBP (mmHg): (male) 144.6 ± 28.3. (female)141.1 ± 25.5 DBP(mmHg): (male)84.2 ± 18.1. (female)81.0 ± 19.0	yes	PKD: 1.8%
Okpechi IG ³⁸	2013, South Africa, South	111	Age (years): 66.3 ± 5.7 Male gender: 47.7% HTN: 71% DM: 19.8%	yes	DN: 22.2% H.scl: 38.8% Ch.GN: 28.8% PKD: 2.7%
Laleye A ³⁹	2012, Benin, West	3783	Age (years): 47.2 (range:29 - 70) Male gender: 24% HTN: 59%	no	DN: 12.5% H.scl: 45% obstructive: 12.5% Ch.GN: 15.8% PKD: 3.3%

Okunola Y ⁴⁰	2013, Nigeria, West	300	Age (years): 49 ±16.25 Male gender: 68%	no	Ch.GN: 58%
Bello BT ⁴¹	2013, Nigeria, West	120	Age (years): 47 + 14 Male gender: 60% SBP(mmHg): 162 ± 32 DBP(mmHg): 94.9 ± 19.6	yes	Tub.int: 8.8% DN: 7.4% H.scl: 34.2% Ch.GN: 39.2% undetermined: 3.45%
El-Minshawy O ⁴²	2011, Egypt, North	800	Age(years): 46 ± 13 Male gender: 65%	no	DN: 11.5% H.scl: 34.6% Ch.GN: 39% PKD: 6.9% undetermined: 7.5%
Okpechi IG ⁴³	2010, South Africa, South	294	Age (years): 33.9 ± 12.0 Male gender: 45.2% HTN:39.8%	yes	Tub.int: 1.2% DN: 26.5% H.scl: 14.6% obstructive: 5% Ch.GN: 21.2%
Madala N ⁴⁴	2012, South Africa, South	148	Age(years): 41.4 ± 13.1 Male gender: 37.2% SBP (mmHg): African (133.6 ± 20.2). Indian (130.1 ± 20.6) DBP (mmHg): African:(133.6 ± 20.2). Indian (130.1 ± 20.6)	no	DN: 41.5% H.scl: 14.6% Ch.GN: 16% undetermined: 15.55%
El Farouki M ⁴⁵	2013, Morocco, North	207	Age (years): 52.43 ± 15.48 Male gender: 64.3% HTN: 73.9% DM:41.5%	no	FSGS: 10.5% MGN: 35% H.scl: 18% SLE: 39%
Okpechi I ⁴⁶	2011, South Africa, South	1284	Age (years): 36.8 ±14.0 years Male gender: 45.2%	yes	DN: 19.4% H.scl: 40% Ch.GN: 21%
Niang A ⁴⁷	2014, Senegal, West	62	Age (years): 47 ± 13 years Male gender: 55%	no	DN: 27.5% H.scl: 10.5% Ch.GN: 8%
Buargub M ⁴⁸	2008, Libya, North	124	Age (years): 47.4±15 Male gender: 62%	no	PKD: 30%

Chijioke A ⁴⁹	2010, Nigeria, Central-West	67	Age (years): 47.4 ± 16.2 Male gender: 57%	no	H.scl: 20% obstructive: 15% Ch.GN: 11% undetermined: 27%
Elsharif M ⁵⁰	2011, Sudan, Northeast	224	Age (years): 45.78± 17.16 Male gender: 67.8%	yes	H.scl: 14.3% obstructive: 11.6% undetermined: 53.5%
Elkhatib ⁵¹	2012, Egypt, North	437	Age (years): 89% <50 years. 8.5% 50–60 years and 3%> 50 years Male gender: 52%	yes	FSGS: 6.8% MGN: 10.9% SLE: 24.7%
Ibrahim S ⁵²	2012, Egypt, North	924	Age (years): 26.5 ± 14.6 years Male gender: 47%	yes	FSGS: 20.2% MGN: 10.5% SLE: 8.6%
Ayach G ⁵³	2011, Morocco, North	386	Age (years): 19 (IQR:12-25) Male gender: 61%	yes	Tub.int: 5.6% DN: 29.8% H.scl: 77.8% Ch.GN: 35%

Tub. Int: tubulo-interstital, DN: diabetic nephropathy, H Scl: hypertensive sclerosis, ch GN: chronic glomerulonephritis, PKD: polycystic kidney disease, HTN: hypertension, DM: diabetes mellitus

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CHRONIC KIDNEY DISEASE IN AFRICA: A SYSTEMATIC REVIEW

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ABSTRACT

Objectives: While increasing attention is being paid to the rising prevalence of chronic diseases in Africa, there is little focus on chronic kidney disease (CKD). This systematic review assesses the CKD burden among the general population and high-risk groups on the entire African continent

Design, setting, and participants: We searched the MEDLINE and PUBMED databases for articles published between January 1st, 1995 and April 7th, 2017 by sensitive search strategies focusing on CKD surveys at the community level and high risk groups. In total, 7918 references were evaluated, of which 7766 articles were excluded because they did not meet the inclusion criteria. Thus, 152 studies were included in the final analysis

Outcome measurement: The pooled prevalence rate of CKD was expressed as a point estimate and 95% CI. No meta-analysis was done. Data were presented for different population.

Results: In the community-level studies, based on available medium and high quality studies, the pooled prevalence of CKD in Africa was 10.1% (95% CI: 9.8%-10.5%). West/Central-West had the highest prevalence (16.5%), followed by Central (16%), Southern (12.2%), Eastern (11.0%), and North (4%) Africa. The prevalence in sub-Saharan Africa was 14.02%. The pooled prevalence of CKD in the high risk groups was 5.6% (95% CI: 5.4-5.8%) in HIV (based on available medium and high quality studies), 24.7% (95% CI: 23.6-25.7%) in diabetes (based on all available studies which are of low quality except four of medium quality) and 34.5% (95 % CI: 34.04%-36%) in hypertensive patients (based on all available studies which are of low quality except two of medium quality)

Conclusion: In Africa, CKD is a public health problem, mainly attributed to high risk conditions as hypertension and diabetes. The poor data quality restricts the validity of the findings and draws the attention to the importance of designing future robust studies

Strengths and limitations of the study

- This systematic review assessed the CKD burden among the general population and highrisk groups on the entire African continent based on studies that covered all Africa from January1st, 1995 till April7th, 2017
- The quality of the included articles was assessed based on standard criteria dealing with clinical trials, diagnostic studies, and observational studies. The articles were assessed based on the population sampling and precision, sampling technique, response rate, and exclusion rate.
- No meta -analysis was conducted in this review due to the huge discrepancy in the definition used to identify CKD, the methods of creatinine measurement, urine protein assessment, and in the quality of the reporting.
- The review findings were limited by the low quality of the majority of studies in Africa
- The prevalence of CKD reported in this review should be interpreted with caution due to the bias introduced from the heterogeneity between studies, analytical and methodological issues, sample size, and study population selection

INTRODUCTION

Chronic kidney disease (CKD) is an emerging global public health problem ¹. The disease is a component of a new epidemic of chronic conditions that replaced malnutrition and infection as leading causes of mortality during the twentieth century². Age-standardized death rates due to CKD have increased during the last 23 years. CKD has shifted from the 36th cause of death in 1990 to the 19th cause in 2013³. The worldwide increase in CKD and kidney failure-necessitating renal replacement therapy (RRT) -and the high rate of cardiovascular mortality and morbidity attributable to CKD are poised to reach epidemic proportions over the next decade. CKD complications represent a considerable burden on global health care resources and only a small number of countries have sufficiently robust economies to meet the challenge posed by this disease. Socioeconomic differences in health exist and individuals of lower socioeconomic status (SES) have a higher risk for mortality and morbidity compared with those of higher SES⁴. A change in the global approach to CKD from the treatment of ESRD to intensive primary and secondary prevention is therefore considered an absolute public health priority⁵. Africa is the second largest continent in the world, with a population of over 1 billion; 961.5 million people live in sub-Saharan Africa and 195 million in Northern Africa⁶. Africa now faces the dual challenge of infectious illnesses and chronic diseases. Africa's chronic disease burden is secondary to various factors, including increased life expectancy, changing lifestyle practices, poverty, urbanization and globalization⁷. The World Health Assembly advocated the Global Action Plan for the Prevention and Control of non-communicable diseases 2013–2020. One of its targets is to reduce premature mortality from chronic diseases by 25% in 2025. These actions have the potential to make a significant impact on the burden of CKD⁸. Unfortunately, CKD problem remains underestimated on the entire continent due to lack of epidemiological information from different African countries. There exists only a single systematic review conducted in sub-Saharan Africa which concluded that CKD is a prevalent and potentially escalating disease across Sub-

- Saharan Africa, with both communicable and non-communicable risk factors⁹. Strategies aimed at
- 2 managing CKD epidemics in Africa critically depend on a reliable assessment of the burden of the
- 3 problem and the establishment of affordable early detection programs. Previous studies reported the
- 4 prevalence of CKD among the general population or the specific prevalence of this condition in
- 5 diseases that are recognized as drivers of renal damage (e.g., diabetes mellitus). These estimates
- 6 have varied across studies due to differences in the methods of Glomerular Filtration Rate (GFR)
- 7 measurement, background risk (general population vs. high risk groups), or demographic
- 8 characteristics (e.g., age, gender)¹⁰.
- 9 With this background in mind, this review aimed to increase the systematic information on the
- burden of CKD in the general population and high risk groups of the entire African continent and
- provide an estimate of the prevalence of CKD in different regions of Africa.

MATERIALS AND METHODS

Data source and search strategy

- We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)
- Guidelines¹¹. A systematic literature search was performed in the PubMed and OVID-MEDLINE
- databases by two authors (DB and SA) to identify articles reporting epidemiology data on CKD in
- the adult population in any geographic area of the African continent. This employed focused, highly
- sensitive search strategies (S1 Table). The search covered the time frame from January 1st, 1995 to
- 19 April 7th, 2017. Papers without language and study design restrictions were located and screened.
- 20 References from relevant studies were screened for supplementary articles.

Study selection and data extraction

- 22 Titles and abstracts were screened independently by two authors (SA and GD), who discarded
- 23 studies that were not relevant to the topic. Case reports, reviews, editorials, letters, and studies
- 24 focusing on African-Americans not living on the African continent, conducted entirely among
- children, or dealing with acute kidney injury or kidney transplantation were excluded. Two authors

(SA, ED) independently assessed the retrieved abstracts and the full texts of these studies to determine eligibility according to the inclusion criteria. Disagreements were resolved through discussion and consensus, or through consultation with a third reviewer (DB), who solved these differences based on study judgments. Furthermore, screening of reference lists of all of the retrieved studies was conducted to check for relevant articles, and a supplementary scan of the reference lists of the systematic reviews was performed to identify any additional studies. Data were extracted from full-text articles and registered using a specifically designed form. These data included study design, geographical area, sample size, the definition of CKD used, prevalence of CKD, age, gender, GFR measurement, type of creatinine assay, proteinuria, the method of outcome assessment and associated comorbidities such as diabetes mellitus and hypertension. Data extraction was performed by one reviewer (SA) and independently verified by another reviewer (DB).

Data extraction and analysis

Studies were categorized according to the reference population as follows: 1) studies dealing with the general population and 2) studies focusing on particular diseases such as diabetes, hypertension, lupus and HIV or settings, e.g., hospital-based surveys and occupational studies.

Information on the assessment of kidney function was collected, including: the equation adopted for GFR estimation ((Cockroft-Gault(CG), Modification of Diet in Renal Disease (MDRD), Chronic Kidney Disease-Epidemiology Collaboration (CKD-EPI)), the type of creatinine assay (Jaffe, standardized or unknown), and the type of proteinuria or albuminuria assay used (semi-quantitative assessment by urinary strips or quantitative in urine samples or 24 h collection). When the study included two or three GFR equations, we defined the CKD prevalence based on the CKD-EPI equation whenever this information was provided. Otherwise, we considered the MDRD equation and lastly the CG equation. In the case of ethnicity correction ¹²⁻¹⁴; we included the equation which corrected for ethnicity. Information on the definition of CKD used in each study was also included ((either the internationally accepted definition as Kidney Disease Outcome Quality Initiative (KDOQI), or other ways of defining CKD)).

Quality assessment

Two independent authors (SA and DB) appraised each article independently and assessed its quality based on standard criteria described into details in previous methodology reviews dealing with clinical trials¹⁵, diagnostic studies¹⁶, and observational studies¹⁷. The articles were assessed based on the subject sampling and precision, sampling technique, response rate, method of assessment of kidney function, and exclusion rate

Statistical analyses

The principal demographic and clinical data for each study were summarized as the mean and standard deviation or as absolute number and percentage, as appropriate. The age range in each study was also recorded. The pooled prevalence rate of CKD was expressed as a point estimate and 95% CI. The prevalence from each study was weighed by the sample size then the pooled prevalence was categorized by the African region. The inter-rater agreement for inclusion and quality assessment was determined using Cohen's kappa (κ) coefficient ¹⁸. The percentage of the different causes of CKD was weighed by the sample size of each study done among CKD patients. Then we simply summed the number of patients for each etiological factor and divided it by the total sample size from the whole included studies. No meta-analysis was conducted in this study. Data were appropriately presented for different populations (general population and CKD patients). The patients' data were stratified by the type of underlying condition, i.e., hypertension, diabetes mellitus, HIV, or systemic lupus erythematosus. All calculations were conducted using SPSS for Windows, version 21, Chicago, Illinois, USA.

RESULTS

22 Search results

- The flow diagram of the selection process is depicted in (Fig. 1). In total, 7897 potentially relevant
- references were initially retrieved. Twenty-one additional citations were found through a personal

search. By screening titles and abstracts, a total 7534 citations were excluded because of search overlap, dealing with the wrong population (African American, AKI, cancer or post-transplant patients), or not providing actual data on CKD. Review articles, case reports, editorials, or letters were also excluded. Amongst the 384 studies selected for full text examination, 232 were excluded because they dealt with a population different from that specifically targeted in this systematic review, such as paediatric populations (122 studies), transplant patients (n=44), or others (n=46) (e.g., Africans living in non-African countries), or because only narrative data were provided (n=20). A total 152 articles were therefore reviewed in detail and included in the analysis. The main characteristics of these studies are summarized in Table 1. The inter-rater agreement for inclusion was κ =0.90 and for the quality assessment was κ =0.85.

Study characteristics

Amongst the 152 studies reviewed, 29 were general population studies (Table 2). One-hundred twenty-three studies focused on selected groups, of which 42 included HIV patients (Table 3), 18 studied diabetic patients (Table 4), nine included hypertensive subjects (Table 5) and twelve were conducted in other populations (Table 6), including one study in lupus patients ¹⁹, one study in rheumatoid arthritis patients ²⁰, one study among sickle cell anemia patients ²¹, two in specific occupational settings (silica exposure²² and exposure to the nephrotoxic hair-dye, paraphenylenediamine²³) and seven studies in family practice²⁴⁻²⁶ or hospital-based²⁷⁻³⁰ surveys. Forty-two studies conducted among CKD patients (S2 Table) ³¹⁻⁷².

The studies that were included covered all regions of Africa. The highest number of the studies came from the Western macro-area (n=54), followed by the Eastern macro-area (n=32), Southern macro-area (n=25). Twenty studies were retrieved from the Northern Africa, eight studies from each of the Central macro-area and the Central-Western macro- area. Three studies were conducted in both the Eastern and Southern regions and two studies in the Sub-Saharan region.

Assessment of kidney function impairment

Urinary markers for kidney disease were assessed in seventy-eight (71%) among one-hundred ten studies conducted in the general population, high risk groups, occupational or hospital-based studies. Proteinuria was assessed by a semi-quantitative method (urinary strips) in twenty-eight studies ²¹, ²⁴, ²⁶, ²⁹, ⁷³⁻⁹⁶. Twenty studies used dipstick with confirmation by quantitative methods, nine of which used dipsticks to identify proteinuria/albuminuria with confirmation by 24-hour proteinuria²⁵, ⁹⁷⁻¹⁰⁴ whereas eleven studies used dipstick with confirmation by the protein-to-creatinine ratio or albumin-to-creatinine ratio¹⁰⁵⁻¹¹⁵. Quantitative methods for the assessment of proteinuria/albuminuria (24-hour proteinuria or albuminuria, PCR, immunoassay, or ACR) were applied in twenty-nine studies ¹⁹, ²⁷, ²⁸, ³⁰, ¹¹⁶⁻¹⁴⁰. In one study, the method of proteinuria assessment was not mentioned ¹⁴¹.

Serum creatinine was measured in ninety-five studies (86%). The Jaffe assay was used in thirty studies²⁹ ,³⁰ ,⁷⁶ ,⁸⁰ ,⁸² ,⁸³ ,⁸⁶ ,⁹⁰ ,⁹⁵ ,⁹⁷ ,¹⁰² ,¹⁰⁵ ,¹¹¹ ,¹¹³ ,¹²⁴ ,¹²⁶ ,¹³⁰ ,¹³¹ ,¹³⁶ ,¹⁴² -¹⁵² whereas the IDMS-calibrated method was used in fifteen studies ¹² ,¹⁴ ,²¹ ,²⁶ ,¹¹⁵ ,¹¹⁷ ,¹³² -¹³⁴ ,¹⁴¹ ,¹⁵³ -¹⁵⁷. In nine studies, both the Jaffe assay and the calibrated serum creatinine were used ¹³ ,²⁰ ,²⁵ ,⁹¹ ,⁹⁸ ,⁹⁹ ,¹⁰⁶ ,¹¹² ,¹⁵⁸. In the remaining forty-one studies provided no information on the method of creatinine measurement ¹⁹ ,²⁴ ,²⁷ ,²⁸ ,⁷⁸ ,⁷⁹ ,⁸¹ ,⁸⁴ ,⁸⁵ ,⁸⁷ -⁸⁹ ,⁹³ ,⁹⁴ ,⁹⁶ ,¹⁰⁰ ,¹⁰¹ ,¹⁰⁴ ,¹⁰⁹ ,¹¹⁴ ,¹¹⁶ ,¹¹⁸ -¹²² ,¹²⁵ ,¹²⁷ ,¹³⁵ ,¹³⁷ -¹³⁹ ,¹⁵⁹ -¹⁶⁷. With respect to the formula used for estimating GFR, the MDRD equation was used in thirty studies ²⁴ -²⁶ ,²⁸ ,²⁹ ,⁹⁴ -⁹⁷ ,¹⁰⁵ ,¹⁰⁶ ,¹¹¹ ,¹¹³ ,¹¹⁶ ,¹¹⁷ ,¹²¹ ,¹²² ,¹²⁶ ,¹³⁰ ,¹³³ ,¹³⁴ ,¹³⁶ ,¹⁴¹ ,¹⁴⁶ ,¹⁴⁹ ,¹⁵³ ,¹⁵⁴ ,¹⁵⁸ ,¹⁵⁹ ,¹⁶⁴ and the CG equation was used in eighteen ¹⁹ ,⁷⁶ ,⁸¹ ,⁸⁶ ,⁸⁸ ,⁹³ ,¹⁰⁰ ,¹⁰² ,¹¹⁴ ,¹¹⁹ ,¹²⁴ ,¹³⁸ ,¹⁴³ ,¹⁴⁵ ,¹⁵⁰ ,¹⁶² ,¹⁶⁷. The other fourteen studies used both the CG and the MDRD equations ⁷⁸ -⁸⁰ ,⁸³ -⁸⁵ ,⁹⁸ ,⁹⁹ ,¹⁰¹ ,¹⁴⁴ ,¹⁴⁷ ,¹⁵² ,¹⁶¹ ,¹⁶³ , whereas fifteen studies estimated GFR by the CG, MDRD, and the CKD-EPI methods ¹² -¹⁴ ,²⁰ ,⁸² ,⁹⁰ ,⁹¹ ,¹⁰⁹ ,¹¹² ,¹¹⁵ ,¹³⁹ ,¹⁴² ,¹⁵⁵ ,¹⁵⁶ ,¹⁶⁰. Six studies used MDRD and CKD-EPI ¹³¹ ,¹³² ,¹³⁷ ,¹⁴⁸ ,¹⁵¹ ,¹⁵⁷ and two studies used CKD-EPI²¹

Definition of CKD

Thirty-one studies defined the presence of CKD as an eGFR below 60 ml/min/1.73 m² ¹², ¹⁴ ^{.20}, ⁸⁰, ⁹³-96, ¹¹¹, ¹¹⁷, ¹¹⁹, ¹³⁹, ¹⁴⁶, ¹⁴⁸-159, ¹⁶¹-164, ¹⁶⁶, ¹⁶⁷, with chronicity confirmed by repeated testing in four other studies ¹⁴²-145. Moreover, twenty-eight studies reported CKD prevalence based on eGFR below 60 ml/min/1.73 m² and/or the presence of proteinuria or albuminuria ²¹, ²⁴, ²⁶, ⁷⁶, ⁷⁸, ⁸²-84, ⁸⁶, ⁹¹, ⁹⁹ ¹⁰⁰, ¹⁰⁵, ¹⁰⁶, ¹⁰⁹, ¹¹²-114, ¹²¹, ¹³⁰-137, ¹⁴¹. Proteinuria/albuminuria was used alone to identify CKD in fourteen studies ⁷³-75, ⁷⁷, ⁸⁷, ⁹², ¹⁰⁷, ¹⁰⁸, ¹¹⁰, ¹²³, ¹²⁸, ¹²⁹, ¹³⁸, ¹⁴⁰. KDOQI staging ¹⁶⁸ of CKD was used in thirteen studies ¹³, ²⁵, ²⁹, ⁷⁹, ⁸⁵, ⁹⁰, ⁹⁷, ⁹⁸, ¹¹⁵, ¹¹⁶, ¹²², ¹²⁴, ¹²⁶. The serum creatinine level (either doubling, or an increase above a certain threshold) was considered to be a marker of the presence of CKD in four studies ⁸⁹, ¹⁰⁴, ¹²⁰, ¹⁶⁵. In sixteen studies, the definition of CKD was either not mentioned or was defined in various ways, including personal history, Creatinine Clearance (CrCl) ≤50 ml/min, clinical manifestations, the presence of albuminuria, elevated serum creatinine, and the average of two measurements of eGFR < 90 ml/min/1.73 m² ¹⁹, ²⁷, ²⁸, ³⁰, ⁸¹, ⁸⁸, ¹⁰¹-103, ¹¹⁸, ¹²⁵, ¹²⁷, ¹⁴⁷, ¹⁶⁰, ¹⁶⁹, ¹⁷⁰.

Paper quality

Paper quality was high in sixteen studies ¹³, ²⁵, ⁷⁵, ⁹⁰, ⁹¹, ⁹⁷, ⁹⁸, ¹⁰⁵, ¹⁰⁶, ¹¹², ¹¹⁶, ¹³²⁻¹³⁴, ¹⁴⁸, ¹⁵⁵. Thirty-five studies were of medium quality ¹², ¹⁴, ²⁶, ²⁹, ⁷³, ⁷⁴, ⁷⁷⁻⁷⁹, ⁸¹, ⁸², ⁹⁶, ¹¹⁰, ¹¹¹, ¹¹⁵, ¹¹⁷, ¹²⁸, ¹³⁰, ¹³¹, ¹³⁷, ¹⁴¹, ¹⁴³⁻¹⁴⁵, ¹⁵⁰⁻¹⁵⁰, ¹⁵², ¹⁵⁴, ¹⁵⁷, ¹⁵⁹⁻¹⁶¹, ¹⁶³, ¹⁶⁶, ¹⁶⁷. The rest of the studies were of low quality.

Prevalence of CKD

Based on the prevalence of eGFR <60 ml/min/1.73m² and/or the presence albuminuria/proteinuria (the current definition of CKD by KDOQI)¹⁶⁸ reported in the 24 medium-high quality studies in **Table 2** the pooled prevalence of CKD in the general population in Africa was 10.1% (95% CI: 9.8%-10.5%). The highest prevalence was reported in the West/Central-West (16.5%), followed by the Central region (16%), Southern (12.2%), Eastern (11.0%), and North (4%) Africa (Fig. 2). The pooled prevalence in Sub-Saharan Africa was 14.02% (95% CI: 13.5- 14.5 %).

Among HIV patients (Table 3), the pooled prevalence of CKD (estimated as above on the

Saharan area

basis of the KDOQI definition in the eighteen medium quality studies in the same table) was 5.6% (95% CI: 5.4-5.8%). Based on the treatment status, the prevalence of renal dysfunction was 9.9% (95 % CI: 9.4- 10.4%) among HIV patients not receiving treatment while the prevalence was 5.2% (95 % CI: 5.0-5.4%) among HIV patients on anti-retroviral therapy .The West/ Central-West recorded the highest prevalence of CKD among HIV patients (11.6%), followed by the East (11.2%), and South (3.5%) macro-areas. The prevalence was reported to be 5.7% among the 3 studies done in both the East and South macro- areas and 2.5% from the study done in the sub-

Among diabetic patients (**Table 4**, all studies are of low quality except for four with medium quality), the pooled prevalence of CKD was 24.7% (95%CI: 23.6-25.7%). The highest prevalence was in the Eastern (46.9%), followed by the Central (40.8%), West/Central-West (27.7%), South (23.0%), and North (18.9%) Africa. One study was done in sub-Saharan reported that the prevalence was 13%

The pooled prevalence of CKD among hypertensive patients (**TABLE 5**, 9 studies; all of low quality except for two with medium quality) was 34.5% (95 % CI: 34.04%-36%). The highest prevalence was reported from one study in the East macro-area (39.5%) followed by the West/Central-West (37.7%), South (25.4%) Africa. No data were found for other African macro-areas.

Among other patient populations (studies reported in Table 6), almost three quarters of the lupus patients had CKD (prevalence=72.0%) based on low quality study ¹⁹. Hospital-based surveys revealed that (the calculation was based on **the total prevalence** reported from all studies including three of high-medium quality and 4 of low quality in the same table) more than one third of patients attending either primary care centres or tertiary hospitals had CKD (pooled prevalence= 36%, 95% CI: 34.4-37.7%). CKD was prevalent among almost 39% of rheumatoid arthritis ²⁰or sickle cell patients ²¹. The study (low quality) conducted among hairdressers exposed to paraphenylenediamine¹⁰⁴ reported that 26.4% of these subjects had renal impairment. Of note,

100% of silica-exposed workers experienced proteinuria (reported from low quality study)¹²⁹.

The prevalence of CKD was variable based on definition used to diagnose CKD. Based on medium-high quality studies; CKD had a 6.2 % prevalence (95% CI: 6.0- 6.4%) in population studies defining this disease as an eGFR below 60 ml/min/1.73 m² ¹², ¹⁴, ⁹⁶, ¹¹¹, ¹¹⁷, ¹⁴⁸, ¹⁵⁰⁻¹⁵², ¹⁵⁴, ¹⁵⁵, ¹⁵⁷, ¹⁵⁹, ¹⁶³, ¹⁶⁶, ¹⁶⁷. When CKD was diagnosed based on eGFR below 60 ml/min/1.73 m² and/or the presence of proteinuria or albuminuria²⁶, ⁷⁸, ⁸², ⁹¹, ¹⁰⁵, ¹⁰⁶, ¹¹², ¹¹⁴, ¹³⁰⁻¹³⁴, ¹⁴¹; the prevalence was 7.3 % (95 %CI: 6.9-7.7%). The prevalence of CKD was 22.5 % (95% CI: 21.5- 23.5%) in studies where the disease was defined on the basis of proteinuria⁷³⁻⁷⁵, ⁷⁷, ¹¹⁰, ¹²⁸. When KDOQI definition (i.e. by combining the eGFR and proteinuria/albuminuria) was used ¹³, ²⁵, ²⁹, ⁷⁹, ⁹⁰, ⁹⁷, ⁹⁸, ¹¹⁵, ¹¹⁶, the prevalence of CKD was 19.7% (95% CI: 18.7-20.8%)

Causes of CKD

- Forty-two studies were conducted specifically to clarify the underlying cause of CKD 31-72. (S2
- Table) The diagnosis was biopsy-proven in seventeen studies³³,³⁹,⁴¹,⁴³⁻⁴⁵,⁴⁸,⁵⁴,⁵⁵,⁵⁸,⁶⁰,⁶³,⁶⁷⁻⁷⁰,⁷².
- 14 Diabetic nephropathy was the leading cause of CKD (20%), followed by hypertensive
- nephrosclerosis (13.5%), chronic glomerulonephritis (13%), tubulo-interstital/obstructive (3.6%),
- lupus nephritis (2.1%), and polycystic kidney disease (2%). In nine studies, the diagnosis remained
- 17 undetermined (2.5%). (Fig. 3)

DISCUSSION

- This systematic review focuses on the burden of CKD on the entire African continent. We assessed
 152 papers published between January 1st, 1995 until April 7th, 2017, reporting the epidemiology of
 CKD in the general population and in specific chronic conditions in Africa. The CKD prevalence
 reported in our review should be interpreted with caution. Our estimates may be affected by the
 analytical heterogeneity used to measure creatinine and albuminuria. Serum creatinine
 concentrations are affected by intra-individual variability with over 20% changes within a 2-week
- period¹⁷¹ and most Jaffe assays overestimate serum creatinine ¹⁷². The resulting bias could vary

according to the creatinine concentration, specific assay, manufacturer, and calibration material used. Although the IDMS calibration standardization has reduced the bias and improved the Inter laboratory comparability¹⁷³, the number of studies reported using IDMS was low in Africa. Moreover, CKD prevalence may additionally be influenced by albuminuria assays which are affected by the inter laboratory differences ¹⁷⁴. The different equations used to estimate GFR could be a source of bias. The systematic underestimation of measured GFR at higher estimated GFR by the MDRD equation is well known, and may reflect higher creatinine generation in healthy individuals compared with individuals with CKD in whom the MDRD equation was derived. This bias is reduced substantially, but not completely, by the CKD-EPI equation, which was derived from studies including people without CKD¹⁷⁵. In addition, differences in sample size, demographics, and clinical characteristics, are all significant limitations in this systematic review for making accurate estimates of the prevalence of CKD in African countries. Furthermore, only five studies 79,142-145 assessed the KDOQI chronicity criterion, which is a fundamental element of the current definition of CKD by this organization. Thus, estimates in this review should be seen as a pragmatic attempt to evaluate the dimension of CKD as a public health issue on the African continent. CKD is now considered to be an important component of the epidemic of non-communicable diseases in economically developed and developing countries alike. In a seminal meta-analysis published in 2014 Stanifer et al.,9 for the first time drew attention to the public health relevance of CKD in the sub-Saharan Africa, a vast area comprising 85% (947.4 million) of the whole African population⁹. In the present systematic review, the lowest prevalence of CKD (4%) was reported in the Northern Africa macro-area; including Egypt, Libya, Tunisia, Algeria, Morocco, the Western Sahara, and Mauritania, and the highest (16.5%) was observed in West/ Central-West Africa, which includes Benin, Burkina Faso, the island nation of Cape Verde, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mali, Mauritania, Niger, Nigeria, Cameroon, the island of Saint Helena, Senegal, Sierra Leone, São Tomé and Príncipe and Togo.

The average prevalence in the entire African continent was 10.1%. The global CKD prevalence was reported to be 13.4% ¹⁷⁶. In sub-Saharan Africa in Stanifer's meta-analysis, the prevalence of CKD was 13.2% ⁹, which is close to that reported in the same area in our review (14.02%). Among the general population of economically developed countries, CKD has a 13.6% prevalence in the USA ¹⁷⁷. In Europe, the reported prevalence is lower and more homogenous, being 8.9% in the Netherlands, 6.8% in Italy, 5.2% in Portugal, 4.7% in Spain, and 3.3% in Norway¹⁷⁸. CKD prevalence in some Asian countries was higher than the estimates in the USA and in Europe, being 17.5% in Thailand¹⁷⁹, 15% in India¹⁸⁰, 13% in Japan¹⁸¹, 11.9% in Taiwan¹⁸², and 9.9% in China¹⁸³. Overall, the estimated prevalence of CKD at the general population level in African countries appears to be comparable and possibly even higher than that reported in other continents. This may be at least in part due to the low quality data for the prevalence of CKD in Africa related to poor sampling techniques, unreliable kidney function measurements, and the different definitions used.

In our review, the prevalence of CKD in surveys based on hospitals or primary care centres (36%) is close to that in Swiss primary care centres (36%) ¹⁸⁴.

Poverty-related factors such as infectious diseases secondary to poor sanitation, inadequate supply of safe water, environmental pollutants and high concentrations of disease transmitting vectors continue to play an important role in the development of CKD in low-income countries. Although rates of diabetic nephropathy are rising, chronic glomerulonephritis and interstitial nephritis are among the principal causes of CKD in many countries ¹⁸⁵.

In Africa, infectious diseases such as HIV, bilharziasis, malaria, hepatitis B and C represent an almost unique cluster of risk factors responsible for CKD¹⁸⁶. HIV/AIDS is pandemic in Africa, with a prevalence ranging from 0.5% in Senegal¹⁸⁷ to 27.4% in Swaziland¹⁸⁸. The global success in bringing effective antiretroviral treatment (HAART) to HIV-infected patients in Africa has determined the emergence of chronic medical illnesses such as HIV-related CKD¹⁸⁹. Up to 50% of kidney diseases in HIV-infected persons result from a wide array of non-HIV-associated nephropathy (HIVAN) pathologies, ranging from glomerulonephritis to diabetic nephropathy ¹⁹⁰.

presentations⁸⁰.

We found that 5.6% of HIV patients complained of renal dysfunction. This figure is lower than that reported in economically developed countries such as France, USA, China, Spain, and Brazil¹⁹¹⁻¹⁹⁵. CKD was higher among HIV patients not receiving HAART compared to those on HAART. Variation in the proportion of HIV patients affected by CKD depends on the heterogeneity in the definition used to determine renal dysfunction, the proportion of the study population on HAART, diverse ethnicities, the associated comorbidities, and the nutritional status of the study population. HIV patients are more prone to nutritional deficiencies due to mal-absorption, impaired oral intake, and the wasting syndrome. Increased availability of HAART has led to some improvement of the nutritional status of patients. However, for certain individuals, undernutrition and weight loss persist despite therapy. Malnutrition exacerbates side effects, alters drug pharmacokinetics, and impinges on adherence thereby limiting the beneficial effects of the therapy ¹⁹⁶. Furthermore, differences in HIV clades or strains in African patients¹⁹⁷ and genetic factor ¹⁹⁸ may influence the replication capacities within the isolated renal reservoir and thus lead to a diversity in clinical

Regarding systemic autoimmune diseases such as lupus, a study conducted among lupus patients from Senegal showed that almost three quarters (71.0%) the patients with this disease had evidence of renal involvement¹⁹. This isolated figure is higher than that reported in other countries¹⁹⁹⁻²⁰¹. More than one third (39%) patients with rheumatoid arthritis had CKD²⁰ which is higher than that reported from Taiwan ²⁰².

Even though there are no sufficient data to precisely reconstruct historical trends, the profile of CKD causes has changed during the last decades. Interstitial nephritis and glomerulonephritis were the main causes of CKD in North Africa²⁰³ and CKD was principally caused by chronic glomerulonephritis and hypertension in East and Tropical Africa²⁰⁴,²⁰⁵. Today, the spectrum of causes of CKD in Africa is dominated by diabetes mellitus and hypertension ²⁰⁶. We found that the prevalence of diabetic and hypertensive nephropathies as a cause of CKD (20% and 13.5%, respectively) exceeded that caused by chronic glomerulonephritis (13%).

Our review has both strengths and limitations. The major strengths include a thorough systematic search of electronic databases and the inclusion of all comprehensive studies with a transparent assessment of CKD prevalence by two independent reviewers. The fact that our literature search was limited to PubMed and Medline OVID but did not include the African Index Medicus, like it was done by Stanifer in the meta-analysis of CKD in sub-Saharan Africa [8], is a limitation of our study. Because there was a huge discrepancy in the definitions used to identify CKD, the methods of creatinine measurement, urine protein assessment, and in the quality of the reporting, we decided to adopt an inclusive strategy. Our primary interest was to identify all studies conducted among different population groups in Africa providing information on CKD and to reconstruct a tentative scenario of the epidemiological dimension concerning disease in the entire African continent. Methodological limitations notwithstanding this review compiled estimates suggesting that the CKD burden in Africa is at least as concerning as that in economicallydeveloped countries. The lack of a consistent definition of CKD makes it difficult to compare the burden of CKD across studies in various countries. Moreover, the failure to demonstrate chronicity when defining CKD is a common limitation of studies investigating CKD prevalence in Africa. It was reported that a single test in time has an extremely poor positive predictive value for confirmation of CKD compared to repeated testing 3 months later. Failure to repeat testing may lead to a significant overestimation of CKD prevalence and underestimation of the burden of CVD in CKD²⁰⁷. In addition, Observational studies are subject to bias and residual confounding which are difficult to account for and there are limitations due to the heterogeneity that arises from differences in age and sex distributions. These poor data quality reported in different studies is considered as a cumbersome problem limiting the accuracy in assessing the burden of CKD in Africa

In conclusion, CKD in Africa appears to be at least as common as in other continents and as such, it constitutes a true public health priority with major cost burden to healthcare systems worldwide. Targeted screening of high-risk groups (including those with hypertension, diabetes mellitus, HIV patients and persons with occupational exposures) should likely be instituted as the

first step in kidney disease prevention whenever and wherever affordable and feasible. Education to increase awareness of CKD among healthcare workers and patients, and the promotion of healthy life styles, should be engrained in preventive programs. The treatment of hypertension and diabetes mellitus are of obvious relevance. Nurses and other health workers should be trained to manage these conditions at the local level if we are to curb the incidence of CKD and to avert the added burden of CKD complications to diabetes, hypertension, and infectious diseases, the deadly trio of

risk factors underlying the CKD epidemic in Africa.

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- 19 SA, DB, and GT: analysed and interpreted the data.
- 20 SA, DB, and CZ: drafted and critically revised the manuscript.
- 21 All of the authors read and approved the final manuscript.

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Table 1: Characteristics of the study population included in the analysis

Study population	Number of the studies	Study characteristics
General population	29	N=30169, age ranging from
		12 to 95 years; 48% males
Diabetic patients	18	N=9082, age ranging from
		14 to 90 years; 43% males
Hypertensive patients	9	N=4123, age ranging from
		19 to 90 years; 43% males
HIV patients	42	N= 67432, age ranging
		from 13 to 74 years; 36%
		males
Occupational group	2	N= 153, age ranging from
		22 to 59 years; one study
		only enrolled females and
		the other principally
D ii		enrolled males
Family practice patients	7	N= 3250, age ranging from
T	1	20-74 years, 44% males
Lupus patients	1	N= 43, age ranging from 16
D1		to 55 years, 7% males
Rheumatoid arthritis	1	N=233, age ranging from
G: 11 11 :		40-70 years, 17.2% males
Sickle cell anemia	1	N=194, age ranging from
CIVD	10	12-40 years, 43.3% males
CKD patients	42	N = 32695, age ranging
		from 12 to 90 years, 58%
		males

Table 2: Studies on CKD among the general population

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6 7 8	Study ID	Year, Country , Region	Location	N	Population Characteristic	Definition of CKD	Method of outcome assessment	Type of creatinine assay	Proteinuria	CKD prevalence	Quality assessme nt
9 10 11 12 13 14	Abdelsatir S ¹⁶⁹	2013 Sudan North- east	All village inhabitants	389	Age (years): 41 ± 15 Male gender: 16.2% Hypertension:39.6%, DM: 17% BMI category: (kg/m²) <18: 6.2%, 18-24.9: 65.8%, 25-29.9: 20.2 %, ≥30: 7.8%	Not identified, personal history	Personal history	Not mentioned	Not measured	Total prevalence (as reported): 6.40%	Low
15 16 17 18 19 20	Fatiu A ⁷³	2011 Nigeria West	Market population	286	Age (years): 49.5 ± 5.7 Male gender: 9.8% Hypertension: 37.7% BMI (kg/m²): 26.76 ± 5.28 <20 kg/m²: 7.4% 20-25 kg/m²: 33.4% > 25 kg/m²: 59%	Proteinuria ≥ +1	Midstream urine sample was tested by urinary strip	Not measured	29.70%	Total prevalence (based on proteinuria prevalence): 29.7%	Medium
21 22 23 24	Traore M ⁷⁴	1998 Mali West	All Household population of the villages	1098	Age (years): 30±12 Male gender: 52%	Proteinuria ≥ +1	Microhaematuria and proteinuria by urinary strip	Not measured	40.80%	Total prevalence (based on proteinuria prevalence): 40.80%	Medium
25 26 27 28 29	Matsha T ¹²	2013 South Africa South	Bellville town inhabitants	1202	Age (years): 52.9 ±14.8 Male gender: 24.7% SBP: 125±20 DBP: 76 ±13 DM: 26.4% BMI: 29.9 ±7.2	eGFR<60 ml/min	4 variables: MDRD, CG, CKD-EPI	Standardized creatinine assay	Not measured	Prevalence of stages 3-5: 7.4% (based on CKD- EPI with ethnicity correction)	Medium
30 31 32 33 34 35 36	Seck SM ⁹⁷	2014 Senegal West	Two stage cluster sampling of Urban and rural inhabitants of Saint- Louis	1037	Age (years): 48.0 ± 16.9 Male gender: 40% Hypertension: 39.1% DM: 12.7% BMI: 26.3 ± 6.8 kg/m ²	KDOQI	Albuminuria by urinary strips. Positive samples were confirmed by 24-hour albuminuria, eGFR by 186 MDRD	Kinetic Jaffe	5.3% albuminuria >1 g/l	Total prevalence: 6.1%	High
37 38 39 40 41 42	Pruijm M ¹¹⁶	2008 Seychell es, East	a random sex- stratified and age- stratified sample inhabitants	1255	Age (years): range, 25-64 Male gender: 46%	KDOQI	Quantitative microalbuminuria by ACR, eGFR using MDRD	Not mentioned	11.4% microalbuminuria, 0.7% macroalbuminuria	Total prevalence: 15.3% Prevalence of stages 3–4 CKD 3.2%.	High

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0 1 2 3 4 5	Sumaili EK ⁹⁸	2009 Congo Central	Multistage sampling of residents of Kinshasa	500	Age (years): 38.6 ± 14.4 Male gender: 41% Hypertension: 27.6% DM: 11.7% BMI category: 25–29.9 kg/m²: 20.3% ≥30 kg/m²: 14.9%	KDOQI	Proteinuria by urinary strip and 24-hour proteinuria, eGFR by CG and 175MDRD	Kinetic Jaffe and IDMS-calibrated	18% proteinuria by dipstick 5% (≥300 mg/day)	Total prevalence: MDRD 12.4% CG 19% Prevalence by stage (MDRD) Stage 1: 2% Sage 2: 2.4% Stage 3: 7.8% Stage 4:0 Stage 5: 0.2%	High
6 7 8 9 0 1 2 3 4 5	Matsha T ¹⁵⁹	2014 South Africa South	All residents of Cape-Town	320	Age (years): mean, 56.4 (55.1–57.6, 95% CI) Male gender: 22% SBP: 124.7 (122.8–126.7, 95% CI)mmHg DBP: 75.5 (74.2–76.7, 95% CI) mmHg BMI: 31.9 (31.2–32.7, 95% CI) kg/m² Mean eGFR at baseline: 68.6±16.7 ml/min/1.73 m²	eGFR< 60 ml/min/ 1.73 m ²	eGFR- 186MDRD (4 variables)	Not mentioned	Not measured	Total Prevalence 28.9% Prevalence by categories eGFR>90 ml/min/1.73m ² :9.4% eGFR60- 90 ml/min/1.73m ² : 58.7% eGFR30-60 ml/min/1.73m ² : 28.1% eGFR<30 ml/min/1.73m ² : 0.9%	Medium
6 7	Sumaili EK ⁷⁵	2008 Congo Central	All Residents of Kinshasa	3018	Age (years): 44.3 ±15.3 Male gender: 59% Hypertension: 18% DM: 4%	Proteinuria ≥ +1	Proteinuria by urinary strip	Not assessed	17.1%	Total prevalence (based on proteinuria prevalence): 17.1%	High
901234	Egbi OG ⁷⁶	2014 Nigeria West	All Civil servants in Bayelsa	179	Age (years): 45.2 ± 10.3 Male gender: 53.1% SBP:128.5± 17.5 mmHg DBP: 81.8 ±13.2 mmHg	eGFR <60 ml/min/1.73 m² and/or presence of proteinuria of at least +1 on dipstick urinalysis	Proteinuria by urinary strip, eGFR by CG equation standardized for body surface area (BSA)	Kinetic Jaffe	5.6%	Total prevalence: 7.8% Prevalence by stage Stage 1:3.4% Stage 2: 2.2% Stage 3: 2.2% None in stage 4 or 5	Low
5 6 7 8 9	Oluyombo R ¹⁰⁵	2013 Nigeria West	Multistage sampling of Households of Ilie	454	Age (years): 45.8 ± 19.0 Male gender: 43% Hypertension: 20.4% DM: 0.6%	eGFR <60 ml/min and/or macroalbuminuria (ACR>300 mg/g or dipstick proteinuria)	Proteinuria by urinary strip, negative cases were estimated for albumin creatinine ratio, eGFR by 186 MDRD	Kinetic Jaffe	Macroalbuminuria in 8.9%	Prevalence: 18.8% Prevalence by stage Stage 1: 2.4% Stage 2: 4.1% Stage 3: 11.8% Stage 4: 0.5%	High
0 1 2	Eastwood J ¹³	2010 Ghana, West	Inhabitants of 12 villages	944	Age (years): 54.7±11.2 Male gender: 38% SBP:125.5±26.0 mmHg	KDOQI	175MDRD, CG, CKD-EPI	Kinetic Jaffe and calibrated IDMS		Total Prevalence (based on CKD-EPI and ethnicity correction) :	High

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4 5 6 7 8					DBP: 74.4 13.6 mmHg DM: 4% BMI: 21.1 ±4.2 kg/m ²					1.7% MDRD: 1.6% (7.2 % without ethnicity correction; CKD-EPI 1.7% (4.7% without ethnicity correction), CG 21.0%.	
10 11 12 13	Gouda Z ¹¹⁷	2011 Egypt North	Community based in Al- Buhayrah governorate	417	Age (years): 39.12 ± 14.29 Male gender: 43.2% Hypertension: 25.20% DM: 10.6% BMI: 29.96 ± 6.18 kg/m ²	eGFR <60 ml/min/1.73 m ²	Quantitative assessment of urinary ACR, eGFR by 175 MDRD	IDMS-calibrated	10.6% microalbuminuria	Total prevalence 18%	Medium
14 15 16 17 18 19 20 21	Ayodele OE ⁷⁷	2011 Nigeria West	People at a major trade center, the public servant secretariat and the state broadcastin g station	586	Age (years): 42.4±11.2 Male gender: 61.4 % Hypertension: 16.4% DM: 3.8% BMI: 25.9±5.4 kg/m ²	proteinuria ≥+1	Proteinuria by urinary strip	Not assessed	2.50%	Total prevalence (based on proteinuria): 2.50%	Medium
22 23 24 25 26 27 28	Abu-Aisha H ⁷⁸	2009 Sudan East	Pilot survey of police housing complex	273	Age (years): 34.3±12 Male gender: 49.1% Hypertension: 27% DM: 5.1%	eGFR <60 ml/min/1.73 m ² and or proteinuria	Proteinuria by urinary strip, 175MDRD, CG	Not mentioned	5.30%	Total prevalence (MDRD) 7.7% [11% by CG] Prevalence by stage Stage 1 or 2: 4.7% Stage 3:2.6% Stage 4: 0 Stage: 0.4%	Medium
29 30 31 32 33 34	Gharbi M ¹⁰⁶	2012 Morocco North	Stratified random sampling of population in two towns	10524	Age (years): range, 25-70 Male gender: (50%), Hypertension: 16.7%	eGFR < 60 ml/ min/1.73 m² or macroalbuminuria or dipstick abnormalities (proteinuria ≥ ++ 1 or haematuria: ≥ ++1) or diabetes type 1 associated with microalbuminuria	175 MDRD, microalbuminuria and proteinuria by urinary strip and ACR	Kinetic Jaffe and IDMS	microalbuminuria (30-299 mg/l): 5.26%	Total prevalence 2.90%	High
35 36 37 38 39 40 41	CU O ¹⁵³	2014 Nigeria West	All attendees to lectures of the Ebreime Foundation for the elderly,	170	Age (years): 68.1±7.7 Male gender: 67.1%	eGFR<60ml/min/1.73 m ²	175 MDRD	IDMS calibrated		Total prevalence: 43.50%, (all cases were at stage 3)	Low

Booysen H ¹⁵⁵	2016 South Africa South	participants from families of black African descent	1221	Age (years):44.1±18.4 Male gender:34.9% BMI (kg/m²):29.5±8.0 Hypertension: 45% Diabetes mellitus:25.2%	eGFR<60ml/min/1.73 m ²	eGFR by CG, 4 variables MDRD, CKD-EPI	IDMS calibrated	Not measured	Total prevalence:6.3%	High
1 Kalyesubul 2 a R ⁹⁰	2017 Uganda East	Community based survey among all households of Wakiso district	955	Age (years):31 (IQR: 24–42) Male gender: 33% BMI(kg/m²) categories: Underweight:5.5% Normal: 56.9% Overweight:24.2% obese : 13.4% Diabetics: 5.9%	KDOQI	Proteinuria by dipstick and eGFR by CG, MDRD, and CKD-EPI	Kinetic Jaffe	0.3%	Total prevalence: 15.2% Prevalence by stage: Stage 1: 6.2% Stage 2:12.7% Stage 3:2.4% Stage 4:0 Stage 5: 0.1%	High
5 6 7 Kaze F ⁹¹ 8	2015 Cameroo n Central- West	Population of the Littoral region	500	Age (years): 45.3 ± 13.2 Male gender: 53.4% BMI (kg/m²): 27.1 ± 5.3 Diabetes mellitus: 2.8% Hypertension: 12.2%	any albuminuria and/or eGFR <60 ml/min/1.73m ²	Albuminuria by dipstick and eGFR by CG, MDRD, CKD-EPI	Kinetic Jaffe and IDMS	7.2%	Total prevalence (CKD- EPI): 10% [14.2% by CG, 11%MDRD]	High
1 Kaze F ¹¹²	2015 Cameroo n Central- West	Population of the Western Region	439	Age (years):47 ± 16.1 Male gender: 42.1% Hypertension: 10.7% Diabetes mellitus: 5.9%	Albuminuria and/or eGFR <60 ml/min confirmed 3 months later	Albumnuria by dipstick and ACR and eGFR by CG, MDRD, CKD-EPI	Kinetic Jaffe and IDMS	12.1% had albuminuria	Total prevalence (CKD-EPI): 27.6% [38.5% by CG, 27.3%MDRD]	High
4 5 6 7 Laurence E ¹³⁰ 9	2016 South Africa South	Teachers from public schools in in the urban area of the Metro South Education District	489	Age (years): 46.3 ± 8.5 Male gender: 30% BMI(kg/m²):males: 29.1 ± 4.8 , females: $32.4.1 \pm 7$. Hypertension: 48.5% Diabetes mellitus: 10.1%	Proteinuria ≥0.30 mg/mg or eGFR <60 ml/min/1.73 m ²	Proteinuria by PCR and eGFR using MDRD	Kinetic Jaffe	Not mentioned	Total prevalence: 10.4%	Medium
1	2016 Uganda East	Urban residents of Kampala	141	Age (years): 64% in age group of 18-39 Male gender: 43% BMI(kg/m²): 25.9 (IQR 22.7–30.7) Hypertension: 38% Impaired fasting blood glucose: 13%	Proteinuria as urine protein of≥1+ on dipstick in the absence of hematuria and leukocyturia	Proteinuria by dipstick	Not measured	13%	Total prevalence(based on proteinuria): 13%	Low
Mogueo A ¹³¹	2015 South Africa South	Household residents of BellVille	902	Age (years): 55±15 Male gender: 23% BMI(kg/m²): 29.9 ±7.2 Hypertension: 49.8% Diabetes mellitus: 27.9%	eGFR <60 ml/min/1.73 m ² or any nephropathy	Albuminuria by ACR and eGFR by MDRD and CKD-EPI	Kinetic Jaffe	2.3%	Total prevalence(CKD-EPI): 21.7% [prevalence by MDRD: 29.7%]	Medium
Peck R ¹⁴⁸	2016, Tanzania	Stratified multistage	1043	Age (years):35.5 ± 15.3 Male gender: 45.7%	eGFR<60 ml/min/1.73 m ²	eGFR by MDRD and CKD-EPI	Kinetic Jaffe	Not measured	Total prevalence)CKD- EPI): 7%	High

4 5 6 7 8		East	sampling of adult population in Mwanza city, Geita and Kahama		BMI(kg/m²) categories: Underweight: 10.5% Normal: 71% Overweight: 11.8% Obese :6.6% Diabetes mellitus: 0.9%						
9 10 11 ^S 12	Stanifer 132	2016, Tanzania , East	stratified, cluster- designed cross- sectional household	481	Hypertension: 17.3% Age (years): 46.9 ± 15.1 Male gender: 74.4% Diabetes mellitus: 9.4% Hypertension: 31%	presence of albuminuria (≥30 mg/dl; confirmed by repeat assessment) and/or a reduction in eGFR ≤60 ml/min/1.73 m ²	Quantitative assessment of albuminuria and eGFR by MDRD and CKD-EPI	IDMS	6.8%	Total prevalence : 11.9%	High
14	Stanifer 133	2015, Tanzania , East	Randomly selected adults	481	Age (years): 45 (IQR 35–59) Male gender: 25.6% Diabetes mellitus: 12.7% Hypertension: 28%	eGFR<60 ml/min/1.73m ² and/or persistent albuminuria	Quantitative assessment of albuminuria and eGFR by MDRD	IDMS	Not mentioned	Total prevalence: 7%	High
18 19 20 21	Stanfier J 34	2016, Tanzania , East	stratified, cluster- designed cross- sectional survey	606	Age (years): 45.5 ±15.5 Male gender: 24.6% Diabetes mellitus: 10.1% Hypertension: 23.7%	the presence of albuminuria (≥30mg/dl confirmed by repeat assessment) and/or a oncemeasured eGFR ≤60 ml/min/1.73m²	Quantitative assessment of albuminuria and eGFR by MDRD	IDMS	Not mentioned	Total prevalence: 8%	High
	Wachukwu 2 ⁹³	2015, Nigeria, West	Adult volunteers in a university	259	Age (years):28.3±9.7 Male gender: 52.1% SBP(mmHg):117.3±15.5 DBP(mmHg): 75.7±11.7	eGFR<60 ml/min/1.73m ²	Proteinuria by dipstick and eGFR by CG	Not mentioned	12.4%	Total prevalence: 1.9%	Low

DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault,

CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative

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Table 3: Studies on CKD among HIV patients

,	Year, Country,	Location			Population	Definition of	Method of outcome	Creatinine assay			Quality
Author	Region		N	Study group	characteristics	CKD	assessment	assay	Proteinuria	CKD prevalence	assessme
1		ART clinic at			Age (years):			Kinetic		Total prevalence	Low
2		the regional			HAART-naïve			Jaffe		(CKD-EPI):	
3					(22.42 : 0.00) 0					,	
4		hospital			(33.42 ± 0.88) , On					10.2%	
5					HAART (36.91 ±					HAART naive:	
6 7		4		HIV (276	0.77)					8.7% CG, 9.1%	
8	2013,			HAART-naïve	Male gender:	eGFR < 60	CG, 186			MDRD, 8.7%	
9	Ghana,			patients		mL/min/1.73 m ²	MDRD,		Not	,	
	ŕ				HAART-naive					CKD-EPI	
O Wkba O ¹⁴²	West		442	166 on HAART)	(28.3%), On	for > 3months	CKD-EPI		measured	On HAART: 14.5%	
2		Three			Age (years): 36.8			Kinetic			Medium
3		centeres in			(32-42.2)	eGFR<60		Jaffe			
4								bulle			
0		Uganda and			Male gender: 35%	ml/min/1.73 m ²					
7		Zimbabwe			SBP: median:110	on ≥ 2					
8					(IQR:100-120)	consecutive visits					
9					,						
0	2011,				mmHg	80 days apart or					
1	Uganda,				DBP: median:70	confirmed 25%					
2	Zimbabwe,			HIV-infected	(60-80) mmHg	decrease if eGFR				Total prevalence :	
3	ŕ				, ,					•	
4	East and			patients initiating	BMI: 21.1 (19.1–	<60 ml/min/1.73			Not	7.2%	
2 3 4 5 6 7 8 9 0 1 2 3 4 5 töhr W ¹⁴³	South		3316	ART	$23.6) \text{ kg/m}^2$	m ² at baseline	CG		measured		
7	2008,	Three			Age (years): 36.8	eGFR<60 ml/min		Kinetic		Total prevalence (Medium
8 9	Uganda,	centeres in		HIV-infected	(32-42.2)	1.73 m^2 on ≥ 2	186 MDRD,	Jaffe	Not	MDRD):3.1%,	
Øtöhr W ¹⁴⁴	Zimbabwe,	Uganda and	3316	patients on ART	Male gender: 35%	consecutive	CG		measured	CG 7.4%	

3									
1	East and	Zimbabwe		SBP: median:110	occasions >80				
5	South			(IQR:100-120)	days apart or				
6 7				mmHg	confirmed 25%				
8 9				DBP: median:70	decrease if eGFR				
10				(60-80) mmHg	<60 ml/min/1.73				
11				BMI categories:	m ² at baseline				
12				<18.5 kg/m ² : 18%					
14				$18.5 - <25 \text{ kg/m}^2$:					
15									
16		4		66%					
18				25-<30 kg/m ² :					
19				12%					
20				\geq 30 kg/m ² : 4%					
92		Outpatients				Not		Total prevalence	Medium
23		HIV clinic			,	mentioned		(MDRD): 45.7%	
24		TITV CIMIC				mentioned			
25								GG: 46.5%	
27				Age (years): 40.1				Prevalence by	
28				(33-46.5) Male				Stages (using	
29				gender:29.7%				MDRD)	
ងប 81				Hypertension:				Stage 1: 30.2%	
12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 ^{ailhol J 79}				2.7%		Proteinuria		Stage 2:13.5%	
\$3 84	2011,			DM: 2%		by urinary		Stage 3: 2%	
94 85	Burundi,		HIV-infected					Stage 4 & 5: no	
36 11.7º					WDOOL		C 100/		
B7 ailhol J ''	East		300 patients	(19.3-24.2) kg/m ²	KDOQI	186MDRD	6.10%	patients	
ង្គុន និង្គ	2014,	Outpatient	HIV-infected	d Age (years): 40.0	Proteinuria≥ +1	Proteinuria Not	Proteinuria	Total prevalence	Low
38 39 40 ¹ (107	Congo,	HIV clinic	patients	± 10.7	by urinary strip or	by urinary measured	≥+1: 41.3%	(based on	
41									

3											
1	Central				Male gender:	albuminuria ≥30	strip and			proteinuria): 41.3	
5					27.8%	mg/dl	ACR			%	
6 7					Hypertension:						
8 9					46.8%.						
10					DM: 1.7%						
11					BMI: 22.3 ± 3.8						
12 13					kg/m2						
14					Kg/III2						
15											
16		Three			age(years): 36.8			Kinetic			Medium
17 18		centeres in			(IQR: 32.0–42.2)			Jaffe			
19		Uganda and		CA	male gender: 35%						
20		Zimbabwe			SBP: median:110	eGFR<60 ml/min					
21					(IQR: 100-120)	1.73 m^2 on ≥ 2					
23											
24					mmHg	consecutive					
25				HIV-infected,	DBP: median:70	occasions >80					
26 97	2008,			ART-naive	(IQR: 60-80)	days apart or					
28	Uganda,			adults with	mmHg	confirmed 25%					
29	Zimbabwe,			CD4+ cell	BMI: median, 21.1	decrease if eGFR				Total prevalence:	
30 81	East and			counts of<200	(IQR:19.1–23.6)	<60 ml/min/1.73			Not	7%	
18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 34 35 34 35 36 37 38 39 40 3bian J ¹⁰⁸	South		3316	cells/mm3	kg/m ²	m ² at baseline	CG		measured		
83 84		HIV			Age (years): 37			Not		Total prevalence (Low
\$ 5		outpatient			(range 16–70	Proteinuria ≥ +1	Proteinuria	measured		based on	
36 87	2009, South	clinic at		HIV-infected	years)	by urinary strip or	by urinary			proteinuria	
97 38	Africa,	Johannesburg		naïve ART	Male gender: 38%	albuminuria ≥30			43.7% had	prevalence):	
39 F. Ling 108			570								
	South	Hospital	578	patients	DM: 4.6% among	mg/dl	PCR		proteinuria	43.7%	
41			•					<u> </u>			

3										21	
1					group with						
5					microalbuminuria						
0 7		All						IDMS-			Medium
8											Medium
9		consenting						calibrated			
10		individuals			Age (years): HIV-						
11		residing in			ve, 28 (IQR: 24-						
12											
13		every		1202 HIV-	35), HIV+ve: 30						
14		household in		infected patients	(IQR: 25-36)					Total prevalence	
15 16	2010,	50 Rakai		and 664 HIV -ve	Male gender: HIV-					among HIV+ve :	
17						CED			Ni-4		
18	Uganda,	District		age- and sex-	ve: (38.7%),	eGFR<			Not	0.7%	
19 ucas G ¹⁵⁴	East	communities	1960	matched controls	HIV+ve (36.4%)	60ml/min/1.73 m ²	MDRD		measured		
20		Primary			_			Not		Total prevalence	Medium
21		health care						mentioned		(CKD-EPI with	
02								mentioned		(CKD-EFI WITH	
23		units				•				coefficient for	
25										black race): 2.5%	
26					Age (years): 30					CG: 3.4%	
27											
28					(IQR: 27–35)					(MDRD with	
29				HIV-infected	Male gender: 30%		CG,186			coefficient for	
ងប ១1	2011, sub-			patients before	BMI:22.8 (IQR:	CrCl <50 ml/min	MDRD,		Not	black race): 2.5%	
91 82 -160			2405								
83	Saharan,		2495	ART	20.4–25.6) kg/m ²		CKD-EPI		measured		
20 21 22 23 24 25 26 27 28 29 30 31 32 _{ao J} ¹⁶⁰ 33 34 35 36 37 38 39 40 ^{ongo A⁹⁹}		Consecutive			Age (years): 43 ±	eGFR< 60	proteinuria	Kinetic		Total prevalence :	Low
\$ 5		HIV patients		HIV-infected	9	ml/min/1.73 m ² /	by dipstick	Jaffe and		20.5%	
36	2012							IDMS			
3 7	2012,	from clinic		(ART	Male gender: 23%	or proteinuria	and 24-hour	IDMS		3% of the patients	
ង៥ ១០	Congo,			treated=264)	Hypertension:	defined as 1+ or	proteinuria,			had eGFR< 60	
рэ и Lango A ⁹⁹	Central		300	(ART naïve =36)	13%	greater	eGFR by		20.50%	ml/min/1.73 m ² by	
TO				,						·	

											28	,
					BMI:24	± 5		MDRD, CG			MDRD	
					(kg/m ²							
		HIV clinic					eGFR <60		Not			Low
		HIV CIMIC						Proteinuria				Low
							ml/min/1.73 m ² ;		mentioned			
)							or proteinuria	by urinary				
					Age (years	s): 38	>+ 1	strip, ACR,				
2					(32-45)		≥+ 1	PCR, eGFR				
3 4	2013,			HIV-infected	Male gender	r: 33%	(confirmed by	by CG,				
5							uPCR > 45				T	
3	Ghana,			patients starting	BMI: 20.3			MDRD,			Total prevalence	
S arfo F ¹⁰⁹	West	4	3137	ART	17.6-22.7) k	g/m ²	mg/mmol)	CKD-EPI			(CKD-EPI):13.8%	
		Electronic							Not			Medium
)		medical							mentioned			
2		records of										
}		patients from										
<u> </u>	2011,	18 sites			Age (years)): 35.5						
)	Cameroon,	throughout			(29.3-44.0)						Total prevalence	
7												
,	Central-	Western		HIV patients	Male	gender:	eGFR<60				(MDRD): 9.4%	
9 9 9 1 2 3 9 9 9 9 9 1 1 1 1 1 1 1 1 1 1 1 1 1	West	Kenya	7383	without ART	26.9%		ml/min/1.73 m ²	CG, MDRD			CG: 20.2%	
		Ambulatory			Age (years)	: 38.84			Kinetic			Low
,		Treatment			(IQR:	33.18-			Jaffe			
· }		Cantan										
		Center			46.23)							
;					Male	gender:						
j					33.9%							
`	2013,				BMI: 20.31	(IOR:					Total prevalence	
, ,							CITID :			37.	•	
1	Congo,			Newly diagnosed	17.97-22.89)	eGFR< 60			Not	:8.5%	
1												

3			1	1	1		1				9
		Academic						Kinetic			Low
		Model for the			Age (years): 35.0			assay			
		Prevention			(range, 19–60)		proteinuria				
3		and			Male gender:		by urinary				
0		Treatment of			32.1%		strip, CG,				
1		HIV/AIDS		HIV-infected	SBP: 104.7		full and		6.2%		
2 3	2007,	(AMPATH)		patients naive to	(range, 80–140)	CrCl<60	abbreviated		(proteinuria	Total prevalence	
Wools-Kaloustian K ⁸⁰	Kenya, East	clinic	373	ART	mm/Hg	ml/min/1.73 m ²	MDRD		≥1+)	:11.50%	
16		HIV/AIDS			Age (years): 34.6			Not			Mediu
17 18		outpatient			± 9.4			mentioned			
10 19		clinic		CL	Male gender:						
20					48.5%						
21					Hypertension:		Proteinuria		38%		
22 23				,		- Donning in 1					
24					13.2%	albuminuria +1	or		proteinuria		
25					BMI categories:	on at least two	albuminuria		with		
26 27					<19.0 kg/m ² : 59.2	occasions (4	by urinary		dipstick	Total prevalence	
28					%	weeks apart) and	strip and 24		21.9%	:38.8 %	
29	2008,				19-25 kg/m ² :	or serum	hours		nephrotic	Among patients;	
30 81	Nigeria,			HIV-infected	37.5%	creatinine >1.5	proteinuria ,		range	8.8% had CrCl <15	
20 21 22 23 24 25 26 27 28 29 30 31 32 _{mem C⁸¹ 33 34 35 36 37 38}	West		400	patients	>25 kg/m ² : 3.3%	mg/dl	CG		proteinuria	ml/min.	
34		Community			Age (years): 34		proteinuria	Kinetic	(9% among	Total prevalence	Mediu
35		based			(IQR: 30–39) HIV	eGFR<60	by urinary	Jaffe	HIV +	among HIV	
36 27	2011,			677 HIV-	+ve/43 (IQR:34–	ml/min/1.73 m ² /	strip, eGFR		and7.2%	+ve:9%	
38	Rwanda,			infected and 214	50) HIV -ve	or proteinuria +1	by MDRD,		among non-	2.7% had eGFR<	
89 Www.44 C ⁸²	· ·		901								
40 ^{vyatt C°2} 41	East		891	HIV-uninfected	Male gender: 0	or greater	CKD-EPI,		infected)	60 ml/min/1.73 m ²	

3									30)
4					Hypertension:		CG		CKD prevalence	
5					HIV+ve: 4.8%/				among HIV-ve:	
6 7					HIV-ve: 8.3%				7.2%	
8 9					BMI (kg/m²):				1.5% had eGFR<	
10					HIV+ve: 20.9				60 ml/min/1.73 m ²	
11					(IQR: 19.0–23.3)/					
12 13					HIV-ve: 20.5					
14 15					(IQR: 18.5–23.3)					
16		HIV clinic of				The presence of	Kinetic			Low
17		Yaoundé				proteinuria +1 or	Jaffe			
18 19		general		CA		more and eGFR<	Proteinuria		Total prevalence	
20	2013,	hospital		All newly		60 ml/min based	by urinary		:36%	
21 22	Cameroon,			diagnosed HIV-	Age (years):	on the average of	strip, eGFR		Among patients;	
23	Central –			infected patients	35±10.7	eGFR by 2	by CG, 175		3% had eGFR< 60	
16 17 18 19 20 21 22 23 24 25olefackKaze F ⁸³ 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 40 40 41 41 41 41 41 41 41 41 41 41 41 41 41	West		104	naïve to HAART	Male gender: 32%	equations	MDRD	36%	ml/min/1,73 m ²	
26		ART clinic in				any proteinuria	Not			Low
28		a central				(≥+1);	mentioned			
29		hospital in				heavy proteinuria				
30 31		Malawi			Age (years): 34.3	(≥+2); any				
32					± 9.3;	proteinuria (≥+1)			Total prevalence:	
33 34					Male gender:	with renal	Proteinuria		23.3%	
35				Consecutive	43.5%	dysfunction (e	by urinary		Among patients	
86 87	2011,			newly referred	Hypertension:	GFR <60	strip, eGFR		with proteinuria;	
38	Malawi,			HIV-infected	11.2%	ml/min/1.73 m ²)	by CG and		5.3% had CrCl<	
39 46 truik G ⁸⁴	East		526	patients on ART	DM: 0.8%	and heavy	MDRD	23.3%	60 ml/minute	
41		<u> </u>								

2 3										31	
						proteinuria (≥+2)					
4 5 6 7 8 9						with renal					
7						dysfunction (CrCl					
8						< 60 mL/minute)					
10						and					
12						the absence of					
13						any alternative					
14						cause for renal					
15 16						dysfunction or					
17		•				proteinuria.					
18						proteinuria.					
19		National					Serum	Not			Low
20 91		Central					creatinine	mentioned	Proteinuria		
22		hospital			Age(years): 22±4	Proteinuria > 0.5	measurement		>0.5 g/24		
23	1998,			HIV-infected	Male gender: 68 %	g/24 hrs and	and 24-hour		hrs in	Total	
24	Benin, West		92	patients		SCr>14 mg/l	proteinuria		23.33%	prevalence:27.16%	
26	Bellill, West		92	patients		3C1>14 Hig/1	proteinuria		23.3370		
27		infections						Not known		Total prevalence	Low
28		unit of the								among AIDS	
29		Jos								group:51.80%	
შ0 81	2003,	University		Consecutive 79						CKD prevalence	
32	Nigeria,	Teaching		AIDS patients					25% (AIDS	among control	
33				_						•	
Agaba El ¹⁷⁰	West	Hospital	126	and 57 controls		Not known	Not known		group)	group: 12.2%	
35 36		Outpatient				CrCl < 60	Proteinuria	Not		Total prevalence:	Low
8 7	2011,	clinics		HIV-infected		ml/min.	by urinary	mentioned		45.9%	
\$8	Zimbabwe,			patients naïve to		Proteinuria ≥ +1	strip and 24-			Among patients;	
20 21 22 23 24 25ttolou V ¹¹⁸ 26 27 28 29 30 31 32 33 4 gaba EI ¹⁷⁰ 35 36 37 38 39 4 gana GT ¹⁰⁰	South		159	ART		and/or PCR > 20	Î		45.90%	7.50% had CrCl<	
40 ^{ana} 31	South		137	71101		und/01 1 CIC > 20	noui		15.7070	7.5070 had CICI	
40											

						mg/mg	proteinuria,			60 ml/min	
							eGFR by CG				
							cork by co	27			_
		Medical				Microalbuminuria		Not			Low
		center				> urinary protein		mentioned			
)					Age (years):	30 and 300 mg/24					
2					31(range,13-63)	h.					
- }					Male gender: 25%,	A cut-off serum	Proteinuria				
ļ		9			Proteinuria -ve:	creatinine level of	by urinary				
5					117±14/70±9	250 mmol/l was					
) 7		4									
3					Microalbuminuria:	used to exclude	hour				
	2006, South				121±15/81±10	those patients	proteinuria,			Total prevalence (
	Africa,			HIV patients not	Macroalbuminuria:	with advanced	CG and			based on	
Man TM¹⁰¹	South		615	on ART	120±12/74±11	nephropathy	MDRD		6%	proteinuria): 6%	
}	2008,	Home-Based			Age (years): 39			Kinetic			Low
	Uganda,	AIDS Care		HIV patients	(median)	CrCl of 25–50	CG, 175	Jaffe	Not	Total prevalence:	
eters P ¹⁴⁷	East		508	starting HAART	Male gender: 41%	ml/min	MDRD		measured	20%	
7	Lust	Clinian	300	starting 11 11 11 11			MBRB	Not	measurea	2070	M.J
3		Clinics			Age (years):						Med
,)					HIV+ve (27 (IQR:			measured		Total prevalence	
	2011,				24- 31)),		Proteinuria		HIV+ve:	among HIV+ve (
2	Cameroon,			199 HIV +ve and	HIV-ve (27 (IQR:		by urinary		39.2%	based on	
) 	Central-			190 HIV -ve	22 -31))	Proteinuria (PCR	strip and		HIV-ve:	proteinuria):	
ao J 110	West		389	pregnant women	Male gender: 0	> 200 mg/g)	PCR		20.9%	39.2%	
7	2011,	Outpatient		HIV-infected	Age (years): 36.1		Proteinuria	Not	36%		Low
Deters P ¹⁴⁷ Bellion of the second of the		clinics			±7.9		and			Total nuovaloress	2011
9	Tanzania,	CHINES		patients naïve to				mentioned	proteinuria	Total prevalence:	
YIsango L ⁸⁵	East		355	ART	Male gender: 35%	KDOQI	albuminuria		≥	85.6%	

1										T	
					BMI (kg/m ²): 21.3		by urinary		+1		
					±3.8		strip eGFR				
							by CG,				
							MDRD				
0		primary			Age (years):			Not			Low
1		healthcare		Consecutive 238	pregnant, 28 (IQR:			mentioned			
2											
3 4		clinic		pregnant women,	25–32), men, 37						
5				1014 non-	(IQR: 32–45),						
6				pregnant, 609	women, 33 (IQR:						
7	2013, South			men; HIV-	28–39)					Total prevalence:	
3										•	
9	Africa,			infected patients	Male gender: 33%		Absolute Scr		Not	5.8%	
9 Nyer L ¹⁶² 1 2 3 4 5 6 7 8 9 0 Mulenga L ¹⁶³	South		1861	eligible for ART		CrCl< 60ml/min	and CG		measured		
2		Clinic			Age (years):			Not			Medium
3					normal CrCl,			mentioned			
4					33.7±7.9,						
7	2008,			HIV-infected,	decreased CrCl,		Absolute				
3	Zambia,			ART-naïve	38.5±9.9		Scr, eGFR			Total prevalence	
9	South			adults initiating	Male gender:		by CG and		Not	(MDRD): 3.2%	
0			25240		· ·	C Cl + CO 1/ :					
Mulenga L.			25249	treatment	39.7%	CrCl< 60 ml/min	MDRD		measured	:	
2		The			Age (years): 37.9+			Kinetic			Low
4		University			10.5			Jaffe and			
5		of Ilorin		Newly diagnosed	Male gender:			IDMS			
6					•			אועונו			
7	2015,	Teaching		HIV-infected	42.6%		Absolute				
2 3 4 5 6 7 8 9 9dedeji T ¹⁵⁸	Nigeria,	hospital,		ART naïve	BMI (kg/m ²):	eGFR< 60	Scr, eGFR		Not	Total prevalence:	
9	West		183	patients	20.88+ 3.56	ml/min/1.73m ²	by MDRD		measured	24%	

3											
<u> </u>											
6		Federal			Age (years); 38.84			Not			Low
6 7		Medical			± 10.65			mentioned			
8		Centre		393 newly	Male gender: 28%						
8 9 10		Centre			-						
				diagnosed drug-	BMI categories:						
11 12				naïve HIV	<18.5.0 kg/m ² : 7%		Quantitative				
13				patients, 136 age	18.5-24.9 kg/m ² :		assessment			Total prevalence	
14				and sex matched	35%	24-hours urine	of			among HIV +ve	
15					_						
16 17	2016,			HIV-	25-29.9 kg/m ² :	protein ≥0.300 g	protienuira,			patients:22.9%	
1 <i>7</i> 18	Nigeria,			seronegative	32%	and/or GFR <60	Scr, and		Not	Prevalence among	
1 9 anyabolu E ¹³⁵	West		529	controls	$\geq 30 \text{ kg/m}^2:23\%$	ml/min	eGFR		mentioned	HIV -ve: 8.1%	
		Medical Out-			Age (years): 40.3			Kinetic			Low
21											Low
22		patient			± 10.3			Jaffe			
33 24		Department			Male gender: 44%	•					
. 25		of University			BMI (kg/m ²): 20.5						
6		of Ilorin			± 4.8 among HIV						
27											
8		Teaching			patients , 26.7 \pm						
29		Hospital			5.3 among control						
1				227 newly-	group						
2				diagnosed, ART	SBP(mmHg):					Total prevalence	
3										•	
34				naïve patients	111.9 ± 1 among		Proteinuria			among HIV	
55 86				with	HIV patients,	albuminuria ≥ 30	by dipstick,			patients: 47.6%	
57	2015,			HIV/AIDS,	126.1 ± 12.0	mg/g and/or	and ACR			The prevalence	
20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 39 30 31	Nigeria,			108age and sex	among control	eGFR < 60	and eGFR		Not	among HIV –ve:	
39			225		-					-	
10 ^{9yokunle D¹¹³}	West		335	matched control	group	ml/ml/1.73m ²	by MDRD		mentioned	16.7%	

3										35	5
					DBP(mmHg): 72.9						
					± 9.5 among HIV						
					patients, 80.6 ± 6.8						
					among control						
0					group						
1											
2		Komfo			Age(years): 39		Proteinuria (Not		Total prevalence	Low
4							ì		270/		Low
		Anokye			(IQR: 35–46)		dipsticks,	mentioned	37% by	(proteinuria) :	
5 6 7	2015,	Teaching			Male gender: 25%		PCR, and		dipstick and	37%	
8	Ghana,	Hospital		HIV patients on	BMI(kg/m ²): 22.9	Proteinuria or	ACR) and		12% by	CrCl<60 ml/min	
9 hadwick D ¹¹⁴	West		330	ART	(IQR: 20.5-26.6)	CrCl<60ml/min	GFR by CG		PCR	among 7%	
0		Two primary			Age (years): HIV			Not			Medium
2		care clinics			+ve: 43 (IQR: 39–			mentioned			
3					50), HIV-ve: 49						
4											
					(IQR:40-56)						
7					Male gender: HIV						
3					+ve: 31%, HIV-						
9					ve:28.7%						
1					Hypertension:						
2					HIV+ve:44%,		7/				
3					HIV-ve: 33.2%						
4											
6					Diabetes mellitus:					Total prevalence:	
7	2015,			210 HIV+ve	HIV +ve: 5% ,					12.1%	
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 6 7 8 9	Kenya,			patients and	HIV -ve: 15.2%		eGFR by		Not	HIV+ve: 17%	
9	East		2206	1996 HIV –ve		CrCl<60 ml/min	CKD-EPI		measured	HIv-ve: 11%	

3											
		Lighthouse					eGFR by	IDMS			Medium
7		Clinic					CG, MDRD,	calibrated		Total prevalence	
3							and CKD-	creatinine		among HIV+ve	
0				116 HIV +ve			EPI with and	and		(creatinine based	
1 2	2016,			ART-naïve	Age (years): 31		without	cystatin-C		CKD-EPI):1.9%	
3	Malawi,	U		patients and 247	(IQR:26-39)	eGFR< 60	correction		Not		
4 Glaser N ¹⁴ 5	East		363	HIV-ve patients	Male gender: 52%	ml/min	factor		measured		
6		Lighthouse			Age (years): 34.1		Proteinuria	IDMS			Medium
7 8		Clinic			±10.9		by dipstick	calibrated		Total prevalence :	
9				CA	Male gender: 52%		and ACR,	creatinine		13%	
20 21 22 23 24					BMI(kg/m ²):		eGFR by	and		Prevalence among	
22	2016,			116 HIV +ve	23.2±4.8		CG, MDRD,	cystatin -C		HIV+ve22%	
23	Malawi,			patients and 247	Hypertension:		and CKD-			Prevalence among	
25 laser N ¹¹⁵	East		363	HIV –ve patients	13.5%	KDOQI	EPI		12.1%	HIV-ve: 9%	
26 27		Gugulethu			Age (years): 34			Not			Medium
28 29	2015, South	Community		HIV infected	(IQR: 29-41)			mentioned			
29 30	Africa,	Health		patients initiated	Male gender: 38%	eGFR< 60			Not	Total prevalence:	
3U 3 Kamkuemah M ¹⁶⁷	South	Centre	1092	ART therapy		ml/min	eGFR by CG		measured	2%	
32		Government		HIV patients on				Kinetic			Low
34		hospitals		HAART, DOTS	Age (years): 38.04			Jaffe			
35	2015,			or on the	± 10.52						
32 34 35 36 37	Cameroon			combined	Male gender:	eGFR <60					
38	Central-			therapy	50.5%	ml/min per 1.73	eGFR by		Not	Total prevalence:	
8 9 L ò lsagha D ¹⁴⁹	West		200	(HAART/DOTS)		m^2	MDRD		measured	8%	
÷ 1											

Age (years) 31.4							,			,	
Gulu O 2015, Regional Uganda, Referral East Hospital O University of Benin Touching Gulu Newly diagnosed Newly diagnosed BMI(kg/m²) <18: eGFR <60 by dipstick ml/min per 1.73 and eGFR by MDRD EGFR <60 by MDRD Proteinuria Proteinuria BMI(kg/m²) <18: eGFR <60 by dipstick ml/min per 1.73 and eGFR by MDRD EGFR <60 by MD		i	infectious			Age (years): 31.4		Not			Low
Gulu O 2015, Regional Uganda, Referral East Hospital O University of Benin Touching Gulu Newly diagnosed Newly diagnosed BMI(kg/m²) <18: eGFR <60 by dipstick ml/min per 1.73 and eGFR by MDRD EGFR <60 by MDRD Proteinuria Proteinuria BMI(kg/m²) <18: eGFR <60 by dipstick ml/min per 1.73 and eGFR by MDRD EGFR <60 by MD		Ċ	diseases			± 9.5		mentioned			
0 2015, Regional Newly diagnosed BMI(kg/m²) <18: eGFR <60 by dipstick Uganda, Referral HIV patients not 2 33% ml/min per 1.73 and eGFR by MDRD $\geq +1:52\%$ 14.4% University of Benin Benin Total prevalence: Total prevalence: East Hospital 361 receiving ART $\leq eGFR <60$ by MDRD $\leq +1:52\%$ 14.4% University of Benin $\leq eGFR <60$ Minerial $\leq eGFR <60$		C	clinic of			Male gender:					
0 2015, Regional Newly diagnosed BMI(kg/m²) <18: eGFR <60 by dipstick Uganda, Referral HIV patients not 2 33% ml/min per 1.73 and eGFR by MDRD $\geq +1:52\%$ 14.4% University of Benin Benin Total prevalence: Total prevalence: East Hospital 361 receiving ART $\leq eGFR <60$ by MDRD $\leq +1:52\%$ 14.4% University of Benin $\leq eGFR <60$ Minerial $\leq eGFR <60$		(Gulu			36.3%		Proteinuria			
1 Uganda, Referral HIV patients not 2 Benin HIV patients not 7 Total prevalence: $\frac{1}{3}$ and $\frac{1}{3}$		2015, I	Regional		Newly diagnosed	BMI(kg/m ²) <18:	eGFR <60	by dipstick			
2 \mathfrak{P}^{94} East Hospital 361 receiving ART \mathfrak{P}^{94} by MDRD $\geq +1:52\%$ 14.4% 4 University of Benin \mathfrak{P}^{94} Benin \mathfrak{P}^{94} and/or accompany \mathfrak{P}^{94} \mathfrak{P}^{9	1	Uganda, I	Referral		HIV patients not	33%	ml/min per 1.73	and eGFR	Proteinuria	Total prevalence:	
4 5 6 Benin Benin Tooching Tooching University of Benin Benin Benin Tooching Benin Tooching Benin B	2 ® dongo P ⁹⁴		Hospital	361	-		•	by MDRD	>+1:52%	14.4%	
Benin Benin Tanahing Benin Tanahing Benin Tanahing Benin Ml/min per 1.73 Quantitative Jaffe	4			301					1.02/0	1,0	
7 $\frac{1}{2}$ and/or accomment											Low
	6	F	Benin				ml/min per 1.73	Quantitative Jaffe			
Hospital Hospital Hospital Age (years): 36.03 kidney injury as proteinuria detected when the by PCR and		7	Teaching				m ² and/or	assessment			
00 1 1 2 2016, 1	9	I	Hospital				evidence of	of			
2016, Nigeria, West Medical in- patients at the Chris 2016, South Hani 2016, South Hani Description #9.08 #9.08 #1IV infected the policy of the patients at the Chris of	0					Age (years): 36.03	kidney injury as	proteinuria			
Nigeria, West Sas HIV infected Male gender: 41% PCR (mg/g) was eGFR by MDRD Not Total prevalence:	2	2016,				± 9.08	detected when the	by PCR and			
4	3	Nigeria,			HIV infected	Male gender: 41%	PCR (mg/g) was	eGFR by	Not	Total prevalence:	
Medical in-	4 Pokafor H ¹³⁶			383						_	
Medical in- patients at 37.0±9.6 Male gender: 60% Male gender: 60% BMI(kg/m²): 20.9 eGFR <60 eGFR by	6			303	naive patients		2200.		mentioned	33.370	
8 patients at the Chris Male gender: 60% BMI(kg/m²): 20.9 eGFR <60 eGFR by	7	l N	Medical in-					IDMS			Low
9	8	F	patients at			37.0±9.6					
2016, South Hani BMI(kg/m²): 20.9 eGFR <60 eGFR by	9	ť	the Chris			Male gender: 60%					
	1	2016, South I	Hani			BMI(kg/m ²): 20.9	eGFR <60	eGFR by			
Africa, Baragwanath HIV infected ±5.1 ml/min per 1.73 CG, MDRD, Not Total prevalence:	2	Africa, I	Baragwanath		HIV infected	±5.1	ml/min per 1.73	CG, MDRD,	Not	Total prevalence:	
South Hospital 100 naïve patients m² CKD-EPI measured 16%	3 နို့eape T ¹⁵⁶	South I	Hospital	100	naïve patients		m ²	CKD-EPI	measured	16%	
5 Rural Age (years): Albuminuria Not Total prevalence Med	5	1	Rural			Age (years):		Albuminuria Not		Total prevalence	Medium
6 2015, South Medical 40(IQR:34-48) Albuminuria or by ACR and mentioned (albuminuria):	6						Albuminuria			•	
Action Courts Applicated Miles and a 200 CCFD by	/				IIIV in Co. ()						
Africa, Centre HIV infected Male gender: 31% eGFR <60 eGFR by 21%	8	Africa,	Centre								
Wensink G ¹³⁷ South 903 adult patients Diabetes mellitus: ml/min / 1.73 m ² MDRD and 21% 2% had eGFR< 60	8 9						1/ 1/ 7/ 7/ 2	1 (DDD 1	010/	40/ 1 1 OFF - CO	1

<u>)</u>										38	3
•					4%		CKD-EPI			ml/min/1.73 m ²	
					Hypertension:						
					23%						
		Outpatient			Age (years):			IDMS			Medium
0		infectious			37.9±9.4						
1		clinic at an			Male gender:						
2 3		academic			35.5%						
4											
5		hospital			Diabetes						
6	2016, South			HIV infected	mellitus:2.2%	eGFR <60	eGFR by				
7	Africa,			patients initiating	Hypertension:	ml/min per 1.73	MDRD and		Not	Total prevalence:	
8 G - J H ¹⁵⁷			(50)			m ²					
Gachor H ¹⁵⁷	South		650	ART	7.8%	m ⁻	CKD-EPI		measured	2 %	
1		Jimma			Age (years):			Kinetic			Medium
2		University			HAART naive:			Jaffe			
3		Specialized			38.25 ±10.8,						
4											
5		Hospital			HAART +ve:						
6 7					35.14 ±9.2						
8					Male gender: 37%						
9					BMI(kg/m ²) :						
0											
1					HAART naïve:		77/				
2					20.7±3.2, HAART						
3 4					+ve: 21.6 ±3.5						
5				(223 HAART							
6					Hypertension:						
7	2016,			naïve and 223	3.36%	eGFR <60					
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9	Ethiopia,			HAART	Diabetes mellitus:	ml/min per 1.73			Not	Total prevalence:	
		1	i	1		1	l	I	1		I

. blond pressure, DBP diastolic blood pressure, IDMS Tooks, arapy, MDRD: Modification of Diet in Renal Disease, CG: Cockroth Gautt . DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, HAART: highly active antiretroviral therapy, DOTS: directly observed treatment short course, ART: antiretroviral therapy, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault, CKD-EPI: Chronic Kidney Disease Epidemiology, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative

Table 4: Studies on CKD among diabetic patients

Study ID	Year, Country , Region	Location N	Study group	Population Characteristics	Definition of CKD	Method of outcome assessment	Creatinin e assay	proteinuria	CKD prevalence	Quality assessment
Janmohamed MN ⁸⁶	2013, Tanzania, East	diabetes mellitus clinic of Bugando Medical Centre in Mwanza	Consecuti ve diabetic patients	Age (years): 54 (IQR: 45-62) Male gender: 46.6% Hypertension: 57.5% BMI (kg/m²): 25.6 (IQR: 22.6-29.6) Duration of DM (years): 6(3-11) 93.8% type 2 DM 6.2% type 1DM	eGFR ≤60 ml/min/1.73 m² or evidence of kidney damage (microalbuminuria or overt proteinuria).	Microalbumin uria, proteinuria by urinary strips, eGFR by CG	Kinetic Jaffe	Overt proteinuria (34.1%), microalbuminuria(45.8%)	Total prevalence:83.7%	Low
Wanjohi FW ⁸⁷	2002, Kenya, East	Outpatient diabetic clinic at Kenyatta National Hospital	Type 2 diabetic patients	Age (years): 53.7 ±9.3 Male gender: 37% Hypertension: 50% BMI (kg/m²): 27.8±6.0 Duration of DM (months): 10.3±7.5	Albuminuria > 20 mg/ L	Albuminuria by urinary strip, CG	Not mentioned		Total prevalence(based on albuminuria): 26%	Low

Bouzid C ¹¹⁹	2011, Tunis, North	nutrition	689	Type 2 diabetic patients from computeri zed hospital	Male gender: 39% Hypertension: 84.6% (renal insufficiency), 57.2% (no renal disease) Duration of DM (years): 11±8	eGFR<60 ml/min	CG, 24-hour proteinuria	Not mentioned	10.1% macroalbumnuria, 13% microalbuminuria	Total prevalence:	Low
Choukem SP ⁸⁸	2012, Cameroon, Central- West	Two main referral centres	420	Consecuti ve type 2 diabetic patients	Age (years): 56.7 ±9.9 Male gender: 49% Hypertension: 50% BMI (kg/m²): 28.5 ±5.2 Duration of DM (years): 4 (IQR: 1-9)	The presence of positive proteinuria with or without low CrCl < 90 ml/min/1.73 m ²	Proteinuria by urinary strip/eGFR by CG	Not mentioned		Total prevalence: 31%	Low
Keeton G ¹²⁰	2004, South Africa, South	Groote Schuur Hospital Outpatients Diabetic Clinic or the Somerset Hospital Outpatients	59	Type 2 diabetic patients	Age (years): 62 ±9.4 Male gender: 36% BMI (kg/m²): (31± 6) Duration of DM (years): 17 (Range: 14-33)	Double Scr level	Proteinuria by PCR, and serum creatinine	Not mentioned		Total prevalence: 66.1%	Low
BouAziz ¹²¹	2012, Tunisia, North	Basic Health Group of Sousse	115	73 type 2 diabetic patients and 42 healthy	Age (mean ±SE in years): 59.3 ±1.1 Male gender: 35% SBP (mean ±SE mmHg): 136.3 ±3.1	Microalbuminuria (defined as $<$ 2.8 g/mmol for women and $<$ 2.3 for men) and eGFR \leq 60 ml/min/1.73 m ²	Measurement of microalbuminu ria, eGFR by MDRD	Not mentioned		Total prevalence:	Low

				voluetees-	DBP (mean ±SE): 76.8						, , , , , , , , , , , , , , , , , , ,
				volunteers	, , , , , , , , , , , , , , , , , , ,						
					±1.9						
					BMI (mean \pm SE in kg/m ²):						
					30.5± 0.7						
					Duration of DM (years):						
					10.6 ±1						
		Referral		Medical	Age (years): 58 ±10.4		Microalbumin				Low
	2010	general		records of	Male gender: 35.7%		uria (>20 mg/L				
Katchunga	2010,	hospital		type 2	Hypertension: 59.2%		and <200	Not		Total prevalence:	
P ¹²²	Congo,		98	diabetic	BMI (kg/m ²): 25.2 ± 4.7	KDOQI	mg/L)	mentioned		66%	
	Central			patients	Duration of DM (years):		eGFR by				
				Î	17.3 ±8.5		MDRD				
		National		Type 1	Age (years): 53.3(range,						Low
			152			Presence of proteinuria				Total prevalence (Low
	2001, Benin,	University hospital centre			21-90)		24-hour proteinuria	Not		based on	
Djrolo F ¹²³	West			diabetic	Male gender: 65.8%			measured	28%	proetinuria level):	
				patients	Duration of DM (years):					28%	
					<1 – 16 or more					2670	
		Tertiary		Randomly							Low
	2011,	hospital		selected	Age (years): 59.4 ± 11.25		Proteinuria by				
Balogun	Nigeria,		40	type 2	Male gender: 37.5%	not mentioned	urinary strip	Jaffe	82.5%	Total prevalence:	
WO ¹⁰²	West			diabetic	Hypertension: 45%		and 24 hrs,	method	macroalbuminuria	90%	
				patients	Tryperionsism is /v		eGFR by CG				
											_
Mafundikwa	2007,	Diabetic clinic		Consecuti			Proteinuria by		Overt proteinuria	Total prevalence:	Low
A 103	Zimbabwe,		75	ve Insulin-	No available data	No available data	urinary strips		21%.	33%	
11	South			dependent			and 24-hour		Microalbuminuria	/*	
		1	l	1	l			l			

				diabetic patients			proteinuria		12%.		
Lutale J ¹²⁴	2007, Tanzania, East	Outpatient diabetic clinic	204	and 153 type 2 diabetic patients	45% type 1 DM 55% type 2DM Age (years): type 1, 21(14– 44.8), type 2, 53 (23.5–85) Male gender: 55% hypertension: 42% BMI (kg/m²): 19.3 ± 3.8 (type 1), 27.8 ± 4.8 (type 2) Duration of DM (years): 3(Range: 0-25)	KDOQI	Quantitative assessment of albuminuria, CrCl by CG	Kinetic Jaffe	Type 1: microalbuminuria was 12.1% and macroalbuminuria 1.1 %. Type 2: microalbuminuria 9.8% Macroalbuminuria 7.2%	Total prevalence: 18.5% 4.6% of Type 1 patients and 22% of Type 2 had eGFR < 60 ml/min/1.73 m ²	Low
Gill G ¹²⁵	2008, Ethiopia, East	Diabetic clinic at Mekelle Hospital	105	All diabetic patients	Age (years): 41±16 Male gender: 70% Hypertension: 5% BMI (kg/m²): 20.6±5.4 Duration of DM (years): 7±6	Nephropathy was considered present if the urinary ACR was >25.0mg/mmol and retinopathy was present. Microalbuminuria was diagnosed if the ACR was >2.5 and <25.0mg/mmol in men and >3.5 and <25.0mg/mmol in women.	ACR, Scr	Not mentioned	51% microalbuminuria	Total prevalence : 51%,	Low
Makulo R 111	2010, Congo, Central	Community	229	Diabetic and 148 impaired fasting	Age (years): 53.1±16.3 Male gender: 33% SBP (mmHg): 128.0±5.7 DBP (mmHg): 78.5±13.4 BMI (kg/m²): 22.6±5.2	eGFR of <60 mL/min/1.73 m ²	Urinary albumin by urinary strip and ACR, eGFR by	Kinetic Jaffe	29.6%	Total prevalence: 29.6% 10% of the patients had eGFR< 60	Medium

				glucose			186MDRD			ml/min/1.73 m ²	
				patients							
Adebamowo S ¹⁵¹	2016, Nigeria, Ghana, Kenya (sub- Saharan)	University medical centers and surrounding communities	4815	and 2607 controls free from DM	Age (years): 48±15 Male gender:41% Hypertension: (68.3% of type 2 DM, and 35.3% of diabetic-free) BMI(kg/m²): 26.9 ± 5.4 (diabetic patients) 25.5 ± 5.7 (non-diabetics)	eGFR of <60 ml/min/1.73 m ²	eGFR by MDRD and CKD-EPI	Kinetic Jaffe	Not measured	Total prevalence (MDRD): 9% 13.4% of type 2DM and 4.8% of diabetic free	Medium
Feteh V ⁹⁵	2016, Cameroon, Central-West	out-patient section of the endocrine unit of the Douala General Hospital	636	Cases of type 2 DM	Age (years): 56.5 ± 10.6 Male gender: 53.1% BMI (kg/m ²): 29.3 ± 14.7 Hypertension: 62.2%	eGFR of <60 ml/min/1.73 m ²	Proteinuria by dipsticks and eGFR by 186 MDRD		68.4% among anemic patients , 57.6% non anemic	Total prevalence: 18.5%	Low
Fiseha T ¹⁵²	2014, Ethiopia, East	Follow-up clinic at Butajira hospital	214	Diabetic patients	Age (years): 45 ± 14.5 Male gender: 57.5% SBP(mmHg): 121 ± 17 DBP(mmHg): 79 ± 10 BMI(kg/m ²): 25.26 ± 4.35	eGFR of <60 ml/min/1.73 m ²	eGFR by CG and 186 MDRD	Kinetic Jaffe	Not measured	Total prevalence (MDRD): 18.2% Prevalence (CG):23.8%	Medium
Pillay S ⁹⁶	2016, South Africa,	All patients seen at Edendale	653	Diabetic patients with or	Among diabetic patients with HIV: Age(years): 50-70	eGFR of <60 ml/min/1.73 m ²	Proteinuria by dipstick and eGFR by 186	Kinetic Jaffe	18%	Total prevalence : 18.8%	Medium

South	Hospital diabetic clinic		Male gender: 32% Among diabetic patients without HIV Age (years): 51-60		MDRD				
2007, Eghan B ¹³⁸ Ghana, West	Outpatient diabetic clinic of the department of medicine at 109 Komfo Anokye Teaching Hospital	HIV) Diabetic patients	Age (years): 54.1±10.9 Male gender: 28% Hypertension: 39% BMI(kg/m²): 26.3±4.4	microalbuminuria if urine albumin excretion was 30–300 mg/day	Albuminuria by urine albumin excretion and eGFR by CG	Not mentioned	43.1%	Total prevalence(based on microalbuminuria): 43.1%	Low

DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault, CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative

Table 5: Studies on CKD among hypertensive patients

	V	T 4°	1	C41		Γ	M.d. J	<u> </u>		1	0
Study ID	Year Country Region	Location	N	Study group	Population characteristics	Definition of CKD	Method of outcome assessment	Creatinine assay	Proteinuria	CKD prevalence	Quality assessment
Osafo C ¹²⁶	2011 Ghana, West	four polyclinics	712	Hypertensive patients	Age (years): 59 (range,19–90) Male gender: 21.3% DM: 14.7% SBP (mmHg): 150 (range,100–280) DBP (mmHg): 90 (range, 60–160) BMI (kg/m²): 29.7 (range,12.2–67.4) BMI categories (kg/m²): <25: 22.3% 25-29.9: 26% >30: 45.7%	KDOQI	Proteinuria by PCR (men>0.3 women>0.2 mg/mg) eGFR by MDRD	Kinetic Jaffe	28.90%	Total prevalence: 46.90% Prevalence by stage: Stage 1-2: 19.1% Stage 3-5: 27.8%	
Ajayi S ¹⁶⁴	2014 Nigeria, West	Tertiary health centre	628	hypertensive and diabetic patients	Age (years): 49.71±13.22 Male gender: 49% DM: 8.6% SBP (mmHg): 135.9 ± 27.4 DBP (mmHg): 87.0 ± 16.3 BMI (kg/m²): 27.8 ± 8.7	eGFR <60 mL/min/1.73 m ²	eGFR by MDRD	Not mentioned	Not measured	Total prevalence: 38.5%	Low
Lengani A ¹²⁷	2000 Burkina Faso West	department of Cardiology or Internal	342	Hypertensive patients	Age (years): 50.6 ±13.8 Male gender: 58%	Serum creatinine ≥ 650 μmol/l and or blood urea >=35 mml/l plus long	scr, 24-hour	Not mentioned		Total prevalence: 50.8%	Low

		medicine				history with clinical					
						manifestations					
						mamiesations					
		University		All hospitalized							Low
Nwankwo	2006	of		hypertensive	Age (years): 44.6 ± 14.9		Measurement of	Not		Total	
E ¹⁶⁵	Nigeria	Maiduguri	185	patients	Male gender: 49%	Scr >135 μmol/l	Scr	mentioned	Not measured	prevalence:	
L	West	Teaching					501	mentioned		45.50%	
		Hospital		UA							
		100 General		Random	Age (years): >=35 years	Albuminuria defined			21.3%	Total	Medium
	2006	practice		hypertensive	Male gender: 48.5%	as (mg/mmol)	Quantitative				
Rayner B ¹²⁸	2006	centres		patients	BMI: 23.6% of the patients had	microalbuminuria 3-	assessment of	not	microalbuminu	prevalence (
	South Africa South	109	1091	a normal BMI	30	albuminuria by	measured	ria 4.1%	based on		
					41.9% were overweight and 34.2% r	macroalbuminuria	ACR		macroalbumin	albumnuria):	
					were frankly obese	>30			uria	25.4%	
	1999	Komfo		Hypertensive	Age (years): 50.5 ±13.0		Proteinuria by			Total	Low
Plange-Rhule		Anokye	4.40	patients	Male gender: 36%	Plasma creatinine		Not	25.500/		
J 89	Ghana,	Teaching	448		SBP (mmHg): 165.0 ±27.8	≥140mol/l	urinary strips and	mentioned	25.50%	prevalence:	
	West	Hospital			DBP (mmHg): 101.9 ±17.9		serum creatinine			30.2%	
		seven		Hypertensive		Persistent				Total	Medium
		central		patients	Age (years): 50.4 ± 6.6	proteinuria on					
		government			Male gender: 64%	Urinalysis in the				prevalence:	
	2009	ministries in			SBP (mmHg):156.0 ±21.5	absence of urinary	Proteinuria and	Enzymatic		13.4%	
Addo J ¹⁴¹	Ghana , West	Accra	219		DBP (mmHg): 95 ±13	tract infection	eGFR by MDRD	assessment	13.4%	4.1% had	
					BMI (kg/m ²): 27.5 ± 5.4	and/or impaired				eGFR< 60	
					(3)	GFR<60 ml/min/				ml/min/1.73	
						1.73 m ²				m ²	
						1.,5 III					

Anokye hypertensive Male gender:37% Teaching patients and 61 SBP (mmHg): hypertensive patients(on			
Teaching patients and 61 SBP (mmHg): hypertensive patients(on			
Hospital and age matched antihypertensive therapy:155.46±1.82,		T	
the controls no antihypertensive therapy:152±3.27),		Total .	
surrounding control (117.38±0.96)		prevalence	
DBP (mmHg): hypertensive patients((CKD-EPI):	
Aryee C ¹³⁹ 2016, Ghana, 242 on antihypertensive eGFR <60 excretion, and eGFR Not	30%	14.5%	
West ml/min/1.73m ² by CG, 186 MDRD, mentioned therapy:101.46±0.94, no		Prevalence by	
and CKD-EPI antihypertensive therapy: 100.50±1.34),		MDRD:13.3%	
		Prevalence by	
control (73.28±0.77)		CG:16.6%	
BMI (kg/m²): hypertensive patients(on			
antihypertensive therapy:29.52±0.39, no			
antihypertensive therapy: 29.8±0.71),			
control (29.36±0.65)			
out- patient Newly diagnosed Microalbumnuria as a		Total	Low
2015 hypertension eligible black Age (years): 54.3 ± 6.2 Quantitative		prevalence (
Nabbaale J ¹⁴⁰ Uganda clinic 256 adult Male gender: 36.7%	39.5%	based on	
East level between 30 and level between 30 and albumin in urine measured		microalbumin	
patients 299 mg/dl.		uria): 39.5%	

DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault,

CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative

Table 6: Studies on CKD among other populations

Study ID	Year Country Region	Location N	Study group	Population Characteristics	Definition of CKD	Method of outcome assessment	Creatinine	Proteinuri a	CKD prevalence	Quality assessment
E.F K ¹⁹	2013 Senegal West	Nephrology department of the Aristide Le Dantec University Hospital Center.	Lupus patients	Age (years): 32.9 Male gender: 7% Hypertension: 30%	Proteinuria > 0.5 g/ 24 hours with or without hematuria/ renal insufficiency/ abnormal renal biopsy	24-hour proteinuria and eGFR by CG	Not mentioned	51%	Total prevalence: 72%	Low
Abd ElHafeez S ²⁹	2009 Egypt North	The Nephrology department at the Main Alexandria University 400 hospital	Relatives of ESRD patients	Age (years): 35.2±11.6 Male gender: 50.8% Hypertension: 60% DM: 11.5% BMI(kg/m²): 28.5±5.89	KDOQI	Proteinuria by urinary strips, 186 MDRD	Kinetic Jaffe	21.3%	Total prevalence 57% Prevalence by stage: Stage 1: 9% Stage 2: 44% Stage 3: 4% Stage 4: 0.3%	medium
Raji Y ²⁸	2015, Nigeria,	Nephrology out-patient 469	(230 first degree relatives of patients with CKD and	Age (years): 33.49 ± 12.0 BMI(kg/m ²): first degree relatives: 25.5 ± 5.3 , controls: 23.8 ± 4.0	Reduced eGFR	Albumnuria by ACR and eGFR by MDRD	Not mentioned	46%	Total prevalence:	Low

	West	clinic at Lagos University Teaching Hospital	230 age- and gender- matched controls with no personal or family history of CKD)	SBP(mmHg): first degree relatives: 116.5 ± 22.5 , controls: 112.1 ± 18.1 DBP(mmHg): first degree relatives: 74.9 ± 12.7 , controls: 71.4 ± 10.5					4%	
EISharif M ²⁴	2013 Sudan East	Primary health care	Patients attending the primary health care facilities	Age (years): 43.35± 12.80 Male gender: 16% Hypertension: 10% DM: 5.95% BMI (kg/m²): 28.67 ± 6.43 BMI categories (kg/m²): <18: 2.38% >25.13: 71.83	without proteinuria.	Proteinuria by urinary strip and eGFR by MDRD	Not mentioned	24.21%	Total prevalence: 10.32%	Low
Mo A ²⁶	2009 Nigeria West	Family practice clinic	Newly registered patients who attended the Family Practice Clinic	Age (years): 50.52 + 13.03 Male gender: 27.2% 32% elevated SBP, 30% elevated DBP DM: 6% Obesity: 32%	Persistently abnormal ACR irrespective of GFR level or persistent eGFR < 60 mL/min/1.73 m² irrespective of the presence or absence of Kidney damage after 3 months	Proteinuria by urinary strip, eGFR by MDRD	Standardized IDMS	14.4%	Total prevalence: 14.4% 10.4% had persistent eGFR< 60 ml/min/1.73 m²	Medium
Sumaili EK	2009 Congo	Primary and secondary 527	At risk population randomly selected	Age (years): 53.9 ± 15.5 Male gender: 43% Hypertension: 58.2% DM: 54.5% Obesity: 16%	KDOQI	Proteinuria by urinary strip, 24-hour proteinuria, 175 MDRD	Kinetic Jaffe	19%	Total prevalence: 36% Prevalence by stage	High

	Cambral I	haalth aana		<u> </u>			<u> </u>			ataon 1:	1
	Central	health care								stage 1: 4.2%, stage 2:	
										6.1%, stage	
										3: 18.3%,	
										stage 4:	
										1.9%, stage 5: 5.7%	
		P. J1		California Company Harl		Postsioneis 24				3. 3.170	T
		Federal		Subjects from medical		Proteinuria as 24					Low
2	2016,	Medical		out-patient department of		hours protein ≥					
Anyabolu E ³⁰ N	Nigeria,	Center	136	the hospital.	Age (years): 38.58±11.79 Male gender: 27.9%	0.300g and impaired	Proteinuria by quantitative	Vinatio Inffa	14.1% had	Total	
	-		130		BMI(kg/m ²): 25.51±6.47	renal filtration	assessment and Scr	Kinetic Jane	proteinuria	prevalence: 14.1%	
	West					function as CrCl				11170	
						<90mls/min					
	2015,	Charlotte		African patients with							Low
	ŕ	Maxeke		rheumatoid arthritis	Age (years): 57.1±10.8 Male gender: 17.2%	GUD.		Kinetic Jaffe	NT .		
Dessein P ²⁰	South	Johannesburg	233		BMI(kg/m ²): 27.4±6.0 Hypertension: 57.5%	eGFR<	eGFR by CG, MDRD,	and IDMS	Not	Total prevalence:	
	Africa,	and Milpark			Diabetes mellitus: 12.5%	60ml/min/1.73m ²	CKD-EPI	calibrated	measured	39%	
S	South	Hospitals									
		Tema		Patients with sickle cell		(eGFR < 60	UA				Low
						`					LOW
2	2015,	General		anemia	Age (years): 23.25 ± 12.04	mL/min/ 1.73 m ² or					
	Ghana,	Hospital	194		Male gender: 43.3% SBP(mmHg): 110.06 ± 8.27	evidence of kidney	Proteinuria by dipstick	IDMS	13.4%	20.20/	
	West				DBP(mmHg): 67.16 ± 8.23 BMI (kg/m ²): 18.85 ± 11.19	damage as	and eGFR by CKD-EPI			39.2%	
	*** 031				Divir (kg/iii). 10.05 ± 11.19	albuminuria, or					
						overt proteinuria					

Rensburg B	South	hospital	the Renal Unit	Male gender: 51.1%	$\mu mol/L)$ and small	assessment and Scr	mentioned	proteinuria	prevalence:	
27	Africa			Hypertension: 13.2%	kidneys on imaging	measurement		>3.5 g/dl	37.9%	
	South			DM: 10.8%	without evidence of					
					reversible causes					
		hairdressing	Hairdressers	A an (consent 40+8		Proteinuria by urinary			Total	Low
	2011	saloons		Age (years): 40±8				26.4% had	prevalence:	
	Sudan	72		Male gender: 0%	Scr level≥2 mg/dl	strip and 24 hrs	Not	albuminuri	26.4%	
M^{104}	East			Hypertension: 19.4%		Scr measurement and	mentioned	a	14% had Scr	
						renal biopsy			≥2 mg/dl	
		male workers	Male workers attending						Total	Low
		attending the	the out-patient clinic of	CA				93% among	prevalence (
	2003	out-patient	the Health Insurance	Age (years): 39.83±7.27				non-silica	among	
EL-Safty I ¹²⁹	Egypt	clinic 81	Organization	Male gender: 100%	Elevated proteinuria		Not measured	exposed	those with	
	North	of the Health	Workers (29 non-	Hypertension: 19.4%		quantitatively		100% silica	Silica	
		Insurance	silicotics, 24					exposed	exposure):	
		Organization	silicotics and 28 referent)		16				100%	

DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault,

CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative

Titles and legends

Fig. 1 Flow diagram of the study selection

Fig. 2 Prevalence of CKD among entire general population

Fig. 3 Main causes of CKD

Supporting information

S1 Table: Search strategy adopted in PubMed and Ovid MEDLINE

S2 Table: Studies among CKD patients

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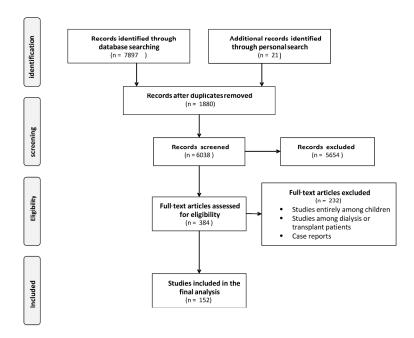


Fig1
254x190mm (300 x 300 DPI)

Fig 1

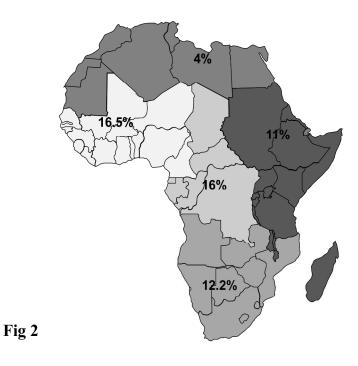


Fig2
254x190mm (300 x 300 DPI)

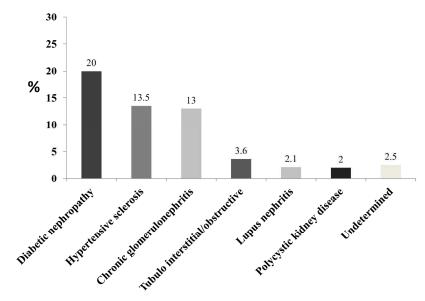


Fig 3

Fig3
254x190mm (300 x 300 DPI)

S1 Table. Search strategy adopted in PubMed and Ovid MEDLINE

- 1. exp Renal Dialysis/
- 2. (hemodialysis or haemodialysis).tw.
- 3. (hemofiltration or haemofiltration).tw.
- 4. (hemodiafiltration or haemodiafiltration).tw.
- 5. dialysis.tw.
- 6. (CAPD or CCPD or APD).tw.
- 7. Renal Insufficiency/
- 8. Kidney Failure/
- 9. exp Renal Insufficiency, Chronic/
- 10. Kidney Diseases/
- 11. Uremia/
- 12. (end-stage renal or end-stage kidney or endstage renal or endstage kidney).tw.
- 13. (ESRF or ESKF or ESRD or ESKD).tw.
- 14. (chronic kidney or chronic renal).tw.
- 15. (CKF or CKD or CRF or CRD).tw.
- 16. (predialysis or pre-dialysis).tw.
- 17. ur?emi\$.tw.
- 18. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17
- 19. afric\$.ti,ab,kw,tw,mp.
- 20. 18 and 19

S2 Table: Studies among CKD patients

Study ID	Year Country Region	N	Population Characteristic	biops y	causes of CKD
El Khayat	2013, Morocco, North	134	Age(years): 54.4±18.1 Male gender: 58.65%	no	Tub.int: 9.7% DN: 44% H.scl: 11.2% Ch.GN: 3.7%
Seck S ³²	2013, Senegal, West	60	Age (years): 70.5±54.6 Male gender: 52% Hypertension: 20% SBP (mmHg): 167 ± 78 DBP (mmHg): 95 ± 55 DM: 18%	no	DN: 25% H.scl: 30%
Seck S ³³	2008, Senegal, West	118	Age (years): 39.28±16.4 Male gender: 56% SBP (mmHg): 160±15 DBP (mmHg): 90±15	yes	Tub.int: 12% H.scl: 20% Ch.GN: 35%
Bourquia A ³⁴	2002, Morocco, North	420	Age (years): 46±3 Male gender: 52%	no	PKD: 3%
Ouattara B ³⁵	2011, Ivory Coast, West	301	Age (years): 44±10 Male gender: 56% Hypertension: 33.5% DM: 12.3%	no	Tub.int: 10.3% DN: 9.65% Ch.GN: 17% undetermined : 29.2%
Lengani A ³⁶	1997, Burkina Faso, West	174	Age (years): 36±15 Male gender: 63% Hypertension: 64.9%	no	Tub.int: 16.1% Ch.GN: 42.5% PKD: 16.1% undetermined : 14.4%
Afifi A ³⁷	2005, Egypt, North	220	Not known	no	DN: 28.2% H.scl: 25.5% obstructive: 5.9%
Diouf B ³⁸	2000, Senegal, West	261	Age (years): 44(range:15-88) Male gender: 46%	no	DN: 20.5% H.scl: 34.23% Ch.GN: 15%
Niang A	2008, Senegal, West	258	Age (years): 28 (range:15-79) Male gender: 75% Hypertension: 12.2%	yes	FSGS: 42% Tub.int: 10%
Sabi K A ⁴⁰	2011, Togo, West	398	Age (years): mean: 42.6 Male gender: 57%	not know n	Tub.int: 20.9% Ch.GN: 40.2%
Ulasi I ⁴¹	2010, Nigeria, West	1538	Age (years): 42.55±15.43 Male gender: 65% Hypertension: 17.2% DM: 11.8%	yes	FSGS: 40.5% H.scl: 17.2%
AbdErrahi m E ⁴²	2001, Tunis, North	299	Age (years): 38.3±14.6 Male gender: 69%	no	DN: 20.3%

			Age (years): 28 (IQR:5-60)		FSGS: 67%
			Male gender: 56%		MGN: 12.5%
			Wate gender. 30%		DN: 23.5%
		115		yes	SLE: 55%
Abdou					undetermined
N ⁴³	2003, Senegal, West				: 7%
Afifi A ⁴⁴	2004, Egypt, North	3172	Age (years): 56.5±29.2	yes	DN: 14.5%
	,		Age (years): 45.6±14.2	-	DN: 8.9%
			Male gender: 62.4%		H.scl: 28%
			Section 621.77		obstructive:
		4905		yes	15%
					PKD: 3%
					undetermined
Afifi A ⁴⁵	1999, Egypt, North				: 16.2%
I			Age (years): 41±16		DN: 17.5%
		130	Male gender: 68%	no	H.scl: 29.7%
Agaba		130		110	Ch.GN:
EI ⁴⁶	2009, Nigeria, West				45.6%
			Age (years): 49 (range: 36-61)		DN: 13.3%
		2417	Male gender: 58%	no	H.scl: 26.1%
Alashek W ⁴⁷	2012 Librar Manth				Ch.GN:
W	2012, Libya, North		Age (years): 46.2±17.6		41.2% DN: 13.4%
			Male gender: 63%		H.scl: 42.8%
			SBP (mmHg): 171.2±31.9		obstructive:
			DBP(mmHg): 102.5±27.4		14.9%
		320	DDI (IIIIIIIg). 102.3±27.4	yes	SLE: 1%
		320		yes	Ch.GN:
					15.9%
Alasia					undetermined
D^{48}	2012, Nigeria, West				: 9.5%
	, ,		Age (years): 39.6±14.8		
			Male gender: 59%		Tub.int: 2.2%
		153	Hypertension: 38.5%	no	H.scl: 31.1%
		133	SBP (mmHg): 167.3±15.5	no	Ch.GN:
Alebiosu			DBP (mmHg): 106±28.9		43.7%
C O ⁴⁹	2006, Nigeria, West		DM: 13.1%		
			Age (years): 47.5±15.7		DN: 16.1%
		201	Male gender: 56.2	no	H.scl: 7.6%
Amira	2012 N W.		Hypertension: 42.8%		Ch.GN: 1.8%
CO ⁵⁰	2012, Nigeria, West		DM: 13.4%		PKD: 2.9%
			Age(years): 36 (range:15-90)		
		760	Male gender: 70.3% Hypertension: 72.4%	no	FSGS: 79.2%
Arogunda		700	SBP (mmHg): 160 (range:120 – 270)	no	F3G3. 19.2%
de FA ⁵¹	2011, Nigeria, West		DBP (mmHg): 100 (range:50 – 209)		
GC 171	2011, 11150114, 11051		Age (years): 51.4±18.0		DN: 14.7%
Counil		6397	Male gender: 56.5%	no	H.scl: 52.8%
$\acute{\mathbf{E}}^{52}$	2008, Tunis, North				PKD: 17.2%
	, ,		Age (years): Male: 50.89±13.43 and Female:		
			48.22±14.70		Tub.int:
		116	Male gender: 61.2%	no	17.1%
Chijioke			SBP(mmHg): 153.41±27.12		Ch.GN: 36%
A ⁵³	2012, Nigeria, West		DBP (mmHg): 93.92±17.19		
Madala	2014, South Africa,	302	Age (years): 47.1±17.0	yes	PKD: 1.8%

ND ⁵⁴	South		Male gender: 45%		
			SBP (mmHg): (male) 144.6 ± 28.3.		
			$(female)141.1 \pm 25.5$		
			DBP(mmHg): (male) 84.2 ± 18.1 .		
			$(female)81.0 \pm 19.0$		
			Age (years): 66.3 ± 5.7		DN: 22.2%
			Male gender: 47.7%		H.scl: 38.8%
		111	Hypertension: 71%	MAG	Ch.GN:
Olemaahi	2012 South Africa	111		yes	28.8%
Okpechi IG ⁵⁵	2013, South Africa,		DM: 19.8%		
IG	South				PKD: 2.7%
			Age (years): 47.2 (range:29 - 70)		DN: 12.5%
			Male gender: 24%		H.scl: 45%
			Hypertension: 59%		obstructive:
		3783		no	12.5%
					Ch.GN:
Laleye					15.8%
A^{56}	2012, Benin, West				PKD: 3.3%
Okunola	2012, 201111, 1100		Age (years): 49 ±16.25		
Y ⁵⁷	2013, Nigeria, West	300	Male gender: 68%	no	Ch.GN: 58%
1	2013, Nigelia, West				Tr. 1. 1 0. 0.07
			Age (years): 47 + 14		Tub.int: 8.8%
			Male gender: 60%		DN: 7.4%
			SBP(mmHg): 162 ± 32		H.scl: 34.2%
		120	DBP(mmHg): 94.9 ± 19.6	yes	Ch.GN:
					39.2%
Bello					undetermined
BT^{58}	2013, Nigeria, West				: 3.45%
	-		Age(years): 46 ± 13		DN: 11.5%
			Male gender: 65%		H.scl: 34.6%
					Ch.GN: 39%
El-		800		no	PKD: 6.9%
Minshawy					undetermined
O ⁵⁹	2011 Frank North				
U	2011, Egypt, North		A () 22.0 + 12.0		: 7.5%
			Age (years): 33.9 ± 12.0		Tub.int: 1.2%
			Male gender: 45.2%		DN: 26.5%
			Hypertension:39.8%		H.scl: 14.6%
		294		yes	obstructive:
					5%
Okpechi	2010, South Africa,				Ch.GN:
$IG^{\overline{60}}$	South				21.2%
			Age(years): 41.4 ± 13.1		
			Male gender: 37.2%		DN: 41.5%
			SBP (mmHg): African (133.6 \pm 20.2). Indian		H.scl: 14.6%
		148	(130.1 \pm 20.6)	no	Ch.GN: 16%
Madala	2012, South Africa,		DBP (mmHg): African:(133.6 \pm 20.2). Indian		undetermined
N ⁶¹					: 15.55%
1N	South		(130.1 ± 20.6)		E000 10.50
			Age (years): 52.43 ± 15.48		FSGS: 10.5%
El		207	Male gender: 64.3%	no	MGN: 35%
Farouki		_==,	Hypertension: 73.9%		H.scl: 18%
M^{62}	2013, Morocco, North		DM:41.5%		SLE: 39%
			Age (years): 36.8 ±14.0 years		DN: 19.4%
Okpechi	2011, South Africa,	1284	Male gender: 45.2%	yes	H.scl: 40%
I^{63}	South				Ch.GN: 21%
	~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~		Age (years): 47 ± 13 years		DN: 27.5%
Niang		62	Male gender: 55%	no	H.scl: 10.5%
A ⁶⁴	2014, Senegal, West	02	Time gender. 55 /6	110	Ch.GN: 8%
Л	2014, Schegal, West				CII.UIN. 070

Buargub M ⁶⁵	2008, Libya, North	124	Age (years): 47.4±15 Male gender: 62%	no	PKD: 30%
Chijioke A ⁶⁶	2010, Nigeria, West	67	Age (years): 47.4 ± 16.2 Male gender: 57%	no	H.scl: 20% obstructive: 15% Ch.GN: 11% undetermined : 27%
Elsharif M ⁶⁷	2011, Sudan, East	224	Age (years): 45.78± 17.16 Male gender: 67.8%	yes	H.scl: 14.3% obstructive: 11.6% ndetermined: 53.5%
Elkhatib	2012, Egypt, North	437	Age (years): 89% <50 years. 8.5% 50–60 years and 3%> 50 years Male gender: 52%	yes	FSGS: 6.8% MGN: 10.9% SLE: 24.7%
Ibrahim S ⁶⁹	2012, Egypt, North	924	Age (years): 26.5 ± 14.6 years Male gender: 47%	yes	FSGS: 20.2% MGN: 10.5% SLE: 8.6%
Ayach G ⁷⁰	2011, Morocco, North	386	Age (years): 19 (IQR:12-25) Male gender: 61%	yes	Tub.int: 5.6% DN: 29.8% H.scl: 77.8% Ch.GN: 35%
Ramilitian a B ⁷¹	2016, Madagascar, East	239	Age (years): 45.5(range: 16-82) Male gender: 40% Diabetes mellitus: 12.6%	No	Tub.int: 10.46% Ch.GN: 40.1% DN:12.6% H.Scl: 35.6%
Zajjari Y ⁷²	2012, Morocco, North	16	Age (years): 60 (47-79) Male gender: 81.3% Hypertension: 56.3%	Yes	DN: 25%

Tub. Int: tubulo-interstital, DN: diabetic nephropathy, H Scl: hypertensive sclerosis, ch GN: chronic glomerulonephritis, PKD: polycystic kidney disease, DM: diabetes mellitus



PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT	•		
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3,4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	N/A
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4,5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4,5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	4, supplementary table 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4,5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	4,5
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	4,5
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	5,6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6



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PRISMA 2009 Checklist

Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I ²) for each meta-analysis.	6
		Page 1 of 2	
Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	6
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	6,7,17, Fig.1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Tables(2-4, supplementary table 2) P:19- 51
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Tables(2-4, supplementary table 2) P:19- 51
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	6-11, 18-51
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Tables 2,3 and 4, P: 19- 51
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	11
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified researeผู้จะporting bitts)://bmjopen.bmj.com/site/about/guidelines.xhtml	12,14, 15

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PRISMA 2009 Checklist

Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.				
FUNDING						
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	54			

For more imu..

Pay. 11 From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. 12 doi:10.1371/journal.pmed1000097

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CHRONIC KIDNEY DISEASE IN AFRICA: A SYSTEMATIC REVIEW

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CHRONIC KIDNEY	DISEASE IN	AFRICA. A	CVCTFMATIC	REVIEW

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ABSTRACT

Objectives: While increasing attention is being paid to the rising prevalence of chronic diseases in Africa, there is little focus on chronic kidney disease (CKD). This systematic review assesses the CKD burden among the general population and high-risk groups on the entire African continent

Design, setting, and participants: We searched the MEDLINE and PUBMED databases for articles published between January 1st, 1995 and April 7th, 2017 by sensitive search strategies focusing on CKD surveys at the community level and high risk groups. In total, 7918 references were evaluated, of which 7766 articles were excluded because they did not meet the inclusion criteria. Thus, 152 studies were included in the final analysis

Outcome measurement: The pooled prevalence rate of CKD was expressed as a point estimate and 95% CI. No meta-analysis was done. Data were presented for different population.

Results: In the community-level studies, based on available medium and high quality studies, the pooled prevalence of CKD in Africa was 10.1% (95% CI: 9.8%-10.5%). West/Central-West had the highest prevalence (16.5%), followed by Central (16%), Southern (12.2%), Eastern (11.0%), and North (4%) Africa. The prevalence in sub-Saharan Africa was 14.02%. The pooled prevalence of CKD in the high risk groups was 5.6% (95% CI: 5.4-5.8%) in HIV (based on available medium and high quality studies), 24.7% (95% CI: 23.6-25.7%) in diabetes (based on all available studies which are of low quality except four of medium quality) and 34.5% (95 % CI: 34.04%-36%) in hypertensive patients (based on all available studies which are of low quality except two of medium quality)

Conclusion: In Africa, CKD is a public health problem, mainly attributed to high risk conditions as hypertension and diabetes. The poor data quality restricts the validity of the findings and draws the attention to the importance of designing future robust studies

Strengths and limitations of the study

- This systematic review assessed the CKD burden among the general population and highrisk groups on the entire African continent based on studies that covered all Africa from January1st, 1995 till April7th, 2017
- The quality of the included articles was assessed based on standard criteria dealing with clinical trials, diagnostic studies, and observational studies. The articles were assessed based on the population sampling and precision, sampling technique, response rate, and exclusion rate.
- No meta -analysis was conducted in this review due to the huge discrepancy in the definition used to identify CKD, the methods of creatinine measurement, urine protein assessment, and in the quality of the reporting.
- The review findings were limited by the low quality of the majority of studies in Africa
- The prevalence of CKD reported in this review should be interpreted with caution due to the bias introduced from the heterogeneity between studies, analytical and methodological issues, sample size, and study population selection

INTRODUCTION

Chronic kidney disease (CKD) is an emerging global public health problem¹. The disease is a component of a new epidemic of chronic conditions that replaced malnutrition and infection as leading causes of mortality during the twentieth century². Age-standardized death rates due to CKD have increased during the last 23 years. CKD has shifted from the 36th cause of death in 1990 to the 19th cause in 2013³. The worldwide increase in CKD and kidney failure-necessitating renal replacement therapy (RRT) -and the high rate of cardiovascular mortality and morbidity attributable to CKD are poised to reach epidemic proportions over the next decade. CKD complications represent a considerable burden on global health care resources and only a small number of countries have sufficiently robust economies to meet the challenge posed by this disease. Socioeconomic differences in health exist and individuals of lower socioeconomic status (SES) have a higher risk for mortality and morbidity compared with those of higher SES⁴. A change in the global approach to CKD from the treatment of ESRD to intensive primary and secondary prevention is therefore considered an absolute public health priority⁵. Africa is the second largest continent in the world, with a population of over 1 billion; 961.5 million people live in sub-Saharan Africa and 195 million in Northern Africa⁶. Africa now faces the dual challenge of infectious illnesses and chronic diseases. Africa's chronic disease burden is secondary to various factors, including increased life expectancy, changing lifestyle practices, poverty, urbanization and globalization⁷. The World Health Assembly advocated the Global Action Plan for the Prevention and Control of non-communicable diseases 2013–2020. One of its targets is to reduce premature mortality from chronic diseases by 25% in 2025. These actions have the potential to make a significant impact on the burden of CKD⁸. Unfortunately, CKD problem remains underestimated on the entire continent due to lack of epidemiological information from different African countries. There exists only a single systematic review conducted in sub-Saharan Africa which concluded that CKD is a prevalent and potentially escalating disease across Sub-

- Saharan Africa, with both communicable and non-communicable risk factors⁹. Strategies aimed at
- 2 managing CKD epidemics in Africa critically depend on a reliable assessment of the burden of the
- 3 problem and the establishment of affordable early detection programs. Previous studies reported the
- 4 prevalence of CKD among the general population or the specific prevalence of this condition in
- 5 diseases that are recognized as drivers of renal damage (e.g., diabetes mellitus). These estimates
- 6 have varied across studies due to differences in the methods of Glomerular Filtration Rate (GFR)
- 7 measurement, background risk (general population vs. high risk groups), or demographic
- 8 characteristics (e.g., age, gender)¹⁰.
- 9 With this background in mind, this review aimed to increase the systematic information on the
- burden of CKD in the general population and high risk groups of the entire African continent and
- provide an estimate of the prevalence of CKD in different regions of Africa.

MATERIALS AND METHODS

Data source and search strategy

- We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)
- Guidelines¹¹. A systematic literature search was performed in the PubMed and OVID-MEDLINE
- databases by two authors (DB and SA) to identify articles reporting epidemiology data on CKD in
- the adult population in any geographic area of the African continent. This employed focused, highly
- sensitive search strategies (S1 Table). The search covered the time frame from January 1st, 1995 to
- 19 April 7th, 2017. Papers without language and study design restrictions were located and screened.
- 20 References from relevant studies were screened for supplementary articles.

21 Study selection and data extraction

- 22 Titles and abstracts were screened independently by two authors (SA and GD), who discarded
- 23 studies that were not relevant to the topic. Case reports, reviews, editorials, letters, and studies
- 24 focusing on African-Americans not living on the African continent, conducted entirely among
- children, or dealing with acute kidney injury or kidney transplantation were excluded. Two authors

(SA, ED) independently assessed the retrieved abstracts and the full texts of these studies to determine eligibility according to the inclusion criteria. Disagreements were resolved through discussion and consensus, or through consultation with a third reviewer (DB), who solved these differences based on study judgments. Furthermore, screening of reference lists of all of the retrieved studies was conducted to check for relevant articles, and a supplementary scan of the reference lists of the systematic reviews was performed to identify any additional studies. Data were extracted from full-text articles and registered using a specifically designed form. These data included study design, geographical area, sample size, the definition of CKD used, prevalence of CKD, age, gender, GFR measurement, type of creatinine assay, proteinuria, the method of outcome assessment and associated comorbidities such as diabetes mellitus and hypertension. Data extraction was performed by one reviewer (SA) and independently verified by another reviewer (DB).

Data extraction and analysis

Studies were categorized according to the reference population as follows: 1) studies dealing with the general population and 2) studies focusing on particular diseases such as diabetes, hypertension, lupus and HIV or settings, e.g., hospital-based surveys and occupational studies.

Information on the assessment of kidney function was collected, including: the equation adopted for GFR estimation ((Cockroft-Gault(CG), Modification of Diet in Renal Disease (MDRD), Chronic Kidney Disease-Epidemiology Collaboration (CKD-EPI)), the type of creatinine assay (Jaffe, standardized or unknown), and the type of proteinuria or albuminuria assay used (semi-quantitative assessment by urinary strips or quantitative in urine samples or 24 h collection). When the study included two or three GFR equations, we defined the CKD prevalence based on the CKD-EPI equation whenever this information was provided. Otherwise, we considered the MDRD equation and lastly the CG equation. In the case of ethnicity correction¹²⁻¹⁴; we included the equation which corrected for ethnicity. Information on the definition of CKD used in each study was also included ((either the internationally accepted definition as Kidney Disease Outcome Quality Initiative (KDOQI), or other ways of defining CKD)).

Quality assessment

Two independent authors (SA and DB) appraised each article independently and assessed its quality based on standard criteria described into details in previous methodology reviews dealing with clinical trials¹⁵, diagnostic studies¹⁶, and observational studies¹⁷. The articles were assessed based on the subject sampling and precision, sampling technique, response rate, method of assessment of kidney function, and exclusion rate

Statistical analyses

The principal demographic and clinical data for each study were summarized as the mean and standard deviation or as absolute number and percentage, as appropriate. The age range in each study was also recorded. The pooled prevalence rate of CKD was expressed as a point estimate and 95% CI. The prevalence from each study was weighed by the sample size then the pooled prevalence was categorized by the African region. The inter-rater agreement for inclusion and quality assessment was determined using Cohen's kappa (κ) coefficient ¹⁸. The percentage of the different causes of CKD was weighed by the sample size of each study done among CKD patients. Then we simply summed the number of patients for each etiological factor and divided it by the total sample size from the whole included studies. No meta-analysis was conducted in this study. Data were appropriately presented for different populations (general population and CKD patients). The patients' data were stratified by the type of underlying condition, i.e., hypertension, diabetes mellitus, HIV, or systemic lupus erythematosus. All calculations were conducted using SPSS for Windows, version 21, Chicago, Illinois, USA.

RESULTS

Search results

- The flow diagram of the selection process is depicted in (Fig. 1). In total, 7897 potentially relevant
- references were initially retrieved. Twenty-one additional citations were found through a personal

search. By screening titles and abstracts, a total 7534 citations were excluded because of search overlap, dealing with the wrong population (African American, AKI, cancer or post-transplant patients), or not providing actual data on CKD. Review articles, case reports, editorials, or letters were also excluded. Amongst the 384 studies selected for full text examination, 232 were excluded because they dealt with a population different from that specifically targeted in this systematic review, such as paediatric populations (122 studies), transplant patients (n=44), or others (n=46) (e.g., Africans living in non-African countries), or because only narrative data were provided (n=20). A total 152 articles were therefore reviewed in detail and included in the analysis. The main characteristics of these studies are summarized in Table 1. The inter-rater agreement for inclusion was κ =0.90 and for the quality assessment was κ =0.85.

Study characteristics

Amongst the 152 studies reviewed, 29 were general population studies (Table 2). One-hundred twenty-three studies focused on selected groups, of which 42 included HIV patients (Table 3), 18 studied diabetic patients (Table 4), nine included hypertensive subjects (Table 5) and twelve were conducted in other populations (Table 6), including one study in lupus patients ¹⁹, one study in rheumatoid arthritis patients ²⁰, one study among sickle cell anemia patients ²¹, two in specific occupational settings (silica exposure²² and exposure to the nephrotoxic hair-dye, paraphenylenediamine²³) and seven studies in family practice²⁴⁻²⁶ or hospital-based²⁷⁻³⁰ surveys. Forty-two studies conducted among CKD patients (S2 Table) ³¹⁻⁷².

The studies that were included covered all regions of Africa. The highest number of the studies came from the Western macro-area (n=54), followed by the Eastern macro-area (n=32), Southern macro-area (n=25). Twenty studies were retrieved from the Northern Africa, eight studies from each of the Central macro-area and the Central-Western macro- area. Three studies were conducted in both the Eastern and Southern regions and two studies in the Sub-Saharan region.

Assessment of kidney function impairment

Urinary markers for kidney disease were assessed in seventy-eight (71%) among one-hundred ten studies conducted in the general population, high risk groups, occupational or hospital-based studies. Proteinuria was assessed by a semi-quantitative method (urinary strips) in twenty-eight studies²¹, 24, 26, 29, 73-96. Twenty studies used dipstick with confirmation by quantitative methods, nine of which used dipsticks to identify proteinuria/albuminuria with confirmation by 24-hour proteinuria²⁵, 97-104 whereas eleven studies used dipstick with confirmation by the protein-to-creatinine ratio or albumin-to-creatinine ratio¹⁰⁵⁻¹¹⁵. Quantitative methods for the assessment of proteinuria/albuminuria (24-hour proteinuria or albuminuria, PCR, immunoassay, or ACR) were applied in twenty-nine studies ¹⁹, 27, 28, 30, 116-140. In one study, the method of proteinuria assessment was not mentioned¹⁴¹.

Serum creatinine was measured in ninety-five studies (86%). The Jaffe assay was used in thirty studies²⁹ ,³⁰ ,⁷⁶ ,⁸⁰ ,⁸² ,⁸³ ,⁸⁶ ,⁹⁰ ,⁹⁵ ,⁹⁷ ,¹⁰² ,¹⁰⁵ ,¹¹¹ ,¹¹³ ,¹²⁴ ,¹²⁶ ,¹³⁰ ,¹³¹ ,¹³⁶ ,¹⁴² -¹⁵² whereas the IDMS-calibrated method was used in fifteen studies ¹² ,¹⁴ ,²¹ ,²⁶ ,¹¹⁵ ,¹¹⁷ ,¹³² -¹³⁴ ,¹⁴¹ ,¹⁵³ -¹⁵⁷. In nine studies, both the Jaffe assay and the calibrated serum creatinine were used ¹³ ,²⁰ ,²⁵ ,⁹¹ ,⁹⁸ ,⁹⁹ ,¹⁰⁶ ,¹¹² ,¹⁵⁸. In the remaining forty-one studies provided no information on the method of creatinine measurement ¹⁹ ,²⁴ ,²⁷ ,²⁸ ,⁷⁸ ,⁷⁹ ,⁸¹ ,⁸⁴ ,⁸⁵ ,⁸⁷ -⁸⁹ ,⁹³ ,⁹⁴ ,⁹⁶ ,¹⁰⁰ ,¹⁰¹ ,¹⁰⁴ ,¹⁰⁹ ,¹¹⁴ ,¹¹⁶ ,¹¹⁸ -¹²² ,¹²⁵ ,¹²⁷ ,¹³⁵ ,¹³⁷ -¹³⁹ ,¹⁵⁹ -¹⁶⁷. With respect to the formula used for estimating GFR, the MDRD equation was used in thirty studies ²⁴ -²⁶ ,²⁸ ,²⁹ ,⁹⁴ -⁹⁷ ,¹⁰⁵ ,¹⁰⁶ ,¹¹¹ ,¹¹³ ,¹¹⁶ ,¹¹⁷ ,¹²¹ ,¹²² ,¹²⁶ ,¹³⁰ ,¹³³ ,¹³⁴ ,¹³⁶ ,¹⁴¹ ,¹⁴⁶ ,¹⁴⁹ ,¹⁵³ ,¹⁵⁴ ,¹⁵⁸ ,¹⁵⁹ ,¹⁶⁴ and the CG equation was used in eighteen ¹⁹ ,⁷⁶ ,⁸¹ ,⁸⁶ ,⁸⁸ ,⁹³ ,¹⁰⁰ ,¹⁰² ,¹¹⁴ ,¹¹⁹ ,¹²⁴ ,¹³⁸ ,¹⁴³ ,¹⁴⁵ ,¹⁵⁰ ,¹⁶² ,¹⁶⁷. The other fourteen studies used both the CG and the MDRD equations ⁷⁸ -⁸⁰ ,⁸³ -⁸⁵ ,⁹⁸ ,⁹⁹ ,¹⁰¹ ,¹⁴⁴ ,¹⁴⁷ ,¹⁵² ,¹⁶¹ ,¹⁶³, whereas fifteen studies estimated GFR by the CG, MDRD, and the CKD-EPI methods ¹² -¹⁴ ,²⁰ ,⁸² ,⁹⁰ ,⁹¹ ,¹⁰⁹ ,¹¹² ,¹¹⁵ ,¹³⁹ ,¹⁴² ,¹⁵⁵ ,¹⁵⁶ ,¹⁶⁰. Six studies used MDRD and CKD-EPI ¹³¹ ,¹³² ,¹³⁷ ,¹⁴⁸ ,¹⁵¹ ,¹⁵⁷ and two studies used CKD-EPI²¹

Definition of CKD

Thirty-one studies defined the presence of CKD as an eGFR below 60 ml/min/1.73 m² 12 .14 .20 .80 .93-96 .111 .117 .119 .139 .146 .148-159 .161-164 .166 .167 , with chronicity confirmed by repeated testing in four other studies 142-145. Moreover, twenty-eight studies reported CKD prevalence based on eGFR below 60 ml/min/1.73 m² and/or the presence of proteinuria or albuminuria 12 .24 .26 .76 .78 .82-84 .86 .91 .99 .100 .105 .106 .109 .112-114 .121 .130-137 .141. Proteinuria/albuminuria was used alone to identify CKD in fourteen studies 73-75 .77 .87 .92 .107 .108 .110 .123 .128 .129 .138 .140. KDOQI staging 168 of CKD was used in thirteen studies 13 .25 .29 .79 .85 .90 .97 .98 .115 .116 .122 .124 .126 . The serum creatinine level (either doubling, or an increase above a certain threshold) was considered to be a marker of the presence of CKD in four studies 9 .104 .120 .165. In sixteen studies, the definition of CKD was either not mentioned or was defined in various ways, including personal history, Creatinine Clearance (CrCl) ≤50 ml/min, clinical manifestations, the presence of albuminuria, elevated serum creatinine, and the average of two measurements of eGFR < 90 ml/min/1.73 m² 19 .27 .28 .30 .81 .88 .101-103 .118 .125 .127 .147 .160 .169 .170

Paper quality

Paper quality was high in sixteen studies ¹³, ²⁵, ⁷⁵, ⁹⁰, ⁹¹, ⁹⁷, ⁹⁸, ¹⁰⁵, ¹⁰⁶, ¹¹², ¹¹⁶, ¹³²⁻¹³⁴, ¹⁴⁸, ¹⁵⁵. Thirty-five studies were of medium quality ¹², ¹⁴, ²⁶, ²⁹, ⁷³, ⁷⁴, ⁷⁷⁻⁷⁹, ⁸¹, ⁸², ⁹⁶, ¹¹⁰, ¹¹¹, ¹¹⁵, ¹¹⁷, ¹²⁸, ¹³⁰, ¹³¹, ¹³⁷, ¹⁴¹, ¹⁴³⁻¹⁴⁵, ¹⁵⁰⁻¹⁵⁰, ¹⁵², ¹⁵⁴, ¹⁵⁷, ¹⁵⁹⁻¹⁶¹, ¹⁶³, ¹⁶⁶, ¹⁶⁷. The rest of the studies were of low quality.

Prevalence of CKD

Based on the prevalence of eGFR <60 ml/min/1.73m² and/or the presence albuminuria/proteinuria (the current definition of CKD by KDOQI)¹⁶⁸ reported in the 24 medium-high quality studies in **Table 2** the pooled prevalence of CKD in the general population in Africa was 10.1% (95% CI: 9.8%-10.5%). The highest prevalence was reported in the West/Central-West (16.5%), followed by the Central region (16%), Southern (12.2%), Eastern (11.0%), and North (4%) Africa (Fig. 2). The pooled prevalence in Sub-Saharan Africa was 14.02% (95% CI: 13.5- 14.5 %).

Among HIV patients (Table 3), the pooled prevalence of CKD (estimated as above on the

Saharan area

basis of the KDOQI definition in the eighteen medium quality studies in the same table) was 5.6% (95% CI: 5.4-5.8%). Based on the treatment status, the prevalence of renal dysfunction was 9.9% (95 % CI: 9.4- 10.4%) among HIV patients not receiving treatment while the prevalence was 5.2% (95 % CI: 5.0-5.4%) among HIV patients on anti-retroviral therapy .The West/ Central-West recorded the highest prevalence of CKD among HIV patients (11.6%), followed by the East (11.2%), and South (3.5%) macro-areas. The prevalence was reported to be 5.7% among the 3 studies done in both the East and South macro- areas and 2.5% from the study done in the sub-

Among diabetic patients (**Table 4**, all studies are of low quality except for four with medium quality), the pooled prevalence of CKD was 24.7% (95%CI: 23.6-25.7%). The highest prevalence was in the Eastern (46.9%), followed by the Central (40.8%), West/Central-West (27.7%), South (23.0%), and North (18.9%) Africa. One study was done in sub-Saharan reported that the prevalence was 13%

The pooled prevalence of CKD among hypertensive patients (**TABLE 5**, 9 studies; all of low quality except for two with medium quality) was 34.5% (95 % CI: 34.04%-36%). The highest prevalence was reported from one study in the East macro-area (39.5%) followed by the West/Central-West (37.7%), South (25.4%) Africa. No data were found for other African macro-areas.

Among other patient populations (studies reported in Table 6), almost three quarters of the lupus patients had CKD (prevalence=72.0%) based on low quality study ¹⁹. Hospital-based surveys revealed that (the calculation was based on **the total prevalence** reported from all studies including three of high-medium quality and 4 of low quality in the same table) more than one third of patients attending either primary care centres or tertiary hospitals had CKD (pooled prevalence= 36%, 95% CI: 34.4-37.7%). CKD was prevalent among almost 39% of rheumatoid arthritis ²⁰or sickle cell patients ²¹. The study (low quality) conducted among hairdressers exposed to paraphenylenediamine¹⁰⁴ reported that 26.4% of these subjects had renal impairment. Of note,

100% of silica-exposed workers experienced proteinuria (reported from low quality study)¹²⁹.

The prevalence of CKD was variable based on definition used to diagnose CKD. Based on medium-high quality studies; CKD had a 6.2 % prevalence (95% CI: 6.0- 6.4%) in population studies defining this disease as an eGFR below 60 ml/min/1.73 m² ¹², ¹⁴, ⁹⁶, ¹¹¹, ¹¹⁷, ¹⁴⁸, ¹⁵⁰⁻¹⁵², ¹⁵⁴, ¹⁵⁵, ¹⁵⁷, ¹⁵⁹, ¹⁶³, ¹⁶⁶, ¹⁶⁷. When CKD was diagnosed based on eGFR below 60 ml/min/1.73 m² and/or the presence of proteinuria or albuminuria²⁶, ⁷⁸, ⁸², ⁹¹, ¹⁰⁵, ¹⁰⁶, ¹¹², ¹¹⁴, ¹³⁰⁻¹³⁴, ¹⁴¹; the prevalence was 7.3 % (95 %CI: 6.9-7.7%). The prevalence of CKD was 22.5 % (95% CI: 21.5- 23.5%) in studies where the disease was defined on the basis of proteinuria⁷³⁻⁷⁵, ⁷⁷, ¹¹⁰, ¹²⁸. When KDOQI definition (i.e. by combining the eGFR and proteinuria/albuminuria) was used ¹³, ²⁵, ²⁹, ⁷⁹, ⁹⁰, ⁹⁷, ⁹⁸, ¹¹⁵, ¹¹⁶, the prevalence of CKD was 19.7% (95% CI: 18.7-20.8%)

Causes of CKD

- Forty-two studies were conducted specifically to clarify the underlying cause of CKD 31-72. (S2
- Table) The diagnosis was biopsy-proven in seventeen studies³³,³⁹,⁴¹,⁴³⁻⁴⁵,⁴⁸,⁵⁴,⁵⁵,⁵⁸,⁶⁰,⁶³,⁶⁷⁻⁷⁰,⁷².
- 14 Vascular/hypertensive sclerosis was the main cause of CKD (16%) followed by diabetic
- nephropathy (15%), chronic glomerulonephritis (13%), tubulo-interstital/obstructive (8%), primary
- glomerular diseases (6%), systemic lupus erythmatosus (3%), and polycystic kidney disease (3%).
- 17 The causes of CKD were undetermined/miscellaneous causes in one fifth of the patients (20%).
- 18 (Fig. 3)

DISCUSSION

- 20 This systematic review focuses on the burden of CKD on the entire African continent. We assessed
- 21 152 papers published between January 1st, 1995 until April 7th, 2017, reporting the epidemiology of
- 22 CKD in the general population and in specific chronic conditions in Africa. The CKD prevalence
- 23 reported in our review should be interpreted with caution. Our estimates may be affected by the
- 24 analytical heterogeneity used to measure creatinine and albuminuria. Serum creatinine
- 25 concentrations are affected by intra-individual variability with over 20% changes within a 2-week

period¹⁷¹ and most Jaffe assays overestimate serum creatinine¹⁷². The resulting bias could vary according to the creatinine concentration, specific assay, manufacturer, and calibration material used. Although the IDMS calibration standardization has reduced the bias and improved the Inter laboratory comparability¹⁷³, the number of studies reported using IDMS was low in Africa. Moreover, CKD prevalence may additionally be influenced by albuminuria assays which are affected by the inter laboratory differences ¹⁷⁴. The different equations used to estimate GFR could be a source of bias. The systematic underestimation of measured GFR at higher estimated GFR by the MDRD equation is well known, and may reflect higher creatinine generation in healthy individuals compared with individuals with CKD in whom the MDRD equation was derived. This bias is reduced substantially, but not completely, by the CKD-EPI equation, which was derived from studies including people without CKD¹⁷⁵. In addition, differences in sample size, demographics, and clinical characteristics, are all significant limitations in this systematic review for making accurate estimates of the prevalence of CKD in African countries. Furthermore, only five studies⁷⁹, 142-145 assessed the KDOQI chronicity criterion, which is a fundamental element of the current definition of CKD by this organization. A single elevated serum creatinine, reduced eGFR or an abnormal urinalysis should initially be viewed as a screening test, and a subject with suspected CKD should be considered to have an azotaemia until CKD is determined by the additional workup and clinical judgment¹⁷⁶. Thus, estimates in this review should be seen as a pragmatic attempt to evaluate the dimension of CKD as a public health issue on the African continent. CKD is now considered to be an important component of the epidemic of non-communicable diseases in economically developed and developing countries alike. In a seminal meta-analysis published in 2014 Stanifer et al.,9 for the first time drew attention to the public health relevance of CKD in the sub-Saharan Africa, a vast area comprising 85% (947.4 million) of the whole African population⁹. In the present systematic review, the lowest prevalence of CKD (4%) was reported in the Northern Africa macro-area; including Egypt, Libya, Tunisia, Algeria,

Morocco, the Western Sahara, and Mauritania, and the highest (16.5%) was observed in West/ Central-West Africa, which includes Benin, Burkina Faso, the island nation of Cape Verde, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mali, Mauritania, Niger, Nigeria, Cameroon, the island of Saint Helena, Senegal, Sierra Leone, São Tomé and Príncipe and Togo. The average prevalence in the entire African continent was 10.1%. The global CKD prevalence was reported to be 13.4% ¹⁷⁷. In sub-Saharan Africa in Stanifer's meta-analysis, the prevalence of CKD was 13.2%, which is close to that reported in the same area in our review (14.02%). Among the general population of economically developed countries, CKD has 13.6% prevalence in the USA¹⁷⁸. In Europe, the reported prevalence is lower and more homogenous, being 8.9% in the Netherlands, 6.8% in Italy, 5.2% in Portugal, 4.7% in Spain, and 3.3% in Norway¹⁷⁹. CKD prevalence in some Asian countries was higher than the estimates in the USA and in Europe, being 17.5% in Thailand¹⁸⁰, 15% in India¹⁸¹, 13% in Japan¹⁸², 11.9% in Taiwan¹⁸³, and 9.9% in China¹⁸⁴. Overall, the estimated prevalence of CKD at the general population level in African countries appears to be comparable and possibly even higher than that reported in other continents. This may be at least in part due to the low quality data for the prevalence of CKD in Africa related to poor sampling techniques, unreliable kidney function measurements, and the different definitions used.

In our review, the prevalence of CKD in surveys based on hospitals or primary care centres (36%) is close to that in Swiss primary care centres (36%) ¹⁸⁵.

Poverty-related factors such as infectious diseases secondary to poor sanitation, inadequate supply of safe water, environmental pollutants and high concentrations of disease transmitting vectors continue to play an important role in the development of CKD in low-income countries. Although rates of diabetic nephropathy are rising, chronic glomerulonephritis and interstitial nephritis are among the principal causes of CKD in many countries ¹⁸⁶.

In Africa, infectious diseases such as HIV, bilharziasis, malaria, hepatitis B and C represent an almost unique cluster of risk factors responsible for CKD¹⁸⁷. HIV/AIDS is pandemic in Africa, with a prevalence ranging from 0.5% in Senegal¹⁸⁸ to 27.4% in Swaziland¹⁸⁹. The global success in

bringing effective antiretroviral treatment (HAART) to HIV-infected patients in Africa has determined the emergence of chronic medical illnesses such as HIV-related CKD¹⁹⁰. Up to 50% of kidney diseases in HIV-infected persons result from a wide array of non-HIV-associated nephropathy (HIVAN) pathologies, ranging from glomerulonephritis to diabetic nephropathy ¹⁹¹. We found that 5.6% of HIV patients complained of renal dysfunction. This figure is lower than that reported in economically developed countries such as France, USA, China, Spain, and Brazil 192-196. CKD was higher among HIV patients not receiving HAART compared to those on HAART. Variation in the proportion of HIV patients affected by CKD depends on the heterogeneity in the definition used to determine renal dysfunction, the proportion of the study population on HAART, diverse ethnicities, the associated comorbidities, and the nutritional status of the study population. HIV patients are more prone to nutritional deficiencies due to mal-absorption, impaired oral intake, and the wasting syndrome. Increased availability of HAART has led to some improvement of the nutritional status of patients. However, for certain individuals, undernutrition and weight loss persist despite therapy. Malnutrition exacerbates side effects, alters drug pharmacokinetics, and impinges on adherence thereby limiting the beneficial effects of the therapy ¹⁹⁷. Furthermore, differences in HIV clades or strains in African patients 198 and genetic factor 199 may influence the replication capacities within the isolated renal reservoir and thus lead to a diversity in clinical presentations⁸⁰.

Regarding systemic autoimmune diseases such as lupus, a study conducted among lupus patients from Senegal showed that almost three quarters (71.0%) the patients with this disease had evidence of renal involvement¹⁹. This isolated figure is higher than that reported in other countries²⁰⁰⁻²⁰². More than one third (39%) patients with rheumatoid arthritis had CKD²⁰ which is higher than that reported from Taiwan ²⁰³.

Even though there are no sufficient data to precisely reconstruct historical trends, the profile of CKD causes has changed during the last decades. Interstitial nephritis and glomerulonephritis were the main causes of CKD in North Africa²⁰⁴ and CKD was principally caused by chronic

glomerulonephritis and hypertension in East and Tropical Africa²⁰⁵, ²⁰⁶. Today, the spectrum of causes of CKD in Africa is dominated by diabetes mellitus and hypertension ²⁰⁷. We found that the prevalence of vascular/hypertensive and diabetic nephropathies as a cause of CKD (16% and 15%, respectively) exceeded that caused by chronic glomerulonephritis (13%).

Our review has both strengths and limitations. The major strengths include a thorough systematic search of electronic databases and the inclusion of all comprehensive studies with a transparent assessment of CKD prevalence by two independent reviewers. The fact that our literature search was limited to PubMed and Medline OVID but did not include the African Index Medicus, like it was done by Stanifer in the meta-analysis of CKD in sub-Saharan Africa [8], is a limitation of our study. Because there was a huge discrepancy in the definitions used to identify CKD, the methods of creatinine measurement, urine protein assessment, and in the quality of the reporting, we decided to adopt an inclusive strategy. Our primary interest was to identify all studies conducted among different population groups in Africa providing information on CKD and to reconstruct a tentative scenario of the epidemiological dimension concerning disease in the entire African continent. Methodological limitations notwithstanding this review compiled estimates suggesting that the CKD burden in Africa is at least as concerning as that in economicallydeveloped countries. The lack of a consistent definition of CKD makes it difficult to compare the burden of CKD across studies in various countries. Moreover, the failure to demonstrate chronicity when defining CKD is a common limitation of studies investigating CKD prevalence in Africa. It was reported that a single test in time has an extremely poor positive predictive value for confirmation of CKD compared to repeated testing 3 months later. Failure to repeat testing may lead to a significant overestimation of CKD prevalence and underestimation of the burden of CVD in CKD²⁰⁸. In addition, Observational studies are subject to bias and residual confounding which are difficult to account for and there are limitations due to the heterogeneity that arises from differences in age and sex distributions. These poor data quality reported in different studies is considered as a cumbersome problem limiting the accuracy in assessing the burden of CKD in Africa

In conclusion, CKD in Africa appears to be at least as common as in other continents and as such, it constitutes a true public health priority with major cost burden to healthcare systems worldwide. Targeted screening of high-risk groups (including those with hypertension, diabetes mellitus, HIV patients and persons with occupational exposures) should likely be instituted as the first step in kidney disease prevention whenever and wherever affordable and feasible. Education to increase awareness of CKD among healthcare workers and patients, and the promotion of healthy life styles, should be engrained in preventive programs. The treatment of hypertension and diabetes mellitus are of obvious relevance. Nurses and other health workers should be trained to manage these conditions at the local level if we are to curb the incidence of CKD and to avert the added burden of CKD complications to diabetes, hypertension, and infectious diseases, the deadly trio of risk factors underlying the CKD epidemic in Africa.

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- SA, DB, and CZ: conceptualized and designed the study.
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- DB and GT: supervised the data capture and analysis.
- SA, DB, and GT: analysed and interpreted the data.
- SA, DB, and CZ: drafted and critically revised the manuscript.
- All of the authors read and approved the final manuscript.

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Table 1: Characteristics of the study population included in the analysis

Study population	Number of the studies	Study characteristics
General population	29	N=30169, age ranging from
		12 to 95 years; 48% males
Diabetic patients	18	N=9082, age ranging from
		14 to 90 years; 43% males
Hypertensive patients	9	N=4123, age ranging from
		19 to 90 years; 43% males
HIV patients	42	N= 67432, age ranging
		from 13 to 74 years; 36%
		males
Occupational group	2	N= 153, age ranging from
		22 to 59 years; one study
		only enrolled females and
		the other principally
		enrolled males
Family practice patients	7	N= 3250, age ranging from
		20-74 years, 44% males
Lupus patients	1	N= 43, age ranging from 16
		to 55 years, 7% males
Rheumatoid arthritis	1	N=233, age ranging from
		40-70 years, 17.2% males
Sickle cell anemia	1	N=194, age ranging from
		12-40 years, 43.3% males
CKD patients	42	N= 34236, age ranging
		from 12 to 90 years, 58%
		males

Table 2: Studies on CKD among the general population

)											
) '	Study ID	Year, Country , Region	Location	N	Population Characteristic	Definition of CKD	Method of outcome assessment	Type of creatinine assay	Proteinuria	CKD prevalence	Quality assessme nt
0 1 2 3 4	Abdelsatir S ¹⁶⁹	2013 Sudan North- east	All village inhabitants	389	Age (years): 41 ± 15 Male gender: 16.2% Hypertension:39.6%, DM: 17% BMI category: (kg/m²) <18: 6.2%, 18-24.9: 65.8%, 25-29.9: 20.2 %, ≥30: 7.8%	Not identified, personal history	Personal history	Not mentioned	Not measured	Total prevalence (as reported): 6.40%	Low
5 6 7 8 9	Fatiu A ⁷³	2011 Nigeria West	Market population	286	Age (years): 49.5 ± 5.7 Male gender: 9.8% Hypertension: 37.7% BMI (kg/m²): 26.76 ± 5.28 <20 kg/m²: 7.4% 20-25 kg/m²: 33.4% > 25 kg/m²: 59%	Proteinuria ≥ +1	Midstream urine sample was tested by urinary strip	Not measured	29.70%	Total prevalence (based on proteinuria prevalence): 29.7%	Medium
21 22 23 24	Traore M ⁷⁴	1998 Mali West	All Household population of the villages	1098	Age (years): 30±12 Male gender: 52%	Proteinuria ≥ +1	Microhaematuria and proteinuria by urinary strip	Not measured	40.80%	Total prevalence (based on proteinuria prevalence): 40.80%	Medium
25 26 27 28 29	Matsha T ¹²	2013 South Africa South	Bellville town inhabitants	1202	Age (years): 52.9 ±14.8 Male gender: 24.7% SBP: 125±20 DBP: 76 ±13 DM: 26.4% BMI: 29.9 ±7.2	eGFR<60 ml/min	4 variables: MDRD, CG, CKD-EPI	Standardized creatinine assay	Not measured	Prevalence of stages 3-5: 7.4% (based on CKD- EPI with ethnicity correction)	Medium
30 31 32	Seck SM ⁹⁷	2014 Senegal West	Two stage cluster sampling of Urban and rural inhabitants of Saint- Louis	1037	Age (years): 48.0 ± 16.9 Male gender: 40% Hypertension: 39.1% DM: 12.7% BMI: 26.3 ± 6.8 kg/m ²	KDOQI	Albuminuria by urinary strips. Positive samples were confirmed by 24-hour albuminuria, eGFR by 186 MDRD	Kinetic Jaffe	5.3% albuminuria >1 g/l	Total prevalence: 6.1%	High
37 38 39 40 41	Pruijm M ¹¹⁶	2008 Seychell es, East	a random sex- stratified and age- stratified sample inhabitants	1255	Age (years): range, 25-64 Male gender: 46%	KDOQI	Quantitative microalbuminuria by ACR, eGFR using MDRD	Not mentioned	11.4% microalbuminuria, 0.7% macroalbuminuria	Total prevalence: 15.3% Prevalence of stages 3–4 CKD 3.2%.	High

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1			of								
5			Seychelle								
3											
7											
3			Multistage sampling of residents of Kinshasa		Age (years): 38.6 ± 14.4 Male gender: 41%				100/	Total prevalence: MDRD 12.4% CG 19%	High
1 2 3 4	Sumaili EK ⁹⁸	2009 Congo Central		500	Hypertension: 27.6% DM: 11.7% BMI category: 25–29.9 kg/m²: 20.3% ≥30 kg/m²: 14.9%	KDOQI	Proteinuria by urinary strip and 24-hour proteinuria, eGFR by CG and 175MDRD	Kinetic Jaffe and	18% proteinuria by dipstick 5% (≥300 mg/day)	Prevalence by stage (MDRD) Stage 1: 2% Sage 2: 2.4% Stage 3: 7.8% Stage 4:0	
15								IDMS-calibrated		Stage 5: 0.2%	
16 17 18 19	Mark	2014	All residents of Cape-Town		Age (years): mean, 56.4 (55.1–57.6, 95% CI) Male gender: 22% SBP: 124.7 (122.8– 126.7, 95% CI)mmHg DBP: 75.5 (74.2–76.7,	OO,				Total Prevalence 28.9% Prevalence by categories eGFR>90 ml/min/1.73m ² :9.4%	Medium
20 21 22 23 24 25	Matsha T ¹⁵⁹	South Africa South		320	95% CI) mmHg BMI: 31.9 (31.2–32.7, 95% CI) kg/m ² Mean eGFR at baseline: 68.6±16.7 ml/min/1.73 m ²	eGFR< 60 ml/min/ 1.73 m ²	eGFR- 186MDRD (4 variables)	Not mentioned	Not measured	eGFR60- 90 ml/min/1.73m ² : 58.7% eGFR30-60 ml/min/1.73m ² : 28.1% eGFR<30 ml/min/1.73m ² : 0.9%	
26 27	Sumaili EK ⁷⁵	2008 Congo Central	All Residents of Kinshasa	3018	Age (years): 44.3 ±15.3 Male gender: 59% Hypertension: 18%	Proteinuria ≥ +1	Proteinuria by urinary strip		17.1%	Total prevalence (based on proteinuria prevalence): 17.1%	High
28		Centrar			DM: 4%			Not assessed		• ′	
29 30 31 32 33	Egbi OG ⁷⁶	2014 Nigeria West	All Civil servants in Bayelsa	179	Age (years): 45.2 ± 10.3 Male gender: 53.1% SBP:128.5±17.5 mmHg DBP: 81.8 ± 13.2 mmHg	eGFR <60 ml/min/1.73 m² and/or presence of proteinuria of at least +1 on dipstick urinalysis	Proteinuria by urinary strip, eGFR by CG equation standardized for body surface area (BSA)	Kinetic Jaffe	5.6%	Total prevalence: 7.8% Prevalence by stage Stage 1:3.4% Stage 2: 2.2% Stage 3: 2.2% None in stage 4 or 5	Low
			Multistage					Terricule June		Total prevalence: 18.8%	High
35 36 37 38	Oluyombo R ¹⁰⁵	2013 Nigeria West	sampling of Households of Ilie	454	Age (years): 45.8 ± 19.0 Male gender: 43% Hypertension: 20.4% DM: 0.6%	eGFR <60 ml/min and/or macroalbuminuria (ACR>300 mg/g or dipstick proteinuria)	Proteinuria by urinary strip, negative cases were estimated for albumin creatinine ratio, eGFR by 186 MDRD	Kinetic Jaffe	Macroalbuminuria in 8.9%	Prevalence by stage Stage 1: 2.4% Stage 2: 4.1% Stage 3: 11.8% Stage 4: 0.5%	ingii
40 41	Eastwood J ¹³	2010 Ghana, West	Inhabitants of 12 villages	944	Age (years): 54.7±11.2 Male gender: 38% SBP:125.5±26.0 mmHg	KDOQI	175MDRD, CG, CKD-EPI	Kinetic Jaffe and calibrated IDMS		Total Prevalence (based on CKD-EPI and ethnicity correction) :	High
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4 5 7 8					DBP: 74.4 13.6 mmHg DM: 4% BMI: 21.1 ±4.2 kg/m ²					MDRD: 1.6% (7.2 % without ethnicity correction; CKD-EPI 1.7% (4.7% without ethnicity correction), CG 21.0%.	
10 11 12 13	Gouda Z ¹¹⁷	2011 Egypt North	Community based in Al- Buhayrah governorate	417	Age (years): 39.12 ± 14.29 Male gender: 43.2% Hypertension: 25.20% DM: 10.6% BMI: 29.96 ± 6.18 kg/m ²	eGFR <60 ml/min/1.73 m ²	Quantitative assessment of urinary ACR, eGFR by 175 MDRD	IDMS-calibrated	10.6% microalbuminuria	Total prevalence 18%	Medium
19	Ayodele OE ⁷⁷	2011 Nigeria West	People at a major trade center, the public servant secretariat and the state broadcastin g station	586	Age (years): 42.4±11.2 Male gender: 61.4 % Hypertension: 16.4% DM: 3.8% BMI: 25.9±5.4 kg/m ²	proteinuria ≥+1	Proteinuria by urinary strip	Not assessed	2.50%	Total prevalence (based on proteinuria): 2.50%	Medium
26 27	Abu-Aisha H ⁷⁸	2009 Sudan East	Pilot survey of police housing complex	273	Age (years): 34.3±12 Male gender: 49.1% Hypertension: 27% DM: 5.1%	eGFR <60 ml/min/1.73 m ² and or proteinuria	Proteinuria by urinary strip, 175MDRD, CG	Not mentioned	5.30%	Total prevalence (MDRD) 7.7% [11% by CG] Prevalence by stage Stage 1 or 2: 4.7% Stage 3:2.6% Stage 4: 0 Stage: 0.4%	Medium
28 29- 30 31 32 33 34	Gharbi M ¹⁰⁶	2012 Morocco North	Stratified random sampling of population in two towns	10524	Age (years): range, 25-70 Male gender: (50%), Hypertension: 16.7%	eGFR < 60 ml/ min/1.73 m² or macroalbuminuria or dipstick abnormalities (proteinuria ≥ ++ 1 or haematuria: ≥ ++1) or diabetes type 1 associated with microalbuminuria	175 MDRD, microalbuminuria and proteinuria by urinary strip and ACR	Kinetic Jaffe and IDMS	microalbuminuria (30-299 mg/l): 5.26%	Total prevalence 2.90%	High
36 37 38 39 40	CU O ¹⁵³	2014 Nigeria West	All attendees to lectures of the Ebreime Foundation for the elderly,	170	Age (years): 68.1±7.7 Male gender: 67.1%	eGFR<60ml/min/1.73 m ²	175 MDRD	IDMS calibrated		Total prevalence: 43.50%, (all cases were at stage 3)	Low
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24 25 26 27 28 29 30	La E ¹³
31 32 33 34 35 36	Lu
37 38 39	Mo A ¹

	2016	participants		Age (years):44.1±18.4						High
Booysen H ¹⁵⁵	2016 South Africa South	from families of black African descent	1221	Male gender:34.9% BMI (kg/m²):29.5±8.0 Hypertension: 45% Diabetes mellitus:25.2%	eGFR<60ml/min/1.73 m ²	eGFR by CG, 4 variables MDRD, CKD-EPI	IDMS calibrated	Not measured	Total prevalence:6.3%	
Kalyesubul a R ⁵⁰	2017 Uganda East	Community based survey among all households of Wakiso district	955	Age (years):31 (IQR: 24–42) Male gender: 33% BMI(kg/m²) categories: Underweight:5.5% Normal: 56.9% Overweight:24.2% obese: 13.4% Diabetics: 5.9%	KDOQI	Proteinuria by dipstick and eGFR by CG, MDRD, and CKD-EPI	Kinetic Jaffe	0.3%	Total prevalence: 15.2% Prevalence by stage: Stage 1: 6.2% Stage 2:12.7% Stage 3:2.4% Stage 4:0 Stage 5: 0.1%	High
Kaze F ⁹¹	2015 Cameroo n Central- West	Population of the Littoral region	500	Age (years): 45.3 ± 13.2 Male gender: 53.4% BMI (kg/m²): 27.1 ±5.3 Diabetes mellitus: 2.8% Hypertension: 12.2%	any albuminuria and/or eGFR <60 ml/min/1.73m ²	Albuminuria by dipstick and eGFR by CG, MDRD, CKD-EPI	Kinetic Jaffe and IDMS	7.2%	Total prevalence (CKD-EPI): 10% [14.2% by CG, 11%MDRD]	High
Kaze F ¹¹²	2015 Cameroo n Central- West	Population of the Western Region	439	Age (years):47 ± 16.1 Male gender: 42.1% Hypertension: 10.7% Diabetes mellitus: 5.9%	Albuminuria and/or eGFR <60 ml/min confirmed 3 months later	Albumnuria by dipstick and ACR and eGFR by CG, MDRD, CKD-EPI	Kinetic Jaffe and	12.1% had albuminuria	Total prevalence (CKD-EPI): 27.6% [38.5% by CG, 27.3%MDRD]	High
Laurence E ¹³⁰	2016 South Africa South	Teachers from public schools in in the urban area of the Metro South Education District	489	Age (years): 46.3 ± 8.5 Male gender: 30% BMI(kg/m²):males: 29.1 ±4.8, females: 32.4.1 ±7. Hypertension: 48.5% Diabetes mellitus: 10.1%	Proteinuria ≥0.30 mg/mg or eGFR <60 ml/min/1.73 m ²	Proteinuria by PCR and eGFR using MDRD	Kinetic Jaffe	Not mentioned	Total prevalence: 10.4%	Medium
Lunyera J ⁹²	2016 Uganda East	Urban residents of Kampala	141	Age (years): 64% in age group of 18-39 Male gender: 43% BMI(kg/m²): 25.9 (IQR 22.7-30.7) Hypertension: 38% Impaired fasting blood glucose: 13%	Proteinuria as urine protein of ≥1+ on dipstick in the absence of hematuria and leukocyturia	Proteinuria by dipstick	Not measured	13%	Total prevalence(based on proteinuria): 13%	Low
Mogueo A ¹³¹	2015 South Africa South	Household residents of BellVille	902	Age (years): 55±15 Male gender: 23% BMI(kg/m²): 29.9 ±7.2 Hypertension: 49.8% Diabetes mellitus: 27.9%	eGFR <60 ml/min/1.73 m ² , or any nephropathy	Albuminuria by ACR and eGFR by MDRD and CKD-EPI	Kinetic Jaffe	2.3%	Total prevalence(CKD-EPI): 21.7% [prevalence by MDRD: 29.7%]	Medium
Peck R ¹⁴⁸	2016, Tanzania	Stratified multistage	1043	Age (years):35.5 ± 15.3 Male gender: 45.7%	eGFR<60 ml/min/1.73 m ²	eGFR by MDRD and CKD-EPI	Kinetic Jaffe	Not measured	Total prevalence)CKD- EPI): 7%	High

4 [5 6 7 8		East	sampling of adult population in Mwanza city, Geita and Kahama		BMI(kg/m²) categories: Underweight: 10.5% Normal: 71% Overweight: 11.8% Obese :6.6% Diabetes mellitus: 0.9% Hypertension: 17.3%						
9 10 11 12 13	Stanifer J ¹³²	2016, Tanzania , East	stratified, cluster- designed cross- sectional household	481	Age (years): 46.9 ± 15.1 Male gender: 74.4% Diabetes mellitus: 9.4% Hypertension: 31%	presence of albuminuria (≥30 mg/dl; confirmed by repeat assessment) and/or a reduction in eGFR ≤60 ml/min/1.73 m ²	Quantitative assessment of albuminuria and eGFR by MDRD and CKD-EPI	IDMS	6.8%	Total prevalence : 11.9%	High
14 15 16 17	Stanifer J ¹³³	2015, Tanzania , East	Randomly selected adults	481	Age (years): 45 (IQR 35–59) Male gender: 25.6% Diabetes mellitus: 12.7% Hypertension: 28%	eGFR<60 ml/min/1.73m ² and/or persistent albuminuria	Quantitative assessment of albuminuria and eGFR by MDRD	IDMS	Not mentioned	Total prevalence: 7%	High
18 19 20 21	Stanfier J	2016, Tanzania , East	stratified, cluster- designed cross- sectional survey	606	Age (years): 45.5 ±15.5 Male gender: 24.6% Diabetes mellitus: 10.1% Hypertension: 23.7%	the presence of albuminuria (≥30mg/dl confirmed by repeat assessment) and/or a oncemeasured eGFR ≤60 ml/min/1.73m²	Quantitative assessment of albuminuria and eGFR by MDRD	IDMS	Not mentioned	Total prevalence: 8%	High
22 23 24 25 26	Wachukwu C ⁹³	2015, Nigeria, West	Adult volunteers in a university	259	Age (years):28.3±9.7 Male gender: 52.1% SBP(mmHg):117.3±15.5 DBP(mmHg): 75.7±11.7	eGFR<60 ml/min/1.73m ²	Proteinuria by dipstick and eGFR by CG	Not mentioned	12.4%	Total prevalence: 1.9%	Low

DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault,

CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative

Table 3: Studies on CKD among HIV patients

	Year,	Location					Method of	Creatinine			Quality
	Country,				Population	Definition of	outcome	assay			assessme
Author O	Region		N	Study group	characteristics	СКО	assessment		Proteinuria	CKD prevalence	
1		ART clinic at			Age (years):			Kinetic		Total prevalence	Low
2		the regional			HAART-naïve			Jaffe		(CKD-EPI):	
3 4		hospital			(33.42 ± 0.88) , On					10.2%	
5					HAART (36.91 ±					HAART naive:	
7		4		HIV (276	0.77)					8.7% CG, 9.1%	
3	2013,			HAART-naïve	Male gender:	eGFR < 60	CG, 186			MDRD, 8.7%	
9	Ghana,			patients	HAART-naive	mL/min/1.73 m ²	MDRD,		Not	CKD-EPI	
) Wkba O ¹⁴²	West		442	166 on HAART)	(28.3%), On	for > 3 months	CKD-EPI		measured	On HAART: 14.5%	
		Three			Age (years): 36.8			Kinetic			Medium
}		centeres in			(32-42.2)	eGFR<60		Jaffe			
		Uganda and			Male gender: 35%	ml/min/1.73 m ²					
7		Zimbabwe			SBP: median:110	on ≥ 2					
3					(IQR:100-120)	consecutive visits					
)	2011,				mmHg	80 days apart or					
					-						
	Uganda,				DBP: median:70	confirmed 25%					
2	Zimbabwe,			HIV-infected	(60-80) mmHg	decrease if eGFR				Total prevalence:	
) -	East and			patients initiating	BMI: 21.1 (19.1–	<60 ml/min/1.73			Not	7.2%	
2 3 4 5 5 7 3 9 9 9 1 2 2 3 4 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	South		3316	ART	23.6) kg/m ²	m ² at baseline	CG		measured		
7	2008,	Three			Age (years): 36.8	eGFR<60 ml/min		Kinetic		Total prevalence (Medium
3	Uganda,	centeres in		HIV-infected	(32-42.2)	1.73 m^2 on ≥ 2	186 MDRD,	Jaffe	Not	MDRD):3.1%,	
9 Stöhr W ¹⁴⁴	Zimbabwe,	Uganda and	3316	patients on ART	Male gender: 35%	consecutive	CG		measured	CG 7.4%	

2 3										25	5
1	East and	Zimbabwe			SBP: median:110	occasions >80					
5	South				(IQR:100-120)	days apart or					
6					mmHg	confirmed 25%					
8											
9					DBP: median:70	decrease if eGFR					
10					(60-80) mmHg	<60 ml/min/1.73					
11					BMI categories:	m ² at baseline					
12 13		0,			<18.5 kg/m ² : 18%						
14											
15					18.5- <25 kg/m ² :						
15 16			100		66%						
17					25-<30 kg/m ² :						
18				N	12%						
90											
91					$\geq 30 \text{ kg/m}^2 : 4\%$						
22		Outpatients						Not		Total prevalence	Medium
23		HIV clinic						mentioned		(MDRD): 45.7%	
24											
25										GG: 46.5%	
26 07					Age (years): 40.1					Prevalence by	
28					(33-46.5) Male					Stages (using	
29					gender:29.7%					MDRD)	
30											
3 1					Hypertension:					Stage 1: 30.2%	
32					2.7%		Proteinuria			Stage 2:13.5%	
19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 Sailhol J 79	2011,				DM: 2%		by urinary			Stage 3: 2%	
85	Burundi,			HIV-infected	BMI: median: 21.8					Stage 4 & 5: no	
36										-	
37 ailhol J 79	East		300	patients	(19.3-24.2) kg/m ²	KDOQI	186MDRD		6.10%	patients	
38	2014,	Outpatient		HIV-infected	Age (years): 40.0	Proteinuria≥ +1	Proteinuria	Not	Proteinuria	Total prevalence	Low
89 40 ^{Masimango} MI ¹⁰⁷	Congo,	HIV clinic	235	patients	± 10.7	by urinary strip or	by urinary	measured	≥+1: 41.3%	(based on	
41	I.	I	1			1	l	I .			I

3										
4	Central				Male gender:	albuminuria ≥30	strip and			proteinuria): 41.3
T 5 6 7 8 9					27.8%	mg/dl	ACR			%
7					Hypertension:					
8					46.8%.					
9 10					DM: 1.7%					
11					BMI: 22.3 ± 3.8					
12										
13 14					kg/m2					
15										
16		Three			age(years): 36.8			Kinetic		Medium
17 18		centeres in			(IQR: 32.0–42.2)			Jaffe		
19		Uganda and		C/A	male gender: 35%					
20		Zimbabwe			SBP: median:110	eGFR<60 ml/min				
21 92					(IQR: 100-120)	1.73 m^2 on ≥ 2				
23					mmHg	consecutive				
24				HIV-infected,	DBP: median:70	occasions >80				
25 26	2000									
27	2008,			ART-naive	(IQR: 60-80)	days apart or				
28	Uganda,			adults with	mmHg	confirmed 25%				
29 80	Zimbabwe,			CD4+ cell	BMI: median, 21.1	decrease if eGFR				Total prevalence:
3 1	East and			counts of<200	(IQR:19.1-23.6)	<60 ml/min/1.73			Not	7%
32 Reid A ¹⁴⁵	South		3316	cells/mm3	kg/m ²	m ² at baseline	CG		measured	
34		HIV			Age (years): 37			Not		Total prevalence (Low
35		outpatient			(range 16–70	Proteinuria ≥ +1	Proteinuria	measured		based on
ቆ6 87	2009, South	clinic at		HIV-infected	years)	by urinary strip or	by urinary			proteinuria
38	Africa,	Johannesburg		naïve ART	Male gender: 38%	albuminuria ≥30	strip and		43.7% had	prevalence):
18 19 20 21 22 23 24 25 26 27 28 29 30 31 32eid A ¹⁴⁵ 33 34 35 36 37 38 39 46 ^{abian J¹⁰⁸}	South	Hospital	578	patients	DM: 4.6% among	mg/dl	PCR		proteinuria	43.7%
41										

									27
					group with				
					microalbuminuria				
		All					IDMS-		Medium
		consenting					calibrated		
)		individuals			Age (years): HIV-				
		residing in			ve, 28 (IQR: 24-				
<u>}</u>		every		1202 HIV-	35), HIV+ve: 30				
+		household in		infected patients	(IQR: 25–36)				Total prevalence
5	2010,	50 Rakai		and 664 HIV -ve	Male gender: HIV-				among HIV+ve :
7	Uganda,	District		age- and sex-	ve: (38.7%),	eGFR<		Not	0.7%
3 Jucas G ¹⁵⁴	East	communities	1960	matched controls	HIV+ve (36.4%)	60ml/min/1.73 m ²	MDRD	measured	
		Primary					Not		Total prevalence Medium
		health care					mentioned		(CKD-EPI with
				· ·	C 1.		mentioned		
		units							coefficient for
						9 ,			black race): 2.5%
,					Age (years): 30				CG: 3.4%
3					(IQR: 27–35)				(MDRD with
)				HIV-infected	Male gender: 30%		CG,186		coefficient for
	2011, sub-			patients before	BMI:22.8 (IQR:	CrCl <50 ml/min	MDRD,	Not	black race): 2.5%
ao J ¹⁶⁰	Saharan,		2495	ART	20.4–25.6) kg/m ²		CKD-EPI	measured	
		Consecutive			Age (years): 43 ±	eGFR< 60	proteinuria Kinetic		Total prevalence : Low
		HIV patients		HIV-infected	9	ml/min/1.73 m ² /	by dipstick Jaffe and		20.5%
7	2012,	from clinic		(ART	Male gender: 23%	or proteinuria	and 24-hour IDMS		3% of the patients
2 3 4 5 5 6 7 8 9 9 9 9 9 9 9 9 9 9 9	Congo,			treated=264)	Hypertension:	defined as 1+ or	proteinuria,		had eGFR< 60
opongo A ⁹⁹	Central		300	(ART naïve =36)	13%	greater	eGFR by	20.50%	ml/min/1.73 m ² by

										28	3
					BMI:24 ± 5		MDRD, CG			MDRD	
					(kg/m ²						
		HIV clinic				eGFR <60		Not			Low
						ml/min/1.73 m ² ;	Proteinuria	mentioned			
n							by urinary	mentioned			
) 1					Age (years): 38	or proteinuria	strip, ACR,				
2					(32-45)	≥+ 1	PCR, eGFR				
3	2013,			HIV-infected	Male gender: 33%	(confirmed by	by CG,				
4 5						uPCR > 45				T ()	
6	Ghana,			patients starting	BMI: 20.3 (IQR:		MDRD,			Total prevalence	
p arfo F ¹⁰⁹	West		3137	ART	17.6-22.7) kg/m ²	mg/mmol)	CKD-EPI			(CKD-EPI):13.8%	
8 9		Electronic						Not			Medium
0		medical						mentioned			
1		records of									
9 0 1 2 3 4 5 6 6 7 8 Supta S ¹⁶¹		patients from			C 1						
4	2011,	18 sites			Age (years): 35.5						
5	Cameroon,	throughout			(29.3-44.0)					Total prevalence	
6 7						CED +CO				_	
, 8	Central-	Western		HIV patients	Male gender:	eGFR<60				(MDRD): 9.4%	
Gupta S ¹⁶¹	West	Kenya	7383	without ART	26.9%	ml/min/1.73 m ²	CG, MDRD			CG: 20.2%	
1		Ambulatory			Age (years): 38.84			Kinetic			Low
2		Treatment			(IQR: 33.18-			Jaffe			
3		Center			46.23)						
4 5					Male gender:						
6					33.9%						
7	2013,				BMI: 20.31 (IQR:					Total prevalence	
0 1 2 3 4 5 6 7 8				Nil i'		CED (()			NI-4	•	
0	Congo,			Newly diagnosed	17.97-22.89)	eGFR< 60			Not	:8.5%	
0 Ekat MH ¹⁴⁶	Central		562	HIV patients	kg/m ²	ml/min/1.73m ²	186MDRD		measured		

3											
4		Academic						Kinetic			Low
5 6		Model for the			Age (years): 35.0			assay			
7		Prevention			(range, 19-60)		proteinuria				
8 9		and			Male gender:		by urinary				
10		Treatment of			32.1%		strip, CG,				
11		HIV/AIDS		HIV-infected	SBP: 104.7		full and		6.2%		
12 13	2007,	(AMPATH)		patients naive to	(range, 80–140)	CrCl<60	abbreviated		(proteinuria	Total prevalence	
Wools-Kaloustian K ⁸⁰	Kenya, East	clinic	373	ART	mm/Hg	ml/min/1.73 m ²	MDRD		≥1+)	:11.50%	
15 16		HIV/AIDS			Age (years): 34.6			Not	/		Medium
17		4									Medium
18		outpatient			± 9.4			mentioned			
19		clinic			Male gender:						
20 21					48.5%						
22					Hypertension:		Proteinuria		38%		
23					13.2%	albuminuria +1	or		proteinuria		
20 21 22 23 24 25 26 27 28 29					BMI categories:	on at least two	albuminuria		with		
26					<19.0 kg/m ² : 59.2	occasions (4	by urinary		dipstick	Total prevalence	
27 D8					%	weeks apart) and	strip and 24		21.9%	:38.8 %	
29	2008,				19-25 kg/m ² :	or serum	hours		nephrotic	Among patients;	
во				HIV-infected	37.5%	creatinine >1.5			•	8.8% had CrCl <15	
00	Nigeria,						proteinuria ,		range		
32 _{mem C⁸¹}	West		400	patients	>25 kg/m ² : 3.3%	mg/dl	CG		proteinuria	ml/min.	
B4		Community			Age (years): 34		proteinuria	Kinetic	(9% among	Total prevalence	Medium
ያ5 86		based			(IQR: 30–39) HIV	eGFR<60	by urinary	Jaffe	HIV +	among HIV	
87	2011,			677 HIV-	+ve/43 (IQR:34–	ml/min/1.73 m ² /	strip, eGFR		and7.2%	+ve:9%	
88	Rwanda,			infected and 214	50) HIV -ve	or proteinuria +1	by MDRD,		among non-	2.7% had eGFR<	
9£mem C ⁸¹ 33 34 35 36 37 38 39 40Wyatt C ⁸²	East		891	HIV-uninfected	Male gender: 0	or greater	CKD-EPI,		infected)	60 ml/min/1.73 m ²	
41						<u> </u>		1			

Hypertension: HV-ve: 4.8% CG CKD prevalence among HIV-ve: 4.8% HIV-ve: 4.8% HIV-ve: 2.9% 60 ml/min/1.73 m² 1.5% had 66 fR 1.5%	2 3										30
BMI (kg/m²): HIV+ve: 20.9 (IQR: 19.0–23.3)/ HIV-ve: 20.5 (IQR: 18.5–23.3) The presence of Kinetic Low						Hypertension:		CG			CKD prevalence
BMI (kg/m²): HIV+ve: 20.9 (IQR: 19.0–23.3)/ HIV-ve: 20.5 (IQR: 18.5–23.3) The presence of Kinetic Low	5 6					HIV+ve: 4.8%/					among HIV-ve:
11	Ţ					HIV-ve: 8.3%					7.2%
11	8 9					BMI (kg/m^2) :					1.5% had eGFR<
12 13 14 15 16 HIV clinic of	10					HIV+ve: 20.9					60 ml/min/1.73 m ²
HIV-ve: 20.5 (IQR: 18.5–23.3) HIV clinic of The presence of Kinetic Low Vecumble 17	1 1					(IQR: 19.0–23.3)/					
14 15 16 HIV clinic of The presence of Kinetic Low 17 Vector 16	13					HIV-ve: 20.5					
16 The presence of Kinetic Low 17 Vegetation of the presence o	14					(IQR: 18.5–23.3)					
Vonedá Vonedá I a Vone	15 16		HIV clinic of				The presence of		Kinetic		Low
Separat Separat Separat Separat Separat Separat Separat Separat Separation S	17								Jaffe		
2013 hospital All newly diagnosed HIV- Age (years): 35±10.7 eGFR by 2 by CG, 175 3% had eGFR < 60 ml/min based by urinary eGFR by 2 by CG, 175 3% had eGFR < 60 ml/min/1,73 m² eGFR by 2 by CG, 175 3% had eGFR < 60 ml/min/1,73 m² eGFR by 2 by CG, 175 3% had eGFR < 60 ml/min/1,73 m² eGFR by 2 by CG, 175 mentioned mentioned mentioned mentioned egaptions equations equa	18 19		general		(Q)		•	Proteinuria			Total prevalence
Cameroon, diagnosed HIV- Age (years): on the average of strip, eGFR Among patients;	20	2013,	hospital		All newly		60 ml/min based	by urinary			:36%
Central - West 104 naive to HAART Male gender: 32% equations MDRD 36% ml/min/1,73 m² 260 27 28 27 27 28 29 29 29 20 20 20 20 20	21 92	Cameroon,			diagnosed HIV-	Age (years):	on the average of	strip, eGFR			Among patients;
26 More Mor	23	Central –			infected patients	35±10.7	eGFR by 2	by CG, 175			3% had eGFR< 60
ART clinic in a central hospital in Malawi Age (years): 34.3 (≥+2); any ± 9.3; proteinuria (≥+1) Male gender: with renal By urinary newly referred Hypertension: GFR <60 strip, eGFR Malawi,	24 2 5 0lefackKaze F ⁸³	West		104		Male gender: 32%				36%	ml/min/1,73 m ²
a central hospital in Malawi Age (years): 34.3 (≥+2); any ± 9.3; proteinuria (≥+1) Male gender: with renal Consecutive 43.5% dysfunction (e by urinary newly referred Hypertension: GFR <60 strip, eGFR With proteinuria; Malawi, M	26		ART clinic in				any proteinuria		Not		Low
hospital in Malawi Age (years): 34.3 (≥+2); any ± 9.3; proteinuria (≥+1) Male gender: with renal Proteinuria Consecutive 43.5% dysfunction (e by urinary newly referred Hypertension: GFR <60 strip, eGFR with proteinuria; Malawi, HIV-infected 11.2% ml/min/1.73 m²) by CG and 5.3% had CrCl<	27 28		a central				(≥+1);		mentioned		
Age (years): 34.3 (≥+2); any ± 9.3; proteinuria (≥+1) Malawi Male gender: with renal Proteinuria Consecutive 43.5% dysfunction (e by urinary newly referred Hypertension: GFR <60 strip, eGFR Malawi, Malaw	29		hospital in				heavy proteinuria				
## ## ## ## ## ## ## ## ## ## ## ## ##	30 81					Age (years): 34.3					
Male gender: with renal Proteinuria Consecutive 43.5% dysfunction (e by urinary Among patients With renal Proteinuria by urinary Among patients With proteinuria; Among patients With proteinuria; HIV-infected 11.2% ml/min/1.73 m²) by CG and Fast 526 patients on ART DM: 0.8% and heavy MDRD 23.3% (60 ml/minute)	32										Total prevalence:
Consecutive 43.5% dysfunction (e by urinary and patients with proteinuria; 38 Malawi, Malawi, Fast Sign Consecutive 43.5% dysfunction (e by urinary strip, eGFR with proteinuria; HIV-infected 11.2% ml/min/1.73 m²) by CG and strip, eGFR with proteinuria; 5.3% had CrCl<	\$3 \$4							Proteinuria			
2011, newly referred Hypertension: GFR <60 strip, eGFR with proteinuria; Malawi, HIV-infected 11.2% ml/min/1.73 m²) by CG and 5.3% had CrCl< Stripk G84 Fast 526 patients on ART DM: 0.8% and heavy MDRD 23.3% 60 ml/minute	85				Consecutive	C					
Malawi, Mal	3 6	2011					,				
39 Struik G84 Fast 526 patients on ART DM: 0.8% and heavy MDRD 23.3% 60 ml/minute	<i>ሄ /</i> 88				-						
*Atrulk (*** Fact 1576 natients on ART DM: (15% Land heavy MDRD 172.3% All ml/minuta	39 30 1 0 84			526						22.20/	
	48 ^{truik G} 41	East		526	patients on ART	DM: 0.8%	and heavy	MDRD		23.3%	60 ml/minute

3											
1						proteinuria (≥+2)					
						with renal					
) 7						dysfunction (CrCl					
3						< 60 mL/minute)					
9						ŕ					
0						and					
1 2						the absence of					
3		0,				any alternative					
4						cause for renal					
5						dysfunction or					
6 7		•				•					
18						proteinuria.					
9		National					Serum	Not			Low
20		Central					creatinine	mentioned	Proteinuria		
21 22		hospital			Age(years): 22±4	Proteinuria > 0.5	measurement		>0.5 g/24		
23	1998,	1		HIV-infected	Male gender: 68 %	g/24 hrs and	and 24-hour		hrs in	Total	
24					Wate gender, 08 76						
os VIII	Benin, West		92	patients		SCr>14 mg/l	proteinuria		23.33%	prevalence:27.16%	
20 27		infections						Not known		Total prevalence	Low
28		unit of the								among AIDS	
29		Jos								group:51.80%	
30	2003,	University		Consecutive 79						CKD prevalence	
31 32									250/ / 175 3	1	
33	Nigeria,	Teaching		AIDS patients					25% (AIDS	among control	
3♠gaba EI ¹⁷⁰	West	Hospital	126	and 57 controls		Not known	Not known		group)	group: 12.2%	
35		Outpatient				CrCl < 60	Proteinuria	Not		Total prevalence :	Low
96 87	2011,	clinics		HIV-infected		ml/min.	by urinary	mentioned		45.9%	
20 21 22 23 24 25 26 27 28 29 30 31 32 33 48 gaba El ¹⁷⁰ 35 36 37 38	Zimbabwe,			patients naïve to		Proteinuria ≥ +1	strip and 24-			Among patients;	
39 • Kana GT ¹⁰⁰	South		159	ART		and/or PCR > 20	hour		45.90%	7.50% had CrCl<	
10 ^{ana G1}	South		137	AKI		anu/of 1 CK ~ 20	noui		⊐ J.7U/0	7.30/0 Hdu CICI	
<i>t</i> I											

						mg/mg	proteinuria,			60 ml/min	
							eGFR by CG				
							carkbyca	27			_
		Medical				Microalbuminuria		Not			Low
		center				> urinary protein		mentioned			
)					Age (years):	30 and 300 mg/24					
2					31(range,13-63)	h.					
- }					Male gender: 25%,	A cut-off serum	Proteinuria				
ļ		9			Proteinuria -ve:	creatinine level of	by urinary				
5					117±14/70±9	250 mmol/l was					
) 7		•									
3					Microalbuminuria:	used to exclude	hour				
	2006, South				121±15/81±10	those patients	proteinuria,			Total prevalence (
	Africa,			HIV patients not	Macroalbuminuria:	with advanced	CG and			based on	
Man TM¹⁰¹	South		615	on ART	120±12/74±11	nephropathy	MDRD		6%	proteinuria): 6%	
}	2008,	Home-Based			Age (years): 39			Kinetic			Low
	Uganda,	AIDS Care		HIV patients	(median)	CrCl of 25–50	CG, 175	Jaffe	Not	Total prevalence:	
eters P ¹⁴⁷	East		508	starting HAART	Male gender: 41%	ml/min	MDRD		measured	20%	
7	Lust	Clinian	300	starting 11 11 11 11			MBRB	Not	measurea	2070	M.J
3		Clinics			Age (years):						Med
,)					HIV+ve (27 (IQR:			measured		Total prevalence	
	2011,				24- 31)),		Proteinuria		HIV+ve:	among HIV+ve (
2	Cameroon,			199 HIV +ve and	HIV-ve (27 (IQR:		by urinary		39.2%	based on	
) 	Central-			190 HIV -ve	22 -31))	Proteinuria (PCR	strip and		HIV-ve:	proteinuria):	
ao J 110	West		389	pregnant women	Male gender: 0	> 200 mg/g)	PCR		20.9%	39.2%	
7	2011,	Outpatient		HIV-infected	Age (years): 36.1		Proteinuria	Not	36%		Low
Deters P ¹⁴⁷ Bellion of the second of the		clinics			±7.9		and			Total nuovaloress	2011
9	Tanzania,	CHINES		patients naïve to				mentioned	proteinuria	Total prevalence:	
YIsango L ⁸⁵	East		355	ART	Male gender: 35%	KDOQI	albuminuria		≥	85.6%	

1											
					BMI (kg/m ²): 21.3		by urinary		+1		
					±3.8		strip eGFR				
							by CG,				
							MDRD				
0		primary			Age (years):			Not			Low
1		healthcare		Consecutive 238	pregnant, 28 (IQR:			mentioned			
2 3		clinic		pregnant women,	25–32), men, 37						
				1014 non-	(IQR: 32–45),						
5											
4 5 6 7		4		pregnant, 609	women, 33 (IQR:						
18	2013, South			men; HIV-	28–39)					Total prevalence:	
9	Africa,			infected patients	Male gender: 33%		Absolute Scr		Not	5.8%	
18 19 20 19 20 19 21 22 23 24 25 26 27 28 29 30 3 Mulenga L ¹⁶³ 32 33 34 35 36 37 38 39 40 dedeji T ¹⁵⁸	South		1861	eligible for ART		CrCl< 60ml/min	and CG		measured		
22		Clinic		_	Age (years):			Not			Mediu
23					normal CrCl,			mentioned			
24					33.7±7.9,						
25 26											
27	2008,			HIV-infected,	decreased CrCl,		Absolute				
28	Zambia,			ART-naïve	38.5±9.9		Scr, eGFR			Total prevalence	
29	South			adults initiating	Male gender:		by CG and		Not	(MDRD): 3.2%	
30 Mulenga L ¹⁶³			25249	treatment	39.7%	CrCl< 60 ml/min	MDRD		measured		
192		TI	2021)	troutinont.				W: v:	measarea		T.
33		The			Age (years): 37.9+			Kinetic			Low
34		University			10.5			Jaffe and			
35		of Ilorin		Newly diagnosed	Male gender:			IDMS			
56 57	2015,	Teaching		HIV-infected	42.6%		Absolute				
88					BMI (kg/m ²):	eGFR< 60	Scr, eGFR		Not	Total prevalence:	
39	Nigeria,	hospital,							INOL	•	
1 dedeji T ¹⁵⁸	West		183	patients	20.88+ 3.56	ml/min/1.73m ²	by MDRD		measured	24%	

										34	4
		Federal			Age (years); 38.84			Not			Low
		Medical			± 10.65			mentioned			
		Centre		393 newly	Male gender: 28%						
				diagnosed drug-	BMI categories:						
				naïve HIV	<18.5.0 kg/m ² : 7%		Quantitative				
<u>}</u>				patients, 136 age	18.5-24.9 kg/m ² :					Total nuccelonas	
							assessment			Total prevalence	
				and sex matched	35%	24-hours urine	of			among HIV +ve	
•	2016,	4		HIV-	25-29.9 kg/m ² :	protein ≥0.300 g	protienuira,			patients:22.9%	
.	Nigeria,			seronegative	32%	and/or GFR <60	Scr, and		Not	Prevalence among	
anyabolu E ¹³⁵	West		529	controls	$\geq 30 \text{ kg/m}^2:23\%$	ml/min	eGFR		mentioned	HIV -ve: 8.1%	
		Medical Out-			Age (years): 40.3			Kinetic			Low
		patient			± 10.3			Jaffe			
		Department			Male gender: 44%	ŀ					
		of University			BMI (kg/m ²): 20.5						
		of Ilorin			± 4.8 among HIV						
		Teaching			patients , 26.7 ±						
		_									
		Hospital			5.3 among control						
				227 newly-	group						
				diagnosed, ART	SBP(mmHg):					Total prevalence	
•				naïve patients	111.9 ± 1 among		Proteinuria			among HIV	
				with	HIV patients,	albuminuria ≥ 30	by dipstick,			patients: 47.6%	
	2015,			HIV/AIDS,	126.1 ± 12.0	mg/g and/or	and ACR			The prevalence	
yyokunle D ¹¹³	Nigeria,			108age and sex	among control	eGFR < 60	and eGFR		Not	among HIV -ve:	
		1	l								

								35	
				DBP(mmHg): 72.9					
				± 9.5 among HIV					
				patients, 80.6 ± 6.8					
				among control					
				group					
	Komfo			Age(years): 39		Proteinuria (Not		Total prevalence	Low
						·	270/ by	•	Low.
2015							-		
Ghana,	Hospital				Proteinuria or		-		
West		330	ART	(IQR: 20.5-26.6)	CrCl<60ml/min	GFR by CG	PCR	among 7%	
	Two primary			Age (years): HIV		Not		1	Medium
	care clinics			+ve: 43 (IQR: 39–		mentioned			
				50), HIV-ve: 49					
				(IQR:40-56)					
				Male gender: HIV					
				+ve: 31%, HIV-					
2015,			210 HIV+ve	HIV +ve: 5% ,				12.1%	
Kenya,			patients and	HIV -ve: 15.2%		eGFR by	Not	HIV+ve: 17%	
East		2206	1996 HIV -ve		CrCl<60 ml/min	CKD-EPI	measured	HIv-ve: 11%	
	2015, Kenya,	Ghana, Hospital West Two primary care clinics 2015, Kenya,	Anokye 2015, Teaching Ghana, Hospital West 330 Two primary care clinics	Anokye 2015, Teaching Ghana, Hospital West Two primary care clinics 2015, Kenya, Anokye Teaching HIV patients on ART HIV patients and	# 9.5 among HIV patients, 80.6 ± 6.8 among control group Komfo	# 9.5 among HIV patients, 80.6 ± 6.8 among control group Komfo	# 9.5 among HIV patients, 80.6 ± 6.8 among control group Komfo	# 9.5 among HIV patients, 80.6 ± 6.8 among control group Romfo	# 9.5 among HIV patients, 80.6 ± 6.8 among control group Komfo

<u>!</u> }										36	5
		Lighthouse					eGFR by	IDMS			Medium
		Clinic					CG, MDRD,	calibrated		Total prevalence	
							and CKD-	creatinine		among HIV+ve	
0				116 HIV +ve			EPI with and	and		(creatinine based	
1 2	2016,			ART-naïve	Age (years): 31		without	cystatin-C		CKD-EPI):1.9%	
3	Malawi,	O_{A}		patients and 247	(IQR:26-39)	eGFR< 60	correction		Not		
4 Glaser N ¹⁴	East		363	HIV-ve patients	Male gender: 52%	ml/min	factor		measured		
6		Lighthouse			Age (years): 34.1		Proteinuria	IDMS			Medium
7		Clinic			±10.9		by dipstick	calibrated		Total prevalence :	
8 9				C/A	Male gender: 52%		and ACR,	creatinine		13%	
					BMI(kg/m ²):		eGFR by	and		Prevalence among	
20 21 22 23 24	2016,			116 HIV +ve	23.2±4.8		CG, MDRD,	cystatin -C		HIV+ve22%	
23	Malawi,			patients and 247	Hypertension:		and CKD-			Prevalence among	
.4 5 ilaser N ¹¹⁵	East		363	HIV –ve patients	13.5%	KDOQI	EPI		12.1%	HIV-ve: 9%	
196		Gugulethu		•	Age (years): 34			Not			Medium
77	2015, South	Community		HIV infected	(IQR: 29-41)			mentioned			
26 27 28 29	Africa,	Health		patients initiated	Male gender: 38%	eGFR< 60		mentioned	Not	Total prevalence:	
80 Kamkuemah M ¹⁶⁷			1092		Male gender. 38%	ml/min	eGFR by CG			2%	
	South	Centre	1092	ART therapy		IIII/IIIII	eGFR by CG		measured	2%	
3		Government		HIV patients on				Kinetic			Low
34 55		hospitals		HAART, DOTS	Age (years): 38.04			Jaffe			
66	2015,			or on the	± 10.52						
52 53 54 55 56 57	Cameroon			combined	Male gender:	eGFR <60					
19	Central-			therapy	50.5%	ml/min per 1.73	eGFR by		Not	Total prevalence:	
Nsagha D ¹⁴⁹	West		200	(HAART/DOTS)		m ²	MDRD		measured	8%	

		in factions			A co. (recome). 21.4			Not	ı		Low
		infectious			Age (years): 31.4			Not			Low
		diseases			± 9.5			mentioned			
		clinic of			Male gender:						
		Gulu			36.3%		Proteinuria				
0	2015,	Regional		Newly diagnosed	BMI(kg/m ²) <18:	eGFR <60	by dipstick				
1	Uganda,	Referral		HIV patients not	33%	ml/min per 1.73	and eGFR		Proteinuria	Total prevalence:	
2 9 dongo P ⁹⁴	East	Hospital	361	receiving ART		m ²	by MDRD		≥ +1: 52%	14.4%	
4	Lust		301	receiving riter			oy MDRD		_ 11.3270	11170	
5		University of				eGFR <60		Kinetic			Low
6		Benin				ml/min per 1.73	Quantitative	Jaffe			
7		Teaching				m ² and/or	assessment				
3 9		Hospital				evidence of	of				
					Age (years): 36.03	kidney injury as	proteinuria				
1	2016				± 9.08	detected when the	_				
2	2016,										
4	Nigeria,			HIV infected	Male gender: 41%	PCR (mg/g) was	eGFR by		Not	Total prevalence:	
5 0 1 2 3 4 5 Skafor U ¹³⁶	West		383	naïve patients		≥200.	MDRD		mentioned	53.5%	
6		Medical in-			Age (years):			IDMS			Low
8		patients at			37.0±9.6						
9		the Chris			Male gender: 60%						
0	2016, South	Hani			BMI(kg/m ²): 20.9	eGFR <60	eGFR by				
2	Africa,	Baragwanath		HIV infected	±5.1	ml/min per 1.73	CG, MDRD,		Not	Total prevalence:	
3		C			±3.1	•				•	
Seape T ¹⁵⁶	South	Hospital	100	naïve patients		m ²	CKD-EPI		measured	16%	
5		Rural			Age (years):		Albuminuria	Not		Total prevalence	Medium
7	2015, South	Medical			40(IQR:34-48)	Albuminuria or	by ACR and	mentioned		(albuminuria):	
6 7 8 9 0 1 2 3 \$eape T ¹⁵⁶ 5 6 7 8 9 Wensink G ¹³⁷	Africa,	Centre		HIV infected	Male gender: 31%	eGFR <60	eGFR by			21%	
y Wensink G ¹³⁷	South		903	adult patients	Diabetes mellitus:	ml/min / 1.73 m ²	MDRD and		21%	2% had eGFR< 60	

2											38	
						4%		CKD-EPI			ml/min/1.73 m ²	
4 5 6 7						Hypertension:						
р 7						23%						
8_			Ontrotions						IDMC			Madiana
9			Outpatient			Age (years):			IDMS			Medium
10			infectious			37.9±9.4						
11 12			clinic at an			Male gender:						
13			academic			35.5%						
14			hospital			Diabetes						
15			nospitai									
16 17		2016, South	4		HIV infected	mellitus:2.2%	eGFR <60	eGFR by				
1 / 18		Africa,			patients initiating	Hypertension:	ml/min per 1.73	MDRD and		Not	Total prevalence:	
19	achor H ¹⁵⁷	South		650	ART	7.8%	m ²	CKD-EPI		measured	2 %	
20			Jimma			Age (years):			Kinetic			Medium
21			University			HAART naive:			Jaffe			
23			-									
24			Specialized									
25			Hospital			HAART +ve:						
26						35.14 ±9.2						
2/						Male gender: 37%						
29												
30						BMI(kg/m ²) :						
31						HAART naïve:		77/				
32						20.7±3.2, HAART						
33						+ve: 21.6 ±3.5						
35					(223 HAART							
36					`	Hypertension:						
37		2016,			naïve and 223	3.36%	eGFR <60					
38		Ethiopia,			HAART	Diabetes mellitus:	ml/min per 1.73			Not	Total prevalence:	
39 40 41	Iekuria Y ¹⁵⁰	East		446	experienced)	21.4%	m^2	eGFR by CG		measured	18.2%	

. blood pressure, DBP diastotic blood pressure, IDMS: boto,
.mpy, MDRD: Modification of Diet to Renal Disease, CG: Cockroft Gault . DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, HAART: highly active antiretroviral therapy, DOTS: directly observed treatment short course, ART: antiretroviral therapy, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault, CKD-EPI: Chronic Kidney Disease Epidemiology, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Table 4: Studies on CKD among diabetic patients

Study ID	Year, Country , Region	Location	N	Study group	Population Characteristics	Definition of CKD	Method of outcome assessment	Creatinin e assay	proteinuria	CKD prevalence	Quality assessment
Janmohamed MN ⁸⁶	2013, Tanzania, East	diabetes mellitus clinic of Bugando Medical Centre in Mwanza	369	Consecuti ve diabetic patients	Age (years): 54 (IQR: 45-62) Male gender: 46.6% Hypertension: 57.5% BMI (kg/m²): 25.6 (IQR: 22.6-29.6) Duration of DM (years): 6(3-11) 93.8% type 2 DM 6.2% type 1DM	eGFR ≤60 ml/min/1.73 m² or evidence of kidney damage (microalbuminuria or overt proteinuria).	Microalbumin uria, proteinuria by urinary strips, eGFR by CG	Kinetic Jaffe	Overt proteinuria (34.1%), microalbuminuria(45.8%)	Total prevalence:83.7%	Low
Wanjohi FW ⁸⁷	2002, Kenya, East	Outpatient diabetic clinic at Kenyatta National Hospital	100	Type 2 diabetic patients	Age (years): 53.7 ±9.3 Male gender: 37% Hypertension: 50% BMI (kg/m²): 27.8±6.0 Duration of DM (months): 10.3±7.5	Albuminuria > 20 mg/ L	Albuminuria by urinary strip, CG	Not mentioned	26% had albuminuria	Total prevalence(based on albuminuria): 26%	Low

Bouzid C ¹¹⁹	2011, Tunis, North	nutrition	689	Type 2 diabetic patients from computeri zed hospital	Male gender: 39% Hypertension: 84.6% (renal insufficiency), 57.2% (no renal disease) Duration of DM (years): 11±8	eGFR<60 ml/min	CG, 24-hour proteinuria	Not mentioned	10.1% macroalbumnuria, 13% microalbuminuria	Total prevalence:	Low
Choukem SP ⁸⁸	2012, Cameroon, Central- West	Two main referral centres	420	Consecuti ve type 2 diabetic patients	Age (years): 56.7 ±9.9 Male gender: 49% Hypertension: 50% BMI (kg/m²): 28.5 ±5.2 Duration of DM (years): 4 (IQR: 1-9)	The presence of positive proteinuria with or without low CrCl < 90 ml/min/1.73 m ²	Proteinuria by urinary strip/eGFR by CG	Not mentioned		Total prevalence: 31%	Low
Keeton G ¹²⁰	2004, South Africa, South	Groote Schuur Hospital Outpatients Diabetic Clinic or the Somerset Hospital Outpatients	59	Type 2 diabetic patients	Age (years): 62 ±9.4 Male gender: 36% BMI (kg/m²): (31± 6) Duration of DM (years): 17 (Range: 14-33)	Double Scr level	Proteinuria by PCR, and serum creatinine	Not mentioned		Total prevalence: 66.1%	Low
BouAziz ¹²¹	2012, Tunisia, North	Basic Health Group of Sousse	115	73 type 2 diabetic patients and 42 healthy	Age (mean ±SE in years): 59.3 ±1.1 Male gender: 35% SBP (mean ±SE mmHg): 136.3 ±3.1	Microalbuminuria (defined as $<$ 2.8 g/mmol for women and $<$ 2.3 for men) and eGFR \leq 60 ml/min/1.73 m ²	Measurement of microalbuminu ria, eGFR by MDRD	Not mentioned		Total prevalence:	Low

				volunteers	DBP (mean ±SE): 76.8 ±1.9 BMI (mean ±SE in kg/m²): 30.5± 0.7 Duration of DM (years): 10.6±1						
Katchunga P ¹²²	2010, Congo, Central	Referral general hospital	98	Medical records of type 2 diabetic patients	Age (years): 58 ±10.4 Male gender: 35.7% Hypertension: 59.2% BMI (kg/m²): 25.2± 4.7 Duration of DM (years): 17.3 ±8.5	KDOQI	Microalbumin uria (>20 mg/L and <200 mg/L) eGFR by MDRD	Not mentioned		Total prevalence: 66%	Low
Djrolo F ¹²³	2001, Benin, West	National University hospital centre	152	Type 1 and 2 diabetic patients	Age (years): 53.3(range, 21-90) Male gender: 65.8% Duration of DM (years): <1 – 16 or more	Presence of proteinuria	24-hour proteinuria	Not measured	28%	Total prevalence (based on proetinuria level): 28%	Low
Balogun WO ¹⁰²	2011, Nigeria, West	Tertiary hospital	40	Randomly selected type 2 diabetic patients	Age (years): 59.4 ± 11.25 Male gender: 37.5% Hypertension: 45%	not mentioned	Proteinuria by urinary strip and 24 hrs, eGFR by CG	Jaffe method	82.5% macroalbuminuria	Total prevalence:	Low
Mafundikwa A ¹⁰³	2007, Zimbabwe, South	Diabetic clinic	75	Consecuti ve Insulin- dependent	No available data	No available data	Proteinuria by urinary strips and 24-hour		Overt proteinuria 21%. Microalbuminuria	Total prevalence:	Low

				diabetic patients			proteinuria		12%.		
Lutale J ¹²⁴	2007, Tanzania, East	Outpatient diabetic clinic	204	type 2 diabetic patients	45% type 1 DM 55% type 2DM Age (years): type 1, 21(14– 44.8), type 2, 53 (23.5–85) Male gender: 55% hypertension: 42% BMI (kg/m²): 19.3 ± 3.8 (type 1), 27.8 ± 4.8 (type 2) Duration of DM (years): 3(Range: 0-25)	KDOQI	Quantitative assessment of albuminuria, CrCl by CG	Kinetic Jaffe	macroalbuminuria	Total prevalence: 18.5% 4.6% of Type 1 patients and 22% of Type 2 had eGFR < 60 ml/min/1.73 m ²	Low
Gill G ¹²⁵	2008, Ethiopia, East	Diabetic clinic at Mekelle Hospital	105	All diabetic patients	Age (years): 41±16 Male gender: 70% Hypertension: 5% BMI (kg/m²): 20.6 ±5.4 Duration of DM (years): 7±6	Nephropathy was considered present if the urinary ACR was >25.0mg/mmol and retinopathy was present. Microalbuminuria was diagnosed if the ACR was >2.5 and <25.0mg/mmol in men and >3.5 and <25.0mg/mmol in women.	ACR, Scr	Not mentioned	51% microalbuminuria	Total prevalence : 51%,	Low
Makulo R ¹¹¹	2010, Congo, Central	Community	229	Diabetic and 148 impaired fasting	Age (years): 53.1±16.3 Male gender: 33% SBP (mmHg): 128.0±5.7 DBP (mmHg): 78.5±13.4 BMI (kg/m²): 22.6±5.2	eGFR of <60 mL/min/1.73 m ²	Urinary albumin by urinary strip and ACR, eGFR by	Kinetic Jaffe	29.6%	Total prevalence: 29.6% 10% of the patients had eGFR< 60	Medium

				glucose			186MDRD			ml/min/1.73 m ²	
Adebamowo S ¹⁵¹	2016, Nigeria, Ghana, Kenya (sub- Saharan)	University medical centers and surrounding communities	4815	and 2607 controls	Age (years): 48±15 Male gender:41% Hypertension: (68.3% of type 2 DM, and 35.3% of diabetic-free) BMI(kg/m²): 26.9 ± 5.4 (diabetic patients) 25.5 ± 5.7 (non-diabetics)	eGFR of <60 ml/min/1.73 m ²	eGFR by MDRD and CKD-EPI	Kinetic Jaffe	Not measured	Total prevalence (MDRD): 9% 13.4% of type 2DM and 4.8% of diabetic free	Medium
Feteh V ⁹⁵	2016, Cameroon, Central-West	out-patient section of the endocrine unit of the Douala General Hospital	636	Cases of type 2 DM	Age (years): 56.5 ± 10.6 Male gender: 53.1% BMI (kg/m ²): 29.3 ± 14.7 Hypertension: 62.2%	eGFR of <60 ml/min/1.73 m ²	Proteinuria by dipsticks and eGFR by 186 MDRD		68.4% among anemic patients , 57.6% non anemic	Total prevalence: 18.5%	Low
Fiseha T ¹⁵²	2014, Ethiopia, East	Follow-up clinic at Butajira hospital	214	Diabetic patients	Age (years): 45 ± 14.5 Male gender: 57.5% SBP(mmHg): 121 ± 17 DBP(mmHg): 79 ± 10 BMI(kg/m²): 25.26 ± 4.35	eGFR of <60 ml/min/1.73 m ²	eGFR by CG and 186 MDRD	Kinetic Jaffe	Not measured	Total prevalence (MDRD): 18.2% Prevalence (CG):23.8%	Medium
Pillay S ⁹⁶	2016, South Africa,	All patients seen at Edendale	653	Diabetic patients with or	Among diabetic patients with HIV: Age(years): 50-70	eGFR of <60 ml/min/1.73 m ²	Proteinuria by dipstick and eGFR by 186	Kinetic Jaffe	18%	Total prevalence : 18.8%	Medium

	South	Hospital		without	Male gender: 32%		MDRD				
		diabetic clinic		HIV (149	Among diabetic patients						
				DM and	without HIV						
				HIV; 504	Age (years): 51-60						
				DM							
				without							
				HIV)							
		Outnotiont									Lam
		Outpatient		Diabetic							Low
		diabetic clinic		patients	100						
		of the					Albuminuria				
	2007,	department of			Age (years): 54.1±10.9	microalbuminuria	by urine			Total prevalence(
D 1 D 138					Male gender: 28%			Not	42.10/	based on	
Eghan B ¹³⁸	Ghana,	medicine at	109		Hypertension: 39%	if urine albumin excretion was	albumin	mentioned	43.1%	microalbuminuria	
	West	Komfo				30-300 mg/day	excretion and				
		Anokye			BMI(kg/m ²): 26.3 ± 4.4		eGFR by CG): 43.1%	
		Teaching									
		Hospital									

DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault, CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative

Table 5: Studies on CKD among hypertensive patients

		1		Lau		1					l a . w.
Study ID	Year Country Region	Location	N	Study group	Population characteristics	Definition of CKD	Method of outcome assessment	Creatinine assay	Proteinuria	CKD prevalence	Quality assessment
Osafo C ¹²⁶	2011 Ghana, West	four polyclinics	712	Hypertensive patients	Age (years): 59 (range,19–90) Male gender: 21.3% DM: 14.7% SBP (mmHg): 150 (range,100–280) DBP (mmHg): 90 (range, 60–160) BMI (kg/m²): 29.7 (range,12.2–67.4) BMI categories (kg/m²): <25: 22.3% 25-29.9: 26% >30: 45.7%	KDOQI	Proteinuria by PCR (men>0.3 women>0.2 mg/mg) eGFR by MDRD	Kinetic Jaffe	28.90%	Total prevalence: 46.90% Prevalence by stage: Stage 1-2: 19.1% Stage 3-5: 27.8%	Low
Ajayi S ¹⁶⁴	2014 Nigeria, West	Tertiary health centre	628	hypertensive and diabetic patients	Age (years): 49.71±13.22 Male gender: 49% DM: 8.6% SBP (mmHg): 135.9 ± 27.4 DBP (mmHg): 87.0 ± 16.3 BMI (kg/m²): 27.8 ± 8.7	eGFR <60 mL/min/1.73 m ²	eGFR by MDRD	Not mentioned	Not measured	Total prevalence: 38.5%	Low
Lengani A ¹²⁷	2000 Burkina Faso West	department of Cardiology or Internal	342	Hypertensive patients	Age (years): 50.6 ±13.8 Male gender: 58%	Serum creatinine ≥ 650 µmol/l and or blood urea >=35 mml/l plus long	Measurement of scr, 24-hour proteinuria	Not mentioned		Total prevalence: 50.8%	Low

		medicine				history with clinical					
						manifestations					
Nwankwo E ¹⁶⁵	2006 Nigeria West	University of Maiduguri Teaching Hospital	185	All hospitalized hypertensive patients	Age (years): 44.6 ± 14.9 Male gender: 49%	Scr >135 μmol/l	Measurement of Scr	Not mentioned	Not measured	Total prevalence: 45.50%	Low
Rayner B ¹²⁸	2006 South Africa South	100 General practice centres	1091	Random hypertensive patients	Age (years): >=35 years Male gender: 48.5% BMI: 23.6% of the patients had a normal BMI 41.9% were overweight and 34.2% were frankly obese	microalbuminuria 3-		not measured	21.3% microalbuminu ria 4.1% macroalbumin uria	Total prevalence (based on albumnuria): 25.4%	Medium
Plange-Rhule J 89	1999 Ghana, West	Komfo Anokye Teaching Hospital	448	Hypertensive patients	Age (years): 50.5 ±13.0 Male gender: 36% SBP (mmHg): 165.0 ±27.8 DBP (mmHg): 101.9 ±17.9	Plasma creatinine ≥140mol/1	Proteinuria by urinary strips and serum creatinine	Not mentioned	25.50%	Total prevalence: 30.2%	Low
Addo J ¹⁴¹	2009 Ghana , West	seven central government ministries in Accra	219	Hypertensive patients	Age (years): 50.4± 6.6 Male gender: 64% SBP (mmHg):156.0 ±21.5 DBP (mmHg): 95 ±13 BMI (kg/m²): 27.5 ± 5.4	Persistent proteinuria on Urinalysis in the absence of urinary tract infection and/or impaired GFR<60 ml/min/ 1.73 m ²	Proteinuria and eGFR by MDRD	Enzymatic assessment	13.4%	Total prevalence: 13.4% 4.1% had eGFR< 60 ml/min/1.73 m²	Medium

		Komfo		180 non-diabetic	Age (years): 22-87				Low
		Anokye		hypertensive	Male gender:37%				
		Teaching		patients and 61	SBP (mmHg): hypertensive patients(on				
		Hospital and		age matched	antihypertensive therapy:155.46±1.82,			Total	
		the		controls	no antihypertensive therapy:152±3.27),			prevalence	
		surrounding			control (117.38±0.96)	I Iring a Managin		-	
	2016, Ghana,	community		UA	DBP (mmHg): hypertensive patients(eGFR <60 excretion, and eGFR Not		(CKD-EPI): 14.5%	
Aryee C ¹³⁹	West		242		on antihypertensive	ml/min/1.73m ² by CG , 186 MDRD, mentioned	30%		
	west				therapy:101.46±0.94, no	and CKD-EPI		Prevalence by	
					antihypertensive therapy: 100.50±1.34),	and CKD-EPI		MDRD:13.3%	
					control (73.28±0.77)			Prevalence by	
					BMI (kg/m²): hypertensive patients(on			CG:16.6%	
					antihypertensive therapy:29.52±0.39, no				
					antihypertensive therapy: 29.8±0.71),				
					control (29.36±0.65)				
		out- patient		Newly diagnosed		Microalbumnuria as a		Total	Low
	2015	hypertension		eligible black	Age (years): 54.3 ± 6.2	random urine albumin Not		prevalence (
Nabbaale J ¹⁴⁰	Uganda	clinic	256	adult	Male gender: 36.7%	assessment of level between 30 and	39.5%	based on	
	East			hypertensive		albumin in urine albumin in urine		microalbumin	
				patients		277 Ing/ui.		uria): 39.5%	

DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault,

CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative

Table 6: Studies on CKD among other populations

Study ID	Year Country Region	Location N	Study group	Population Characteristics	Definition of CKD	Method of outcome assessment	Creatinine assay	Proteinuri a	CKD prevalence	Quality assessment
E.F K ¹⁹	2013 Senegal West	Nephrology department of the Aristide Le Dantec University Hospital Center.	Lupus patients	Age (years): 32.9 Male gender: 7% Hypertension: 30%	Proteinuria > 0.5 g/ 24 hours with or without hematuria/ renal insufficiency/ abnormal renal biopsy	24-hour proteinuria and eGFR by CG	Not mentioned	51%	Total prevalence: 72%	Low
Abd ElHafeez S ²⁹	2009 Egypt North	The Nephrology department at the Main Alexandria University 400 hospital	Relatives of ESRD patients	Age (years): 35.2±11.6 Male gender: 50.8% Hypertension: 60% DM: 11.5% BMI(kg/m²): 28.5±5.89	KDOQI	Proteinuria by urinary strips, 186 MDRD	Kinetic Jaffe	21.3%	Total prevalence 57% Prevalence by stage: Stage 1: 9% Stage 2: 44% Stage 3: 4% Stage 4: 0.3%	medium
Raji Y ²⁸	2015, Nigeria,	Nephrology out-patient 469	(230 first degree relatives of patients with CKD and	Age (years): 33.49 ± 12.0 BMI(kg/m ²): first degree relatives: 25.5 ± 5.3 , controls: 23.8 ± 4.0	Reduced eGFR	Albumnuria by ACR and eGFR by MDRD	Not mentioned	46%	Total prevalence:	Low

	West	clinic at Lagos University Teaching Hospital		230 age- and gender- matched controls with no personal or family history of CKD)	SBP(mmHg): first degree relatives: 116.5 ± 22.5 , controls: 112.1 ± 18.1 DBP(mmHg): first degree relatives: 74.9 ± 12.7 , controls: 71.4 ± 10.5					4%	
ElSharif M ²⁴	2013 Sudan East	Primary health care	252	primary health care facilities	Age (years): 43.35± 12.80 Male gender: 16% Hypertension: 10% DM: 5.95% BMI (kg/m²): 28.67 ± 6.43 BMI categories (kg/m²): <18: 2.38% >25.13: 71.83	eGFR of < 60 mL/min/ 1.73 m ² with or without proteinuria.	Proteinuria by urinary strip and eGFR by MDRD	Not mentioned	24.21%	Total prevalence: 10.32%	Low
Mo A ²⁶	2009 Nigeria West	Family practice clinic	250	Newly registered patients who attended the Family Practice Clinic	Age (years): 50.52 + 13.03 Male gender: 27.2% 32% elevated SBP, 30% elevated DBP DM: 6% Obesity: 32%	Persistently abnormal ACR irrespective of GFR level or persistent eGFR < 60 mL/min/1.73 m² irrespective of the presence or absence of Kidney damage after 3 months	Proteinuria by urinary strip, eGFR by MDRD	Standardized IDMS	14.4%	Total prevalence: 14.4% 10.4% had persistent eGFR< 60 ml/min/1.73 m²	Medium
Sumaili EK	2009 Congo	Primary and secondary	527	At risk population randomly selected	Age (years): 53.9 ± 15.5 Male gender: 43% Hypertension: 58.2% DM: 54.5% Obesity: 16%	KDOQI	Proteinuria by urinary strip, 24-hour proteinuria, 175 MDRD	Kinetic Jaffe	19%	Total prevalence: 36% Prevalence by stage	High

П	0 1	I 1.1		T					ı		
	Central	health care								stage 1: 4.2%, stage 2:	
										6.1%, stage	
										3: 18.3%, stage 4:	
										1.9%, stage	
				O _A						5: 5.7%	
		Federal		Subjects from medical		Proteinuria as 24					Low
	2016,	Medical		out-patient department of		hours protein ≥					
Anyabolu E ³⁰	Nigeria,	Center	136	the hospital.	Age (years): 38.58±11.79 Male gender: 27.9%	0.300g and impaired	Proteinuria by quantitative	Kinetic Jaffe	14.1% had	Total	
,	West				BMI(kg/m ²): 25.51 ± 6.47	renal filtration	assessment and Scr		proteinuria	prevalence: 14.1%	
						function as CrCl					
						<90mls/min					
	2015,	Charlotte		African patients with							Low
	South	Maxeke		rheumatoid arthritis	Age (years): 57.1±10.8 Male gender: 17.2%	eGFR<		Kinetic Jaffe	Not		
Dessein P ²⁰	Africa,	Johannesburg	233		BMI(kg/m ²): 27.4±6.0 Hypertension: 57.5%	60ml/min/1.73m ²	eGFR by CG, MDRD, CKD-EPI	and IDMS	measured	Total prevalence:	
	South	and Milpark			Diabetes mellitus: 12.5%	00111/11111/1:/5111	CAB EIT	calibrated	measurea	39%	
	South	Hospitals					OA				
		Tema		Patients with sickle cell		(eGFR < 60					Low
	2015,	General		anemia	Age (years): 23.25 ± 12.04	mL/min/ 1.73 m ² or					
Ephraim R ²¹	Ghana,	Hospital	194		Male gender: 43.3% SBP(mmHg): 110.06 ± 8.27	evidence of kidney	Proteinuria by dipstick	IDMS	13.4%	20.20/	
	West				DBP(mmHg): 67.16 ± 8.23 BMI (kg/m ²): 18.85 ± 11.19	damage as	and eGFR by CKD-EPI	-		39.2%	
	051				2 (agiii). 10.00 = 11.19	albuminuria, or					
						overt proteinuria					
van	2010	Tertiary	1216	New patients referred to	Age (years): 39.6 ± 15.9	Elevated SCr(>130	Proteinuria by quantitative	Not	16.7%	Total	Low

Rensburg B	South	hospital		the Renal Unit	Male gender: 51.1%	μmol/L) and small	assessment and Scr	mentioned	proteinuria	prevalence:	
27	Africa				Hypertension: 13.2%	kidneys on imaging	measurement		>3.5 g/dl	37.9%	
	South				DM: 10.8%	without evidence of					
						reversible causes					
		hairdressing		Hairdressers	Age (years): 40±8		Proteinuria by urinary			Total	Low
Hamdouk	2011 Sudan	saloons	72		Male gender: 0%	Scr level≥2 mg/dl	strip and 24 hrs	Not	26.4% had albuminuri	prevalence: 26.4%	
M ¹⁰⁴	East		12		Hypertension: 19.4%	Ser iever_2 mg/ui		mentioned	a	14% had Scr	
							renal biopsy			≥2 mg/dl	
		male workers		Male workers attending	50					Total	Low
		attending the		the out-patient clinic of					93% among	prevalence (
	2003	out-patient		the Health Insurance	Age (years): 39.83±7.27		Ai		non-silica	among	
EL-Safty I ¹²⁹	Egypt	clinic	81	Organization	Male gender: 100%	Elevated proteinuria	Assessment of proteinuria	Not measured	exposed	those with	
	North	of the Health		Workers (29 non-	Hypertension: 19.4%		quantitatively		100% silica	Silica	
		Insurance		silicotics, 24					exposed	exposure):	
DW E.F.		Organization		silicotics and 28 referent)	DD 17 4 17 11 1 17 17	MG L to File		L I'm di CD		100%	

DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault,

CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative

Titles and legends

Fig. 1 Flow diagram of the study selection

Fig. 2 Prevalence of CKD among entire general population. Estimates from this figure should be presented with caution as it is bound to be imprecise and inaccurate due to its tentative way of estimation

Fig. 3 Main causes of CKD

Supporting information

S1 Table: Search strategy adopted in PubMed and Ovid MEDLINE

idies among Cru. **S2 Table:** Studies among CKD patients



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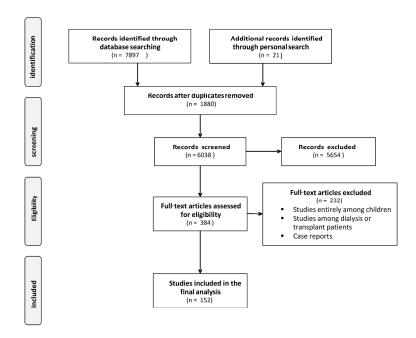


Fig1

. . . x 300 DPI)

Fig 1

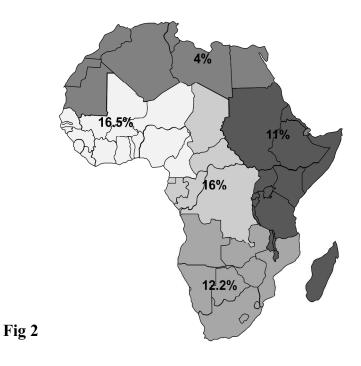


Fig2
254x190mm (300 x 300 DPI)

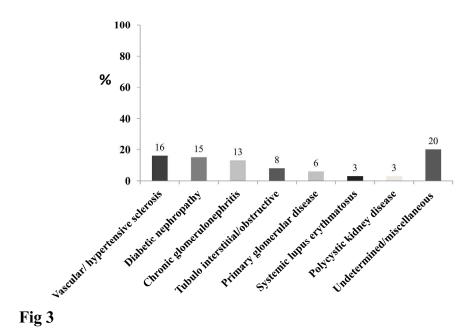


Fig 3
254x190mm (300 x 300 DPI)

S1 Table. Search strategy adopted in PubMed and Ovid MEDLINE

- 1. exp Renal Dialysis/
- 2. (hemodialysis or haemodialysis).tw.
- 3. (hemofiltration or haemofiltration).tw.
- 4. (hemodiafiltration or haemodiafiltration).tw.
- 5. dialysis.tw.
- 6. (CAPD or CCPD or APD).tw.
- 7. Renal Insufficiency/
- 8. Kidney Failure/
- 9. exp Renal Insufficiency, Chronic/
- 10. Kidney Diseases/
- 11. Uremia/
- 12. (end-stage renal or end-stage kidney or endstage renal or endstage kidney).tw.
- 13. (ESRF or ESKF or ESRD or ESKD).tw.
- 14. (chronic kidney or chronic renal).tw.
- 15. (CKF or CKD or CRF or CRD).tw.
- 16. (predialysis or pre-dialysis).tw.
- 17. ur?emi\$.tw.
- 18. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17
- 19. afric\$.ti,ab,kw,tw,mp.
- 20. 18 and 19

S2 Table: Studies among CKD patients

	Year		T		1
	Country	N		biopsy	causes of CKD
Study ID	Region	1	Population Characteristic	biopsy	causes of CKD
El Khayat	2013, Morocco, North	134	Age(years): 54.4±18.1 Male gender: 58.65%	no	DN: 44.02% H.scl: 11.2% Tub.int: 9.7% SLE: 5% Ch.GN: 3.7% Undetermined: 26.11%
Seck S ³²	2013, Senegal, West	60	Age (years): 70.5±54.6 Male gender: 52% Hypertension: 20% SBP (mmHg): 167 ± 78 DBP (mmHg): 95 ± 55 DM: 18%	no	H.scl: 30% DN: 25%
Seck S ³³	2008, Senegal, West	118	Age (years): 39.28±16.4 Male gender: 56% SBP (mmHg): 160±15 DBP (mmHg): 90±15	yes	Ch.GN: 35% Vascular nephropathy: 20.2% Tub.int: 12% DN: 10.5% PKD: 4.2% Autoimmune: 4.2% Neoplasm: 1.6% H.scl: 0.8% Undetermined: 11.5%
Bourquia A ³⁴	2002, Morocco, North	420	Age (years): 46±3 Male gender: 52%	no	PKD: 6.5%
Ouattara B ³⁵	2011, Ivory Coast, West	301	Age (years): 44±10 Male gender: 56% Hypertension: 33.5% DM: 12.3%	no	Nephroangiosclerosis:25.2% HIV nephropathy:17% Interstitial nephritis: 10.3% DN: 9.6% Ch.GN: 6.6% PKD:2.3% Undetermined: 29.2%
Lengani A ³⁶	1997, Burkina Faso, West	174	Age (years): 36±15 Male gender: 63% Hypertension: 64.9%	no	Ch.GN: 42.5% Vascular nephropathy: 23.6% Tub.int: 16.1% PKD: 1% Undetermined: 16.8%
Afifi A ³⁷	2005, Egypt, North	220	Not known	no	DN: 28.2% H.scl: 25.5% Obstructive uropathy: 13.5% Cystitis: 6.8% Simple cyst: 4.5% Undetermined: 29.5%
Diouf B ³⁸	2000, Senegal, West	261	Age (years): 44(range:15-88) Male gender: 46%	no	Nephroangiosclerosis: 25% DN: 20.5% Ch.GN: 15% Undetermined: 34%
Niang A ³⁹	2008, Senegal, West	258	Age (years): 28 (range:15-79) Male gender: 75% Hypertension: 12.2%	yes	FSGS: 52% MGN: 12% Minimal change diseases: 7.7%
Sabi K ⁴⁰	2011, Togo, West	398	Age (years): mean: 42.6	not	Ch.GN: 40.2%

			Male gender: 57%	known	Tub.int: 20.9%
			Wate gender. 37 %	KIIOWII	Nephroangiosclerosis: 17.6%
	2010, Nigeria,	1538	Age (years): 42.55±15.43 Male gender: 65% Hypertension: 17.2% DM: 11.8%	yes	H.scl: 17.2% Ch.GN:14.6% DN:11.8% Undetermined:51.6%
Ulasi I ⁴¹ AbdErrahim E ⁴²	West 2001, Tunis,	1471	Age (years): 38.3±14.6	no	Others: 4.6% DN: 20.3%
E	North	115	Male gender: 69% Age (years): 28 (IQR:5-60) Male gender: 56%	yes	FSGS: 46.9% MGN:8.7% Minimal change disease:6.1% Endocapillary GN: 2.6% Mesangioproliferative: 1.7% Extracapillary GN:1.7% IgA nephropathy:1.7% SLE: 13%
Abdou N ⁴³	2003, Senegal, West				H.scl: 2% Undetermined: 7% Others:11%
Afifi A ⁴⁴	2004, Egypt, North	3172	Age (years): 56.5±29.2	yes	DN: 14.5%
		4905	Age (years): 45.6±14.2 Male gender: 62.4%	yes	H.scl: 28% Ch.GN: 16.2% Obstructive uropathy: 15% DN: 8.9% PKD: 3%
Afifi A ⁴⁵	1999, Egypt, North				Undetermined: 16.2%
Agaba E ⁴⁶	2009, Nigeria, West	130	Age (years): 41±16 Male gender: 68%	no	Ch.GN: 39% H.scl: 34.6% DN: 11.8% PKD: 6.9% Undetermined: 7.7%
Alashek W ⁴⁷	2012, Libya, North	2417	Age (years): 49 (range: 36-61) Male gender: 58%	no	DN: 26.5% Ch.GN: 21.2% H.scl: 14.6% Congenital and hereditary: 12.3% PKD: 6.3% Obstructive uropathy: 5% Chronic pyleonephritis: 2% Interstitial nephritis: 1.2% Autoimmune disease: 0.7% Other: 2.9% undetermined: 7.3%
Alasia D ⁴⁸	2012 , Nigeria, West	320	Age (years): 46.2±17.6 Male gender: 63% SBP (mmHg): 171.2±31.9 DBP(mmHg): 102.5±27.4	yes	Ch.GN: 45.7% H.scl: 29.8% DN: 17.5% PKD: 3% Obstructive uropathy: 2% Undetermined: 2%
Alebiosu C ⁴⁹	2006, Nigeria, West	153	Age (years): 39.6±14.8 Male gender: 59% Hypertension: 38.5% SBP (mmHg): 167.3±15.5 DBP (mmHg): 106±28.9 DM: 13.1%	no	Ch.GN: 41.2% H.scl: 26.1% DN: 13.1%

	1	1	T	г	77 4 42 0 24
			Age (years): 47.5±15.7		H.scl: 42.8%
			Male gender: 56.2		Ch.GN: 15.9%
			Hypertension: 42.8%		Obstructive uropathy: 14.9%
			DM: 13.4%		DN: 13.4%
		201		no	PKD: 1%
					SLE: 1%
					Sickle cell nephropathy: 1%
	2012 Nigaria				
	2012, Nigeria,				Analgesic nephropathy:0.5%
Amira C ⁵⁰	West				Undetermined: 9.5%
			Age(years): 36 (range:15-90)		Ch. GN: 43.7%
			Male gender: 70.3%		H.scl: 31.1%
			Hypertension: 72.4%		Obstructive uropathy: 6.7%
		760	SBP (mmHg): 160	no	DN: 3.7%
			(range:120 – 270)		Tub.int: 2.2%
Arogundade	2011, Nigeria,		DBP (mmHg): 100 (range:50		PKD: 0.7%
F ⁵¹	West		- 209)		Undetermined: 12%
1	TT CSt		Age (years): 51.4±18.0		DN: 35%
			Male gender: 56.5%		H.scl: 25.3%
		6397		no	Tub.int: 19.7%
					Ch.GN: 13%
					PKD: 2.2%
Counil É ⁵²	2008, Tunis, North				Undetermined:52.8%
			Age (years): Male:		H.scl:52.58%
			50.89±13.43 and Female:		Ch.GN: 17.2%
			48.22±14.70		Tub.int: 17.1%
			Male gender: 61.2%		PKD: 4.3%
		116	SBP(mmHg): 153.41±27.12	no	DN: 2.6%
			DBP (mmHg): 93.92±17.19		
	2012 N		DBF (IIIIIIIIg). 93.92±17.19		Chronic pyelonephritis: 2.6%
C1 · · · 1 . 4.53	2012, Nigeria				Obstructive uropathy:1.7%
Chijioke A ⁵³	,West				Undetermined: 1.9%
			Age (years): 47.1±17.0		H.scl: 75.2%
			Male gender: 45%		DN: 29.8%
		302	SBP (mmHg): (male) 144.6 ±	A Troo	HIV nephropathy: 28.6%
	2014, South	302	28.3. (female)141.1 ± 25.5	yes	Ch.GN: 7%
	Africa,		DBP(mmHg): (male)84.2 ±		Tub.int:6%
Madala N ⁵⁴	South		18.1. (female)81.0 ± 19.0		Undetermined: 6%
1,100,0010, 1,	50411		Age (years): 66.3 ± 5.7		MGN: 14.4%
			Male gender: 47.7%		Mesangioproliferative GN:8.1%
			e e		Crescentic GN: 7.2%
			Hypertension: 71% DM: 19.8%		
			DIVI: 19.8%		Mesangiocapillary GN: 3.6%
					Post infectious GN: 2.7%
					FSGS:1.8%
					IgAN nephropathy: 0.9%
					DN:12.6%
					Ch.GN: 5.4%
		111			SLE: 4.5%
		111		yes	H.scl: 3.6%
					Amyloidosis: 2.7%
					Myeloma: 2.7%
					Crescentric GN: 1.8%
					HIV nephropathy:0.9%
					Thrombocytopenic purpura:0.9%
					Hemolytic uremic: 0.9%
	2013, South				Tub.int: 17.2%
	Africa,				Miscellaneous: 8.1%
Okpechi I ⁵⁵	South				
	1	1	1		1

			17.2	1	
			Age (years): 47.2 (range:29 -		
		3783	70)	no	PKD: 1.8%
56		-,	Male gender: 24%		
Laleye A ⁵⁶	2012, Benin, West		Hypertension: 59%		
			Age (years): 49 ±16.25		H.Scl: 38.8%
			Male gender: 68%		Ch.GN: 28.8%
		300		no	DN:22.5%
		300		no	PKD:2.7%
	2013, Nigeria,				SLE: 1.1%
Okunola Y ⁵⁷	West				Undetermined: 6.1%
			Age (years): 47 + 14		H.scl: 45%
			Male gender: 60%		Ch.GN: 15.8%
			SBP(mmHg): 162 ± 32		DN: 12.5%
			DBP(mmHg): 94.9 ± 19.6		Obstructive uropathy: 12.5%
			DDI (IIIIIIII).		PKD: 3.3%
		120		yes	Ch. Pyelonephritis: 2.5%
		120		yes	SLE: 1.7%
					Analgesic nephropathy: 1.7%
					Sickle cell nephropathy: 1.7%
	2013, Nigeria,				Toxic nephropathy: 0.8%
Bello B ⁵⁸	West				Undetermined: 2.5%
ם טווט ם	vv est		A 22(1/2012), 46 + 12		H.scl: 20%
			Age(years): 46 ± 13 Male gender: 65%		
			Male gender: 65%		Obstructive uropathy: 15%
					Ch.GN: 11%
		800		no	SLE: 9%
					DN: 8%
					Analgesic nephropathy: 5%
El-Minshawy					Chronic pyelonephritis: 5%
O ⁵⁹	2011, Egypt, North				Undetermined: 27%
			Age (years): 33.9 ± 12.0		Cresentic GN: 5%
			Male gender: 45.2%		Ch GN: 15.7%
			Hypertension:39.8%		FSGS: 15.7%
					IgA nephropathy: 1.7%
					Minimal change disease: 6.6%
					Mesangiocapillary GN: 19%
					MGN: 14.9%
		20.4			Mesangial proliferative GN: 12.4%
		294		yes	Postinfectious GN: 9%
					HIV nephropathy: 42.8%
					SLE: 13.3%
					DN: 9.2%
					MGN: 6.9%
					Ch.GN: 5.85%
	2010, South				Mesnagiocapillary: 4.6%
Okpechi I ⁶⁰	Africa, South				Others: 17.4%
Окресии 1	7111100, 500011		Age(years): 41.4 ± 13.1		Othors. 17.770
			Male gender: 37.2%		Ch.GN: 39.2%
			SBP (mmHg): African (133.6		H.scl: 34.4%
		148	± 20.2). Indian (130.1 ± 20.6)	no	DN: 7.4%
		140		no	PKD:6.8%
	2012 Sauth		DBP (mmHg):		
Modala Nt61	2012, South		African: (133.6 ± 20.2) .		Undetermined: 3.4%
Madala N ⁶¹	Africa, South		Indian (130.1 ± 20.6)		DNI 41 501
			Age (years): 52.43 ± 15.48		DN: 41.5%
	2012 35	207	Male gender: 64.3%	no	Ch.GN: 16%
El Farouki M ⁶²	2013, Morocco,		Hypertension: 73.9%		Tub.int: 14%
1 N / 1 U Z	North		DM:41.5%	1	H.scl: 12%

					PKD: 1%
					Undetermined: 15.5%
			A 72 (vacans): 26 9 114 0		
			Age (years): 36.8 ±14.0		Mesangiocapillary: 20.4%
			Male gender: 45.2%		Mesangioproliferative:19.2% MGN:18.5%
					Crescentric GN: 11.4%
					FSGS: 10.5% Post infectious: 8.2%
		1284		****	
		1284		yes	Minimal change: 6% IgA nephropathy: 5.8%
					SLE: 19%
					Infection related: 15%
					Vascular causes:9%
	2011, South				Hereditary: 6%
Okpechi I ⁶³	Africa, South				Undetermined: 3.5%
Окресін 1	7 Hilled, South		Age (years): 47 ± 13		Nephrosclerosis: 40.3%
			Male gender: 55%		Ch.GN: 21%
			Titalo golidol. 33 /0		DN: 19.4%
		62		no	PKD: 3.2%
	2014, Senegal,				Tub.int: 1.6%
Niang A ⁶⁴	West				Undetermined: 14.5%
1 (1441)	,, est		Age (years): 47.4±15		DN: 27.4%
			Male gender: 62%		H.scl: 10.5%
			1710 8010011 0270		Ch.GN: 8%
					Nephrolithiasis: 7.3%
					Amyloidosis: 6.8%
		124		no	Chronic interstitial nephrtitis: 6.4%
					PKD: 4%
					Ischemic: 3.2%
					SLE: 0.8%
	2008, Libya,				Familial: 0.8%
Buargub M ⁶⁵	North				Undetermined: 30.6%
	2010, Nigeria,	126	Age (years): 47.4 ± 16.2	A	DVD. 15 40
Chijioke A ⁶⁶	West	436	Male gender: 57%	no	PKD: 15.4%
			Age (years): 45.78± 17.16		H.sclerosis: 14.29%
			Male gender: 67.8%		Obstructive uropathy: 11.61%
					Ch.GN: 9.8%
		224		yes	DN: 8.04%
		224		yes	Anaglesic nephropathy: 1.34%
					Renovascular: 0.45%
					PKD: 0.9%
Elsharif M ⁶⁷	2011, Sudan, East				Undetermined: 53.57%
			Age (years): 89% <50 years.		SLE: 24.7%
			8.5% 50–60 years and 3%>		MGN: 10.9%
			50 years		FSGS: 6.8%
			Male gender: 52%		Mesangiocapillary GN: 6.7%
					Acute interstitial nephritis: 6.25%
		405			Membaranous nephropathy: 5.4%
		437		yes	Crescentric GN: 5.4%
					Chronic interstitial nephrtitis:4.5%
					Minimal change disease: 3.8%
					focal proliferative GN: 3.6%
					Amyloidosis: 2.7%
E11.1. 43.3.68	2012 E N - 1				Nephrosclerosis: 1.13%
Elkhatib M ⁶⁸	2012, Egypt, North				Undetermined: 3.6%

			Age (years): 26.5 ± 14.6		FSGS: 28.57%
			years		mesangioproliferative GN: 20.02%
			Male gender: 47%		MGN: 14%
		924		****	Minimal change disease: 8.55%
		924		yes	Amyloidosis: 5.52%
					Diffuse proliferative GN: 5.20%
					Focal proliferative GN: 3.68%
Ibrahim S ⁶⁹	2012, Egypt, North				DN:0.22%
			Age (years): 19 (IQR:12-25)		MGN :79.20%
			Male gender: 61%		FSGS: 9.10%
		386		yes	Extramembranous
	2011, Morocco,				glomerulonephritis:9.10%
Ayach G ⁷⁰	North				Renal amyloidosis: 2.6%.
			Age (years): 45.5(range: 16-		Ch.GN: 40.1%
		239	82)	No	H.Scl: 35.6%
Ramilitiana	2016, Madagascar,		Male gender: 40%	NO	DN:12.6%
B^{71}	East		Diabetes mellitus: 12.6%		Tub.int: 10.46%
			Age (years): 60 (47-79)		
	2012, Morocco,	16	Male gender: 81.3%	Yes	DN: 25%
Zajjari Y ⁷²	North		Hypertension: 56.3%		

Tub. Int: tubulo-interstital, DN: diabetic nephropathy, H. Scl: hypertensive sclerosis, Ch. GN: chronic glomerulonephritis, PKD: polycystic kidney disease, DM: diabetes mellitus, SLE: sytemic lupus erthmatosus, FSGS: focal segemental glomerulosclerosis, MGN: membaronus gloemrulonephritis



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PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3,4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	N/A
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4,5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4,5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	4, supplementary table 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4,5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	4,5
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	4,5
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	5,6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6



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PRISMA 2009 Checklist

Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I ²) for each meta-analysis.	6
		Page 1 of 2	
Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	6
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	6,7,17, Fig.1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Tables(2-4, supplementary table 2) P:19- 51
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Tables(2-4, supplementary table 2) P:19- 51
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	6-11, 18-51
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Tables 2,3 and 4, P: 19- 51
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	11
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified researeผู้จะporting bitts)://bmjopen.bmj.com/site/about/guidelines.xhtml	12,14, 15

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Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	16
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	54

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CHRONIC KIDNEY DISEASE IN AFRICA: A SYSTEMATIC REVIEW

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CHRONIC KIDNEY DISEASE IN AFRICA: A SYSTEMATIC REVIEW

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ABSTRACT

Objectives: While increasing attention is being paid to the rising prevalence of chronic diseases in Africa, there is little focus on chronic kidney disease (CKD). This systematic review assesses the CKD burden among the general population and high-risk groups on the entire African continent

Design, setting, and participants: We searched the MEDLINE and PUBMED databases for articles published between January 1st, 1995 and April 7th, 2017 by sensitive search strategies focusing on CKD surveys at the community level and high risk groups. In total, 7918 references were evaluated, of which 7766 articles were excluded because they did not meet the inclusion criteria. Thus, 152 studies were included in the final analysis

Outcome measurement: The pooled prevalence rate of CKD was expressed as a point estimate and 95% CI. No meta-analysis was done. Data were presented for different population.

Results: In the community-level studies, based on available medium and high quality studies, the pooled prevalence of CKD in Africa was 10.1% (95% CI: 9.8%-10.5%). West/Central-West had the highest prevalence (16.5%), followed by Central (16%), Southern (12.2%), Eastern (11.0%), and North (4%) Africa. The prevalence in sub-Saharan Africa was 14.02%. The pooled prevalence of CKD in the high risk groups was 5.6% (95% CI: 5.4-5.8%) in HIV (based on available medium and high quality studies), 24.7% (95% CI: 23.6-25.7%) in diabetes (based on all available studies which are of low quality except four of medium quality) and 34.5% (95 % CI: 34.04%-36%) in hypertensive patients (based on all available studies which are of low quality except two of medium quality)

Conclusion: In Africa, CKD is a public health problem, mainly attributed to high risk conditions as hypertension and diabetes. The poor data quality restricts the validity of the findings and draws the attention to the importance of designing future robust studies

Strengths and limitations of the study

- This systematic review assessed the CKD burden among the general population and highrisk groups on the entire African continent based on studies that covered all Africa from January1st, 1995 till April7th, 2017
- The quality of the included articles was assessed based on standard criteria dealing with clinical trials, diagnostic studies, and observational studies. The articles were assessed based on the population sampling and precision, sampling technique, response rate, and exclusion rate.
- No meta -analysis was conducted in this review due to the huge discrepancy in the definition used to identify CKD, the methods of creatinine measurement, urine protein assessment, and in the quality of the reporting.
- The review findings were limited by the low quality of the majority of studies in Africa
- The prevalence of CKD reported in this review should be interpreted with caution due to the bias introduced from the heterogeneity between studies, analytical and methodological issues, sample size, and study population selection

INTRODUCTION

Chronic kidney disease (CKD) is an emerging global public health problem¹. The disease is a component of a new epidemic of chronic conditions that replaced malnutrition and infection as leading causes of mortality during the twentieth century². Age-standardized death rates due to CKD have increased during the last 23 years. CKD has shifted from the 36th cause of death in 1990 to the 19th cause in 20133. The worldwide increase in CKD and kidney failure-necessitating renal replacement therapy (RRT) -and the high rate of cardiovascular mortality and morbidity attributable to CKD are poised to reach epidemic proportions over the next decade. CKD complications represent a considerable burden on global health care resources and only a small number of countries have sufficiently robust economies to meet the challenge posed by this disease. Socioeconomic differences in health exist and individuals of lower socioeconomic status (SES) have a higher risk for mortality and morbidity compared with those of higher SES⁴. A change in the global approach to CKD from the treatment of ESRD to intensive primary and secondary prevention is therefore considered an absolute public health priority⁵. Africa is the second largest continent in the world, with a population of over 1 billion; 961.5 million people live in sub-Saharan Africa and 195 million in Northern Africa⁶. Africa now faces the dual challenge of infectious illnesses and chronic diseases. Africa's chronic disease burden is secondary to various factors, including increased life expectancy, changing lifestyle practices, poverty, urbanization and globalization⁷. The World Health Assembly advocated the Global Action Plan for the Prevention and Control of non-communicable diseases 2013–2020. One of its targets is to reduce premature mortality from chronic diseases by 25% in 2025. These actions have the potential to make a significant impact on the burden of CKD⁸. Unfortunately, CKD problem remains underestimated on the entire continent due to lack of epidemiological information from different African countries. There exists only a single systematic review conducted in sub-Saharan Africa which concluded that CKD is a prevalent and potentially escalating disease across Sub-

- Saharan Africa, with both communicable and non-communicable risk factors⁹. Strategies aimed at
- 2 managing CKD epidemics in Africa critically depend on a reliable assessment of the burden of the
- 3 problem and the establishment of affordable early detection programs. Previous studies reported the
- 4 prevalence of CKD among the general population or the specific prevalence of this condition in
- 5 diseases that are recognized as drivers of renal damage (e.g., diabetes mellitus). These estimates
- 6 have varied across studies due to differences in the methods of Glomerular Filtration Rate (GFR)
- 7 measurement, background risk (general population vs. high risk groups), or demographic
- 8 characteristics (e.g., age, gender)¹⁰.
- 9 With this background in mind, this review aimed to increase the systematic information on the
- burden of CKD in the general population and high risk groups of the entire African continent and
- provide an estimate of the prevalence of CKD in different regions of Africa.

MATERIALS AND METHODS

Data source and search strategy

- We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)
- Guidelines¹¹. A systematic literature search was performed in the PubMed and OVID-MEDLINE
- databases by two authors (DB and SA) to identify articles reporting epidemiology data on CKD in
- the adult population in any geographic area of the African continent. This employed focused, highly
- sensitive search strategies (S1 Table). The search covered the time frame from January 1st, 1995 to
- April 7th, 2017. Papers without language and study design restrictions were located and screened.
- 20 References from relevant studies were screened for supplementary articles.

Study selection and data extraction

- 22 Titles and abstracts were screened independently by two authors (SA and GD), who discarded
- 23 studies that were not relevant to the topic. Case reports, reviews, editorials, letters, and studies
- 24 focusing on African-Americans not living on the African continent, conducted entirely among
- children, or dealing with acute kidney injury or kidney transplantation were excluded. Two authors

(SA, ED) independently assessed the retrieved abstracts and the full texts of these studies to determine eligibility according to the inclusion criteria. Disagreements were resolved through discussion and consensus, or through consultation with a third reviewer (DB), who solved these differences based on study judgments. Furthermore, screening of reference lists of all of the retrieved studies was conducted to check for relevant articles, and a supplementary scan of the reference lists of the systematic reviews was performed to identify any additional studies. Data were extracted from full-text articles and registered using a specifically designed form. These data included study design, geographical area, sample size, the definition of CKD used, prevalence of CKD, age, gender, GFR measurement, type of creatinine assay, proteinuria, the method of outcome assessment and associated comorbidities such as diabetes mellitus and hypertension. Data extraction was performed by one reviewer (SA) and independently verified by another reviewer (DB).

Data extraction and analysis

Studies were categorized according to the reference population as follows: 1) studies dealing with the general population and 2) studies focusing on particular diseases such as diabetes, hypertension, lupus and HIV or settings, e.g., hospital-based surveys and occupational studies.

Information on the assessment of kidney function was collected, including: the equation adopted for GFR estimation ((Cockroft-Gault(CG), Modification of Diet in Renal Disease (MDRD), Chronic Kidney Disease-Epidemiology Collaboration (CKD-EPI)), the type of creatinine assay (Jaffe, standardized or unknown), and the type of proteinuria or albuminuria assay used (semi-quantitative assessment by urinary strips or quantitative in urine samples or 24 h collection). When the study included two or three GFR equations, we defined the CKD prevalence based on the CKD-EPI equation whenever this information was provided. Otherwise, we considered the MDRD equation and lastly the CG equation. In the case of ethnicity correction¹²⁻¹⁴; we included the equation which corrected for ethnicity. Information on the definition of CKD used in each study was also included ((either the internationally accepted definition as Kidney Disease Outcome Quality Initiative (KDOQI), or other ways of defining CKD)).

Quality assessment

Two independent authors (SA and DB) appraised each article independently and assessed its quality based on standard criteria described into details in previous methodology reviews dealing with clinical trials¹⁵, diagnostic studies¹⁶, and observational studies¹⁷. The articles were assessed based on the subject sampling and precision, sampling technique, response rate, method of assessment of kidney function, and exclusion rate

Statistical analyses

The principal demographic and clinical data for each study were summarized as the mean and standard deviation or as absolute number and percentage, as appropriate. The age range in each study was also recorded. The pooled prevalence rate of CKD was expressed as a point estimate and 95% CI. The prevalence from each study was weighed by the sample size then the pooled prevalence was categorized by the African region. The inter-rater agreement for inclusion and quality assessment was determined using Cohen's kappa (κ) coefficient ¹⁸. The percentage of the different causes of CKD was weighed by the sample size of each study done among CKD patients. Then we simply summed the number of patients for each etiological factor and divided it by the total sample size from the whole included studies. No meta-analysis was conducted in this study. Data were appropriately presented for different populations (general population and CKD patients). The patients' data were stratified by the type of underlying condition, i.e., hypertension, diabetes mellitus, HIV, or systemic lupus erythematosus. All calculations were conducted using SPSS for Windows, version 21, Chicago, Illinois, USA.

RESULTS

Search results

- The flow diagram of the selection process is depicted in (Fig. 1). In total, 7897 potentially relevant
- references were initially retrieved. Twenty-one additional citations were found through a personal

search. By screening titles and abstracts, a total 7534 citations were excluded because of search overlap, dealing with the wrong population (African American, AKI, cancer or post-transplant patients), or not providing actual data on CKD. Review articles, case reports, editorials, or letters were also excluded. Amongst the 384 studies selected for full text examination, 232 were excluded because they dealt with a population different from that specifically targeted in this systematic review, such as paediatric populations (122 studies), transplant patients (n=44), or others (n=46) (e.g., Africans living in non-African countries), or because only narrative data were provided (n=20). A total 152 articles were therefore reviewed in detail and included in the analysis. The main characteristics of these studies are summarized in Table 1. The inter-rater agreement for inclusion was κ =0.90 and for the quality assessment was κ =0.85.

Study characteristics

Amongst the 152 studies reviewed, 29 were general population studies (Table 2). One-hundred twenty-three studies focused on selected groups, of which 42 included HIV patients (Table 3), 18 studied diabetic patients (Table 4), nine included hypertensive subjects (Table 5) and twelve were conducted in other populations (Table 6), including one study in lupus patients ¹⁹, one study in rheumatoid arthritis patients ²⁰, one study among sickle cell anemia patients ²¹, two in specific occupational settings (silica exposure²² and exposure to the nephrotoxic hair-dye, paraphenylenediamine²³) and seven studies in family practice²⁴⁻²⁶ or hospital-based²⁷⁻³⁰ surveys. Forty-two studies conducted among CKD patients (S2 Table) ³¹⁻⁷².

The studies that were included covered all regions of Africa. The highest number of the studies came from the Western macro-area (n=54), followed by the Eastern macro-area (n=32), Southern macro-area (n=25). Twenty studies were retrieved from the Northern Africa, eight studies from each of the Central macro-area and the Central-Western macro- area. Three studies were conducted in both the Eastern and Southern regions and two studies in the Sub-Saharan region.

Assessment of kidney function impairment

Urinary markers for kidney disease were assessed in seventy-eight (71%) among one-hundred ten studies conducted in the general population, high risk groups, occupational or hospital-based studies. Proteinuria was assessed by a semi-quantitative method (urinary strips) in twenty-eight studies²¹, ²⁴, ²⁶, ²⁹, ⁷³⁻⁹⁶. Twenty studies used dipstick with confirmation by quantitative methods, nine of which used dipsticks to identify proteinuria/albuminuria with confirmation by 24-hour proteinuria²⁵, ⁹⁷⁻¹⁰⁴ whereas eleven studies used dipstick with confirmation by the protein-to-creatinine ratio or albumin-to-creatinine ratio¹⁰⁵⁻¹¹⁵. Quantitative methods for the assessment of proteinuria/albuminuria (24-hour proteinuria or albuminuria, PCR, immunoassay, or ACR) were applied in twenty-nine studies ¹⁹, ²⁷, ²⁸, ³⁰, ¹¹⁶⁻¹⁴⁰. In one study, the method of proteinuria assessment was not mentioned¹⁴¹.

Serum creatinine was measured in ninety-five studies (86%). The Jaffe assay was used in thirty studies²⁹, 30, 76, 80, 82, 83, 86, 90, 95, 97, 102, 105, 111, 113, 124, 126, 130, 131, 136, 142-152, whereas the IDMS-calibrated method was used in fifteen studies ¹², 14, 21, 26, 115, 117, 132-134, 141, 153-157. In nine studies, both the Jaffe assay and the calibrated serum creatinine were used ¹³, 20, 25, 91, 98, 99, 106, 112, 158. In the remaining forty-one studies provided no information on the method of creatinine measurement ¹⁹, 24, 27, 28, 78, 79, 81, 84, 85, 87-89, 93, 94, 96, 100, 101, 104, 109, 114, 116, 118-122, 125, 127, 135, 137-139, 159-167. With respect to the formula used for estimating GFR, the MDRD equation was used in thirty studies ²⁴⁻²⁶, 28, 29, 94-97, 105, 106, 111, 113, 116, 117, 121, 122, 126, 130, 133, 134, 136, 141, 146, 149, 153, 154, 158, 159, 164, and the CG equation was used in eighteen ¹⁹, 76, 81, 86-88, 93, 100, 102, 114, 119, 124, 138, 143, 145, 150, 162, 167. The other fourteen studies used both the CG and the MDRD equations ⁷⁸⁻⁸⁰, 83-85, 98, 99, 101, 144, 147, 152, 161, 163, whereas fifteen studies estimated GFR by the CG, MDRD, and the CKD-EPI methods ¹²⁻¹⁴, 20, 82, 90, 91, 109, 112, 115, 139, 142, 155, 156, 160. Six studies used MDRD and CKD-EPI ¹³¹, 132, 137, 148, 151, 157, and two studies used CKD-EPI²¹, 166. In other two studies the formula was not mentioned ³⁰, 135

Definition of CKD

Thirty-one studies defined the presence of CKD as an eGFR below 60 ml/min/1.73 m² 12 ,14 ,20 ,80 ,93 -96 ,111 ,117 ,119 ,139 ,146 ,148 -159 ,161 -164 ,166 ,167 , with chronicity confirmed by repeated testing in four other studies 142 -145. Moreover, twenty-eight studies reported CKD prevalence based on eGFR below 60 ml/min/1.73 m² and/or the presence of proteinuria or albuminuria 21 ,24 ,26 ,76 ,78 ,82 -84 ,86 ,91 ,99 ,100 ,105 ,106 ,109 ,112 -114 ,121 ,130 -137 ,141. Proteinuria/albuminuria was used alone to identify CKD in fourteen studies 73 -75 ,77 ,87 ,92 ,107 ,108 ,110 ,123 ,128 ,129 ,138 ,140. KDOQI staging 168 of CKD was used in thirteen studies 13 ,25 ,29 ,79 ,85 ,90 ,97 ,98 ,115 ,116 ,122 ,124 ,126 . The serum creatinine level (either doubling, or an increase above a certain threshold) was considered to be a marker of the presence of CKD in four studies 89 ,104 ,120 ,165. In sixteen studies, the definition of CKD was either not mentioned or was defined in various ways, including personal history, Creatinine Clearance (CrCl) ≤50 ml/min, clinical manifestations, the presence of albuminuria, elevated serum creatinine, and the average of two measurements of eGFR < 90 ml/min/1.73 m² 19 ,27 ,28 ,30 ,81 ,88 ,101 -103 ,118 ,125 ,127 ,147 ,160 ,169 ,170 .

Paper quality

- Paper quality was high in sixteen studies ¹³, ²⁵, ⁷⁵, ⁹⁰, ⁹¹, ⁹⁷, ⁹⁸, ¹⁰⁵, ¹⁰⁶, ¹¹², ¹¹⁶, ¹³²⁻¹³⁴, ¹⁴⁸, ¹⁵⁵. Thirty-five studies were of medium quality ¹², ¹⁴, ²⁶, ²⁹, ⁷³, ⁷⁴, ⁷⁷⁻⁷⁹, ⁸¹, ⁸², ⁹⁶, ¹¹⁰, ¹¹¹, ¹¹⁵, ¹¹⁷, ¹²⁸, ¹³⁰, ¹³¹, ¹³⁷, ¹⁴¹, ¹⁴³⁻¹⁴⁵, ¹⁵⁰⁻¹⁸⁰, ¹³⁰, ¹³⁰,
- 17 152,154,157,159-161,163,166,167. The rest of the studies were of low quality.

Prevalence of CKD

Based on the prevalence of eGFR <60 ml/min/1.73m² and/or the presence albuminuria/proteinuria (the current definition of CKD by KDOQI)¹⁶⁸ reported in the 24 medium-high quality studies in **Table 2** the pooled prevalence of CKD in the general population in Africa was 10.1% (95% CI: 9.8%-10.5%). The highest prevalence was reported in the West/Central-West (16.5%), followed by the Central region (16%), Southern (12.2%), Eastern (11.0%), and North (4%) Africa (Fig. 2). The pooled prevalence in Sub-Saharan Africa was 14.02% (95% CI: 13.5- 14.5%).

Among HIV patients (**Table 3**), the pooled prevalence of CKD (estimated as above on the

Saharan area

basis of the KDOQI definition in the eighteen medium quality studies in the same table) was 5.6% (95% CI: 5.4-5.8%). Based on the treatment status, the prevalence of renal dysfunction was 9.9% (95 % CI: 9.4- 10.4%) among HIV patients not receiving treatment while the prevalence was 5.2% (95 % CI: 5.0-5.4%) among HIV patients on anti-retroviral therapy .The West/ Central-West recorded the highest prevalence of CKD among HIV patients (11.6%), followed by the East (11.2%), and South (3.5%) macro-areas. The prevalence was reported to be 5.7% among the 3 studies done in both the East and South macro- areas and 2.5% from the study done in the sub-

Among diabetic patients (**Table 4**, all studies are of low quality except for four with medium quality), the pooled prevalence of CKD was 24.7% (95%CI: 23.6-25.7%). The highest prevalence was in the Eastern (46.9%), followed by the Central (40.8%), West/Central-West (27.7%), South (23.0%), and North (18.9%) Africa. One study was done in sub-Saharan reported that the prevalence was 13%

The pooled prevalence of CKD among hypertensive patients (**TABLE 5**, 9 studies; all of low quality except for two with medium quality) was 34.5% (95 % CI: 34.04%-36%). The highest prevalence was reported from one study in the East macro-area (39.5%) followed by the West/Central-West (37.7%), South (25.4%) Africa. No data were found for other African macro-areas.

Among other patient populations (studies reported in Table 6), almost three quarters of the lupus patients had CKD (prevalence=72.0%) based on low quality study ¹⁹. Hospital-based surveys revealed that (the calculation was based on **the total prevalence** reported from all studies including three of high-medium quality and 4 of low quality in the same table) more than one third of patients attending either primary care centres or tertiary hospitals had CKD (pooled prevalence= 36%, 95% CI: 34.4-37.7%). CKD was prevalent among almost 39% of rheumatoid arthritis ²⁰or sickle cell patients ²¹. The study (low quality) conducted among hairdressers exposed to paraphenylenediamine ¹⁰⁴ reported that 26.4% of these subjects had renal impairment. Of note,

100% of silica-exposed workers experienced proteinuria (reported from low quality study)¹²⁹.

The prevalence of CKD was variable based on definition used to diagnose CKD. Based on medium-high quality studies; CKD had a 6.2 % prevalence (95% CI: 6.0- 6.4%) in population studies defining this disease as an eGFR below 60 ml/min/1.73 m² ¹², ¹⁴, ⁹⁶, ¹¹¹, ¹¹⁷, ¹⁴⁸, ¹⁵⁰-¹⁵², ¹⁵⁴, ¹⁵⁵, ¹⁵⁷, ¹⁵⁹, ¹⁶³, ¹⁶⁶, ¹⁶⁷. When CKD was diagnosed based on eGFR below 60 ml/min/1.73 m² and/or the presence of proteinuria or albuminuria²⁶, ⁷⁸, ⁸², ⁹¹, ¹⁰⁵, ¹⁰⁶, ¹¹², ¹¹⁴, ¹³⁰-¹³⁴, ¹⁴¹; the prevalence was 7.3 % (95 %CI: 6.9-7.7%). The prevalence of CKD was 22.5 % (95% CI: 21.5- 23.5%) in studies where the disease was defined on the basis of proteinuria⁷³-⁷⁵, ⁷⁷, ¹¹⁰, ¹²⁸. When KDOQI definition (i.e. by combining the eGFR and proteinuria/albuminuria) was used ¹³, ²⁵, ²⁹, ⁷⁹, ⁹⁰, ⁹⁷, ⁹⁸, ¹¹⁵, ¹¹⁶, the prevalence of CKD was 19.7% (95% CI: 18.7-20.8%)

Causes of CKD

- Forty-two studies were conducted specifically to clarify the underlying cause of CKD 31-72. (S2
- Table) The diagnosis was biopsy-proven in seventeen studies³³, 39, 41, 43-45, 48, 54, 55, 58, 60, 63, 67-70, 72.
- Vascular/hypertensive sclerosis was the main cause of CKD (16%) followed by diabetic
- nephropathy (15%), chronic glomerulonephritis (13%), tubulo-interstital/obstructive (8%), primary
- glomerular diseases (6%), systemic lupus erythmatosus (3%), and polycystic kidney disease (3%).
- 17 The causes of CKD were undetermined/miscellaneous causes in one fifth of the patients (20%).
- 18 (Fig. 3)

DISCUSSION

- This systematic review focuses on the burden of CKD on the entire African continent. We assessed
- 21 152 papers published between January 1st, 1995 until April 7th, 2017, reporting the epidemiology of
- 22 CKD in the general population and in specific chronic conditions in Africa. The CKD prevalence
- 23 reported in our review should be interpreted with caution. Our estimates may be affected by the
- 24 analytical heterogeneity used to measure creatinine and albuminuria. Serum creatinine
- concentrations are affected by intra-individual variability with over 20% changes within a 2-week

period¹⁷¹ and most Jaffe assays overestimate serum creatinine¹⁷². The resulting bias could vary according to the creatinine concentration, specific assay, manufacturer, and calibration material used. Although the IDMS calibration standardization has reduced the bias and improved the Inter laboratory comparability¹⁷³, the number of studies reported using IDMS was low in Africa. Moreover, CKD prevalence may additionally be influenced by albuminuria assays which are affected by the inter laboratory differences ¹⁷⁴. The different equations used to estimate GFR could be a source of bias. The systematic underestimation of measured GFR at higher estimated GFR by the MDRD equation is well known, and may reflect higher creatinine generation in healthy individuals compared with individuals with CKD in whom the MDRD equation was derived. This bias is reduced substantially, but not completely, by the CKD-EPI equation, which was derived from studies including people without CKD¹⁷⁵. In addition, differences in sample size, demographics, and clinical characteristics, are all significant limitations in this systematic review for making accurate estimates of the prevalence of CKD in African countries. Furthermore, only five studies⁷⁹, 142-145 assessed the KDOQI chronicity criterion, which is a fundamental element of the current definition of CKD by this organization. A single elevated serum creatinine, reduced eGFR or an abnormal urinalysis should initially be viewed as a screening test, and a subject with suspected CKD should be considered to have an azotaemia until CKD is determined by the additional workup and clinical judgment¹⁷⁶. Thus, estimates in this review should be seen as a pragmatic attempt to evaluate the dimension of CKD as a public health issue on the African continent. CKD is now considered to be an important component of the epidemic of non-communicable diseases in economically developed and developing countries alike. In a seminal meta-analysis published in 2014 Stanifer et al.,9 for the first time drew attention to the public health relevance of CKD in the sub-Saharan Africa, a vast area comprising 85% (947.4 million) of the whole African population⁹. In the present systematic review, the lowest prevalence of CKD (4%) was reported in the Northern Africa macro-area; including Egypt, Libya, Tunisia, Algeria,

Morocco, the Western Sahara, and Mauritania, and the highest (16.5%) was observed in West/ Central-West Africa, which includes Benin, Burkina Faso, the island nation of Cape Verde, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mali, Mauritania, Niger, Nigeria, Cameroon, the island of Saint Helena, Senegal, Sierra Leone, São Tomé and Príncipe and Togo. The average prevalence in the entire African continent was 10.1%. The global CKD prevalence was reported to be 13.4% ¹⁷⁷. In sub-Saharan Africa in Stanifer's meta-analysis, the prevalence of CKD was 13.2%, which is close to that reported in the same area in our review (14.02%). Among the general population of economically developed countries, CKD has 13.6% prevalence in the USA¹⁷⁸. In Europe, the reported prevalence is lower and more homogenous, being 8.9% in the Netherlands, 6.8% in Italy, 5.2% in Portugal, 4.7% in Spain, and 3.3% in Norway¹⁷⁹. CKD prevalence in some Asian countries was higher than the estimates in the USA and in Europe, being 17.5% in Thailand¹⁸⁰, 15% in India¹⁸¹, 13% in Japan¹⁸², 11.9% in Taiwan¹⁸³, and 9.9% in China¹⁸⁴. Overall, the estimated prevalence of CKD at the general population level in African countries appears to be comparable and possibly even higher than that reported in other continents. This may be at least in part due to the low quality data for the prevalence of CKD in Africa related to poor sampling techniques, unreliable kidney function measurements, and the different definitions used.

In our review, the prevalence of CKD in surveys based on hospitals or primary care centres (36%) is close to that in Swiss primary care centres (36%) ¹⁸⁵.

Poverty-related factors such as infectious diseases secondary to poor sanitation, inadequate supply of safe water, environmental pollutants and high concentrations of disease transmitting vectors continue to play an important role in the development of CKD in low-income countries. Although rates of diabetic nephropathy are rising, chronic glomerulonephritis and interstitial nephritis are among the principal causes of CKD in many countries ¹⁸⁶.

In Africa, infectious diseases such as HIV, bilharziasis, malaria, hepatitis B and C represent an almost unique cluster of risk factors responsible for CKD¹⁸⁷. HIV/AIDS is pandemic in Africa, with a prevalence ranging from 0.5% in Senegal¹⁸⁸ to 27.4% in Swaziland¹⁸⁹. The global success in

bringing effective antiretroviral treatment (HAART) to HIV-infected patients in Africa has

determined the emergence of chronic medical illnesses such as HIV-related CKD¹⁹⁰. Up to 50% of kidney diseases in HIV-infected persons result from a wide array of non-HIV-associated nephropathy (HIVAN) pathologies, ranging from glomerulonephritis to diabetic nephropathy ¹⁹¹. We found that 5.6% of HIV patients complained of renal dysfunction. This figure is lower than that reported in economically developed countries such as France, USA, China, Spain, and Brazil 192-196. CKD was higher among HIV patients not receiving HAART compared to those on HAART. Variation in the proportion of HIV patients affected by CKD depends on the heterogeneity in the definition used to determine renal dysfunction, the proportion of the study population on HAART, diverse ethnicities, the associated comorbidities, and the nutritional status of the study population. HIV patients are more prone to nutritional deficiencies due to mal-absorption, impaired oral intake, and the wasting syndrome. Increased availability of HAART has led to some improvement of the nutritional status of patients. However, for certain individuals, undernutrition and weight loss persist despite therapy. Malnutrition exacerbates side effects, alters drug pharmacokinetics, and impinges on adherence thereby limiting the beneficial effects of the therapy ¹⁹⁷. Furthermore, differences in HIV clades or strains in African patients 198 and genetic factor 199 may influence the replication capacities within the isolated renal reservoir and thus lead to a diversity in clinical presentations⁸⁰.

Regarding systemic autoimmune diseases such as lupus, a study conducted among lupus patients from Senegal showed that almost three quarters (71.0%) the patients with this disease had evidence of renal involvement¹⁹. This isolated figure is higher than that reported in other countries²⁰⁰⁻²⁰². More than one third (39%) patients with rheumatoid arthritis had CKD²⁰ which is higher than that reported from Taiwan ²⁰³.

Even though there are no sufficient data to precisely reconstruct historical trends, the profile of CKD causes has changed during the last decades. Interstitial nephritis and glomerulonephritis were the main causes of CKD in North Africa²⁰⁴ and CKD was principally caused by chronic

glomerulonephritis and hypertension in East and Tropical Africa²⁰⁵, ²⁰⁶. Today, the spectrum of causes of CKD in Africa is dominated by diabetes mellitus and hypertension ²⁰⁷. We found that the prevalence of vascular/hypertensive and diabetic nephropathies as a cause of CKD (16% and 15%, respectively) exceeded that caused by chronic glomerulonephritis (13%).

Our review has both strengths and limitations. The major strengths include a thorough systematic search of electronic databases and the inclusion of all comprehensive studies with a transparent assessment of CKD prevalence by two independent reviewers. The fact that our literature search was limited to PubMed and Medline OVID but did not include the African Index Medicus, like it was done by Stanifer in the meta-analysis of CKD in sub-Saharan Africa [8], is a limitation of our study. Because there was a huge discrepancy in the definitions used to identify CKD, the methods of creatinine measurement, urine protein assessment, and in the quality of the reporting, we decided to adopt an inclusive strategy. Our primary interest was to identify all studies conducted among different population groups in Africa providing information on CKD and to reconstruct a tentative scenario of the epidemiological dimension concerning disease in the entire African continent. Methodological limitations notwithstanding this review compiled estimates suggesting that the CKD burden in Africa is at least as concerning as that in economicallydeveloped countries. The lack of a consistent definition of CKD makes it difficult to compare the burden of CKD across studies in various countries. Moreover, the failure to demonstrate chronicity when defining CKD is a common limitation of studies investigating CKD prevalence in Africa. It was reported that a single test in time has an extremely poor positive predictive value for confirmation of CKD compared to repeated testing 3 months later. Failure to repeat testing may lead to a significant overestimation of CKD prevalence and underestimation of the burden of CVD in CKD²⁰⁸. In addition, Observational studies are subject to bias and residual confounding which are difficult to account for and there are limitations due to the heterogeneity that arises from differences in age and sex distributions. These poor data quality reported in different studies is considered as a cumbersome problem limiting the accuracy in assessing the burden of CKD in Africa

In conclusion, CKD in Africa appears to be at least as common as in other continents and as such, it constitutes a true public health priority with major cost burden to healthcare systems worldwide. Targeted screening of high-risk groups (including those with hypertension, diabetes mellitus, HIV patients and persons with occupational exposures) should likely be instituted as the first step in kidney disease prevention whenever and wherever affordable and feasible. Education to increase awareness of CKD among healthcare workers and patients, and the promotion of healthy life styles, should be engrained in preventive programs. The treatment of hypertension and diabetes mellitus are of obvious relevance. Nurses and other health workers should be trained to manage these conditions at the local level if we are to curb the incidence of CKD and to avert the added burden of CKD complications to diabetes, hypertension, and infectious diseases, the deadly trio of risk factors underlying the CKD epidemic in Africa.

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- DB and GT: supervised the data capture and analysis.
- 19 SA, DB, and GT: analysed and interpreted the data.
- 20 SA, DB, and CZ: drafted and critically revised the manuscript.
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Table 1: Characteristics of the study population included in the analysis

Study population	Number of the studies	Study characteristics
General population	29	N=30169, age ranging from
		12 to 95 years; 48% males
Diabetic patients	18	N=9082, age ranging from
		14 to 90 years; 43% males
Hypertensive patients	9	N=4123, age ranging from
		19 to 90 years; 43% males
HIV patients	42	N= 67432, age ranging
		from 13 to 74 years; 36%
	79%	males
Occupational group	2	N= 153, age ranging from
		22 to 59 years; one study
		only enrolled females and
		the other principally
		enrolled males
Family practice patients	7	N= 3250, age ranging from
		20-74 years, 44% males
Lupus patients	1	N= 43, age ranging from 16
		to 55 years, 7% males
Rheumatoid arthritis	1	N=233, age ranging from
		40-70 years, 17.2% males
Sickle cell anemia	1	N=194, age ranging from
		12-40 years, 43.3% males
CKD patients	42	N= 34236, age ranging
		from 12 to 90 years, 58%
		males

Table 2: Studies on CKD among the general population

6 7 8	Study ID	Year, Country , Region	Location	N	Population Characteristic	Definition of CKD	Method of outcome assessment	Type of creatinine assay	Proteinuria	CKD prevalence	Quality assessme nt
) 0 1 2 3	Abdelsatir S ¹⁶⁹	2013 Sudan North- east	All village inhabitants	389	Age (years): 41 ± 15 Male gender: 16.2% Hypertension:39.6%, DM: 17% BMI category: (kg/m²) <18: 6.2%, 18-24.9: 65.8%, 25-29.9: 20.2 %, ≥30: 7.8%	Not identified, personal history	Personal history	Not mentioned	Not measured	Total prevalence (as reported): 6.40%	Low
5 7 8 9 20	Fatiu A ⁷³	2011 Nigeria West	Market population	286	Age (years): 49.5 ± 5.7 Male gender: 9.8% Hypertension: 37.7% BMI (kg/m²): 26.76 ± 5.28 <20 kg/m²: 7.4% 20-25 kg/m²: 33.4% > 25 kg/m²: 59%	Proteinuria ≥ +1	Midstream urine sample was tested by urinary strip	Not measured	29.70%	Total prevalence (based on proteinuria prevalence): 29.7%	Medium
2	Traore M ⁷⁴	1998 Mali West	All Household population of the villages	1098	Age (years): 30±12 Male gender: 52%	Proteinuria ≥ +1	Microhaematuria and proteinuria by urinary strip	Not measured	40.80%	Total prevalence (based on proteinuria prevalence): 40.80%	Medium
25 26 27 28 29	Matsha T ¹²	2013 South Africa South	Bellville town inhabitants	1202	Age (years): 52.9 ±14.8 Male gender: 24.7% SBP: 125±20 DBP: 76 ±13 DM: 26.4% BMI: 29.9 ±7.2	eGFR<60 ml/min	4 variables: MDRD, CG, CKD-EPI	Standardized creatinine assay	Not measured	Prevalence of stages 3-5: 7.4% (based on CKD- EPI with ethnicity correction)	Medium
30 31 32 33 34 35 36	Seck SM ⁹⁷	2014 Senegal West	Two stage cluster sampling of Urban and rural inhabitants of Saint- Louis	1037	Age (years): 48.0 ± 16.9 Male gender: 40% Hypertension: 39.1% DM: 12.7% BMI: 26.3 ± 6.8 kg/m ²	KDOQI	Albuminuria by urinary strips. Positive samples were confirmed by 24-hour albuminuria, eGFR by 186 MDRD	Kinetic Jaffe	5.3% albuminuria >1 g/l	Total prevalence: 6.1%	High
	Pruijm M ¹¹⁶	2008 Seychell es, East	a random sex- stratified and age- stratified sample inhabitants	1255	Age (years): range, 25-64 Male gender: 46%	KDOQI	Quantitative microalbuminuria by ACR, eGFR using MDRD	Not mentioned	11.4% microalbuminuria, 0.7% macroalbuminuria	Total prevalence: 15.3% Prevalence of stages 3–4 CKD 3.2%.	High

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			of Seychelle								
0 1 2 3 4 5	Sumaili EK ⁹⁸	2009 Congo Central	Multistage sampling of residents of Kinshasa	500	Age (years): 38.6 ± 14.4 Male gender: 41% Hypertension: 27.6% DM: 11.7% BMI category: 25–29.9 kg/m ² : 20.3% ≥30 kg/m ² : 14.9%	KDOQI	Proteinuria by urinary strip and 24-hour proteinuria, eGFR by CG and 175MDRD	Kinetic Jaffe and IDMS-calibrated	18% proteinuria by dipstick 5% (≥300 mg/day)	Total prevalence: MDRD 12.4% CG 19% Prevalence by stage (MDRD) Stage 1: 2% Sage 2: 2.4% Stage 3: 7.8% Stage 4:0 Stage 5: 0.2%	High
6 7 8 9 0 1 2 3 4 5	Matsha T ¹⁵⁹	2014 South Africa South	All residents of Cape-Town	320	Age (years): mean, 56.4 (55.1–57.6, 95% CI) Male gender: 22% SBP: 124.7 (122.8– 126.7, 95% CI)mmHg DBP: 75.5 (74.2–76.7, 95% CI) mmHg BMI: 31.9 (31.2–32.7, 95% CI) kg/m² Mean eGFR at baseline: 68.6±16.7 ml/min/1.73 m²	eGFR< 60 ml/min/ 1.73 m ²	eGFR- 186MDRD (4 variables)	Not mentioned	Not measured	Total Prevalence 28.9% Prevalence by categories eGFR>90 ml/min/1.73m ² :9.4% eGFR60- 90 ml/min/1.73m ² : 58.7% eGFR30-60 ml/min/1.73m ² : 28.1% eGFR<30 ml/min/1.73m ² : 0.9%	Medium
6 7	Sumaili EK ⁷⁵	2008 Congo Central	All Residents of Kinshasa	3018	Age (years): 44.3 ±15.3 Male gender: 59% Hypertension: 18% DM: 4%	Proteinuria ≥ +1	Proteinuria by urinary strip	Not assessed	17.1%	Total prevalence (based on proteinuria prevalence): 17.1%	High
901234	Egbi OG ⁷⁶	2014 Nigeria West	All Civil servants in Bayelsa	179	Age (years): 45.2 ± 10.3 Male gender: 53.1% SBP:128.5± 17.5 mmHg DBP: 81.8 ±13.2 mmHg	eGFR <60 ml/min/1.73 m ² and/or presence of proteinuria of at least +1 on dipstick urinalysis	Proteinuria by urinary strip, eGFR by CG equation standardized for body surface area (BSA)	Kinetic Jaffe	5.6%	Total prevalence: 7.8% Prevalence by stage Stage 1:3.4% Stage 2: 2.2% Stage 3: 2.2% None in stage 4 or 5	Low
5 6 7 8 9	Oluyombo R ¹⁰⁵	2013 Nigeria West	Multistage sampling of Households of Ilie	454	Age (years): 45.8 ± 19.0 Male gender: 43% Hypertension: 20.4% DM: 0.6%	eGFR <60 ml/min and/or macroalbuminuria (ACR>300 mg/g or dipstick proteinuria)	Proteinuria by urinary strip, negative cases were estimated for albumin creatinine ratio, eGFR by 186 MDRD	Kinetic Jaffe	Macroalbuminuria in 8.9%	Prevalence: 18.8% Prevalence by stage Stage 1: 2.4% Stage 2: 4.1% Stage 3: 11.8% Stage 4: 0.5%	High
0 1 2	Eastwood J ¹³	2010 Ghana, West	Inhabitants of 12 villages	944	Age (years): 54.7±11.2 Male gender: 38% SBP:125.5±26.0 mmHg	KDOQI	175MDRD, CG, CKD-EPI	Kinetic Jaffe and calibrated IDMS		Total Prevalence (based on CKD-EPI and ethnicity correction) :	High

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4 5 6 7 8 9					DBP: 74.4 13.6 mmHg DM: 4% BMI: 21.1 ±4.2 kg/m ²					MDRD: 1.6% (7.2 % without ethnicity correction; CKD-EPI 1.7% (4.7% without ethnicity correction), CG 21.0%.	
10 11 12 13	Gouda Z ¹¹⁷	2011 Egypt North	Community based in Al- Buhayrah governorate	417	Age (years): 39.12 ± 14.29 Male gender: 43.2% Hypertension: 25.20% DM: 10.6% BMI: 29.96 ± 6.18 kg/m ²	eGFR <60 ml/min/1.73 m ²	Quantitative assessment of urinary ACR, eGFR by 175 MDRD	IDMS-calibrated	10.6% microalbuminuria	Total prevalence 18%	Medium
14 15 16 17 18 19 20 21	Ayodele OE ⁷⁷	2011 Nigeria West	People at a major trade center, the public servant secretariat and the state broadcastin g station	586	Age (years): 42.4±11.2 Male gender: 61.4 % Hypertension: 16.4% DM: 3.8% BMI: 25.9±5.4 kg/m ²	proteinuria ≥+1	Proteinuria by urinary strip	Not assessed	2.50%	Total prevalence (based on proteinuria): 2.50%	Medium
22 23 24 25 26 27 28	Abu-Aisha H ⁷⁸	2009 Sudan East	Pilot survey of police housing complex	273	Age (years): 34.3±12 Male gender: 49.1% Hypertension: 27% DM: 5.1%	eGFR <60 ml/min/1.73 m ² and or proteinuria	Proteinuria by urinary strip, 175MDRD, CG	Not mentioned	5.30%	Total prevalence (MDRD) 7.7% [11% by CG] Prevalence by stage Stage 1 or 2: 4.7% Stage 3:2.6% Stage 4: 0 Stage: 0.4%	Medium
29 30 31 32 33 34 35	Gharbi M ¹⁰⁶	2012 Morocco North	Stratified random sampling of population in two towns	10524	Age (years): range, 25-70 Male gender: (50%), Hypertension: 16.7%	eGFR < 60 ml/ min/1.73 m² or macroalbuminuria or dipstick abnormalities (proteinuria ≥ ++ 1 or haematuria: ≥ ++1) or diabetes type 1 associated with microalbuminuria	175 MDRD, microalbuminuria and proteinuria by urinary strip and ACR	Kinetic Jaffe and IDMS	microalbuminuria (30-299 mg/l): 5.26%	Total prevalence 2.90%	High
36 37 38 39 40 41 42	CU O ¹⁵³	2014 Nigeria West	All attendees to lectures of the Ebreime Foundation for the elderly,	170	Age (years): 68.1±7.7 Male gender: 67.1%	eGFR<60ml/min/1.73 m ²	175 MDRD	IDMS calibrated		Total prevalence: 43.50%, (all cases were at stage 3)	Low

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	Booysen H ¹⁵⁵	2016 South Africa South	participants from families of black African descent	1221	Age (years):44.1±18.4 Male gender:34.9% BMI (kg/m²):29.5±8.0 Hypertension: 45% Diabetes mellitus:25.2%	eGFR<60ml/min/1.73 m ²	eGFR by CG, 4 variables MDRD, CKD-EPI	IDMS calibrated	Not measured	Total prevalence:6.3%	High
0 1 2 3 4	Kalyesubul a R ⁹⁰	2017 Uganda East	Community based survey among all households of Wakiso district	955	Age (years):31 (IQR: 24-42) Male gender: 33% BMI(kg/m²) categories: Underweight:5.5% Normal: 56.9% Overweight:24.2% obese: 13.4% Diabetics: 5.9%	KDOQI	Proteinuria by dipstick and eGFR by CG, MDRD, and CKD-EPI	Kinetic Jaffe	0.3%	Total prevalence: 15.2% Prevalence by stage: Stage 1: 6.2% Stage 2:12.7% Stage 3:2.4% Stage 4:0 Stage 5: 0.1%	High
5 6 7 8	Kaze F ⁹¹	2015 Cameroo n Central- West	Population of the Littoral region	500	Age (years): 45.3 ± 13.2 Male gender: 53.4% BMI (kg/m²): 27.1 ±5.3 Diabetes mellitus: 2.8% Hypertension: 12.2%	any albuminuria and/or eGFR <60 ml/min/1.73m ²	Albuminuria by dipstick and eGFR by CG, MDRD, CKD-EPI	Kinetic Jaffe and IDMS	7.2%	Total prevalence (CKD-EPI): 10% [14.2% by CG, 11%MDRD]	High
0 1 2 3	Kaze F ¹¹²	2015 Cameroo n Central- West	Population of the Western Region	439	Age (years):47 ± 16.1 Male gender: 42.1% Hypertension: 10.7% Diabetes mellitus: 5.9%	Albuminuria and/or eGFR <60 ml/min confirmed 3 months later	Albumnuria by dipstick and ACR and eGFR by CG, MDRD, CKD-EPI	Kinetic Jaffe and IDMS	12.1% had albuminuria	Total prevalence (CKD-EPI): 27.6% [38.5% by CG, 27.3%MDRD]	High
4 5 6 7 8 9	Laurence E ¹³⁰	2016 South Africa South	Teachers from public schools in in the urban area of the Metro South Education	489	Age (years): 46.3 ± 8.5 Male gender: 30% BMI(kg/m²):males: 29.1 ± 4.8 , females: $32.4.1 \pm 7$. Hypertension: 48.5% Diabetes mellitus: 10.1%	Proteinuria ≥0.30 mg/mg or eGFR <60 ml/min/1.73 m ²	Proteinuria by PCR and eGFR using MDRD	Kinetic Jaffe	Not mentioned	Total prevalence: 10.4%	Medium
1 2 3 4 5 6	Lunyera J ⁹²	2016 Uganda East	Urban residents of Kampala	141	Age (years): 64% in age group of 18-39 Male gender: 43% BMI(kg/m²): 25.9 (IQR 22.7-30.7) Hypertension: 38% Impaired fasting blood glucose: 13%	Proteinuria as urine protein of ≥1+ on dipstick in the absence of hematuria and leukocyturia	Proteinuria by dipstick	Not measured	13%	Total prevalence(based on proteinuria): 13%	Low
7 8 9	Mogueo A ¹³¹	2015 South Africa South	Household residents of BellVille	902	Age (years): 55±15 Male gender: 23% BMI(kg/m²): 29.9 ±7.2 Hypertension: 49.8% Diabetes mellitus: 27.9%	eGFR <60 ml/min/1.73 m ² , or any nephropathy	Albuminuria by ACR and eGFR by MDRD and CKD-EPI	Kinetic Jaffe	2.3%	Total prevalence(CKD-EPI): 21.7% [prevalence by MDRD: 29.7%]	Medium
1	Peck R ¹⁴⁸	2016, Tanzania	Stratified multistage	1043	Age (years):35.5 ± 15.3 Male gender: 45.7%	eGFR<60 ml/min/1.73 m ²	eGFR by MDRD and CKD-EPI	Kinetic Jaffe	Not measured	Total prevalence)CKD-EPI): 7%	High

4 5 6 7 8		, East	sampling of adult population in Mwanza city, Geita and Kahama		BMI(kg/m²) categories: Underweight: 10.5% Normal: 71% Overweight: 11.8% Obese :6.6% Diabetes mellitus: 0.9% Hypertension: 17.3%						
9 10 11 12 13	Stanifer J ¹³²	2016, Tanzania , East	stratified, cluster- designed cross- sectional household	481	Age (years): 46.9 ± 15.1 Male gender: 74.4% Diabetes mellitus: 9.4% Hypertension: 31%	presence of albuminuria (≥30 mg/dl; confirmed by repeat assessment) and/or a reduction in eGFR ≤60 ml/min/1.73 m ²	Quantitative assessment of albuminuria and eGFR by MDRD and CKD-EPI	IDMS	6.8%	Total prevalence : 11.9%	High
14 15 16 17	Stanifer J ¹³³	2015, Tanzania , East	Randomly selected adults	481	Age (years): 45 (IQR 35–59) Male gender: 25.6% Diabetes mellitus: 12.7% Hypertension: 28%	eGFR<60 ml/min/1.73m ² and/or persistent albuminuria	Quantitative assessment of albuminuria and eGFR by MDRD	IDMS	Not mentioned	Total prevalence: 7%	High
18 19 20 21	Stanfier J	2016, Tanzania , East	stratified, cluster- designed cross- sectional survey	606	Age (years): 45.5 ±15.5 Male gender: 24.6% Diabetes mellitus: 10.1% Hypertension: 23.7%	the presence of albuminuria (≥30mg/dl confirmed by repeat assessment) and/or a oncemeasured eGFR ≤60 ml/min/1.73m²	Quantitative assessment of albuminuria and eGFR by MDRD	IDMS	Not mentioned	Total prevalence: 8%	High
22 23 24 25 26	Wachukwu C ⁹³	2015, Nigeria, West	Adult volunteers in a university	259	Age (years):28.3±9.7 Male gender: 52.1% SBP(mmHg):117.3±15.5 DBP(mmHg): 75.7±11.7	eGFR<60 ml/min/1.73m ²	Proteinuria by dipstick and eGFR by CG	Not mentioned	12.4%	Total prevalence: 1.9%	Low

DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault,

CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative

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Table 3: Studies on CKD among HIV patients

	Year,	Location					Method of	Creatinine			Quality
l e e e e e e e e e e e e e e e e e e e	Country,				Population	Definition of	outcome	assay			assessme
Author O	Region		N	Study group	characteristics	CKD	assessment		Proteinuria	CKD prevalence	
1		ART clinic at			Age (years):			Kinetic		Total prevalence	Low
2		the regional			HAART-naïve			Jaffe		(CKD-EPI):	
3		hospital			(33.42 ± 0.88) , On					10.2%	
4		nospitai			,						
5 6				(07.6	HAART (36.91 ±					HAART naive:	
7				HIV (276	0.77)					8.7% CG, 9.1%	
8	2013,			HAART-naïve	Male gender:	eGFR < 60	CG, 186			MDRD, 8.7 %	
9	Ghana,			patients		mL/min/1.73 m ²	MDRD,		Not		
0 Wkba O ¹⁴²	West		442	166 on HAART)	HAART-naive	for > 3months	CKD-EPI		measured	CKD-EPI	
N KOA O	West		442	100 oli HAART)	(28.3%), On	101 > SHIOHUIS	CKD-EF1		illeasured	On HAART: 14.5%	
2		Three			Age (years): 36.8			Kinetic			Medium
3 4		centeres in			(32-42.2)	eGFR<60		Jaffe			
4 5		Uganda and			Male gender: 35%	ml/min/1.73 m ²					
6											
7		Zimbabwe			SBP: median:110	on ≥ 2					
8					(IQR:100-120)	consecutive visits					
9	2011,				mmHg	80 days apart or					
0	·				C						
1	Uganda,				DBP: median:70	confirmed 25%					
2	Zimbabwe,			HIV-infected	(60-80) mmHg	decrease if eGFR				Total prevalence:	
3 4	East and			patients initiating	BMI: 21.1 (19.1–	<60 ml/min/1.73			Not	7.2%	
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6	South		3316	ART	$23.6) \text{ kg/m}^2$	m ² at baseline	CG		measured		
7	2008,	Three			Age (years): 36.8	eGFR<60 ml/min		Kinetic		Total prevalence (Medium
8	Uganda,	centeres in		HIV-infected	(32-42.2)	1.73 m^2 on ≥ 2	186 MDRD,	Jaffe	Not	MDRD):3.1%,	
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. G töhr W ¹⁴⁴	Zimbabwe,	Uganda and	3316	patients on ART	Male gender: 35%	consecutive	CG		measured	CG 7.4%	

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4	East and	Zimbabwe			SBP: median:110	occasions >80					
5	South				(IQR:100-120)	days apart or					
6 7					mmHg	confirmed 25%					
8					DBP: median:70	decrease if eGFR					
9 10					(60-80) mmHg	<60 ml/min/1.73					
11					BMI categories:	m ² at baseline					
12 13					<18.5 kg/m ² : 18%						
14					18.5- <25 kg/m ² :						
15											
16 17					66%						
18					25-<30 kg/m ² :						
19					12%						
20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37					\geq 30 kg/m ² : 4%						
22		Outpatients						Not		Total prevalence Me	edium
23		HIV clinic				,		mentioned		(MDRD): 45.7%	
24 25										GG: 46.5%	
26					Age (years): 40.1					Prevalence by	
27 D8					(33-46.5) Male					Stages (using	
29					gender:29.7%					MDRD)	
80					Hypertension:					Stage 1: 30.2%	
р I В2					2.7%		Proteinuria			Stage 2:13.5%	
33	2011										
84 85	2011,				DM: 2%		by urinary			Stage 3: 2%	
გე 36	Burundi,			HIV-infected	BMI: median: 21.8		strip, CG,			Stage 4 & 5: no	
	East		300	patients	(19.3-24.2) kg/m ²	KDOQI	186MDRD		6.10%	patients	
88 Ra	2014,	Outpatient		HIV-infected	Age (years): 40.0	Proteinuria≥ +1	Proteinuria	Not	Proteinuria	Total prevalence Lo	w
39 Masimango MI ¹⁰⁷	Congo,	HIV clinic	235	patients	± 10.7	by urinary strip or	by urinary	measured	≥+1: 41.3%	(based on	
 			l								

2 3										26	,)
	entral				Male gender:	albuminuria ≥30	strip and			proteinuria): 41.3	
5					27.8%	mg/dl	ACR			%	
6					Hypertension:						
8					46.8%.						
9											
10 11					DM: 1.7%						
12					BMI: 22.3 ± 3.8						
13					kg/m2						
14 15											
16		Three			age(years): 36.8			Kinetic			Medium
17		centeres in			(IQR: 32.0–42.2)			Jaffe			
18 19		Uganda and		Q	male gender: 35%						
20		Zimbabwe			SBP: median:110	eGFR<60 ml/min					
21		Zimbabwe									
22					(IQR: 100-120)	1.73 m^2 on ≥ 2					
24					mmHg	consecutive					
25				HIV-infected,	DBP: median:70	occasions >80					
26 ₂₀	008,			ART-naive	(IQR: 60-80)	days apart or					
28 Us	ganda,			adults with	mmHg	confirmed 25%					
29 Zii	mbabwe,			CD4+ cell	BMI: median, 21.1	decrease if eGFR				Total prevalence :	
\$0	ast and			counts of<200	(IQR:19.1-23.6)	<60 ml/min/1.73			Not	7%	
Φ1 32 _{aid Δ} 145	outh		3316	cells/mm3	kg/m ²	m ² at baseline	CG				
33 So	outn		3310	cens/mm3		m at basenne	CG		measured		_
\$4		HIV			Age (years): 37			Not		Total prevalence (Low
86		outpatient			(range 16–70	Proteinuria $\geq +1$	Proteinuria	measured		based on	
37 20	009, South	clinic at		HIV-infected	years)	by urinary strip or	by urinary			proteinuria	
38 Af	frica,	Johannesburg		naïve ART	Male gender: 38%	albuminuria ≥30	strip and		43.7% had	prevalence):	
20 21 22 23 24 25 26 27 28 29 30 31 32 4id A ¹⁴⁵ So 33 34 35 36 37 38 39 4f ^a bian J ¹⁰⁸ So	outh	Hospital	578	patients	DM: 4.6% among	mg/dl	PCR		proteinuria	43.7%	
41											

3											
4					group with						
5					microalbuminuria						
6											
		All						IDMS-			Medium
9		consenting						calibrated			
10		individuals			Age (years): HIV-						
11											
12		residing in			ve, 28 (IQR: 24-						
12 13		every		1202 HIV-	35), HIV+ve: 30						
14 15		household in		infected patients	(IQR: 25-36)					Total prevalence	
16	2010,	50 Rakai		and 664 HIV -ve	Male gender: HIV-					among HIV+ve :	
17	Uganda,	District		age- and sex-	ve: (38.7%),	eGFR<			Not	0.7%	
18 9ucas G ¹⁵⁴	East		1960	matched controls	HIIV (26 A01)	60ml/min/1.73 m ²	MDRD				
	East	communities	1900	matched controls	HIV+ve (36.4%)	60mi/mm/1./3 m	MDKD		measured		
01		Primary						Not		Total prevalence	Medium
92		health care						mentioned		(CKD-EPI with	
23											
24		units								coefficient for	
25										black race): 2.5%	
26					Age (years): 30					CG: 3.4%	
27											
28					(IQR: 27–35)					(MDRD with	
29				HIV-infected	Male gender: 30%		CG,186			coefficient for	
្សប 81	2011, sub-			patients before	BMI:22.8 (IQR:	CrCl <50 ml/min	MDRD,		Not	black race): 2.5%	
$32_{ao\ J^{160}}$	Saharan,		2495	ART	20.4–25.6) kg/m ²		CKD-EPI		measured		
33		Communications			A == (:::====): 12	aCED 4 60		Kinetic		Total mususlamas .	T
34		Consecutive			Age (years): 43 ±	eGFR< 60	proteinuria	Kineuc		Total prevalence :	LOW
გე 86		HIV patients		HIV-infected	9	ml/min/1.73 m ² /	by dipstick	Jaffe and		20.5%	
37	2012,	from clinic		(ART	Male gender: 23%	or proteinuria	and 24-hour	IDMS		3% of the patients	
38	Congo,			treated=264)	Hypertension:	defined as 1+ or	proteinuria,			had eGFR< 60	
20 21 22 23 24 25 26 27 28 29 30 31 32 _{ao J} ¹⁶⁰ 33 34 35 36 37 38 39 40 ^{ongo A} ⁹⁹	Central		300	(ART naïve =36)	13%	greater	eGFR by		20.50%	ml/min/1.73 m ² by	

										28)
					BMI:24 ± 5		MDRD, CG			MDRD	
					(kg/m ²						
		HIV clinic				eGFR <60		Not			Low
						ml/min/1.73 m ² ;	Proteinuria	mentioned			
)						or proteinuria	by urinary				
1					Age (years): 38		strip, ACR,				
2					(32-45)	≥+ 1	PCR, eGFR				
3 4	2013,		7	HIV-infected	Male gender: 33%	(confirmed by	by CG,				
5	Ghana,			patients starting	BMI: 20.3 (IQR:	uPCR > 45	MDRD,			Total prevalence	
6 \$ arfo F ¹⁰⁹	West	4	3137	ART	17.6-22.7) kg/m ²	mg/mmol)	CKD-EPI			(CKD-EPI):13.8%	
3		Electronic		8 ,				Not			Mediu
9		medical						mentioned			
1		records of									
2		patients from			8 ,						
3 1		1				•					
5	2011,	18 sites			Age (years): 35.5						
5	Cameroon,	throughout			(29.3-44.0)					Total prevalence	
/ 2	Central-	Western		HIV patients	Male gender:	eGFR<60				(MDRD): 9.4%	
9 0 1 2 3 4 5 5 6 7 3 Gupta S ¹⁶¹	West	Kenya	7383	without ART	26.9%	ml/min/1.73 m ²	CG, MDRD			CG: 20.2%	
)		Ambulatory			Age (years): 38.84			Kinetic			Low
) <u>)</u>		Treatment			(IQR: 33.18-			Jaffe			
3		Center			46.23)						
<u> </u>					Male gender:						
) }					33.9%						
0 1 2 3 4 5 6 7 3										m . 1	
3	2013,				BMI: 20.31 (IQR:					Total prevalence	
/ }	Congo,			Newly diagnosed	17.97-22.89)	eGFR< 60			Not	:8.5%	
Ekat MH ¹⁴⁶	Central		562	HIV patients	kg/m ²	ml/min/1.73m ²	186MDRD		measured		

42 43 44

45

3		Academic						Kinetic			T
† 5		Academic						Kinetic			Low
		Model for the			Age (years): 35.0			assay			
7		Prevention			(range, 19–60)		proteinuria				
3		and			Male gender:		by urinary				
10		Treatment of			32.1%		strip, CG,				
11		HIV/AIDS		HIV-infected	SBP: 104.7		full and		6.2%		
12 13	2007,	(AMPATH)		patients naive to	(range, 80–140)	CrCl<60	abbreviated		(proteinuria	Total prevalence	
1 Wools-Kaloustian K ⁸⁰ 15	Kenya, East	clinic	373	ART	mm/Hg	ml/min/1.73 m ²	MDRD		≥1+)	:11.50%	
15 16		HIV/AIDS			Age (years): 34.6			Not			Medium
17		outpatient			± 9.4			mentioned			
18		clinic		R.	Male gender:			memoriou			
19 20		Cillic			, and the second						
21					48.5%						
22					Hypertension:		Proteinuria		38%		
23 24					13.2%	albuminuria +1	or		proteinuria		
25					BMI categories:	on at least two	albuminuria		with		
20 21 22 23 24 25 26 27 28 29					<19.0 kg/m ² : 59.2	occasions (4	by urinary		dipstick	Total prevalence	
27 28					%	weeks apart) and	strip and 24		21.9%	:38.8 %	
29	2008,				19-25 kg/m ² :	or serum	hours		nephrotic	Among patients;	
80 51	Nigeria,			HIV-infected	37.5%	creatinine >1.5	proteinuria ,		range	8.8% had CrCl <15	
2201	West		400	patients	>25 kg/m ² : 3.3%	mg/dl	CG		proteinuria	ml/min.	
33	West	G :	400	patients		ilig/ui		77	•) (''
84 55		Community			Age (years): 34		proteinuria	Kinetic	(9% among	•	Medium
86		based			(IQR: 30–39) HIV	eGFR<60	by urinary	Jaffe	HIV +	among HIV	
37	2011,			677 HIV-	+ve/43 (IQR:34–	ml/min/1.73 m ² /	strip, eGFR		and7.2%	+ve:9%	
38	Rwanda,			infected and 214	50) HIV -ve	or proteinuria +1	by MDRD,		among non-	2.7% had eGFR<	
P&mem C ⁸¹ 33 84 85 86 87 88 89 40 Vyatt C ⁸²	East		891	HIV-uninfected	Male gender: 0	or greater	CKD-EPI,		infected)	60 ml/min/1.73 m ²	
11 11											

2 3										30
					Hypertension:		CG			CKD prevalence
4 5 6 7 8 9					HIV+ve: 4.8%/					among HIV-ve:
7					HIV-ve: 8.3%					7.2%
8 9					BMI (kg/m ²):					1.5% had eGFR<
					HIV+ve: 20.9					60 ml/min/1.73 m ²
11 12					(IQR: 19.0–23.3)/					
13		UA			HIV-ve: 20.5					
14 15					(IQR: 18.5–23.3)					
16		HIV clinic of				The presence of		Kinetic		Low
17		Yaoundé				proteinuria +1 or		Jaffe		
19		general		CA		more and eGFR<	Proteinuria			Total prevalence
20	2013,	hospital		All newly		60 ml/min based	by urinary			:36%
21 22	Cameroon,			diagnosed HIV-	Age (years):	on the average of	strip, eGFR			Among patients;
23	Central –			infected patients	35±10.7	eGFR by 2	by CG, 175			3% had eGFR< 60
24 25olefackKaze F ⁸³	West		104	naïve to HAART	Male gender: 32%	equations	MDRD		36%	ml/min/1,73 m ²
26		ART clinic in				any proteinuria		Not		Low
28		a central				(≥+1);		mentioned		
29		hospital in				heavy proteinuria				
80 81		Malawi			Age (years): 34.3	(≥+2); any				
32					± 9.3;	proteinuria (≥ +1)				Total prevalence:
83 84					Male gender:	with renal	Proteinuria			23.3%
35				Consecutive	43.5%	dysfunction (e	by urinary			Among patients
ያ6 87	2011,			newly referred	Hypertension:	GFR <60	strip, eGFR			with proteinuria;
38 8	Malawi,			HIV-infected	11.2%	ml/min/1.73 m ²)	by CG and			5.3% had CrCl<
18 19 20 21 22 23 24 25olefackKaze F ⁸³ 26 27 28 29 30 31 32 33 34 35 36 37 38 39 48 6 truik G ⁸⁴	East		526	patients on ART	DM: 0.8%	and heavy	MDRD		23.3%	60 ml/minute
1 1		l				I				

3										
4						proteinuria (≥+2)				
5						with renal				
6 7										
						dysfunction (CrCl				
8 9						< 60 mL/minute)				
						(oo mizminate)				
10						and				
11						the absence of				
12 13										
13						any alternative				
14						cause for renal				
15										
14 15 16 17						dysfunction or				
17						proteinuria.				
18										
19		National					Serum Not			Low
20		Central					creatinine mention	ed Proteinuria		
21					A () 22.4	D 0.5		0.5 /0.4		
22		hospital			Age(years): 22±4	Proteinuria > 0.5	measurement	>0.5 g/24		
23	1998,			HIV-infected	Male gender: 68 %	g/24 hrs and	and 24-hour	hrs in	Total	
24	Danin Wast		02			SC = 14 == =/1		22.2201		
25ttolou v	Benin, West		92	patients		SCr>14 mg/l	proteinuria	23.33%	prevalence:27.16%	
26		infections					Not kno	wn	Total prevalence	Low
27									among AIDS	
28		unit of the							among AIDS	
29		Jos							group:51.80%	
18 19 20 21 22 23 24 25ttolou V ¹¹⁸ 26 27 28 29 30 31 32 33 4gaba EI ¹⁷⁰ 35 36 37 38 39 46ana GT ¹⁰⁰	2003,	University		Consecutive 79					CKD prevalence	
\$1	2005,	Oniversity		Consecutive /9					pievalence	
32	Nigeria,	Teaching		AIDS patients				25% (AIDS	among control	
ຽວ A gaba FI ¹⁷⁰	West	Hospital	126	and 57 controls		Not known	Not known	group)	group: 12.2%	
54 ⁻⁵⁻⁰⁻⁰	11 031	•	120	and 57 controls		110t KHOWH	1 tot known	group)	510up. 12.2/0	
55		Outpatient				CrCl < 60	Proteinuria Not		Total prevalence :	Low
50	2011,	clinics		HIV-infected		ml/min.	by urinary mention	ed	45.9%	
57		cimics								
58	Zimbabwe,			patients naïve to		Proteinuria $\geq +1$	strip and 24-		Among patients;	
カラ n Kana GT ¹⁰⁰	South		159	ART		and/or PCR > 20	hour	45.90%	7.50% had CrCl<	
41			190.0				· 	.5.5076		
							l			

										32	2
						mg/mg	proteinuria,			60 ml/min	
							eGFR by CG				
		Medical				Microalbuminuria		Not			Low
		center				> urinary protein		mentioned			
0		Come			Ago (voors)	30 and 300 mg/24		memoned			
1					Age (years):						
2					31(range,13-63)	h.					
3					Male gender: 25%,	A cut-off serum	Proteinuria				
4 5		U /			Proteinuria -ve:	creatinine level of	by urinary				
6					117±14/70±9	250 mmol/l was	strip and 24-				
7					Microalbuminuria:	used to exclude	hour				
8 9	2006, South			CA	121±15/81±10	those patients	proteinuria,			Total prevalence (
0	Africa,			HIV patients not	Macroalbuminuria:	with advanced	CG and			based on	
1 ⊉ian TM ¹⁰¹	South		615	on ART	120±12/74±11	nephropathy	MDRD		6%	proteinuria): 6%	
3	2008,	Home-Based			Age (years): 39	, ,		Kinetic		,	Low
4				*****		G GI	00 175		NY 4		Low
6	Uganda,	AIDS Care		HIV patients	(median)	CrCl of 25–50	CG, 175	Jaffe	Not	Total prevalence:	
Peters P ¹⁴⁷	East		508	starting HAART	Male gender: 41%	ml/min	MDRD		measured	20%	
8		Clinics			Age (years):			Not			Medium
9					HIV+ve (27 (IQR:			measured		Total prevalence	
1	2011,				24- 31)),		Proteinuria		HIV+ve:	among HIV+ve (
2	Cameroon,			199 HIV +ve and	HIV-ve (27 (IQR:		by urinary		39.2%	based on	
3 4 5 6 Peters P ¹⁴⁷ 7 8 9 0 1 2 3 4 5 ao J ¹¹⁰ 6 7 8 9	Central-			190 HIV -ve	22 -31))	Proteinuria (PCR	strip and		HIV-ve:	proteinuria):	
5 _{190 I} 110	West		389	pregnant women	Male gender: 0	> 200 mg/g)	PCR		20.9%	39.2%	
6		0	307			> 200 mg/g)		NY .		33.2 %	*
7	2011,	Outpatient		HIV-infected	Age (years): 36.1		Proteinuria	Not	36%		Low
9	Tanzania,	clinics		patients naïve to	±7.9		and	mentioned	proteinuria	Total prevalence:	
Msango L ⁸⁵	East		355	ART	Male gender: 35%	KDOQI	albuminuria		≥	85.6%	

3											
4					BMI (kg/m ²): 21.3		by urinary		+1		
5					±3.8		strip eGFR				
6					±3.6		strip eGFK				
7							by CG,				
8							MDRD				
9							MIDKD				
10		primary			Age (years):			Not			Low
11		healthcare		Consecutive 238	pregnant, 28 (IQR:			mentioned			
12				Consecutive 250				mentioned			
13		clinic		pregnant women,	25–32), men, 37						
14				1014 non-	(IQR: 32–45),						
15											
16				pregnant, 609	women, 33 (IQR:						
17	2013, South			men; HIV-	28–39)					Total prevalence:	
18										•	
19	Africa,			infected patients	Male gender: 33%		Absolute Scr		Not	5.8%	
20 Myer L ¹⁶²	South		1861	eligible for ART		CrCl< 60ml/min	and CG		measured		
21 '		~									
22		Clinic			Age (years):			Not			Medium
23					normal CrCl,			mentioned			
24 [22.7.7.0						
25					33.7±7.9,						
<u>26</u>	2008,			HIV-infected,	decreased CrCl,		Absolute				
27	71.			ADT	29.5+0.0		G. GED			T-4-1	
28	Zambia,			ART-naïve	38.5±9.9		Scr, eGFR			Total prevalence	
29	South			adults initiating	Male gender:		by CG and		Not	(MDRD): 3.2%	
19 20 Myer L ¹⁶² 21 22 23 24 25 26 27 28 29 30 3 Mulenga L ¹⁶³			25249	traatmant	39.7%	CrCl< 60 ml/min	MDRD		measured	:	
3 Mulenga L			23249	treatment	39.1%	CrC/< 60 mi/min	MIDRD		measured	:	
52		The			Age (years): 37.9+		7/	Kinetic			Low
B3		Linivarsity			10.5			Inffo or 1			
B4 L-		University			10.3			Jaffe and			
B5		of Ilorin		Newly diagnosed	Male gender:			IDMS			
<u>ያ</u> 6	2015,	Teaching		HIV-infected	42.6%		Absolute				
32 33 34 35 36 37 38 39	2015,	reaching		111 v -IIIIecteu	42.0%		Absolute				
38	Nigeria,	hospital,		ART naïve	BMI (kg/m ²):	eGFR< 60	Scr, eGFR		Not	Total prevalence:	
					•	1	1	1	l	l	1
89 40 ^{dedeji} T ¹⁵⁸	West		183	patients	20.88+ 3.56	ml/min/1.73m ²	by MDRD		measured	24%	

		Federal			Age (years); 38.84			Not			Low
		Medical			± 10.65			mentioned			
								mentioned			
		Centre		393 newly	Male gender: 28%						
0				diagnosed drug-	BMI categories:						
1				naïve HIV	<18.5.0 kg/m ² : 7%		Quantitative				
2											
3				patients, 136 age	18.5-24.9 kg/m ² :		assessment			Total prevalence	
4 5				and sex matched	35%	24-hours urine	of			among HIV +ve	
6	2016,			HIV-	25-29.9 kg/m ² :	protein ≥0.300 g	protienuira,			patients:22.9%	
7	Nigeria,			seronegative	32%	and/or GFR <60	Scr, and		Not	Prevalence among	
3				seronegative					Not	_	
nyabolu E ¹³⁵	West		529	controls	\geq 30 kg/m ² :23%	ml/min	eGFR		mentioned	HIV -ve: 8.1%	
9		Medical Out-			Age (years): 40.3			Kinetic			Low
I D		patient			± 10.3			Jaffe			
3											
4		Department			Male gender: 44%						
5		of University			BMI (kg/m ²): 20.5						
6		of Ilorin			± 4.8 among HIV						
7											
3		Teaching			patients , 26.7 ±						
9		Hospital			5.3 among control						
3 1				227 newly-	group						
2				diagnosed, ART	SBP(mmHg):					Total prevalence	
3				_							
4				naïve patients	111.9 ± 1 among		Proteinuria			among HIV	
5				with	HIV patients,	albuminuria ≥ 30	by dipstick,			patients: 47.6%	
O 7	2015,			HIV/AIDS,	126.1 ± 12.0	mg/g and/or	and ACR			The prevalence	
<i>I</i>									NI	among HIV -ve:	
R	NT:						rand ettER	1	Not	among HIV ve	1
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9	Nigeria,			108age and sex	among control	eGFR < 60 ml/ml/1.73m ²	and eGFR		1,00	among mv –vc.	

										35	5
					DBP(mmHg): 72.9						
					± 9.5 among HIV						
					patients, 80.6 ± 6.8						
					among control						
0					group						
1 2											
3		Komfo			Age(years): 39		Proteinuria (Not		Total prevalence	Low
4		Anokye			(IQR: 35-46)		dipsticks,	mentioned	37% by	(proteinuria) :	
5	2015							memoned	·		
6 7	2015,	Teaching			Male gender: 25%		PCR, and		dipstick and	37%	
8	Ghana,	Hospital		HIV patients on	BMI(kg/m ²): 22.9	Proteinuria or	ACR) and		12% by	CrCl<60 ml/min	
9 hadwick D ¹¹⁴	West		330	ART	(IQR: 20.5-26.6)	CrCl<60ml/min	GFR by CG		PCR	among 7%	
'0		Two primary			Age (years): HIV			Not			Medium
2		care clinics			+ve: 43 (IQR: 39–			mentioned			
3					50), HIV-ve: 49						
4					(IQR:40-56)						
6											
7					Male gender: HIV						
8					+ve: 31%, HIV-						
9					ve:28.7%						
1					Hypertension:						
2					HIV+ve:44%,						
3					HIV-ve: 33.2%		70/				
5					Diabetes mellitus:					Total prevalence:	
6	2015			210							
7	2015,			210 HIV+ve	HIV +ve: 5% ,					12.1%	
20 21 22 23 44 55 66 67 89 90 11 12 33 44 95 66 67 88 99	Kenya,			patients and	HIV -ve: 15.2%		eGFR by		Not	HIV+ve: 17%	
EdwardsJ ¹⁶⁶	East		2206	1996 HIV -ve		CrCl<60 ml/min	CKD-EPI		measured	HIv-ve: 11%	
1		1				<u> </u>					

<u>.</u> }										36	6
		Lighthouse					eGFR by	IDMS			Medium
•		Clinic					CG, MDRD,	calibrated		Total prevalence	
							and CKD-	creatinine		among HIV+ve	
0				116 HIV +ve			EPI with and	and		(creatinine based	
1 2	2016,			ART-naïve	Age (years): 31		without	cystatin-C		CKD-EPI):1.9%	
3	Malawi,	O_{A}		patients and 247	(IQR:26-39)	eGFR< 60	correction		Not		
4 Glaser N ¹⁴	East		363	HIV-ve patients	Male gender: 52%	ml/min	factor		measured		
6		Lighthouse			Age (years): 34.1		Proteinuria	IDMS			Medium
7		Clinic			±10.9		by dipstick	calibrated		Total prevalence :	
8 9				C/A	Male gender: 52%		and ACR,	creatinine		13%	
					BMI(kg/m ²):		eGFR by	and		Prevalence among	
20 21 22 23 24	2016,			116 HIV +ve	23.2±4.8		CG, MDRD,	cystatin -C		HIV+ve22%	
23	Malawi,			patients and 247	Hypertension:		and CKD-			Prevalence among	
2 4 Silaser N ¹¹⁵	East		363	HIV –ve patients	13.5%	KDOQI	EPI		12.1%	HIV-ve: 9%	
6		Gugulethu			Age (years): 34			Not			Medium
27 28	2015, South	Community		HIV infected	(IQR: 29-41)			mentioned			
26 27 28 29	Africa,	Health		patients initiated	Male gender: 38%	eGFR< 60			Not	Total prevalence:	
80 Kamkuemah M ¹⁶⁷	South	Centre	1092	ART therapy	maio genden 507e	ml/min	eGFR by CG		measured	2%	
	30444	Government	10,2	HIV patients on		,	torice, ce	Kinetic	measurea	- 70	Low
12 13 14 15 16 17		hospitals		HAART, DOTS	Age (years): 38.04			Jaffe			LOW
34 35	2015	nospitais			± 10.52			Jane			
86	2015,			or on the		-CED (CO					
57 88	Cameroon			combined	Male gender:	eGFR <60	.CED 1		No	Tatal as 1	
19	Central-			therapy	50.5%	ml/min per 1.73	eGFR by		Not	Total prevalence:	
Nsagha D ¹⁴⁹	West		200	(HAART/DOTS)		m ²	MDRD		measured	8%	

3	Ī	1	T	I		T			T	Ī	T
1 -		infectious			Age (years): 31.4			Not			Low
		diseases			± 9.5			mentioned			
5 6 7		clinic of			Male gender:						
8 9		Gulu			36.3%		Proteinuria				
0	2015,	Regional		Newly diagnosed	BMI(kg/m^2) <18:	eGFR <60	by dipstick				
12	Uganda,	Referral		HIV patients not	33%	ml/min per 1.73	and eGFR		Proteinuria	Total prevalence:	
1 3)dongo P ⁹⁴	East	Hospital	361	receiving ART		m^2	by MDRD		≥ +1: 52%	14.4%	
14		University of				eGFR <60		Kinetic			Low
15		•					Onemaitetine	Laffa			
16 17		Benin				ml/min per 1.73	Quantitative	Jaffe			
1, 18		Teaching				m ² and/or	assessment				
19		Hospital				evidence of	of				
20					Age (years): 36.03	kidney injury as	proteinuria				
21	2016,				± 9.08	detected when the	by PCR and				
22 03											
23 24	Nigeria,			HIV infected	Male gender: 41%	PCR (mg/g) was	eGFR by		Not	Total prevalence:	
9 8kafor U ¹³⁶	West		383	naïve patients		≥200.	MDRD		mentioned	53.5%	
26		Medical in-			Age (years):			IDMS			Low
k/ p8		patients at			37.0±9.6						
29		the Chris			Male gender: 60%						
во											
B1	2016, South	Hani			BMI(kg/m ²): 20.9	eGFR <60	eGFR by				
B2	Africa,	Baragwanath		HIV infected	±5.1	ml/min per 1.73	CG, MDRD,		Not	Total prevalence:	
3 Aseape T ¹⁵⁶	South	Hospital	100	naïve patients		m ²	CKD-EPI		measured	16%	
\$5		Rural			Age (years):		Albuminuria	Not		Total prevalence	Medium
86 87	2015, South	Medical			40(IQR:34-48)	Albuminuria or	by ACR and	mentioned		(albuminuria):	
38	Africa,	Centre		HIV infected	Male gender: 31%	eGFR <60	eGFR by			21%	
20 21 22 23 24 25)kafor U ¹³⁶ 26 27 28 29 30 31 32 33 3 ² eape T ¹⁵⁶ 35 36 37 38 39 40)Vensink G ¹³⁷	South		903	adult patients	Diabetes mellitus:	ml/min / 1.73 m ²	MDRD and		21%	2% had eGFR< 60	
40 ^{Vensink} G ¹³⁷	South		903	adult patients	Diabetes mellitus:	ml/min / 1.73 m ²	MDKD and		21%	2% nad eGFR< 60	

3										38
					4%		CKD-EPI			ml/min/1.73 m ²
4 5 6 7					Hypertension:					
7					23%					
8		Outpatient			Age (years):			IDMS		Medium
9								151115		Mediani
10 11		infectious			37.9±9.4					
12		clinic at an			Male gender:					
13		academic			35.5%					
14		hospital			Diabetes					
15 16	2016, South			HIV infected	mellitus:2.2%	eGFR <60	eGFR by			
17	Africa,	4		patients initiating	Hypertension:	ml/min per 1.73	MDRD and		Not	Total prevalence:
18										
1 G achor H ¹⁵⁷	South		650	ART	7.8%	m ²	CKD-EPI		measured	2 %
21		Jimma			Age (years):			Kinetic		Medium
22		University			HAART naive:			Jaffe		
23		Specialized			38.25 ±10.8,					
24 95		Hospital			HAART +ve:					
26					35.14 ±9.2					
27						1/1/2				
28					Male gender: 37%					
29					BMI(kg/m ²) :					
3 1					HAART naïve:		77/			
32					20.7±3.2, HAART					
3 3					+ve: 21.6 ±3.5					
ρ 4 35				(222 114 4 D.T.						
3 6				(223 HAART	Hypertension:					
3 7	2016,			naïve and 223	3.36%	eGFR <60				
38	Ethiopia,			HAART	Diabetes mellitus:	ml/min per 1.73			Not	Total prevalence:
20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 40 40 40 41 41 41 41 41 41 41 41 41 41 41 41 41	East		446	experienced)	21.4%	m ²	eGFR by CG		measured	18.2%
<u>41</u>	1			1				i	·	

pressure. DBP: disatolic blood pressure, IDMS: Intrope .

DBP: Multifraction of Diet in Renal Disease, CG: Coskrult Gault , CK. DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, HAART: highly active antiretroviral therapy, DOTS: directly observed treatment short course, ART: antiretroviral therapy, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault, CKD-EPI: Chronic Kidney Disease Epidemiology, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative

Table 4: Studies on CKD among diabetic patients

Study ID	Year, Country , Region	Location	N	Study group	Population Characteristics	Definition of CKD	Method of outcome assessment	Creatinin e assay	proteinuria	CKD prevalence	Quality assessment
Janmohamed MN ⁸⁶	2013, Tanzania, East	diabetes mellitus clinic of Bugando Medical Centre in Mwanza	369	Consecuti ve diabetic patients	Age (years): 54 (IQR: 45-62) Male gender: 46.6% Hypertension: 57.5% BMI (kg/m²): 25.6 (IQR: 22.6-29.6) Duration of DM (years): 6(3-11) 93.8% type 2 DM 6.2% type 1DM	eGFR ≤60 ml/min/1.73 m² or evidence of kidney damage (microalbuminuria or overt proteinuria).	Microalbumin uria, proteinuria by urinary strips, eGFR by CG	Kinetic Jaffe	Overt proteinuria (34.1%), microalbuminuria(45.8%)	Total prevalence:83.7%	Low
Wanjohi FW ⁸⁷	2002, Kenya, East	Outpatient diabetic clinic at Kenyatta National Hospital	100	Type 2 diabetic patients	Age (years): 53.7 ±9.3 Male gender: 37% Hypertension: 50% BMI (kg/m²): 27.8±6.0 Duration of DM (months): 10.3±7.5	Albuminuria > 20 mg/ L	Albuminuria by urinary strip, CG	Not mentioned	26% had albuminuria	Total prevalence(based on albuminuria): 26%	

Bouzid C ¹¹⁹	2011, Tunis, North	nutrition	689	Type 2 diabetic patients from computeri zed hospital	Male gender: 39% Hypertension: 84.6% (renal insufficiency), 57.2% (no renal disease) Duration of DM (years): 11±8	eGFR<60 ml/min	CG, 24-hour proteinuria	Not mentioned	10.1% macroalbumnuria, 13% microalbuminuria	Total prevalence: 19.8%	Low
Choukem SP ⁸⁸	2012, Cameroon, Central- West	Two main referral centres	420	Consecuti ve type 2 diabetic patients	Age (years): 56.7 ±9.9 Male gender: 49% Hypertension: 50% BMI (kg/m²): 28.5 ±5.2 Duration of DM (years): 4 (IQR: 1-9)	The presence of positive proteinuria with or without low CrCl < 90 ml/min/1.73 m ²	Proteinuria by urinary strip/eGFR by CG	Not mentioned		Total prevalence: 31%	Low
Keeton G ¹²⁰	2004, South Africa, South	Groote Schuur Hospital Outpatients Diabetic Clinic or the Somerset Hospital Outpatients	59	Type 2 diabetic patients	Age (years): 62 ±9.4 Male gender: 36% BMI (kg/m²): (31± 6) Duration of DM (years): 17 (Range: 14-33)	Double Scr level	Proteinuria by PCR, and serum creatinine	Not mentioned		Total prevalence: 66.1%	Low
BouAziz ¹²¹	2012, Tunisia, North	Basic Health Group of Sousse	115	73 type 2 diabetic patients and 42 healthy	Age (mean ±SE in years): 59.3 ±1.1 Male gender: 35% SBP (mean ±SE mmHg): 136.3 ±3.1	Microalbuminuria (defined as < 2.8 g/mmol for women and < 2.3 for men) and eGFR \leq 60 ml/min/1.73 m ²	Measurement of microalbuminu ria, eGFR by MDRD	Not mentioned		Total prevalence:	Low

				volunteers	DBP (mean ±SE): 76.8 ±1.9 BMI (mean ±SE in kg/m²):						
		Referral		Medical	30.5±0.7 Duration of DM (years): 10.6±1 Age (years): 58 ±10.4		Microalbumin				Low
Katchunga P ¹²²	2010, Congo, Central	general	98	records of type 2 diabetic patients	Male gender: 35.7% Hypertension: 59.2% BMI (kg/m²): 25.2± 4.7 Duration of DM (years): 17.3 ±8.5	KDOQI	uria (>20 mg/L and <200 mg/L) eGFR by MDRD	Not mentioned		Total prevalence: 66%	
Djrolo F ¹²³	2001, Benin, West	National University hospital centre	152	Type 1 and 2 diabetic patients	Age (years): 53.3(range, 21-90) Male gender: 65.8% Duration of DM (years): <1 – 16 or more	Presence of proteinuria	24-hour proteinuria	Not measured	28%	Total prevalence (based on proetinuria level): 28%	Low
Balogun WO ¹⁰²	2011, Nigeria, West	Tertiary hospital	40	Randomly selected type 2 diabetic patients	Age (years): 59.4 ± 11.25 Male gender: 37.5% Hypertension: 45%	not mentioned	Proteinuria by urinary strip and 24 hrs, eGFR by CG	Jaffe method	82.5% macroalbuminuria	Total prevalence:	Low
Mafundikwa A ¹⁰³	2007, Zimbabwe, South	Diabetic clinic	75	Consecuti ve Insulin- dependent	No available data	No available data	Proteinuria by urinary strips and 24-hour		Overt proteinuria 21%. Microalbuminuria	Total prevalence: 33%	Low

				diabetic patients			proteinuria		12%.		
Lutale J ¹²⁴	2007, Tanzania, East	Outpatient diabetic clinic	204	and 153 type 2 diabetic patients	45% type 1 DM 55% type 2DM Age (years): type 1, 21(14– 44.8), type 2, 53 (23.5–85) Male gender: 55% hypertension: 42% BMI (kg/m²): 19.3 ± 3.8 (type 1), 27.8 ± 4.8 (type 2) Duration of DM (years): 3(Range: 0-25)	KDOQI	Quantitative assessment of albuminuria, CrCl by CG	Kinetic Jaffe	macroalbuminuria	Total prevalence: 18.5% 4.6% of Type 1 patients and 22% of Type 2 had eGFR < 60 ml/min/1.73 m ²	Low
Gill G ¹²⁵	2008, Ethiopia, East	Diabetic clinic at Mekelle Hospital	105	All diabetic patients	Age (years): 41±16 Male gender: 70% Hypertension: 5% BMI (kg/m²): 20.6 ±5.4 Duration of DM (years): 7±6	Nephropathy was considered present if the urinary ACR was >25.0mg/mmol and retinopathy was present. Microalbuminuria was diagnosed if the ACR was >2.5 and <25.0mg/mmol in men and >3.5 and <25.0mg/mmol in women.	ACR, Scr	Not mentioned	51% microalbuminuria	Total prevalence : 51%,	Low
Makulo R 111	2010, Congo, Central	Community based	229	81 Diabetic and 148 impaired fasting	Age (years): 53.1±16.3 Male gender: 33% SBP (mmHg): 128.0±5.7 DBP (mmHg): 78.5±13.4 BMI (kg/m²): 22.6±5.2	eGFR of <60 mL/min/1.73 m ²	Urinary albumin by urinary strip and ACR, eGFR by	Kinetic Jaffe	29.6%	Total prevalence: 29.6% 10% of the patients had eGFR< 60	Medium

				glucose			186MDRD			ml/min/1.73 m ²	
				patients							
		University		2208	Age (years): 48±15						Medium
		,									Wediam
	2016,	medical		Cases of	Male gender:41%					Total prevalence	
	Nigeria,	centers and		type 2 DM	Hypertension: (68.3% of					(MDRD):	
Adebamowo	Ghana,	surrounding		and 2607	type 2 DM, and 35.3% of		eGFR by	Kinetic		9%	
	,	communities	4815	controls	diabetic-free)	eGFR of <60 ml/min/1.73 m ²	MDRD and		Not measured		
S ¹⁵¹	Kenya			free from	BMI(kg/m ²): 26.9 ± 5.4		CKD-EPI	Jaffe		13.4% of type	
	(sub-			DM	(diabetic patients)					2DM and 4.8% of	
	Saharan)			Divi						diabetic free	
					25.5 ± 5.7 (non-diabetics)						
		out-patient		Cases of							Low
	2016	section of the		type 2 DM	Age (years): 56.5 ± 10.6		Proteinuria by		60.45		
	2016,	endocrine unit			Male gender: 53.1%		dipsticks and	Kinetic	68.4% among	Total prevalence:	
Feteh V ⁹⁵	Cameroon,	of the Douala	636		BMI (kg/m ²): 29.3 ± 14.7	eGFR of <60 ml/min/1.73 m ²	eGFR by 186	Jaffe	anemic patients,	18.5%	
	Central-West	General			Hypertension: 62.2%		MDRD		57.6% non anemic		
					Hypertension. 62.2%		MDKD				
		Hospital									
		Follow-up		Diabetic	Age (years): 45 ± 14.5					Total prevalence	Medium
	2014,	clinic at		patients	Male gender: 57.5%		eGFR by CG	Tr		•	
Fiseha T ¹⁵²	Ethiopia,	Butajira	214		SBP(mmHg): 121 ± 17	eGFR of <60 ml/min/1.73 m ²	and 186	Kinetic	Not measured	(MDRD): 18.2%	
	East	hospital			DBP(mmHg): 79 ± 10		MDRD	Jaffe		Prevalence	
		1			BMI(kg/m ²): 25.26 ± 4.35					(CG):23.8%	
	2016	A 11		Did a	-		B) (P
	2016,	All patients		Diabetic	Among diabetic patients		Proteinuria by	Kinetic		Total prevalence :	Medium
Pillay S ⁹⁶	South	seen at	653	patients	with HIV:	eGFR of <60 ml/min/1.73 m ²	dipstick and	Jaffe	18%	18.8%	
	Africa,	Edendale		with or	Age(years): 50-70		eGFR by 186				
				1				1			

	South	Hospital		without	Male gender: 32%		MDRD				
		diabetic clinic		HIV (149	Among diabetic patients						
				DM and	without HIV						
				HIV; 504	Age (years): 51-60						
				DM							
				without							
				HIV)							
		Outpatient		Diabetic							Low
Eghan B ¹³⁸	2007, Ghana, West	diabetic clinic of the department of	109	patients	Age (years): 54.1±10.9 Male gender: 28% Hypertension: 39% BMI(kg/m²): 26.3±4.4	microalbuminuria if urine albumin excretion was 30–300 mg/day	Albuminuria by urine albumin excretion and eGFR by CG	Not mentioned	43.1%	Total prevalence(based on microalbuminuria): 43.1%	

DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault, CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative

Table 5: Studies on CKD among hypertensive patients

Study ID	Year Country	Location	N	Study group	Population characteristics	Definition of CKD	Method of outcome	Creatinine	Proteinuria	CKD	Quality assessment
2.002, 22	Region		ľ				assessment	assay		prevalence	
Osafo C ¹²⁶	2011 Ghana, West	four polyclinics	712	Hypertensive patients	Age (years): 59 (range,19–90) Male gender: 21.3% DM: 14.7% SBP (mmHg): 150 (range,100–280) DBP (mmHg): 90 (range, 60–160) BMI (kg/m²): 29.7 (range,12.2–67.4) BMI categories (kg/m²): <25: 22.3% 25-29.9: 26% >30: 45.7%	KDOQI	Proteinuria by PCR (men>0.3 women>0.2 mg/mg) eGFR by MDRD	Kinetic Jaffe	28.90%	Total prevalence: 46.90% Prevalence by stage: Stage 1-2: 19.1% Stage 3-5: 27.8%	Low
Ajayi S ¹⁶⁴	2014 Nigeria, West	Tertiary health centre	628		Age (years): 49.71±13.22 Male gender : 49% DM: 8.6% SBP (mmHg): 135.9 ± 27.4 DBP (mmHg): 87.0 ± 16.3 BMI (kg/m²): 27.8 ± 8.7	eGFR <60 mL/min/1.73 m ²	eGFR by MDRD	Not mentioned	Not measured	Total prevalence: 38.5%	Low
Lengani A ¹²⁷	2000 Burkina Faso West	department of Cardiology or Internal	342	Hypertensive patients	Age (years): 50.6 ±13.8 Male gender: 58%	Serum creatinine \geq 650 µmol/l and or blood urea >=35 mml/l plus long	Measurement of scr, 24-hour proteinuria	Not mentioned		Total prevalence: 50.8%	Low

		medicine				history with clinical					
						manifestations					
		University		All hospitalized							Low
Nwankwo E ¹⁶⁵	2006 Nigeria West	of Maiduguri Teaching Hospital	185	hypertensive	Age (years): 44.6 ± 14.9 Male gender: 49%	Scr >135 μmol/l	Measurement of Scr	Not mentioned	Not measured	Total prevalence: 45.50%	
Rayner B ¹²⁸	2006 South Africa South	100 General practice centres	1091	Random hypertensive patients	Age (years): >=35 years Male gender: 48.5% BMI: 23.6% of the patients had a normal BMI 41.9% were overweight and 34.2% were frankly obese	microalbuminuria 3-		not measured	21.3% microalbuminu ria 4.1% macroalbumin uria	Total prevalence (based on albumnuria): 25.4%	Medium
Plange-Rhule J 89	1999 Ghana, West	Komfo Anokye Teaching Hospital	448	Hypertensive patients	Age (years): 50.5 ±13.0 Male gender: 36% SBP (mmHg): 165.0 ±27.8 DBP (mmHg): 101.9 ±17.9	Plasma creatinine ≥140mol/1	Proteinuria by urinary strips and serum creatinine	Not mentioned	25.50%	Total prevalence: 30.2%	Low
Addo J ¹⁴¹	2009 Ghana , West	seven central government ministries in Accra	219	Hypertensive patients	Age (years): 50.4± 6.6 Male gender: 64% SBP (mmHg):156.0 ±21.5 DBP (mmHg): 95 ±13 BMI (kg/m²): 27.5 ± 5.4	Persistent proteinuria on Urinalysis in the absence of urinary tract infection and/or impaired GFR<60 ml/min/ 1.73 m ²	Proteinuria and eGFR by MDRD	Enzymatic assessment	13.4%	Total prevalence: 13.4% 4.1% had eGFR< 60 ml/min/1.73 m²	Medium

		Komfo		180 non-diabetic	Age (years): 22-87					Low
		Anokye		hypertensive	Male gender:37%					
		Teaching		patients and 61	SBP (mmHg): hypertensive patients(on					
		Hospital and		age matched	antihypertensive therapy:155.46±1.82,				Total	
		the		controls	no antihypertensive therapy:152±3.27),				prevalence	
		surrounding			control (117.38±0.96)		Urine albumin		(CKD-EPI):	
	2016, Ghana,	community		UA	DBP (mmHg): hypertensive patients(eGFR <60	excretion, and eGFR	Not	14.5%	
Aryee C ¹³⁹	West		242		on antihypertensive	ml/min/1.73m ²	by CG, 186 MDRD,	mentioned 30%	Prevalence by	
	West				therapy:101.46±0.94, no	111/1111//1.75111	and CKD-EPI	mentioned	MDRD:13.3%	
					antihypertensive therapy: 100.50±1.34),		and CRD LIT		Prevalence by	
					control (73.28±0.77)				CG:16.6%	
					BMI (kg/m²): hypertensive patients(on				00.10.0%	
					antihypertensive therapy:29.52±0.39, no					
					antihypertensive therapy: 29.8±0.71),					
					control (29.36±0.65)					
		out- patient		Newly diagnosed		Microalbumnuria as a			Total	Low
	2015	hypertension		eligible black	Age (years): 54.3 ± 6.2	random urine albumin	Quantitative	Not	prevalence (
Nabbaale J ¹⁴⁰	Uganda	clinic	256	adult	Male gender: 36.7%	level between 30 and	assessment of	measured 39.5%	based on	
	East			hypertensive		299 mg/dl.	albumin in urine		microalbumin	
				patients	DDD diestelie bleed assesses IDMC			Ladification of Diet in Bound Die	uria): 39.5%	

DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault,

CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative

Table 6: Studies on CKD among other populations

Study ID	Year Country Region	Location	N	Study group	Population Characteristics	Definition of CKD	Method of outcome assessment	Creatinine assay	Proteinuri a	CKD prevalence	Quality assessment
E.F K ¹⁹	2013 Senegal West	Nephrology department of the Aristide Le Dantec University Hospital Center.	43	Lupus patients	Age (years): 32.9 Male gender: 7% Hypertension: 30%	Proteinuria > 0.5 g/ 24 hours with or without hematuria/ renal insufficiency/ abnormal renal biopsy	24-hour proteinuria and eGFR by CG	Not mentioned	51%	Total prevalence: 72%	Low
Abd ElHafeez S ²⁹	2009 Egypt North	The Nephrology department at the Main Alexandria University hospital	400	Relatives of ESRD patients	Age (years): 35.2±11.6 Male gender: 50.8% Hypertension: 60% DM: 11.5% BMI(kg/m²): 28.5±5.89	KDOQI	Proteinuria by urinary strips, 186 MDRD	Kinetic Jaffe	21.3%	Total prevalence 57% Prevalence by stage: Stage 1: 9% Stage 2: 44% Stage 3: 4% Stage 4: 0.3%	medium
Raji Y ²⁸	2015, Nigeria,	Nephrology out-patient	469	(230 first degree relatives of patients with CKD and	Age (years): 33.49 ± 12.0 BMI(kg/m ²): first degree relatives: 25.5 ± 5.3 , controls: 23.8 ± 4.0	Reduced eGFR	Albumnuria by ACR and eGFR by MDRD	Not mentioned	46%	Total prevalence:	Low

		230 age- and gender-	SBP(mmHg): first degree					4%	
	Lanca	matched controls with no	relatives: 116.5 ± 22.5 , controls: 112.1 ± 18.1						
	Lagos	matched controls with no	DBP(mmHg): first degree						
	University	personal or family history	relatives: 74.9 ± 12.7 , controls: 71.4 ± 10.5						
	Teaching	of CKD)							
	Hospital								
	Primary	Patients attending the	Age (years): 43.35± 12.80						Low
	health care	primary	Male gender: 16%						
2013		health care facilities	Hypertension: 10%	eGFR of < 60				Total	
	252		DM: 5.95%	mL/min/	Proteinuria by urinary	Not	24 21%		
	232		BMI (kg/m ²): 28.67 ± 6.43	$1.73 ext{ m}^2 ext{ with or}$	strip and eGFR by MDRD	mentioned	24.2170	•	
Last			BMI categories (kg/m²):	without proteinuria.				10.52 /6	
			<18: 2.38%						
			>25.13: 71.83) ,					
	Family	Newly registered patients		Persistently					Medium
	practice clinic	who attended the Family		abnormal ACR				Total	
		Practice Clinic	Age (years): 50.52 + 13.03	irrespective of GFR				prevalence:	
2009			Male gender: 27.2%	level or persistent				14.4%	
	250		32% elevated SBP, 30%	eGFR < 60	Proteinuria by urinary	Standardized	14 4%	10.4% had	
West			elevated DBP	mL/min/1.73 m ²	strip, eGFR by MDRD	IDMS		persistent	
			DM: 6%	irrespective of the				eGFR< 60	
			Obesity: 32%	presence or absence				ml/min/1.73	
				of Kidney damage				m ²	
				after 3 months					
2009	Primary and	At risk population	Age (years): 53.9 ± 15.5 Male gender: 43%	KDOOL	Proteinuria by urinary	Vinatia I. CC.	100	Total prevalence:	High
Congo	secondary 527	randomly selected	Hypertension: 58.2% DM: 54.5% Obesity: 16%	KDOQI	strip, 24-hour proteinuria, 175 MDRD	Kinetic Jaffe	19%	36% Prevalence by stage	
2 N	2009	Teaching Hospital Primary health care 2013 Sudan Family practice clinic 2009 Nigeria 250 Primary and 257	Primary health care Patients attending the primary health care facilities Family practice clinic Who attended the Family Practice Clinic Newly registered patients who attended the Family Practice Clinic Primary and Street S	University Teaching Hospital Primary health care Primary health care facilities Primary health care facilities Patients attending the primary health care facilities Primary health care facilities Patients attending the primary Hospital Hypertension: 10% DM: 5.95% BMI (kg/m²): 28.67 ± 6.43 BMI categories (kg/m²): 418: 2.38% >25.13: 71.83 Newly registered patients who attended the Family Practice Clinic Age (years): 50.52 + 13.03 Male gender: 27.2% 32% elevated SBP, 30% elevated DBP DM: 6% Obesity: 32% Obesity: 32% Primary and secondary Primary and secondary At risk population randomly selected Age (years): 53.9 ± 15.5 Male gender: 43% Hypertension: 58.2% DM: 54.5% Pomit of CKD) Age (years): 53.9 ± 15.5 Male gender: 58.2% DM: 54.5% Pomit of CKD) Age (years): 53.9 ± 15.5 Male gender: 58.2% DM: 54.5%	University Teaching Hospital Primary health care Primary Patients attending the primary health care facilities Primary health care facilities Primary Patients attending the primary Hospital Primary Patients attending the primary Male gender: 16% Hypertension: 10% BMI (kg/m²): 28.67 ± 6.43 BMI (kg/m²): 28.67 ± 6.43 BMI categories (kg/m²): Vest Practice clinic Persistently abnormal ACR irrespective of GFR level or persistent 32% elevated SBP, 30% elevated DBP DM: 6% DM: 6% DM: 6% DM: 6% DM: 6% DM: 6% Primary and Congo Primary and Congo Primary and S27 At risk population randomly selected Primary and Congo Primary and S27 At risk population randomly selected Age (years): 53.9 ± 15.5 Male gender: 43% Hypertension: 58.2% DM: 54.5% KDOQI MALP (years): 53.9 ± 15.5 Male gender: 43% Hypertension: 58.2% DM: 5.45.% KDOQI	University Teaching Hospital Primary health care Primary health care facilities Primary health care facilities Proteinuria by urinary strip and eGFR by MDRD Proteinuria Proteinuria	University Teaching Hospital Primary health care Proteinuria by urinary Not BMI (kg/m²): 28.67 ± 6.43 BMI (kg/m²): 28.67 ± 6.43 BMI categories (kg/m²): 48.2.38% >25.13: 71.83 Proteinuria Proteinuria by urinary Not mentioned Primary Not mentioned Primary Not mentioned Proteinuria by urinary Not mentioned Age (years): 50.52 + 13.03 West Practice clinic Practice Clinic Age (years): 50.52 + 13.03 Male gender: 27.2% Age (years): 50.52 + 13.03 Male gender: 27.2% alonomal ACR irrespective of GFR level or persistent eGFR < 60 mL/min/1.73 m² irrespective of the presence or absence of Kidney damage after 3 months Proteinuria by urinary Standardized IDMS Nost Proteinuria by urinary Standardized primary Age (years): 53.9 ± 15.5 Male gender: 43% Hypertension: 88.2% DM: 43.5% KDOQI Proteinuria by urinary Standardized Nost Kinetic Jaffe Nost 43.5% Nost Nost Rinetic Jaffe Nord Nost Kinetic Jaffe Nord Nost Kinetic Jaffe Nord Nost Nost Nord Rinetic Jaffe Proteinuria by urinary strip, 24-hour proteinuria, princip 24-hour proteinuria, princip 34-hour proteinuria, princip 35-r Male gender: 43% Hypertension: 88.2% BMI (minut) Rinetic Jaffe Nord Nord Nord Rinetic Jaffe Nord Nord	University Teaching Hospital Primary health care Proteinuria DM: 5.95% BMI (kg/m²): 28.67 ± 6.43 BMI (kg/m²): 28.67 ± 6.43 BMI (kg/m²): 28.13 * 71.83 Proteinuria Proteinuria Proteinuria by urinary strip and eGFR by MDRD Proteinuria Protein	University Teaching Hospital Primary health care Proteinuria BMI (kg/m²): 28.67 ± 6.43 BMI categories (kg/m²): class clas

	C	114		<u> </u>				1	1	
	Central	health care							stage 1: 4.2%, stage 2:	
									6.1%, stage	
									3: 18.3%,	
									stage 4:	
			0						1.9%, stage 5: 5.7%	
		Federal	Subjects from medical		Proteinuria as 24					Low
	2016,	Medical	out-patient department of		hours protein ≥					
Anyabolu E ³⁰	Nigeria,	Center 136	the hospital.	Age (years): 38.58±11.79 Male gender: 27.9%	0.300g and impaired	Proteinuria by quantitative	Kinetic Jaffe	14.1% had	Total	
	West			BMI(kg/m ²): 25.51±6.47	renal filtration	assessment and Scr		proteinuria	prevalence: 14.1%	
					function as CrCl					
					<90mls/min					
	2015,	Charlotte	African patients with	Age (years): 57.1±10.8						Low
. p ²⁰	South	Maxeke	rheumatoid arthritis	Male gender: 17.2% BMI(kg/m ²): 27.4±6.0	eGFR<		Kinetic Jaffe	Not	Total	
Dessein P ²⁰	Africa,	Johannesburg 233 and Milpark		Hypertension: 57.5% Diabetes mellitus: 12.5%	60ml/min/1.73m ²	eGFR by CG, MDRD, CKD-EPI	and IDMS calibrated	measured	prevalence: 39%	
	South	Hospitals					canbrated			
		Tema	Patients with sickle cell		(eGFR < 60					Low
		General	anemia		mL/min/ 1.73 m ² or					
F 1 : 521	2015,	Hospital		Age (years): 23.25 ± 12.04 Male gender: 43.3%	evidence of kidney		TD1 (G	12.46		
Ephraim R ²¹	Ghana, West	194		SBP(mmHg): 110.06 ± 8.27 DBP(mmHg): 67.16 ± 8.23 BMI (kg/m ²): 18.85 ± 11.19	damage as	Proteinuria by dipstick and eGFR by CKD-EPI	IDMS	13.4%	39.2%	
	WEST			Divii (kg/iii). 10.03 ± 11.19	albuminuria, or					
					overt proteinuria					
van	2010	Tertiary 1216	New patients referred to	Age (years): 39.6 ± 15.9	Elevated SCr(>130	Proteinuria by quantitative	Not	16.7%	Total	Low

Rensburg B	South	hospital	the Renal Unit	Male gender: 51.1%	μmol/L) and small	assessment and Scr	mentioned	proteinuria	prevalence:	
27	Africa			Hypertension: 13.2%	kidneys on imaging	measurement		>3.5 g/dl	37.9%	
	South			DM: 10.8%	without evidence of					
					reversible causes					
		hairdressing	Hairdressers	Age (years): 40±8		Proteinuria by urinary			Total	Low
Hamdouk	2011	saloons		Male gender: 0%			Not	26.4% had	prevalence:	
M ¹⁰⁴	Sudan	72		Hypertension: 19.4%	Scr level≥2 mg/dl	•	mentioned	albuminuri	26.4%	
IVI	East			Hypertension: 19.4%		renal biopsy	mentioned	a	14% had Scr	
						renai biopsy			≥2 mg/dl	
		male workers	Male workers attending						Total	Low
		attending the	the out-patient clinic of					93% among	prevalence (
	2003	out-patient	the Health Insurance	Age (years): 39.83±7.27		A		non-silica	among	
EL-Safty I ¹²⁹	Egypt	clinic 81	Organization	Male gender: 100%	Elevated proteinuria	Assessment of proteinuria	Not measured	exposed	those with	
	North	of the Health	Workers (29 non-	Hypertension: 19.4%		quantitatively		100% silica	Silica	
		Insurance	silicotics, 24					exposed	exposure):	
		Organization	silicotics and 28 referent)						100%	

DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault,

CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative

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Titles and legends

Fig. 1 Flow diagram of the study selection

Fig. 2 Prevalence of CKD among entire general population. Estimates from this figure should be presented with caution as it is bound to be imprecise and inaccurate due to its tentative way of estimation

Fig. 3 Main causes of CKD

Supporting information

S1 Table: Search strategy adopted in PubMed and Ovid MEDLINE

idies among CK12 para. **S2 Table:** Studies among CKD patients



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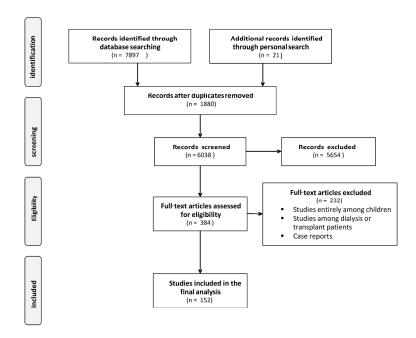


Fig1

. . . x 300 DPI)

Fig 1

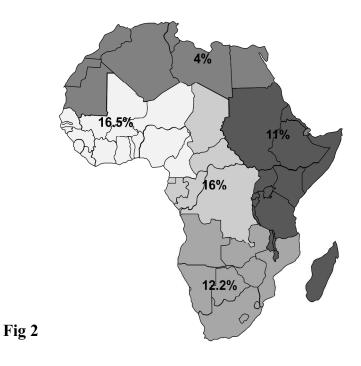


Fig2
254x190mm (300 x 300 DPI)

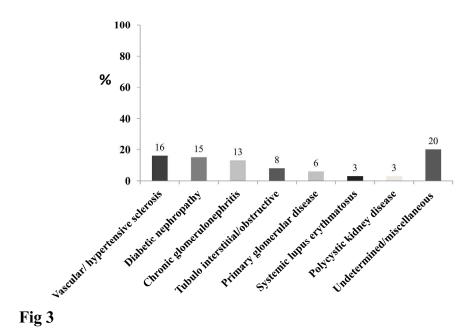


Fig 3
254x190mm (300 x 300 DPI)

S1 Table. Search strategy adopted in PubMed and Ovid MEDLINE

- 1. exp Renal Dialysis/
- 2. (hemodialysis or haemodialysis).tw.
- 3. (hemofiltration or haemofiltration).tw.
- 4. (hemodiafiltration or haemodiafiltration).tw.
- 5. dialysis.tw.
- 6. (CAPD or CCPD or APD).tw.
- 7. Renal Insufficiency/
- 8. Kidney Failure/
- 9. exp Renal Insufficiency, Chronic/
- 10. Kidney Diseases/
- 11. Uremia/
- 12. (end-stage renal or end-stage kidney or endstage renal or endstage kidney).tw.
- 13. (ESRF or ESKF or ESRD or ESKD).tw.
- 14. (chronic kidney or chronic renal).tw.
- 15. (CKF or CKD or CRF or CRD).tw.
- 16. (predialysis or pre-dialysis).tw.
- 17. ur?emi\$.tw.
- 18. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17
- 19. afric\$.ti,ab,kw,tw,mp.
- 20. 18 and 19

S2 Table: Studies among CKD patients

	Year		T		1
	Country	N		biopsy	causes of CKD
Study ID	Region	1	Population Characteristic	biopsy	causes of CKD
El Khayat	2013, Morocco, North	134	Age(years): 54.4±18.1 Male gender: 58.65%	no	DN: 44.02% H.scl: 11.2% Tub.int: 9.7% SLE: 5% Ch.GN: 3.7% Undetermined: 26.11%
Seck S ³²	2013, Senegal, West	60	Age (years): 70.5±54.6 Male gender: 52% Hypertension: 20% SBP (mmHg): 167 ± 78 DBP (mmHg): 95 ± 55 DM: 18%	no	H.scl: 30% DN: 25%
Seck S ³³	2008, Senegal, West	118	Age (years): 39.28±16.4 Male gender: 56% SBP (mmHg): 160±15 DBP (mmHg): 90±15	yes	Ch.GN: 35% Vascular nephropathy: 20.2% Tub.int: 12% DN: 10.5% PKD: 4.2% Autoimmune: 4.2% Neoplasm: 1.6% H.scl: 0.8% Undetermined: 11.5%
Bourquia A ³⁴	2002, Morocco, North	420	Age (years): 46±3 Male gender: 52%	no	PKD: 6.5%
Ouattara B ³⁵	2011, Ivory Coast, West	301	Age (years): 44±10 Male gender: 56% Hypertension: 33.5% DM: 12.3%	no	Nephroangiosclerosis:25.2% HIV nephropathy:17% Interstitial nephritis: 10.3% DN: 9.6% Ch.GN: 6.6% PKD:2.3% Undetermined: 29.2%
Lengani A ³⁶	1997, Burkina Faso, West	174	Age (years): 36±15 Male gender: 63% Hypertension: 64.9%	no	Ch.GN: 42.5% Vascular nephropathy: 23.6% Tub.int: 16.1% PKD: 1% Undetermined: 16.8%
Afifi A ³⁷	2005, Egypt, North	220	Not known	no	DN: 28.2% H.scl: 25.5% Obstructive uropathy: 13.5% Cystitis: 6.8% Simple cyst: 4.5% Undetermined: 29.5%
Diouf B ³⁸	2000, Senegal, West	261	Age (years): 44(range:15-88) Male gender: 46%	no	Nephroangiosclerosis: 25% DN: 20.5% Ch.GN: 15% Undetermined: 34%
Niang A ³⁹	2008, Senegal, West	258	Age (years): 28 (range:15-79) Male gender: 75% Hypertension: 12.2%	yes	FSGS: 52% MGN: 12% Minimal change diseases: 7.7%
Sabi K ⁴⁰	2011, Togo, West	398	Age (years): mean: 42.6	not	Ch.GN: 40.2%

			Male gender: 57%	known	Tub.int: 20.9%
			Wate gender. 37 %	KIIOWII	Nephroangiosclerosis: 17.6%
	2010, Nigeria,	1538	Age (years): 42.55±15.43 Male gender: 65% Hypertension: 17.2% DM: 11.8%	yes	H.scl: 17.2% Ch.GN:14.6% DN:11.8% Undetermined:51.6%
Ulasi I ⁴¹ AbdErrahim E ⁴²	West 2001, Tunis,	1471	Age (years): 38.3±14.6	no	Others: 4.6% DN: 20.3%
E	North	115	Male gender: 69% Age (years): 28 (IQR:5-60) Male gender: 56%	yes	FSGS: 46.9% MGN:8.7% Minimal change disease:6.1% Endocapillary GN: 2.6% Mesangioproliferative: 1.7% Extracapillary GN:1.7% IgA nephropathy:1.7% SLE: 13%
Abdou N ⁴³	2003, Senegal, West				H.scl: 2% Undetermined: 7% Others:11%
Afifi A ⁴⁴	2004, Egypt, North	3172	Age (years): 56.5±29.2	yes	DN: 14.5%
		4905	Age (years): 45.6±14.2 Male gender: 62.4%	yes	H.scl: 28% Ch.GN: 16.2% Obstructive uropathy: 15% DN: 8.9% PKD: 3%
Afifi A ⁴⁵	1999, Egypt, North				Undetermined: 16.2%
Agaba E ⁴⁶	2009, Nigeria, West	130	Age (years): 41±16 Male gender: 68%	no	Ch.GN: 39% H.scl: 34.6% DN: 11.8% PKD: 6.9% Undetermined: 7.7%
Alashek W ⁴⁷	2012, Libya, North	2417	Age (years): 49 (range: 36-61) Male gender: 58%	no	DN: 26.5% Ch.GN: 21.2% H.scl: 14.6% Congenital and hereditary: 12.3% PKD: 6.3% Obstructive uropathy: 5% Chronic pyleonephritis: 2% Interstitial nephritis: 1.2% Autoimmune disease: 0.7% Other: 2.9% undetermined: 7.3%
Alasia D ⁴⁸	2012 , Nigeria, West	320	Age (years): 46.2±17.6 Male gender: 63% SBP (mmHg): 171.2±31.9 DBP(mmHg): 102.5±27.4	yes	Ch.GN: 45.7% H.scl: 29.8% DN: 17.5% PKD: 3% Obstructive uropathy: 2% Undetermined: 2%
Alebiosu C ⁴⁹	2006, Nigeria, West	153	Age (years): 39.6±14.8 Male gender: 59% Hypertension: 38.5% SBP (mmHg): 167.3±15.5 DBP (mmHg): 106±28.9 DM: 13.1%	no	Ch.GN: 41.2% H.scl: 26.1% DN: 13.1%

	1	1	T	г	77 4 42 0 24
			Age (years): 47.5±15.7		H.scl: 42.8%
			Male gender: 56.2		Ch.GN: 15.9%
			Hypertension: 42.8%		Obstructive uropathy: 14.9%
			DM: 13.4%		DN: 13.4%
		201		no	PKD: 1%
					SLE: 1%
					Sickle cell nephropathy: 1%
	2012 Nigaria				
	2012, Nigeria,				Analgesic nephropathy:0.5%
Amira C ⁵⁰	West				Undetermined: 9.5%
			Age(years): 36 (range:15-90)		Ch. GN: 43.7%
			Male gender: 70.3%		H.scl: 31.1%
			Hypertension: 72.4%		Obstructive uropathy: 6.7%
		760	SBP (mmHg): 160	no	DN: 3.7%
			(range:120 – 270)		Tub.int: 2.2%
Arogundade	2011, Nigeria,		DBP (mmHg): 100 (range:50		PKD: 0.7%
F ⁵¹	West		- 209)		Undetermined: 12%
1	West				
			Age (years): 51.4±18.0		DN: 35%
			Male gender: 56.5%		H.scl: 25.3%
		6397		no	Tub.int: 19.7%
		,			Ch.GN: 13%
					PKD: 2.2%
Counil É ⁵²	2008, Tunis, North				Undetermined:52.8%
			Age (years): Male:		H.scl:52.58%
			50.89±13.43 and Female:		Ch.GN: 17.2%
			48.22±14.70		Tub.int: 17.1%
			Male gender: 61.2%		PKD: 4.3%
		116		no	
			SBP(mmHg): 153.41±27.12		DN: 2.6%
			DBP (mmHg): 93.92±17.19		Chronic pyelonephritis: 2.6%
52	2012, Nigeria				Obstructive uropathy:1.7%
Chijioke A ⁵³	,West				Undetermined: 1.9%
			Age (years): 47.1±17.0		H.scl: 75.2%
			Male gender: 45%		DN: 29.8%
		202	SBP (mmHg): (male) 144.6 ±		HIV nephropathy: 28.6%
	2014, South	302	28.3. (female)141.1 ± 25.5	yes	Ch.GN: 7%
	Africa,		DBP(mmHg): (male)84.2 ±		Tub.int:6%
Madala N ⁵⁴	South		18.1. (female)81.0 \pm 19.0		Undetermined: 6%
Madaia iv	South		· · · · · · · · · · · · · · · · · · ·		
			Age (years): 66.3 ± 5.7		MGN: 14.4%
			Male gender: 47.7%		Mesangioproliferative GN:8.1%
			Hypertension: 71%		Crescentic GN: 7.2%
			DM: 19.8%		Mesangiocapillary GN: 3.6%
					Post infectious GN: 2.7%
					FSGS:1.8%
					IgAN nephropathy: 0.9%
					DN:12.6%
					Ch.GN: 5.4%
					SLE: 4.5%
		111		yes	
					H.scl: 3.6%
					Amyloidosis: 2.7%
					Myeloma: 2.7%
					Crescentric GN: 1.8%
					HIV nephropathy:0.9%
					Thrombocytopenic purpura:0.9%
					Hemolytic uremic: 0.9%
	2013, South				Tub.int: 17.2%
	Africa,				Miscellaneous: 8.1%
Okpechi I ⁵⁵	· ·				iviiscenaneous. 6.1 //
Okpecii I	South]	

			17.2 (20	1	I
			Age (years): 47.2 (range:29 -		
		3783	70)	no	PKD: 1.8%
		3703	Male gender: 24%	no	116. 1.0%
Laleye A ⁵⁶	2012, Benin, West		Hypertension: 59%		
			Age (years): 49 ±16.25		H.Scl: 38.8%
			Male gender: 68%		Ch.GN: 28.8%
			g		DN:22.5%
		300		no	PKD:2.7%
	2013, Nigeria,				SLE: 1.1%
011 . 3757					
Okunola Y ⁵⁷	West				Undetermined: 6.1%
			Age (years): 47 + 14		H.scl: 45%
			Male gender: 60%		Ch.GN: 15.8%
			SBP(mmHg): 162 ± 32		DN: 12.5%
			DBP(mmHg): 94.9 ± 19.6		Obstructive uropathy: 12.5%
					PKD: 3.3%
		120		yes	Ch. Pyelonephritis: 2.5%
				700	SLE: 1.7%
					Analgesic nephropathy: 1.7%
	2012 N:				Sickle cell nephropathy: 1.7%
D 11 D 58	2013, Nigeria,				Toxic nephropathy: 0.8%
Bello B ⁵⁸	West				Undetermined: 2.5%
			Age(years): 46 ± 13		H.scl: 20%
			Male gender: 65%		Obstructive uropathy: 15%
					Ch.GN: 11%
		000			SLE: 9%
		800		no	DN: 8%
					Analgesic nephropathy: 5%
El-Minshawy					Chronic pyelonephritis: 5%
O ⁵⁹	2011 Formt North				
U	2011, Egypt, North		1 () 22 0 : 12 0		Undetermined: 27%
			Age (years): 33.9 ± 12.0		Cresentic GN: 5%
			Male gender: 45.2%		Ch GN: 15.7%
			Hypertension:39.8%		FSGS: 15.7%
					IgA nephropathy: 1.7%
					Minimal change disease: 6.6%
					Mesangiocapillary GN: 19%
					MGN: 14.9%
					Mesangial proliferative GN: 12.4%
		294		yes	Postinfectious GN: 9%
					HIV nephropathy: 42.8%
					SLE: 13.3%
					DN: 9.2%
					MGN: 6.9%
					Ch.GN: 5.85%
	2010, South				Mesnagiocapillary: 4.6%
Okpechi I ⁶⁰	Africa, South				Others: 17.4%
			Age(years): 41.4 ± 13.1		
			Male gender: 37.2%		Ch.GN: 39.2%
			SBP (mmHg): African (133.6		H.scl: 34.4%
		148	± 20.2). Indian (130.1 ± 20.6)	no	DN: 7.4%
		170	DBP (mmHg):	110	PKD:6.8%
	2012 S4				
3.61	2012, South		African: (133.6 ± 20.2) .		Undetermined: 3.4%
Madala N ⁶¹	Africa, South		Indian (130.1 ± 20.6)		_
			Age (years): 52.43 ± 15.48		DN: 41.5%
		207	Male gender: 64.3%	no	Ch.GN: 16%
El Farouki	2013, Morocco,	207	Hypertension: 73.9%	no	Tub.int: 14%
M^{62}	North		DM:41.5%		H.scl: 12%
L				L	

					PKD: 1%
					Undetermined: 15.5%
			A ma (vianes): 26 9 114 0		
			Age (years): 36.8 ±14.0		Mesangiocapillary: 20.4%
			Male gender: 45.2%		Mesangioproliferative:19.2% MGN:18.5%
					Crescentric GN: 11.4%
					FSGS: 10.5% Post infectious: 8.2%
		1284		****	
		1284		yes	Minimal change: 6% IgA nephropathy: 5.8%
					SLE: 19%
					Infection related: 15%
					Vascular causes:9%
	2011, South				Hereditary: 6%
Okpechi I ⁶³	Africa, South				Undetermined: 3.5%
Окресін 1	7 Hilled, Soddii		Age (years): 47 ± 13		Nephrosclerosis: 40.3%
			Male gender: 55%		Ch.GN: 21%
			Whate gender, 33 %		DN: 19.4%
		62		no	PKD: 3.2%
	2014, Senegal,		/		Tub.int: 1.6%
Niang A ⁶⁴	West				Undetermined: 14.5%
1 (1441)	***************************************		Age (years): 47.4±15		DN: 27.4%
			Male gender: 62%		H.scl: 10.5%
			Wate gender: 02%		Ch.GN: 8%
					Nephrolithiasis: 7.3%
					Amyloidosis: 6.8%
		124		no	Chronic interstitial nephrtitis: 6.4%
					PKD: 4%
					Ischemic: 3.2%
					SLE: 0.8%
	2008, Libya,				Familial: 0.8%
Buargub M ⁶⁵	North				Undetermined: 30.6%
	2010, Nigeria,	126	Age (years): 47.4 ± 16.2	A	DVD. 15 40/
Chijioke A ⁶⁶	West	436	Male gender: 57%	no	PKD: 15.4%
			Age (years): 45.78± 17.16		H.sclerosis: 14.29%
			Male gender: 67.8%		Obstructive uropathy: 11.61%
					Ch.GN: 9.8%
		224		yes	DN: 8.04%
		227		yes	Anaglesic nephropathy: 1.34%
					Renovascular: 0.45%
- 67					PKD: 0.9%
Elsharif M ⁶⁷	2011, Sudan, East				Undetermined: 53.57%
			Age (years): 89% <50 years.		SLE: 24.7%
			8.5% 50–60 years and 3%>		MGN: 10.9%
			50 years		FSGS: 6.8%
			Male gender: 52%		Mesangiocapillary GN: 6.7%
					Acute interstitial nephritis: 6.25%
		407			Membaranous nephropathy: 5.4%
		437		yes	Crescentric GN: 5.4%
					Chronic interstitial nephrtitis:4.5%
					Minimal change disease: 3.8%
					focal proliferative GN: 3.6%
					Amyloidosis: 2.7%
Ellahotila N 68	2012 Formt Name				Nephrosclerosis: 1.13%
Elkhatib M ⁶⁸	2012, Egypt, North				Undetermined: 3.6%

			Age (years): 26.5 ± 14.6		FSGS: 28.57%
			years		mesangioproliferative GN: 20.02%
			Male gender: 47%		MGN: 14%
		924		****	Minimal change disease: 8.55%
		924		yes	Amyloidosis: 5.52%
					Diffuse proliferative GN: 5.20%
					Focal proliferative GN: 3.68%
Ibrahim S ⁶⁹	2012, Egypt, North				DN:0.22%
			Age (years): 19 (IQR:12-25)		MGN :79.20%
			Male gender: 61%		FSGS: 9.10%
		386		yes	Extramembranous
	2011, Morocco,				glomerulonephritis:9.10%
Ayach G ⁷⁰	North				Renal amyloidosis: 2.6%.
			Age (years): 45.5(range: 16-		Ch.GN: 40.1%
		239	82)	No	H.Scl: 35.6%
Ramilitiana	2016, Madagascar,	239	Male gender: 40%	NO	DN:12.6%
B^{71}	East		Diabetes mellitus: 12.6%		Tub.int: 10.46%
			Age (years): 60 (47-79)		
	2012, Morocco,	16	Male gender: 81.3%	Yes	DN: 25%
Zajjari Y ⁷²	North		Hypertension: 56.3%		

Tub. Int: tubulo-interstital, DN: diabetic nephropathy, H. Scl: hypertensive sclerosis, Ch. GN: chronic glomerulonephritis, PKD: polycystic kidney disease, DM: diabetes mellitus, SLE: sytemic lupus erthmatosus, FSGS: focal segemental glomerulosclerosis, MGN: membaronus gloemrulonephritis



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PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3,4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	N/A
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4,5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4,5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	4, supplementary table 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4,5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	4,5
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	4,5
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	5,6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6



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PRISMA 2009 Checklist

Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I ²) for each meta-analysis.	6					
Page 1 of 2								
Section/topic	#	Checklist item	Reported on page #					
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6					
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	6					
RESULTS								
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	6,7,17, Fig.1					
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Tables(2-4, supplementary table 2) P:19- 51					
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Tables(2-4, supplementary table 2) P:19- 51					
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	6-11, 18-51					
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A					
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Tables 2,3 and 4, P: 19- 51					
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A					
DISCUSSION								
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	11					
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified researeผู้จะporting bitts)://bmjopen.bmj.com/site/about/guidelines.xhtml	12,14, 15					

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Conclusions	clusions 26 Provide a general interpretation of the results in the context of other evidence, and implications for future research.						
FUNDING							
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	54				

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For more into...
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Prevalence and burden of chronic kidney disease among the general population and high risk groups in Africa: a systematic review"

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TITLE PAGE

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ABSTRACT

Objectives: While increasing attention is paid to the rising prevalence of chronic diseases in Africa, there is little focus on chronic kidney disease (CKD). This systematic review assesses CKD burden among the general population and high-risk groups on the entire African continent

Design, setting, and participants: We searched MEDLINE and PUBMED databases for articles published between January 1st, 1995 and April 7th, 2017 by sensitive search strategies focusing on CKD surveys at the community level and high risk groups. In total, 7918 references were evaluated, of which 7766 articles were excluded because they did not meet the inclusion criteria. Thus, 152 studies were included in the final analysis

Outcome measurement: The prevalence of CKD in each study group was expressed as a range and pooled prevalence rate of CKD was calculated as a point estimate and 95% CI. No meta-analysis was done. Data were presented for different population.

Results: In the community-level studies, based on available medium and high quality studies, The prevalence of CKD ranged from 2% to 41% (pooled prevalence:10.1%; 95% CI: 9.8%-10.5%). The prevalence of CKD in the high risk groups ranged from 1% to 46% (pooled prevalence 5.6%; 95% CI: 5.4-5.8%) in HIV (based on available medium and high quality studies), 11% to 90% (Pooled prevalence: 24.7%; 95%CI: 23.6-25.7%) in diabetes (based on all available studies which are of low quality except four of medium quality) and 13% to 51% (pooled prevalence: 34.5%; 95 % CI: 34.04%-36%) in hypertensive patients (based on all available studies which are of low quality except two of medium quality)

Conclusion: In Africa, CKD is a public health problem, mainly attributed to high risk conditions as hypertension and diabetes. The poor data quality restricts the validity of the findings and draws the attention to the importance of designing future robust studies

Strengths and limitations of the study

- This systematic review assessed the CKD burden among the general population and highrisk groups on the entire African continent based on studies that covered all Africa from January1st, 1995 till April7th, 2017
- The quality of the included articles was assessed based on standard criteria dealing with clinical trials, diagnostic studies, and observational studies. The articles were assessed based on the population sampling and precision, sampling technique, response rate, and exclusion rate.
- No meta -analysis was conducted in this review due to the huge discrepancy in the definition used to identify CKD, the methods of creatinine measurement, urine protein assessment, and in the quality of the reporting.
- The review findings were limited by the low quality of the majority of studies in Africa
- There is paucity of information about CKD prevalence in age and gender groups which affects the accuracy of the pooled prevalence estimated from each group
- The prevalence of CKD reported in this review should be interpreted with caution due to the bias introduced from the heterogeneity between studies, analytical and methodological issues, sample size, and study population selection

INTRODUCTION

Chronic kidney disease (CKD) is an emerging global public health problem¹. The disease is a component of a new epidemic of chronic conditions that replaced malnutrition and infection as leading causes of mortality during the twentieth century². Age-standardized death rates due to CKD have increased during the last 23 years. CKD has shifted from the 36th cause of death in 1990 to the 19th cause in 2013³. The worldwide increase in CKD and kidney failure-necessitating renal replacement therapy (RRT) -and the high rate of cardiovascular mortality and morbidity attributable to CKD are poised to reach epidemic proportions over the next decade. CKD complications represent a considerable burden on global health care resources and only a small number of countries have sufficiently robust economies to meet the challenge posed by this disease. Socioeconomic differences in health exist and individuals of lower socioeconomic status (SES) have a higher risk for mortality and morbidity compared with those of higher SES⁴. A change in the global approach to CKD from the treatment of ESRD to intensive primary and secondary prevention is therefore considered an absolute public health priority⁵. Africa is the second largest continent in the world, with a population of over 1 billion; 961.5 million people live in sub-Saharan Africa and 195 million in Northern Africa⁶. Africa now faces the dual challenge of infectious illnesses and chronic diseases. Africa's chronic disease burden is secondary to various factors, including increased life expectancy, changing lifestyle practices, poverty, urbanization and globalization⁷. The World Health Assembly advocated the Global Action Plan for the Prevention and Control of non-communicable diseases 2013–2020. One of its targets is to reduce premature mortality from chronic diseases by 25% in 2025. These actions have the potential to make a significant impact on the burden of CKD⁸. Unfortunately, CKD problem remains underestimated on the entire continent due to lack of epidemiological information from different African countries. There exists only a single systematic review conducted in sub-Saharan Africa which concluded that CKD is a prevalent and potentially escalating disease across Sub-

- Saharan Africa, with both communicable and non-communicable risk factors⁹. Strategies aimed at
- managing CKD epidemics in Africa critically depend on a reliable assessment of the burden of the
- problem and the establishment of affordable early detection programs. Previous studies reported the
- prevalence of CKD among the general population or the specific prevalence of this condition in
- diseases that are recognized as drivers of renal damage (e.g., diabetes mellitus). These estimates
- have varied across studies due to differences in the methods of Glomerular Filtration Rate (GFR)
- measurement, background risk (general population vs. high risk groups), or demographic
- characteristics (e.g., age, gender)¹⁰.
- With this background in mind, this review aimed to increase the systematic information on the
- burden of CKD in the general population and high risk groups of the entire African continent and
- provide an estimate of the prevalence of CKD in different regions of Africa.

MATERIALS AND METHODS

Data source and search strategy

- We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)
- Guidelines¹¹. A systematic literature search was performed in the PubMed and OVID-MEDLINE
- databases by two authors (DB and SA) to identify articles reporting epidemiology data on CKD in
- the adult population in any geographic area of the African continent. This employed focused, highly
- sensitive search strategies (S1 Table). The search covered the time frame from January 1st, 1995 to
- April 7th, 2017. Papers without language and study design restrictions were located and screened.
- References from relevant studies were screened for supplementary articles.

Study selection and data extraction

- Titles and abstracts were screened independently by two authors (SA and GD), who discarded
- studies that were not relevant to the topic. Case reports, reviews, editorials, letters, and studies
- focusing on African-Americans not living on the African continent, conducted entirely among
- children, or dealing with acute kidney injury or kidney transplantation were excluded. Two authors

(SA, ED) independently assessed the retrieved abstracts and the full texts of these studies to determine eligibility according to the inclusion criteria. Disagreements were resolved through discussion and consensus, or through consultation with a third reviewer (DB), who solved these differences based on study judgments. Furthermore, screening of reference lists of all of the retrieved studies was conducted to check for relevant articles, and a supplementary scan of the reference lists of the systematic reviews was performed to identify any additional studies. Data were extracted from full-text articles and registered using a specifically designed form. These data included study design, geographical area, sample size, the definition of CKD used, prevalence of CKD, age, gender, GFR measurement, type of creatinine assay, proteinuria, the method of outcome assessment and associated comorbidities such as diabetes mellitus and hypertension. Data extraction was performed by one reviewer (SA) and independently verified by another reviewer (DB).

Data extraction and analysis

Studies were categorized according to the reference population as follows: 1) studies dealing with the general population and 2) studies focusing on particular diseases such as diabetes, hypertension, lupus and HIV or settings, e.g., hospital-based surveys and occupational studies.

Information on the assessment of kidney function was collected, including: the equation adopted for GFR estimation ((Cockroft-Gault(CG), Modification of Diet in Renal Disease (MDRD), Chronic Kidney Disease-Epidemiology Collaboration (CKD-EPI)), the type of creatinine assay (Jaffe, standardized or unknown), and the type of proteinuria or albuminuria assay used (semi-quantitative assessment by urinary strips or quantitative in urine samples or 24 h collection). When the study included two or three GFR equations, we defined the CKD prevalence based on the CKD-EPI equation whenever this information was provided. Otherwise, we considered the MDRD equation and lastly the CG equation. In the case of ethnicity correction¹²⁻¹⁴; we included the equation which corrected for ethnicity. Information on the definition of CKD used in each study was also included ((either the internationally accepted definition as Kidney Disease Outcome Quality Initiative (KDOQI), or other ways of defining CKD)).

Quality assessment

Two independent authors (SA and DB) appraised each article independently and assessed its quality based on standard criteria described into details in previous methodology reviews dealing with clinical trials¹⁵, diagnostic studies¹⁶, and observational studies¹⁷. The articles were assessed based on the subject sampling and precision, sampling technique, response rate, method of assessment of kidney function, and exclusion rate

Statistical analyses

The principal demographic and clinical data for each study were summarized as the mean and standard deviation or as absolute number and percentage, as appropriate. The age range in each study was also recorded. The range of the CKD prevalence for each study group was reported. The pooled prevalence rate of CKD was expressed as a point estimate and 95% CI. The prevalence from each study was weighed by the sample size then the pooled prevalence was categorized by the African region. The inter-rater agreement for inclusion and quality assessment was determined using Cohen's kappa (κ) coefficient ¹⁸. The percentage of the different causes of CKD was weighed by the sample size of each study done among CKD patients. Then we simply summed the number of patients for each etiological factor and divided it by the total sample size from the whole included studies. No meta-analysis was conducted in this study. Data were appropriately presented for different populations (general population and CKD patients). The patients' data were stratified by the type of underlying condition, i.e., hypertension, diabetes mellitus, HIV, or systemic lupus erythematosus. All calculations were conducted using SPSS for Windows, version 21, Chicago, Illinois, USA.

RESULTS

Search results

The flow diagram of the selection process is depicted in (Fig. 1). In total, 7897 potentially relevant

references were initially retrieved. Twenty-one additional citations were found through a personal search. By screening titles and abstracts, a total 7534 citations were excluded because of search overlap, dealing with the wrong population (African American, AKI, cancer or post-transplant patients), or not providing actual data on CKD. Review articles, case reports, editorials, or letters were also excluded. Amongst the 384 studies selected for full text examination, 232 were excluded because they dealt with a population different from that specifically targeted in this systematic review, such as paediatric populations (122 studies), transplant patients (n=44), or others (n=46) (e.g., Africans living in non-African countries), or because only narrative data were provided (n=20). A total 152 articles were therefore reviewed in detail and included in the analysis. The main characteristics of these studies are summarized in Table 1. The inter-rater agreement for inclusion was κ =0.90 and for the quality assessment was κ =0.85.

Study characteristics

Amongst the 152 studies reviewed, 29 were general population studies (Table 2). One-hundred twenty-three studies focused on selected groups, of which 42 included HIV patients (Table 3), 18 studied diabetic patients (Table 4), nine included hypertensive subjects (Table 5) and twelve were conducted in other populations (Table 6), including one study in lupus patients¹⁹, one study in rheumatoid arthritis patients ²⁰, one study among sickle cell anemia patients ²¹, two in specific occupational settings (silica exposure²² and exposure to the nephrotoxic hair-dye, paraphenylenediamine²³) and seven studies in family practice²⁴⁻²⁶ or hospital-based²⁷⁻³⁰ surveys. Forty-two studies conducted among CKD patients (S2 Table)³¹⁻⁷².

The studies that were included covered all regions of Africa. The highest number of the studies came from the Western macro-area (n=54), followed by the Eastern macro-area (n=32), Southern macro-area (n=25). Twenty studies were retrieved from the Northern Africa, eight studies from each of the Central macro-area and the Central-Western macro- area. Three studies were conducted

in both the Eastern and Southern regions and two studies in the Sub-Saharan region.

Assessment of kidney function impairment

Urinary markers for kidney disease were assessed in seventy-eight (71%) among one-hundred ten studies conducted in the general population, high risk groups, occupational or hospital-based studies. Proteinuria was assessed by a semi-quantitative method (urinary strips) in twenty-eight studies²¹, 24, 26, 29, 73-96. Twenty studies used dipstick with confirmation by quantitative methods, nine of which used dipsticks to identify proteinuria/albuminuria with confirmation by 24-hour proteinuria²⁵, 97-104 whereas eleven studies used dipstick with confirmation by the protein-to-creatinine ratio or albumin-to-creatinine ratio¹⁰⁵⁻¹¹⁵. Quantitative methods for the assessment of proteinuria/albuminuria (24-hour proteinuria or albuminuria, PCR, immunoassay, or ACR) were applied in twenty-nine studies ¹⁹, 27, 28, 30, 116-140. In one study, the method of proteinuria assessment was not mentioned¹⁴¹.

Serum creatinine was measured in ninety-five studies (86%). The Jaffe assay was used in thirty studies²⁹ ,30 ,76 ,80 ,82 ,83 ,86 ,90 ,95 ,97 ,102 ,105 ,111 ,113 ,124 ,126 ,130 ,131 ,136 ,142-152 whereas the IDMS-calibrated method was used in fifteen studies ¹² ,14 ,21 ,26 ,115 ,117 ,132-134 ,141 ,153-157. In nine studies, both the Jaffe assay and the calibrated serum creatinine were used ¹³ ,20 ,25 ,91 ,98 ,99 ,106 ,112 ,158. In the remaining forty-one studies provided no information on the method of creatinine measurement ¹⁹ ,24 ,27 ,28 ,78 ,79 ,81 ,84 ,85 ,87-89 ,93 ,94 ,96 ,100 ,101 ,104 ,109 ,114 ,116 ,118-122 ,125 ,127 ,135 ,137-139 ,159-167. With respect to the formula used for estimating GFR, the MDRD equation was used in thirty studies ²⁴⁻²⁶ ,28 ,29 ,94-97 ,105 ,106 ,111 ,113 ,116 ,117 ,121 ,122 ,126 ,130 ,133 ,134 ,136 ,141 ,146 ,149 ,153 ,154 ,158 ,159 ,164 and the CG equation was used in eighteen ¹⁹ ,76 ,81 ,86-88 ,93 ,100 ,102 ,114 ,119 ,124 ,138 ,143 ,145 ,150 ,162 ,167. The other fourteen studies used both the CG and the MDRD equations ⁷⁸⁻⁸⁰ ,83-85 ,98 ,99 ,101 ,144 ,147 ,152 ,161 ,163 , whereas fifteen studies estimated GFR by the CG, MDRD, and the CKD-EPI methods ¹²⁻¹⁴ ,20 ,82 ,90 ,91 ,109 ,112 ,115 ,139 ,142 ,155 ,156 ,160. Six studies used MDRD and CKD-EPI ¹³¹ ,132 ,137 ,148 ,151 ,157 and two studies used CKD-EPI²¹ ,166. In other two studies the formula was not mentioned ³⁰ ,135

Definition of CKD

Thirty-one studies defined the presence of CKD as an eGFR below 60 ml/min/1.73 m² 12 ,14 ,20 ,80 ,93-96 ,111 ,117 ,119 ,139 ,146 ,148-159 ,161-164 ,166 ,167 , with chronicity confirmed by repeated testing in four other studies 142-145. Moreover, twenty-eight studies reported CKD prevalence based on eGFR below 60 ml/min/1.73 m² and/or the presence of proteinuria or albuminuria 121 ,24 ,26 ,76 ,78 ,82-84 ,86 ,91 ,99 ,100 ,105 ,106 ,109 ,112-114 ,121 ,130-137 ,141. Proteinuria/albuminuria was used alone to identify CKD in fourteen studies 73-75 ,77 ,87 ,92 ,107 ,108 ,110 ,123 ,128 ,129 ,138 ,140. KDOQI staging 168 of CKD was used in thirteen studies 13 ,25 ,29 ,79 ,85 ,90 ,97 ,98 ,115 ,116 ,122 ,124 ,126 . The serum creatinine level (either doubling, or an increase above a certain threshold) was considered to be a marker of the presence of CKD in four studies 9 ,104 ,120 ,165. In sixteen studies, the definition of CKD was either not mentioned or was defined in various ways, including personal history, Creatinine Clearance (CrCl) ≤50 ml/min, clinical manifestations, the presence of albuminuria, elevated serum creatinine, and the average of two measurements of eGFR < 90 ml/min/1.73 m² 19 ,27 ,28 ,30 ,81 ,88 ,101-103 ,118 ,125 ,127 ,147 ,160 ,169 ,170 .

Paper quality

Paper quality was high in sixteen studies ¹³, ²⁵, ⁷⁵, ⁹⁰, ⁹¹, ⁹⁷, ⁹⁸, ¹⁰⁵, ¹⁰⁶, ¹¹², ¹¹⁶, ¹³²⁻¹³⁴, ¹⁴⁸, ¹⁵⁵. Thirty-five studies were of medium quality ¹², ¹⁴, ²⁶, ²⁹, ⁷³, ⁷⁴, ⁷⁷⁻⁷⁹, ⁸¹, ⁸², ⁹⁶, ¹¹⁰, ¹¹¹, ¹¹⁵, ¹¹⁷, ¹²⁸, ¹³⁰, ¹³¹, ¹³⁷, ¹⁴¹, ¹⁴³⁻¹⁴⁵, ¹⁵⁰⁻¹⁵⁰, ¹⁵², ¹⁵⁴, ¹⁵⁷, ¹⁵⁹⁻¹⁶¹, ¹⁶³, ¹⁶⁶, ¹⁶⁷. The rest of the studies were of low quality.

Prevalence of CKD

The included medium/ high quality studies in the general population in Africa provided estimates of CKD prevalence by disparate criteria **Table 2**. The prevalence of CKD ranged from 2% to 41% (pooled prevalence: 10.1%; 95% CI: 9.8%-10.5%). The prevalence was reported to range from 2 % to 41% (pooled estimate 16.5%) in the West/Central-West, followed by the Central region where the prevalence ranged from 12-17 % (pooled estimate 16%), Southern (CKD prevalence range 6% to 29%, pooled estimate 12.2%), in Eastern, prevalence ranged from 7% to 15% (pooled estimate 11.0%), and North where the prevalence ranged from 3-13% (pooled

estimate 4%) Africa (Fig. 2). In Sub-Saharan Africa, the prevalence ranged from 2-14 (Pooled prevalnce: 14.02%;95% CI: 13.5- 14.5 %). In studies defining CKD as eGFR<60 ml/min; the prevalence of CKD ranged from 7%-29% (pooled estimate 13.2%) while in those who adopted the combined criterion GFR<60 ml/min/1.73 m² and/or the presence of proteinuria or albuminuria, the prevalence ranged from 3% to22% (pooled estimate 5.6%.) When defined according to KDOQI, the prevalence ranged from 2% to 28% (pooled estimate 10.8%). Finally, in studies reporting on proteinuria/albuminuria only, the prevalence ranged from 3% to 41% (pooled estimate 18.9%). The CKD prevalence for each age or gender group was not reported in the majority of the studies. In Fig. S1 we show graphically the relationship between gender and age and CKD prevalence in the medium-high quality studies of this systematic review.

Among HIV patients (Table 3), the prevalence of CKD in the eighteen medium quality studies ranged from 1% to 46% (pooled prevalence 5.6%; 95% CI: 5.4-5.8%). The prevalence of CKD in the West/ Central-West ranged from 9% to 39% (pooled estimate 11.6%) and the East, where the prevalence ranged from 1% to 46% (pooled estimate 11.2%), areas had a seemingly similar figures which was higher than in the South (3.5%) macro-areas. Based on the treatment status, the prevalence of renal dysfunction ranged from 1 to 47% (pooled prevalence 9.9%; 95 % CI: 9.4- 10.4%) among HIV patients not receiving treatment while it ranged from 7% to 33% (pooled prevalence: 5.2%; 95 % CI: 5.0-5.4%) among HIV patients on anti-retroviral therapy. The prevalence was reported to be 5.7% (range: 3.1-7.2%) among the 3 studies done in both the East and South macro- areas and 2.5% from the study done in the sub-Saharan area. According to the definition; the prevalence of CKD ranged from 1% to 18% (pooled estimate 4.7%) in studies which defined CKD as eGFR < 60ml/min. In studies which defined CKD as eGFR < 60 ml/min/1.73 m² and/or the presence of proteinuria or albuminuria, the CKD prevalence ranged from 9% to 21% (pooled estimate 5.6%). There are other four studies which defined CKD based on either the presence of proteinuria, KDOQI, CrCl< 50 ml/min, or albuminuria and serum creatinine. In these 4 studies, the prevalence of CKD ranged from 3 % to 46% (pooled estimate 12.6%). The CKD

prevalence for each age or gender group was not reported in the majority of the studies. In **Fig. S1** we show graphically the relationship between gender and age and CKD prevalence among HIV patients in the medium-high quality studies

Among diabetic patients (**Table 4**, all studies are of low quality except for four with medium quality), the prevalence of CKD ranged from 11% to 90% (Pooled prevalence: 24.7%; 95%CI: 23.6-25.7%). The highest prevalence was in the Eastern, ranged from 18% to 84% (pooled estimate 46.9%), followed by the Central where the CKD prevalence ranged from 30 % to 66% (pooled estimate 40.8%). In the West/Central-West, CKD prevalence ranged from 18% to 90% (pooled estimate 27.7%), while in South the CKD prevalence ranged from 18% to 66% (pooled estimate 23.0%), and in North, CKD prevalence ranged from 11% to 20% (pooled estimate 18.9%) Africa. One study was done in sub-Saharan reported that the prevalence was 13%. Among diabetic patients; CKD prevalence ranged from 11% to 83% (pooled estimate 51.8%); when CKD defined as eGFR < 60 ml/min/1.73 m² and/or the presence of proteinuria or albuminuria. When CKD was defined based on proteinuria/albuminuria, CKD prevalence ranged from 26% to 51 % (pooled estimate 36.3%). In diabetic patients who had CKD based on eGFR < 60 ml/min/1.73 m²; the prevalence ranged from 13% to 30% (pooled estimate 16.6%). When KDOQI was used to define CKD, the prevalence of CKD ranged from 19% to 66% (pooled estimate 34.2%). The CKD prevalence for each age or gender group was not reported in the majority of the studies. In Fig. S1 we show graphically the relationship between gender and age and CKD prevalence among diabetic patients in the included studies

The prevalence of CKD among hypertensive patients (**TABLE 5**, 9 studies; all of low quality except for two with medium quality) ranged from 13% to 51% (pooled prevalence: 34.5%; 95 % CI: 34.04%-36%). The highest prevalence was reported from one study in the East macro-area (39.5%) followed by the West/Central-West, where the prevalence ranged from 13% to 51% (pooled estimate 37.7%). In South Africa, the CKD prevalence, which was reported from one study

was 25.4%. No data were found for other African macro-areas. In studies which defined CKD as eGFR < 60 ml/min/1.73 m², the prevalence of CKD ranged from 38.5% to 40% (pooled estimate 38.9%). When serum creatinine was used to define CKD, the prevalence ranged from 30% to 51% (pooled estimate 40.3%). When CKD was defined according to albumnirua/ proteinuria, the prevalence of CKD ranged from 15% to 25% (pooled estimate 23.6%). In one study, CKD was define according to KDOQI criteria and it was prevalent among 47% of hypertensive patients. The CKD prevalence for each age or gender group was not reported in the majority of the studies. In Fig. S1 we show graphically the relationship between gender and age and CKD prevalence among diabetic patients in the included studies

Among other patient populations (studies reported in Table 6), almost three quarters of the lupus patients had CKD (prevalence=72.0%) based on low quality study¹⁹. Hospital-based surveys revealed that (the calculation was based on **the total prevalence** reported from all studies including three of high-medium quality and 4 of low quality in the same table) more than one third of patients attending either primary care centres or tertiary hospitals had CKD (range: 11-57%, pooled prevalence= 36%, 95% CI: 34.4-37.7%). In hospital based studies when CKD was defined as eGFR < 60 ml/min/1.73 m² and/or the presence of proteinuria or albuminuria; the prevalence ranged from 10% to 14% (pooled estimate 12.4%), while the prevalence ranged from 49% to 57% (pooled estimate 45.1%) when CKD defined according KDOQI. Chronic kidney disease was prevalent among almost 39% of rheumatoid arthritis ²⁰or sickle cell patients²¹. The study (low quality) conducted among hairdressers exposed to paraphenylenediamine¹⁰⁴ reported that 26.4% of these subjects had renal impairment. Of note, 100% of silica-exposed workers experienced proteinuria (reported from low quality study)¹²⁹.

Causes of CKD

- 25 Forty-two studies were conducted specifically to clarify the underlying cause of CKD ³¹⁻⁷². (S2
- Table) The diagnosis was biopsy-proven in seventeen studies³³,³⁹,⁴¹,⁴³⁻⁴⁵,⁴⁸,⁵⁴,⁵⁵,⁵⁸,⁶⁰,⁶³,⁶⁷⁻⁷⁰,⁷².

- 1 Vascular/hypertensive sclerosis was the main cause of CKD (16%) followed by diabetic
- 2 nephropathy (15%), chronic glomerulonephritis (13%), tubulo-interstital/obstructive (8%), primary
- 3 glomerular diseases (6%), systemic lupus erythmatosus (3%), and polycystic kidney disease (3%).
- 4 The causes of CKD were undetermined/miscellaneous causes in one fifth of the patients (20%).
- 5 (Fig. 3)

DISCUSSION

- 7 This systematic review focuses on the burden of CKD on the entire African continent. We assessed
- 8 152 papers published between January 1st, 1995 until April 7th, 2017, reporting the epidemiology of
 - CKD in the general population and in specific chronic conditions in Africa. The CKD prevalence
 - reported in our review should be interpreted with caution. Our estimates may be affected by the
- analytical heterogeneity used to measure creatinine and albuminuria. Serum creatinine
- concentrations are affected by intra-individual variability with over 20% changes within a 2-week
 - period¹⁷¹ and most Jaffe assays overestimate serum creatinine¹⁷². The resulting bias could vary
- according to the creatinine concentration, specific assay, manufacturer, and calibration material
 - used. Although the IDMS calibration standardization has reduced the bias and improved the Inter
 - laboratory comparability¹⁷³, the number of studies reported using IDMS was low in Africa.
 - Moreover, CKD prevalence may additionally be influenced by albuminuria assays which are
- affected by the inter laboratory differences ¹⁷⁴. The different equations used to estimate GFR could
- be a source of bias. The systematic underestimation of measured GFR at higher estimated GFR by
- the MDRD equation is well known, and may reflect higher creatinine generation in healthy
- individuals compared with individuals with CKD in whom the MDRD equation was derived. This
- bias is reduced substantially, but not completely, by the CKD-EPI equation, which was derived
- 23 from studies including people without CKD¹⁷⁵. In addition, differences in sample size,
- demographics, and clinical characteristics, are all significant limitations in this systematic review
- for making accurate estimates of the prevalence of CKD in African countries. Age and gender are

well known determinants of the risk of CKD development, progression and complication. While the prevalence of CKD tends to be higher in women, the disease is more severe in men, who also have a higher risk of all-cause and CVD mortality across different levels of renal function. However, the risk relationships of reduced eGFR and higher albuminuria with mortality were steeper in women than in men. Moreover, the risk of progression to ESRD at a given eGFR rate and urinary albumin-creatinine ratio seemed equivalent in men and women¹⁷⁶, 177. The lack of information on the prevalence of CKD by age and gender in studies included in this systematic review, only 11% of the included studies reported CKD prevalence by either age or gender groups, limits the value and the reliability of pooled estimates of CKD prevalence in Africa and in its macro-areas. To circumvent this limitation we showed the prevalence of CKD in the various studies in relationship to the proportion of males and age in the same studies. However the number of studies is too small for reliably capturing the effect of age and gender on CKD prevalence in Africa. Furthermore, only five studies⁷⁹, 142-145 assessed the KDOQI chronicity criterion, which is a fundamental element of the current definition of CKD by this organization. A single elevated serum creatinine, reduced eGFR or an abnormal urinalysis should initially be viewed as a screening test, and the diagnosis of CKD should confirmed with repeated tests, additional workup and clinical judgment¹⁷⁸. Thus, estimates in this review should be seen as a pragmatic attempt to evaluate the dimension of CKD as a public health issue on the African continent. CKD is now considered to be an important component of the epidemic of non-communicable diseases in economically developed and developing countries alike. In a seminal meta-analysis published in 2014 Stanifer et al.,9 for the first time drew attention to the public health relevance of CKD in the sub-Saharan Africa, a vast area comprising 85% (947.4 million) of the whole African population⁹. In the present systematic review, the lowest prevalence of CKD (4%) was reported in the Northern Africa macro-area; including Egypt, Libya, Tunisia, Algeria, Morocco, the Western Sahara, and Mauritania, and the highest (16.5%) was observed in West/ Central-West Africa, which includes Benin, Burkina Faso, the island nation of Cape Verde,

Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mali, Mauritania, Niger, Nigeria, Cameroon, the island of Saint Helena, Senegal, Sierra Leone, São Tomé and Príncipe and Togo. The average prevalence in the entire African continent was 10.1%. The global CKD prevalence was reported to be 13.4% ¹⁷⁹. In sub-Saharan Africa in Stanifer's meta-analysis, the prevalence of CKD was 13.2%, which is close to that reported in the same area in our review (14.02%). Among the general population of economically developed countries, CKD has 13.6% prevalence in the USA¹⁸⁰. In Europe, the reported prevalence is lower and more homogenous, being 8.9% in the Netherlands, 6.8% in Italy, 5.2% in Portugal, 4.7% in Spain, and 3.3% in Norway¹⁸¹. CKD prevalence in some Asian countries was higher than the estimates in the USA and in Europe, being 17.5% in Thailand¹⁸², 15% in India¹⁸³, 13% in Japan¹⁸⁴, 11.9% in Taiwan¹⁸⁵, and 9.9% in China¹⁸⁶. Overall, the estimated prevalence of CKD at the general population level in African countries appears to be comparable and possibly even higher than that reported in other continents. This may be at least in part due to the low quality data for the prevalence of CKD in Africa related to poor sampling techniques, unreliable kidney function measurements, and the different definitions used.

In our review, the prevalence of CKD in surveys based on hospitals or primary care centres (36%) is close to that in Swiss primary care centres (36%) ¹⁸⁷.

Poverty-related factors such as infectious diseases secondary to poor sanitation, inadequate supply of safe water, environmental pollutants and high concentrations of disease transmitting vectors continue to play an important role in the development of CKD in low-income countries. Although rates of diabetic nephropathy are rising, chronic glomerulonephritis and interstitial nephritis are among the principal causes of CKD in many countries ¹⁸⁸.

In Africa, infectious diseases such as HIV, bilharziasis, malaria, hepatitis B and C represent an almost unique cluster of risk factors responsible for CKD¹⁸⁹. HIV/AIDS is pandemic in Africa, with a prevalence ranging from 0.5% in Senegal¹⁹⁰ to 27.4% in Swaziland¹⁹¹. The global success in bringing effective antiretroviral treatment (HAART) to HIV-infected patients in Africa has determined the emergence of chronic medical illnesses such as HIV-related CKD¹⁹². Up to 50% of

kidney diseases in HIV-infected persons result from a wide array of non-HIV-associated nephropathy (HIVAN) pathologies, ranging from glomerulonephritis to diabetic nephropathy ¹⁹³. We found that 5.6% of HIV patients complained of renal dysfunction. This figure is lower than that reported in economically developed countries such as France, USA, China, Spain, and Brazil 194-198. CKD was higher among HIV patients not receiving HAART compared to those on HAART. Variation in the proportion of HIV patients affected by CKD depends on the heterogeneity in the definition used to determine renal dysfunction, the proportion of the study population on HAART, diverse ethnicities, the associated comorbidities, and the nutritional status of the study population. HIV patients are more prone to nutritional deficiencies due to mal-absorption, impaired oral intake, and the wasting syndrome. Increased availability of HAART has led to some improvement of the nutritional status of patients. However, for certain individuals, undernutrition and weight loss persist despite therapy. Malnutrition exacerbates side effects, alters drug pharmacokinetics, and impinges on adherence thereby limiting the beneficial effects of the therapy ¹⁹⁹. Furthermore, differences in HIV clades or strains in African patients²⁰⁰ and genetic factor ²⁰¹ may influence the replication capacities within the isolated renal reservoir and thus lead to a diversity in clinical presentations⁸⁰.

Regarding systemic autoimmune diseases such as lupus, a study conducted among lupus patients from Senegal showed that almost three quarters (71.0%) the patients with this disease had evidence of renal involvement¹⁹. This isolated figure is higher than that reported in other countries²⁰²⁻²⁰⁴. More than one third (39%) patients with rheumatoid arthritis had CKD²⁰ which is higher than that reported from Taiwan ²⁰⁵.

Even though there are no sufficient data to precisely reconstruct historical trends, the profile of CKD causes has changed during the last decades. Interstitial nephritis and glomerulonephritis were the main causes of CKD in North Africa²⁰⁶ and CKD was principally caused by chronic glomerulonephritis and hypertension in East and Tropical Africa²⁰⁷, ²⁰⁸. Today, the spectrum of causes of CKD in Africa is dominated by diabetes mellitus and hypertension ²⁰⁹. We found that the

prevalence of vascular/hypertensive and diabetic nephropathies as a cause of CKD (16% and 15%, respectively) exceeded that caused by chronic glomerulonephritis (13%).

Our review has both strengths and limitations. The major strengths include a thorough systematic search of electronic databases and the inclusion of all comprehensive studies with a transparent assessment of CKD prevalence by two independent reviewers. The fact that our literature search was limited to PubMed and Medline OVID but did not include the African Index Medicus, like it was done by Stanifer in the meta-analysis of CKD in sub-Saharan Africa [8], is a limitation of our study. Because there was a huge discrepancy in the definitions used to identify CKD, the methods of creatinine measurement, urine protein assessment, and in the quality of the reporting, we decided to adopt an inclusive strategy. Our primary interest was to identify all studies conducted among different population groups in Africa providing information on CKD and to reconstruct a tentative scenario of the epidemiological dimension concerning disease in the entire African continent. Methodological limitations notwithstanding this review compiled estimates suggesting that the CKD burden in Africa is at least as concerning as that in economicallydeveloped countries. The lack of a consistent definition of CKD makes it difficult to compare the burden of CKD across studies in various countries. Moreover, the failure to demonstrate chronicity when defining CKD is a common limitation of studies investigating CKD prevalence in Africa. It was reported that a single test in time has an extremely poor positive predictive value for confirmation of CKD compared to repeated testing 3 months later. Failure to repeat testing may lead to a significant overestimation of CKD prevalence and underestimation of the burden of CVD in CKD²¹⁰. In addition, Observational studies are subject to bias and residual confounding which are difficult to account for and there are limitations due to the heterogeneity that arises from differences in age and sex distributions. These poor data quality reported in different studies is considered as a cumbersome problem limiting the accuracy in assessing the burden of CKD in Africa

In conclusion, CKD in Africa appears to be at least as common as in other continents and as such, it constitutes a true public health priority with major cost burden to healthcare systems

worldwide. Targeted screening of high-risk groups (including those with hypertension, diabetes mellitus, HIV patients and persons with occupational exposures) should likely be instituted as the first step in kidney disease prevention whenever and wherever affordable and feasible. Education to increase awareness of CKD among healthcare workers and patients, and the promotion of healthy life styles, should be engrained in preventive programs. The treatment of hypertension and diabetes mellitus are of obvious relevance. Nurses and other health workers should be trained to manage these conditions at the local level if we are to curb the incidence of CKD and to avert the added burden of CKD complications to diabetes, hypertension, and infectious diseases, the deadly trio of risk factors underlying the CKD epidemic in Africa.

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- SA, DB, and CZ: conceptualized and designed the study.
- SA, GD, and ED: participated in revising the articles included in the review and retrieved the
- necessary information.
- DB and GT: supervised the data capture and analysis.
- SA, DB, and GT: analysed and interpreted the data.
- SA, DB, and CZ: drafted and critically revised the manuscript.
- All of the authors read and approved the final manuscript.

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Table 1: Characteristics of the study population included in the analysis

Study population	Number of the studies	Study characteristics
General population	29	N=30169, age ranging from
• •		12 to 95 years; 48% males
Diabetic patients	18	N=9082, age ranging from
		14 to 90 years; 43% males
Hypertensive patients	9	N=4123, age ranging from
		19 to 90 years; 43% males
HIV patients	42	N= 67432, age ranging
		from 13 to 74 years; 36%
		males
Occupational group	2	N= 153, age ranging from
		22 to 59 years; one study
		only enrolled females and
		the other principally
		enrolled males
Family practice patients	7	N= 3250, age ranging from
		20-74 years, 44% males
Lupus patients	1	N= 43, age ranging from 16
		to 55 years, 7% males
Rheumatoid arthritis	1	N=233, age ranging from
		40-70 years, 17.2% males
Sickle cell anemia	1	N=194, age ranging from
		12-40 years, 43.3% males
CKD patients	42	N= 34236, age ranging
		from 12 to 90 years, 58%
		males

Table 2: Studies on CKD among the general population

	ady ID	Year, Country, Region	Locatio n	N	Population Characteristic	Definition of CKD	Method of outcome assessment	Type of creatinine assay	Proteinuria	CKD prevalence	Quality assessme nt
12 S ¹⁶ 13	delsatir 9	2013 Sudan North-east	All village inhabita nts	389	Age (years): 41 ± 15 Male gender: 16.2% Hypertension:39.6%, DM: 17% BMI category: (kg/m²) <18: 6.2%, 18-24.9: 65.8%, 25-29.9: 20.2 %, ≥30: 7.8%	Not identified, personal history	Personal history	Not mentioned	Not measured	Total prevalence (as reported): 6.40%	Low
15 16 17 18 Fat 19 20	tiu A ⁷³	2011 Nigeria West	Market populati on	286	Age (years): 49.5 ± 5.7 Male gender: 9.8% Hypertension: 37.7% BMI (kg/m²): 26.76 ± 5.28 <20 kg/m²: 7.4% 20-25 kg/m²: 33.4% > 25 kg/m²: 59%	Proteinuria ≥ +1	Midstream urine sample was tested by urinary strip	Not measured	29.70%	Total prevalence (based on proteinuria prevalence): 29.7%	Medium
	aore M ⁷⁴	1998 Mali West	All Househo ld populati on of the villages	1098	Age (years): 30±12 Male gender: 52%	Proteinuria ≥ +1	Microhaematuria and proteinuria by urinary strip	Not measured	40.80%	Total prevalence (based on proteinuria prevalence): 40.80%	Medium
22 Tra 24 25 Tra 26 27 Ma 29 30 — 31	atsha T ¹²	2013 South Africa South	Bellville town inhabita nts	1202	Age (years): 52.9 ±14.8 Male gender: 24.7% SBP: 125±20 DBP: 76 ±13 DM: 26.4% BMI: 29.9 ±7.2	eGFR<60 ml/min	4 variables: MDRD, CG, CKD-EPI	Standardized creatinine assay	Not measured	Prevalence of stages 3-5: 7.4% (based on CKD- EPI with ethnicity correction)	Medium
33 34 Sec 35 36 37	ck SM ⁹⁷	2014 Senegal West	Two stage cluster sampling of Urban and rural inhabita nts of Saint- Louis	1037	Age (years): 48.0 ± 16.9 Male gender: 40% Hypertension: 39.1% DM: 12.7% BMI: 26.3 ± 6.8 kg/m ²	KDOQI	Albuminuria by urinary strips. Positive samples were confirmed by 24-hour albuminuria, eGFR by 186 MDRD	Kinetic Jaffe	5.3% albuminuria >1 g/l	Total prevalence: 6.1%	High
38	uijm 16	2008 Seychelles, East	a random sex- stratified and age- stratified	1255	Age (years): range, 25-64 Male gender: 46%	KDOQI	Quantitative microalbuminuria by ACR, eGFR using MDRD	Not mentioned	11.4% microalbuminuria, 0.7% macroalbuminuria	Total prevalence: 15.3% Prevalence of stages 3–4 CKD 3.2%.	High

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; ;			sample inhabita nts of Seychell e								
3 4 5	Sumaili EK ⁹⁸	2009 Congo Central	Multista ge sampling of residents of Kinshasa	500	Age (years): 38.6 ± 14.4 Male gender: 41% Hypertension: 27.6% DM: 11.7% BMI category: 25–29.9 kg/m²: 20.3% ≥30 kg/m²: 14.9%	KDOQI	Proteinuria by urinary strip and 24-hour proteinuria, eGFR by CG and 175MDRD	Kinetic Jaffe and IDMS-calibrated	18% proteinuria by dipstick 5% (≥300 mg/day)	Total prevalence: MDRD 12.4% CG 19% Prevalence by stage (MDRD) Stage 1: 2% Sage 2: 2.4% Stage 3: 7.8% Stage 4:0 Stage 5: 0.2%	High
6 7 8 9 9 1 2 3 4 2 5	Matsha T ¹⁵⁹	2014 South Africa South	All residents of Cape- Town	320	Age (years): mean, 56.4 (55.1–57.6, 95% CI) Male gender: 22% SBP: 124.7 (122.8– 126.7, 95% CI)mmHg DBP: 75.5 (74.2–76.7, 95% CI) mmHg BMI: 31.9 (31.2–32.7, 95% CI) kg/m² Mean eGFR at baseline: 68.6±16.7 ml/min/1.73 m²	eGFR< 60 ml/min/ 1.73 m ²	eGFR- 186MDRD (4 variables)	Not mentioned	Not measured	Total Prevalence 28.9% Prevalence by categories eGFR>90 ml/min/1.73m²:9.4% eGFR60- 90 ml/min/1.73m²: 58.7% eGFR30-60 ml/min/1.73m²: 28.1% eGFR<30 ml/min/1.73m²: 0.9%	Medium
6 7 8 9 0 1 1 2 3	Sumaili EK ⁷⁵	2008 Congo Central	All Resident s of Kinshasa	3018	Age (years): 44.3 ±15.3 Male gender: 59% Hypertension: 18% DM: 4%	Proteinuria ≥ +1	Proteinuria by urinary strip	Not assessed	17.1%	Total prevalence (based on proteinuria prevalence): 17.1% Prevalence by age: 12-21 years: 8.7% 22-31 years: 11.4% 32-41 years: 18.6% 42-51 years: 18.2% 52-61 years: 18.9% 62-71 years: 22.4% ≥ 72 years: 19.7%	High
88	Egbi OG ⁷⁶	2014 Nigeria West	All Civil servants in Bayelsa	179	Age (years): 45.2 ± 10.3 Male gender: 53.1% SBP:128.5±17.5 mmHg DBP: 81.8 ± 13.2 mmHg	eGFR <60 ml/min/1.73 m ² and/or presence of proteinuria of at least +1 on dipstick urinalysis	Proteinuria by urinary strip, eGFR by CG equation standardized for body surface area (BSA)	Kinetic Jaffe	5.6%	Total prevalence: 7.8% Prevalence by stage Stage 1:3.4% Stage 2: 2.2% Stage 3: 2.2% None in stage 4 or 5	Low
.0 1 .2	Oluyombo R ¹⁰⁵	2013 Nigeria West	Multista ge sampling	454	Age (years): 45.8 ± 19.0 Male gender: 43% Hypertension: 20.4%	eGFR <60 ml/min and/or macroalbuminuria (ACR>300 mg/g or	Proteinuria by urinary strip, negative cases were estimated for albumin creatinine ratio, eGFR by 186	Kinetic Jaffe	Macroalbuminuria in 8.9%	Total prevalence: 18.8% Prevalence by stage	High

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4 5 6			of Househo lds of Ilie		DM: 0.6%	dipstick proteinuria)	MDRD			Stage 1: 2.4% Stage 2: 4.1% Stage 3: 11.8% Stage 4: 0.5%	
7 8 9 10 11 12 13 14	J ¹³	2010 Ghana, West	Inhabita nts of 12 villages	944	Age (years): 54.7±11.2 Male gender: 38% SBP:125.5±26.0 mmHg DBP: 74.4 13.6 mmHg DM: 4% BMI: 21.1 ±4.2 kg/m ²	KDOQI	175MDRD, CG, CKD-EPI	Kinetic Jaffe and calibrated IDMS		Total Prevalence (based on CKD-EPI and ethnicity correction): 1.7% MDRD: 1.6% (7.2 % without ethnicity correction; CKD-EPI 1.7% (4.7% without ethnicity correction), CG 21.0%.	High
15 16 17 18 19 20 21	Gouda Z ¹¹⁷	2011 Egypt North	Commu nity based in Al- Buhayra h governor ate	417	Age (years): 39.12 ± 14.29 Male gender: 43.2% Hypertension: 25.20% DM: 10.6% BMI: 29.96 ± 6.18 kg/m ²	eGFR <60 ml/min/1.73 m ²	Quantitative assessment of urinary ACR, eGFR by 175 MDRD	IDMS-calibrated	10.6% microalbuminuria	Total prevalence 18% Prevalence by age: 18–29 years: 0.8% 30–44 years: 6.1% 45–60 years: 19.6% >60 years:40% Prevalence by gender: Females: 9.6% Males: 12%	Medium
22 23 24 25 26 27 28 29 30 31		2011 Nigeria West	People at a major trade center, the public servant secretari at and the state broadcas ting station	586	Age (years): 42.4±11.2 Male gender: 61.4 % Hypertension: 16.4% DM: 3.8% BMI: 25.9±5.4 kg/m ²	proteinuria ≥+1	Proteinuria by urinary strip	Not assessed	2.50%	Total prevalence (based on proteinuria): 2.50% Prevalence by gender: Females: 1.7% Males :3%	Medium
32 33 34 35 36 37 38	Abu-Aisha H ⁷⁸	2009 Sudan East	Pilot survey of police housing complex	273	Age (years): 34.3±12 Male gender: 49.1% Hypertension: 27% DM: 5.1%	eGFR <60 ml/min/1.73 m ² and or proteinuria	Proteinuria by urinary strip, 175MDRD, CG	Not mentioned	5.30%	Total prevalence (MDRD) 7.7% [11% by CG] Prevalence by stage Stage 1 or 2: 4.7% Stage 3:2.6% Stage 4: 0 Stage: 0.4%	Medium
39 40 41	Gharbi M ¹⁰⁶	2012 Morocco North	Stratifie d random sampling	10524	Age (years): range, 25-70 Male gender: (50%), Hypertension: 16.7%	eGFR < 60 ml/ min/1.73 m² or macroalbuminuria or dipstick abnormalities (proteinuria	175 MDRD, microalbuminuria and proteinuria by urinary strip and ACR	Kinetic Jaffe and IDMS	microalbuminuria (30-299 mg/l): 5.26%	Total prevalence 2.90%	High

2 3 4 5 6	
7 8 9 10 11 12 13 14 15 16	CU O ¹⁵³
17 18 19 20	Booysen H ¹⁵⁵
21 22 23 24 25 26 27 28	Kalyesubul a R ⁹⁰
29 30 31 32 33	Kaze F ⁹¹
34 35 36 37 38	Kaze F ¹¹²
39 40	Laurence F ¹³⁰

•											
; ;			of populati on in two towns			≥ ++ 1 or haematuria: ≥ ++1) or diabetes type 1 associated with microalbuminuria					
0 1 2 3 4 5 6	CU O ¹⁵³	2014 Nigeria West	All attendee s to lectures of the Ebreime Foundati on for the elderly,	170	Age (years): 68.1±7.7 Male gender: 67.1%	eGFR<60ml/min/1.73 m ²	175 MDRD	IDMS calibrated		Total prevalence: 43.50%, (all cases were at stage 3) Prevalence by age: ≤ 65 years: 49.1% > 65 years: 40.7% Prevalence by gender: Females: 64% Males: 33%	Low
7 8 9	Booysen H ¹⁵⁵	2016 South Africa South	participa nts from families of black African descent	1221	Age (years):44.1±18.4 Male gender:34.9% BMI (kg/m²):29.5±8.0 Hypertension: 45% Diabetes mellitus:25.2%	eGFR<60ml/min/1.73 m ²	eGFR by CG, 4 variables MDRD, CKD-EPI	IDMS calibrated	Not measured	Total prevalence:6.3%	High
11 22 3 4 5 6 7 8	Kalyesubul a R ⁹⁰	2017 Uganda East	Commu nity based survey among all househol ds of Wakiso district	955	Age (years):31 (IQR: 24–42) Male gender: 33% BMI(kg/m²) categories: Underweight:5.5% Normal: 56.9% Overweight:24.2% obese: 13.4% Diabetics: 5.9%	KDOQI	Proteinuria by dipstick and eGFR by CG, MDRD, and CKD-EPI	Kinetic Jaffe	0.3%	Total prevalence: 15.2% Prevalence by stage: Stage 1: 6.2% Stage 2:12.7% Stage 3:2.4% Stage 4:0 Stage 5: 0.1%	High
9 0 1 2 3	Kaze F ⁹¹	2015 Cameroon Central- West	Populati on of the Littoral region	500	Age (years): 45.3 ± 13.2 Male gender: 53.4% BMI (kg/m²): 27.1 ±5.3 Diabetes mellitus: 2.8% Hypertension: 12.2%	any albuminuria and/or eGFR <60 ml/min/1.73m ²	Albuminuria by dipstick and eGFR by CG, MDRD, CKD-EPI	Kinetic Jaffe and IDMS	7.2%	Total prevalence (CKD-EPI): 10% [14.2% by CG, 11%MDRD] Prevalence by gender: Females: 9.8% Males: 10.1%	High
4 5 6 7 8	Kaze F ¹¹²	2015 Cameroon Central- West	Populati on of the Western Region	439	Age (years):47 ± 16.1 Male gender: 42.1% Hypertension: 10.7% Diabetes mellitus: 5.9%	Albuminuria and/or eGFR <60 ml/min confirmed 3 months later	Albumnuria by dipstick and ACR and eGFR by CG, MDRD, CKD-EPI	Kinetic Jaffe and IDMS	12.1% had albuminuria	Total prevalence (CKD-EPI): 27.6% [38.5% by CG, 27.3%MDRD] Prevalence by gender: Females: 15.4% Males: 10.2%	High
9 0 1 2	Laurence E ¹³⁰	2016 South Africa South	Teachers from public schools	489	Age (years): 46.3 ± 8.5 Male gender: 30% BMI(kg/m²):males: 29.1 ±4.8, females: 32.4.1 ±7.	Proteinuria ≥0.30 mg/mg or eGFR <60 ml/min/1.73 m ²	Proteinuria by PCR and eGFR using MDRD	Kinetic Jaffe	Not mentioned	Total prevalence: 10.4% Prevalence by gender: Females: 10.9% Males:9%	Medium

٥_											
4 5 6 7 8			in in the urban area of the Metro South Educatio		Hypertension: 48.5% Diabetes mellitus: 10.1%						
9			n								
10 11 12 13 14 15 16	Lunyera J ⁹²	2016 Uganda East	District Urban residents of Kampala	141	Age (years): 64% in age group of 18-39 Male gender: 43% BMI(kg/m²): 25.9 (IQR 22.7-30.7) Hypertension: 38% Impaired fasting blood glucose: 13%	Proteinuria as urine protein of ≥1+ on dipstick in the absence of hematuria and leukocyturia	Proteinuria by dipstick	Not measured	13%	Total prevalence(based on proteinuria): 13% Prevalence by age: 18–39 years : 16% 40–59 years : 4% ≥60 years: 0 Prevalence by gender: Females: 11% Males: 15%	Low
18 19 20 21	Mogueo A ¹³¹	2015 South Africa South	Househo ld residents of BellVille	902	Age (years): 55±15 Male gender: 23% BMI(kg/m²): 29.9 ±7.2 Hypertension: 49.8% Diabetes mellitus: 27.9%	eGFR <60 ml/min/1.73 m ² , or any nephropathy	Albuminuria by ACR and eGFR by MDRD and CKD-EPI	Kinetic Jaffe	2.3%	Total prevalence(CKD-EPI): 21.7% [prevalence by MDRD: 29.7%] Prevalence by gender: Females:23.3% Males: 16.6%	Medium
28 29 30 31	Peck R ¹⁴⁸	2016, Tanzania, East	Stratifie d multista ge sampling of adult populati on in Mwanza city, Geita and Kahama	1043	Age (years):35.5 ± 15.3 Male gender: 45.7% BMI(kg/m²) categories: Underweight: 10.5% Normal: 71% Overweight: 11.8% Obese :6.6% Diabetes mellitus: 0.9% Hypertension: 17.3%	eGFR<60 ml/min/1.73 m ²	eGFR by MDRD and CKD-EPI	Kinetic Jaffe	Not measured	Total prevalence)CKD- EPI): 7% Prevalence by age: <25 years: 3.4% 25–34 years: 4.9% 35–44 years: 7.2% ≥45 years: 12.1% Prevalence by gender Females: 6% Males: 7.3%	High
32 33 34 35 36 37	Stanifer J ¹³²	2016, Tanzania, East	stratified , cluster- designed cross- sectional househol d	481	Age (years): 46.9 ± 15.1 Male gender: 74.4% Diabetes mellitus: 9.4% Hypertension: 31%	presence of albuminuria (≥30 mg/dl; confirmed by repeat assessment) and/or a reduction in eGFR ≤60 ml/min/1.73 m ²	Quantitative assessment of albuminuria and eGFR by MDRD and CKD-EPI	IDMS	6.8%	Total prevalence : 11.9%	High
38 39 40 41	Stanifer J ¹³³	2015, Tanzania, East	Randoml y selected adults	481	Age (years): 45 (IQR 35–59) Male gender: 25.6% Diabetes mellitus: 12.7% Hypertension: 28%	eGFR<60 ml/min/1.73m ² and/or persistent albuminuria	Quantitative assessment of albuminuria and eGFR by MDRD	IDMS	Not mentioned	Total prevalence: 7% Prevalence by age: 18–39 years: 7.6% 40–59 years: 5.4% 60+ years: 7.7% Prevalence by gender	High

3											
4 5										Females: 6.2% Males: 7.9%	
6 7 8 9 10 11 12		2016, Tanzania, East	stratified , cluster- designed cross- sectional survey	606	Age (years): 45.5 ±15.5 Male gender: 24.6% Diabetes mellitus: 10.1% Hypertension: 23.7%	the presence of albuminuria (≥30mg/dl confirmed by repeat assessment) and/or a oncemeasured eGFR ≤60 ml/min/1.73m ²	Quantitative assessment of albuminuria and eGFR by MDRD	IDMS	Not mentioned	Total prevalence: 8% Prevalence by age: 18–39 years: 6.4% 40–59 years: 9.3% 60+ years: 10.5 % Prevalence by gender Females: 7.2% Males: 11.4%	High
14 15	Wachukwu C ⁹³	2015, Nigeria, West	Adult voluntee rs in a universit y	259	Age (years):28.3±9.7 Male gender: 52.1% SBP(mmHg):117.3±15.5 DBP(mmHg): 75.7±11.7	eGFR<60 ml/min/1.73m ²	Proteinuria by dipstick and eGFR by CG	Not mentioned	12.4%	Total prevalence: 1.9%	Low

DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault,

CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative

Table 3: Studies on CKD among HIV patients

6	Year,	Location					Method of	Creatinine			Quality
8	Country,				Population	Definition of	outcome	assay			assessment
9 Author	Region		N	Study group	characteristics	CKD	assessment		Proteinuria	CKD prevalence	
1 <mark>0</mark>		ART clinic at						Kinetic			Low
12		the regional						Jaffe		Total prevalence	
13		hospital								(CKD-EPI):	
14 15		nospitai								10.2%	
16										HAART naive:	
17											
18										8.7% CG, 9.1%	
20										MDRD, 8.7%	
21										CKD-EPI	
22					N _b					On HAART: 14.5%	
23										CG, 12.6% MDRD,	
25					Age (years):					12.6% CKD-EPI	
26						7 /_					
27					HAART-naïve					Prevalence by	
28					(33.42 ± 0.88) , On					gender:	
30					HAART (36.91 ±					Females: HAART-	
31					0.77)					Naïve (7.5%),	
32				HIV (276	Male gender:					HAART (14%)	
84	2013,			HAART-naïve	HAART-naive	eGFR < 60	CG, 186			Males: HAART-	
3 5	ŕ								37.		
18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 36	Ghana,			patients	(28.3%), On	mL/min/1.73 m ²	MDRD,		Not	Naïve (11.5%),	
3	West		442	166 on HAART)	HAART (22.3%)	for > 3months	CKD-EPI		measured	HAART (8.1%)	
3 <u>8</u> 39	2011,	Three		HIV-infected	Age (years): 36.8	eGFR<60		Kinetic	Not	Total prevalence :	Medium
4 Qtöhr W ¹⁴³	Uganda,	centeres in	3316	patients initiating	(32-42.2)	ml/min/1.73 m ²	CG	Jaffe	measured	7.2%	
41 42											

3											
1	Zimbabwe,	Uganda and		ART	Male gender: 35%	on ≥ 2					
4 5 6 7 8 9	East and	Zimbabwe			SBP: median:110	consecutive visits					
7	South				(IQR:100-120)	80 days apart or					
8					mmHg	confirmed 25%					
10					DBP: median:70	decrease if eGFR					
11					(60-80) mmHg	<60 ml/min/1.73					
12 13					BMI: 21.1 (19.1–	m ² at baseline					
14					23.6) kg/m ²						
15 16		Three			Age (years): 36.8			Kinetic			Medium
17		centeres in			(32-42.2)			Jaffe			1/10414111
18					Male gender: 35%			Jane			
20		Uganda and			_						
21		Zimbabwe			SBP: median:110						
22					(IQR:100-120)						
23					mmHg						
24 25					DBP: median:70	eGFR<60 ml/min					
26					(60-80) mmHg	1.73 m^2 on ≥ 2					
27					BMI categories:	consecutive					
28 29											
30					<18.5 kg/m ² : 18%	occasions >80					
31	2008,				$18.5 - < 25 \text{ kg/m}^2$:	days apart or					
\$2 50	Uganda,				66%	confirmed 25%					
83 84	Zimbabwe,				25-<30 kg/m ² :	decrease if eGFR				Total prevalence (
3 5	East and			HIV-infected	12%	<60 ml/min/1.73	186 MDRD,		Not	MDRD):3.1%,	
18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 töhr W ¹⁴⁴	South		3316	patients on ART	$\geq 30 \text{ kg/m}^2 : 4\%$	m ² at baseline	CG		measured	CG 7.4%	
38	2011,	Outpatients		HIV-infected	Age (years): 40.1		Proteinuria	Not		Total prevalence	Medium
38 39 46 ^{ailhol J 79}	Burundi,	HIV clinic	300	patients	(33-46.5) Male	KDOQI	by urinary	mentioned	6.10%	(MDRD): 45.7%	
41		I							<u> </u>		

}										29	9
	East				gender:29.7%		strip, CG,			GG: 46.5%	
					Hypertension:		186MDRD			Prevalence by	
					2.7%					Stages (using	
					DM: 2%					MDRD)	
)					BMI: median: 21.8					Stage 1: 30.2%	
1					(19.3-24.2) kg/m ²					Stage 2:13.5%	
2 3					, , , ,					Stage 3: 2%	
4										Stage 4 & 5: no	
5										patients	
6 7										patients	_
_		Outpatient			Age (years): 40.0			Not			Low
9		HIV clinic			± 10.7			measured			
U 1					Male gender:						
2					27.8%						
3					Hypertension:	ŀ					
4 5					46.8%.						
6					DM: 1.7%	Proteinuria≥ +1	Proteinuria			Total prevalence	
7	2014,				BMI: 22.3 ± 3.8	by urinary strip or	by urinary			(based on	
8 a											
0	Congo,			HIV-infected	kg/m2	albuminuria ≥30	strip and		Proteinuria	proteinuria): 41.3	
8 9 0 1 2 3 4 5 6 7 8 9 0 Masimango MI ¹⁰⁷	Central		235	patients		mg/dl	ACR		≥+1: 41.3%	%	
2		Three		HIV-infected,	age(years): 36.8	eGFR<60 ml/min		Kinetic			Medium
4	2008,	centeres in		ART-naive	(IQR: 32.0–42.2)	1.73 m^2 on ≥ 2		Jaffe			
2 3 4 5 6 7 8 9 Reid A ¹⁴⁵	Uganda,	Uganda and		adults with	male gender: 35%	consecutive					
6 7	Zimbabwe,	Zimbabwe		CD4+ cell	SBP: median:110	occasions >80				Total prevalence:	
, B	East and			counts of<200	(IQR: 100-120)	days apart or			Not	7%	
9 D.: J. A 145			2216				CC			,,,,	
Keia A	South		3316	cells/mm3	mmHg	confirmed 25%	CG		measured		

3				1				-		50	
4					DBP: median:70	decrease if eGFR					
					(IQR: 60-80)	<60 ml/min/1.73					
7					mmHg	m ² at baseline					
В					BMI: median, 21.1						
9 10					(IQR:19.1–23.6)						
10 11											
12					kg/m ²						
13		HIV			Age (years): 37			Not			Low
14 15		outpatient			(range 16–70			measured			
16		clinic at			years)					Total prevalence (
17		Johannesburg			Male gender: 38%	Proteinuria ≥ +1	Proteinuria			based on	
18 19	2009, South	Hospital		HIV-infected	DM: 4.6% among	by urinary strip or	by urinary			proteinuria	
20		Поэрна			_				42.70/ 1 1	Î	
20 21	Africa,			naïve ART	group with	albuminuria ≥30	strip and		43.7% had	prevalence):	
2⊉abian J ¹⁰⁸	South		578	patients	microalbuminuria	mg/dl	PCR		proteinuria	43.7%	
23 24		All						IDMS-			Medium
25		consenting						calibrated			
26		individuals			Age (years): HIV-						
27 ho		residing in			ve, 28 (IQR: 24-						
29				1202 HIV-	35), HIV+ve: 30						
80		every									
81		household in		infected patients	(IQR: 25–36)					Total prevalence	
β2 R3	2010,	50 Rakai		and 664 HIV -ve	Male gender: HIV-					among HIV+ve :	
34	Uganda,	District		age- and sex-	ve: (38.7%),	eGFR<			Not	0.7%	
5 5ucas G ¹⁵⁴	East	communities	1960	matched controls	HIV+ve (36.4%)	60ml/min/1.73 m ²	MDRD		measured		
B6		Primary		HIV-infected	Age (years): 30		CG,186	Not		Total prevalence	Medium
23 24 25 26 27 28 29 30 31 32 33 34 35_ucas G ¹⁵⁴ 36 37 38	20111					C=C1 <50 ···1/···			Not	•	
89 <u> </u>	2011, sub-	health care		patients before	(IQR: 27–35)	CrCl <50 ml/min	MDRD,	mentioned	Not	(CKD-EPI with	
	Saharan,	units	2495	ART	Male gender: 30%		CKD-EPI		measured	coefficient for	
11	1	1		I	L	1	l	l	l		

3											•
4					BMI:22.8 (IQR:					black race): 2.5%	
5					20.4–25.6) kg/m ²					CG: 3.4%	
5 6 7 8 9										(MDRD with	
8										coefficient for	
10										black race): 2.5%	
11		0,								Prevalence by age:	
12 13		OA								<30 years: 29.8%	
14										30-39 years:57.1%	
15 16										≥ 40 years: 13.1%	
17										Prevalence by	
18 19				CA						gender:	
20										Females: 66.7%	
<u>21</u> 22		Consecutive			Age (years): 43 ±			Kinetic		Total prevalence :	Low
23		HIV patients			9		proteinuria	Jaffe and		20.5%	
24 25		from clinic			Male gender: 23%	eGFR< 60	by dipstick	IDMS		3% of the patients	
2 6				HIV-infected	Hypertension:	ml/min/1.73 m ² /	and 24-hour			had eGFR< 60	
27 28	2012,			(ART	13%	or proteinuria	proteinuria,			ml/min/1.73 m ² by	
29	Congo,			treated=264)	BMI:24 ± 5	defined as 1+ or	eGFR by			MDRD	
20 21 22 23 24 25 26 27 28 29 30 3 † ongo A ⁹⁹ 32 33 34 35 36 37 38 39 40 40 41	Central		300	(ART naïve =36)	(kg/m ²	greater	MDRD, CG		20.50%		
8 2		HIV clinic		, ,		eGFR <60		Not			Low
3 3		THY CHINC					Proteinuria				Low
84 55					Age (years): 38	ml/min/1.73 m ² ;	by urinary	mentioned			
86					(32-45)	or proteinuria	strip, ACR,				
\$ 7	2013,			HIV-infected	Male gender: 33%	≥+ 1	PCR, eGFR				
38 80	Ghana,			patients starting	BMI: 20.3 (IQR:	(confirmed by	by CG,			Total prevalence	
40 c 5109			2125				-			_	
Sarto F ¹⁰²	West		3137	ART	17.6-22.7) kg/m ²	uPCR > 45	MDRD,			(CKD-EPI):13.8%	
42											

3												
1							mg/mmol)	CKD-EPI				
		Electronic							Not			Medium
7												
В		medical							mentioned			
		records of									Total prevalence	
10		patients from									(MDRD): 9.4%	
11 12	2011,	18 sites			Age (yea	rs): 35.5					CG: 20.2%	
13	Cameroon,	throughout			(29.3-44.0))					Prevalence by	
14	Central-	Western		HIV patients	Male	gender:	eGFR<60				gender;	
15 169 upta S ¹⁶¹	West	Kenya	7383	without ART	26.9%	_	ml/min/1.73 m ²	CG, MDRD			Females: 79.1%	
17								,	***			_
18 19		Ambulatory			Age (yea	rs): 38.84			Kinetic			Low
19		Treatment			(IQR:	33.18-			Jaffe			
20		Center			46.23)							
21					Male	gender:						
23						gender.						
24					33.9%							
25	2013,				BMI: 20	31 (IQR:					Total prevalence	
20 21 22 23 24 25 26	Congo,			Newly diagnosed	17.97-22.	89)	eGFR< 60			Not	:8.5%	
2 8 kat MH ¹⁴⁶	Central		562	HIV patients	kg/m²		ml/min/1.73m ²	186MDRD		measured		
29		Academic							Kinetic			Low
30		Model for the			Age (yea	ra): 25 0						
82									assay			
33 3		Prevention			(range, 19	9–60)		proteinuria				
B4		and			Male	gender:		by urinary				
35 86		Treatment of			32.1%			strip, CG,				
B7		HIV/AIDS		HIV-infected	SBP:	104.7		full and		6.2%		
29 80 81 82 83 84 85 86 87 88	2007,	(AMPATH)		patients naive to	(range,	80–140)	CrCl<60	abbreviated		(proteinuria	Total prevalence	
39 40 Wools-Kaloustian K ⁸⁰	Kenya, East	clinic	373	ART	mm/Hg		ml/min/1.73 m ²	MDRD		≥1+)	:11.50%	

									33
		HIV/AIDS			Age (years): 34.6		Not		Medium
		outpatient			± 9.4		mentione	d	
		clinic			Male gender:				
					48.5%				
)					Hypertension:		Proteinuria	38%	
					13.2%	albuminuria +1	or	proteinuria	
<u>}</u>		0/			BMI categories:	on at least two	albuminuria	with	
ļ					<19.0 kg/m ² : 59.2	occasions (4	by urinary	dipstick	Total prevalence
					%	weeks apart) and	strip and 24	21.9%	:38.8 %
7	2008,	4			19-25 kg/m ² :	or serum	hours	nephrotic	Among patients;
3	Nigeria,			HIV-infected	37.5%	creatinine >1.5	proteinuria ,	range	8.8% had CrCl <15
Emem C ⁸¹	West		400	patients	>25 kg/m ² : 3.3%	mg/dl	CG	proteinuria	ml/min.
	West	Cit	400	patrents	Age (years): 34	mg/ui		protemana	Medium
3		Community					Kinetic		Medium
1		based			(IQR: 30–39) HIV		Jaffe		
5					+ve/43 (IQR:34-				
7					50) HIV -ve				Total prevalence
3					Male gender: 0				among HIV
)					Hypertension:				+ve:9%
1					HIV+ve: 4.8%/				2.7% had eGFR<
2					HIV-ve: 8.3%		proteinuria		60 ml/min/1.73 m ²
1					BMI (kg/m^2) :		by urinary	(9% among	CKD prevalence
5					HIV+ve: 20.9	eGFR<60	strip, eGFR	HIV +	among HIV-ve:
7	2011,			677 HIV-	(IQR: 19.0–23.3)/	ml/min/1.73 m ² /	by MDRD,	and7.2%	7.2%
1	Rwanda,			infected and 214	HIV-ve: 20.5	or proteinuria +1	CKD-EPI,	among non-	1.5% had eGFR<
4			891	HIV-uninfected	(IQR: 18.5–23.3)	or greater	CG	infected)	60 ml/min/1.73 m ²

		HIV clinic of				The presence of		Kinetic			Low
		Yaoundé				proteinuria +1 or		Jaffe			
		general				more and eGFR<	Proteinuria			Total prevalence	
	2013,	hospital		All newly		60 ml/min based	by urinary			:36%	
0	Cameroon,			diagnosed HIV-	Age (years):	on the average of	strip, eGFR			Among patients;	
1	Central -			infected patients	35±10.7	eGFR by 2	by CG, 175			3% had eGFR< 60	
B olefackKaze F ⁸³	West	U A	104	naïve to HAART	Male gender: 32%	equations	MDRD		36%	ml/min/1,73 m ²	
4 5		ART clinic in				any proteinuria		Not			Low
5		a central				(≥+1);		mentioned			
7		hospital in				heavy proteinuria					
3		Malawi		CVA		(≥+2); any					
)						proteinuria (≥+1)					
						with renal					
3				•							
1						dysfunction (e					
5						GFR <60					
7						ml/min/1.73 m ²)					
3						and heavy					
9						proteinuria (≥+2)					
) 1					Age (years): 34.3	with renal					
2					± 9.3;	dysfunction (CrCl				Total prevalence:	
3					Male gender:	< 60 mL/minute)	Proteinuria			23.3%	
1 5				Commonstive	Č	ŕ					
5				Consecutive	43.5%	and	by urinary			Among patients	
7	2011,			newly referred	Hypertension:	the absence of	strip, eGFR			with proteinuria;	
8	Malawi,			HIV-infected	11.2%	any alternative	by CG and			5.3% had CrCl<	
Struik G ⁸⁴	East		526	patients on ART	DM: 0.8%	cause for renal	MDRD		23.3%	60 ml/minute	

										35	5
						dysfunction or					
						proteinuria.					
		National					Serum	Not			Low
									Duotoimumio		
		Central					creatinine	mentioned	Proteinuria		
0		hospital			Age(years): 22±4	Proteinuria > 0.5	measurement		>0.5 g/24		
2	1998,			HIV-infected	Male gender: 68 %	g/24 hrs and	and 24-hour		hrs in	Total	
3ttolou V ¹¹⁸	Benin, West		92	patients		SCr>14 mg/l	proteinuria		23.33%	prevalence:27.16%	
4 		infections						Not known		Total prevalence	Low
6		unit of the								among AIDS	
7		Jos								group:51.80%	
8	2003,			Consecutive 70							
9 0	,	University		Consecutive 79						•	
1	Nigeria,	Teaching		AIDS patients					25% (AIDS	among control	
⊉ gaba EI ¹⁷⁰	West	Hospital	126	and 57 controls	A)	Not known	Not known		group)	group: 12.2%	
3 4		Outpatient					Proteinuria	Not			Low
5		clinics				CrCl < 60	by urinary	mentioned		Total prevalence :	
6						ml/min.	strip and 24-			45.9%	
0 1 2 gaba EI ¹⁷⁰ 3 4 5 6 7 8 9 0 † ana GT ¹⁰⁰ 2 3 4 5 6 7 8 9 0 than TM ¹⁰¹	2011,			HIV-infected		Proteinuria ≥ +1	hour			Among patients;	
9											
0	Zimbabwe,			patients naïve to		and/or PCR > 20	proteinuria,			7.50% had CrCl<	
Fana GT ¹⁰⁰	South		159	ART		mg/mg	eGFR by CG		45.90%	60 ml/min	
2 3		Medical			Age (years):	Microalbuminuria	Proteinuria	Not			Low
4		center			31(range,13-63)	> urinary protein	by urinary	mentioned			
5					Male gender: 25%,	30 and 300 mg/24	strip and 24-				
6	2006, South				Proteinuria -ve:	h.	hour			Total prevalence (
/ 8				HIN							
9	Africa,			HIV patients not	117±14/70±9	A cut-off serum	proteinuria,			based on	
Man TM ¹⁰¹	South		615	on ART	Microalbuminuria:	creatinine level of	CG and		6%	proteinuria): 6%	

<u> </u>										36	
1					121±15/81±10	250 mmol/l was	MDRD				
					Macroalbuminuria:	used to exclude					
7					120±12/74±11	those patients					
3						with advanced					
10						nephropathy					
1	2008,	Home-Based			Age (years): 39			Kinetic			Low
2	Uganda,	AIDS Care		HIV patients	(median)	CrCl of 25-50	CG, 175	Jaffe	Not	Total prevalence:	
4 Peters P ¹⁴⁷	East		508	starting HAART	Male gender: 41%	ml/min	MDRD		measured	20%	
6		Clinics			Age (years):			Not			Medium
7					HIV+ve (27 (IQR:			measured		Total prevalence	
8 9	2011,			C/A	24- 31)),		Proteinuria		HIV+ve:	among HIV+ve (
	Cameroon,			199 HIV +ve and	HIV-ve (27 (IQR:		by urinary		39.2%	based on	
21 22	Central-			190 HIV -ve	22 -31))	Proteinuria (PCR	strip and		HIV-ve:	proteinuria):	
20 21 22 23 _{Jao J} ¹¹⁰ 24 25 26 27 28 29 30 31	West		389	pregnant women	Male gender: 0	> 200 mg/g)	PCR		20.9%	39.2%	
24 25		Outpatient					Proteinuria	Not			Low
26		clinics					and	mentioned			
27 28					Age (years): 36.1		albuminuria				
29					±7.9		by urinary		36%		
30 R1	2011,			HIV-infected	Male gender: 35%		strip eGFR		proteinuria		
32	Tanzania,			patients naïve to	BMI (kg/m ²): 21.3		by CG,		≥	Total prevalence:	
3. ⚠ Sango L ⁸⁵	East		355	ART	±3.8	KDOQI	MDRD		+1	85.6%	
85 86 87		primary		Consecutive 238	Age (years):			Not			Low
36 37	2013, South	healthcare		pregnant women,	pregnant, 28 (IQR:			mentioned		Total prevalence:	
88 89	Africa,	clinic		1014 non-	25–32), men, 37		Absolute Scr		Not	5.8%	
3 9 ֈ ტ ^y yer L ¹⁶²	South		1861	pregnant, 609	(IQR: 32–45),	CrCl< 60ml/min	and CG		measured		
 				<u> </u>	<u> </u>	<u> </u>					

1											
2 3										37	7
4				men; HIV-	women, 33 (IQR:						
				infected patients	28–39)						
5 7				eligible for ART	Male gender: 33%						
3				engible for AKT	Wate gender. 3376						
10		Clinic			Age (years):			Not			Medium
11 12					normal CrCl,			mentioned			
13					33.7±7.9,						
14	2008,			HIV-infected,	decreased CrCl,		Absolute				
15	Zambia,			ART-naïve	38.5±9.9					Total nuovalenas	
6 7		4								Total prevalence	
 18	South			adults initiating	Male gender:		by CG and		Not	(MDRD): 3.2%	
9 Iulenga L ¹⁶³			25249	treatment	39.7%	CrCl< 60 ml/min	MDRD		measured	:	
20 21		The			Age (years): 37.9+			Kinetic			Low
22		University			10.5			Jaffe and			
23		of Ilorin			Male gender:			IDMS			
24		Teaching		Newly diagnosed	42.6%						
25 26						9,					
27	2015,	hospital,		HIV-infected	BMI (kg/m^2) :		Absolute				
28	Nigeria,			ART naïve	20.88+ 3.56	eGFR< 60	Scr, eGFR		Not	Total prevalence:	
20 21 22 23 24 25 26 27 28 29 3dedeji T ¹⁵⁸ 30 81 82 83 84 85 86 87 88 89 40 nyabolu E ¹³⁵	West		183	patients		ml/min/1.73m ²	by MDRD		measured	24%	
31		Federal		393 newly	Age (years); 38.84			Not			Low
32		Medical		diagnosed drug-	± 10.65		Quantitative	mentioned			
B3		Centre		naïve HIV	Male gender: 28%		assessment			Total prevalence	
B5						24 hours				•	
36 36				patients, 136 age	BMI categories:	24-hours urine				among HIV +ve	
B7	2016,			and sex matched	<18.5.0 kg/m ² : 7%	protein ≥0.300 g	protienuira,			patients:22.9%	
88 90	Nigeria,			HIV-	18.5-24.9 kg/m ² :	and/or GFR <60	Scr, and		Not	Prevalence among	
10 nyabolu E ¹³⁵	West		529	seronegative	35%	ml/min	eGFR		mentioned	HIV -ve: 8.1%	
41									l		L

									38	3
				controls	25-29.9 kg/m ² :					
					32%					
					$\geq 30 \text{ kg/m}^2:23\%$					
		Medical Out-			Age (years): 40.3		Kinetic			Low
)		patient			± 10.3		Jaffe			
1										
2		Department			Male gender: 44%					
3		of University			BMI (kg/m ²): 20.5					
4		of Ilorin			± 4.8 among HIV					
5										
5		Teaching			patients , 26.7 \pm					
7		Hospital			5.3 among control					
					group					
))										
					SBP(mmHg):					
					111.9 ± 1 among					
3					HIV patients,	,				
1										
5					126.1 ± 12.0					
					among control					
				227 newly-	group					
3					group					
				diagnosed, ART	DBP(mmHg): 72.9				Total prevalence	
) 				naïve patients	± 9.5 among HIV		Proteinuria		among HIV	
				:41		ماليسنسسنم > 20				
3				with	patients, 80.6 ± 6.8	albuminuria ≥ 30	by dipstick,		patients: 47.6%	
1	2015,			HIV/AIDS,	among control	mg/g and/or	and ACR		The prevalence	
5	Nigeria,			108age and sex	group	eGFR < 60	and eGFR	Not	among HIV -ve:	
3			225		· •					
yokunie D	West		335	matched control		ml/ml/1.73m ²	by MDRD	mentioned	16.7%	
8	2015,	Komfo		HIV patients on	Age(years): 39	Proteinuria or	Proteinuria (Not	37% by	Total prevalence	Low
8 9 ∳hadwick D ¹¹⁴	Ghana,	Anokye	330	ART	(IQR: 35–46)	CrCl<60ml/min	dipsticks, mentioned	dipstick and	(proteinuria) :	

3		I		I .		T .	I nan .	I		[·	
4	West	Teaching			Male gender: 25%		PCR, and		12% by	37%	
		Hospital			BMI(kg/m ²): 22.9		ACR) and		PCR	CrCl<60 ml/min	
7					(IQR: 20.5-26.6)		GFR by CG			among 7%	
9		Two primary			Age (years): HIV			Not			Medium
10		care clinics			+ve: 43 (IQR: 39–			mentioned			
11 12					50), HIV-ve: 49						
13		UA			(IQR:40-56)						
14 15					Male gender: HIV						
16					+ve: 31%, HIV-						
17			De		ve:28.7%						
18 19				CA	Hypertension:						
20					HIV+ve:44%,						
21 22					HIV-ve: 33.2%						
23					Diabetes mellitus:	•					
24 25					HIV +ve: 5% ,					Total prevalence:	
26	2015,			210 HIV+ve	HIV -ve: 15.2%	71.				12.1%	
27 28	Kenya,			patients and			eGFR by		Not	HIV+ve: 17%	
19 20 21 22 23 24 25 26 27 28 29 _{dwards} J ¹⁶⁶	East		2206	1996 HIV –ve		CrCl<60 ml/min	CKD-EPI		measured	HIv-ve: 11%	
80 81		Lighthouse					eGFR by	IDMS			Medium
32		Clinic					CG, MDRD,	calibrated		Total prevalence	
B3 B4							and CKD-	creatinine		among HIV+ve	
B5				116 HIV +ve			EPI with and	and		(creatinine based	
B6	2016,			ART-naïve	Age (years): 31		without	cystatin-C		CKD-EPI):1.9%	
88	Malawi,			patients and 247	(IQR:26-39)	eGFR< 60	correction		Not	,	
2¥dwardsJ ¹⁶⁶ 30 31 32 33 34 35 36 37 38 39 46 ^{0laser} N ¹⁴	East		363	HIV-ve patients	Male gender: 52%	ml/min	factor		measured		
1 1											

										40)
		Lighthouse			Age (years): 34.1		Proteinuria	IDMS			Medium
		Clinic			±10.9		by dipstick	calibrated		Total prevalence :	
					Male gender: 52%		and ACR,	creatinine		13%	
					BMI(kg/m ²):		eGFR by	and		Prevalence among	
	2016,			116 HIV +ve	23.2±4.8		CG, MDRD,	cystatin -C		HIV+ve22%	
<u>.</u>	Malawi,			patients and 247	Hypertension:		and CKD-			Prevalence among	
Glaser N ¹¹⁵	East	0	363	HIV –ve patients	13.5%	KDOQI	EPI		12.1%	HIV-ve: 9%	
		Gugulethu						Not		Total prevalence:	Medium
· 		Community	10					mentioned		2%	
		Health								Prevalence by age:	
		Centre		6 /						<29 years: 17%	
										29–34 years: 28%	
										34-41 years: 5%	
										>41 years: 50%	
•					Age (years): 34					Prevalence by	
, ,	2015, South			HIV infected	(IQR: 29-41)					gender:	
	Africa,			patients initiated	Male gender: 38%	eGFR< 60			Not	Male: 28%	
amkuemah M ¹⁶⁷	South		1092	ART therapy		ml/min	eGFR by CG		measured	Females: 72%	
		Government		HIV patients on				Kinetic			Low
		hospitals		HAART, DOTS	Age (years): 38.04			Jaffe			
	2015,			or on the	± 10.52						
	Cameroon			combined	Male gender:	eGFR <60					
) ,	Central-			therapy	50.5%	ml/min per 1.73	eGFR by		Not	Total prevalence:	
Nsagha D ¹⁴⁹	West		200	(HAART/DOTS)		m ²	MDRD		measured	8%	
Odongo P ⁹⁴	2015,	infectious	361	Newly diagnosed	Age (years): 31.4	eGFR <60	Proteinuria	Not	Proteinuria	Total prevalence:	Low

3										
4	Uganda,	diseases	HIV patients not	± 9.5	ml/min per 1.73	by dipstick	mentioned	≥ +1: 52%	14.4%	
5 6	East	clinic of	receiving ART	Male gender:	m^2	and eGFR			Prevalence by	
7		Gulu		36.3%		by MDRD			gender:	
8 9		Regional		BMI(kg/m ²) <18:					Females: 16.5%	
10		Referral		33%					Males: 10.4%	
11 12		Hospital								
13		University of			eGFR <60		Kinetic			Low
14		Benin			ml/min per 1.73	Quantitative	Jaffe			
15 16		Teaching			m ² and/or	assessment				
17		(
18		Hospital			evidence of	of				
19				Age (years): 36.03	kidney injury as	proteinuria				
20 91	2016,			± 9.08	detected when the	by PCR and				
22	Nigeria,		HIV infected	Male gender: 41%	PCR (mg/g) was	eGFR by		Not	Total prevalence:	
20 21 22 23 kafor U ¹³⁶ 24 25 26 27 28 29 30 31 33 34 35 34 35 36 37 38 39 40 Wensink G ¹³⁷	West		naïve patients		≥200.	MDRD		mentioned	53.5%	
25		Medical in-		Age (years):			IDMS			Low
26 57		patients at		37.0±9.6						
27 28		the Chris		Male gender: 60%						
29	2016, South	Hani		BMI(kg/m ²): 20.9	eGFR <60	eGFR by				
30 81	Africa,	Baragwanath	HIV infected	±5.1	ml/min per 1.73	CG, MDRD,		Not	Total prevalence:	
32 eape T ¹⁵⁶	South	Hospital	100 naïve patients		m ²	CKD-EPI		measured	16%	
84		Rural		Age (years):		Albuminuria	Not		Total prevalence	Medium
\$5		Medical		40(IQR:34-48)		by ACR and	mentioned		(albuminuria):	
3 6	2015, South	Centre		Male gender: 31%	Albuminuria or	eGFR by			21%	
₿/ 88		Contro	HIM (c 1							
39	Africa,		HIV infected	Diabetes mellitus:	eGFR <60	MDRD and			2% had eGFR< 60	
Wensink G ¹³⁷	South		903 adult patients	4%	ml/min / 1.73 m ²	CKD-EPI		21%	ml/min/1.73 m ²	

2 3										42	2
1					Hypertension:						
					23%						
7		Outpatient			Age (years):			IDMS			Medium
3		infectious			37.9±9.4						
0		clinic at an			Male gender:						
2		academic			35.5%						
3		hospital			Diabetes						
4	2016, South			HIV infected	mellitus:2.2%	eGFR <60	eGFR by				
5	Africa,			patients initiating	Hypertension:	ml/min per 1.73	MDRD and		Not	Total prevalence:	
7		((50)			m ²				_	
8	South		650	ART	7.8%	m	CKD-EPI		measured	2 %	
9		Jimma			Age (years):			Kinetic			Medium
20		University			HAART naive:			Jaffe			
2		Specialized			38.25 ±10.8,						
23		Hospital			HAART +ve:	•					
4					35.14 ±9.2						
25						3					
7					Male gender: 37%						
28					BMI(kg/m ²) :						
29					HAART naïve:						
80					20.7±3.2, HAART		77/				
32					+ve: 21.6 ±3.5						
33											
34					Hypertension:						
35				(223 HAART	3.36%						
37	2016,			naïve and 223	Diabetes mellitus:	eGFR <60					
88	Ethiopia,			HAART	21.4%	ml/min per 1.73			Not	Total prevalence:	
39	East		446	experienced)		m ²	eGFR by CG		measured	18.2%	

DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, HAART: highly active antiretroviral therapy, DOTS: directly

observed treatment short course, ART: antiretroviral therapy, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault, CKD-EPI: Chronic Kidney Disease Epidemiology, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative



Table 4: Studies on CKD among diabetic patients

Study ID	Year, Country , Region	Location	N	Study group	Population Characteristics	Definition of CKD	Method of outcome assessment	Creatinin e assay	proteinuria	CKD prevalence	Quality assessment
Janmohamed MN ⁸⁶	2013, Tanzania, East	diabetes mellitus clinic of Bugando Medical Centre in Mwanza		Consecuti ve diabetic patients	Age (years): 54 (IQR: 45-62) Male gender: 46.6% Hypertension: 57.5% BMI (kg/m²): 25.6 (IQR: 22.6-29.6) Duration of DM (years): 6(3-11) 93.8% type 2 DM 6.2% type 1DM	eGFR ≤60 ml/min/1.73 m² or evidence of kidney damage (microalbuminuria or overt proteinuria).	Microalbumin uria, proteinuria by urinary strips, eGFR by CG	Kinetic Jaffe	Overt proteinuria (34.1%), microalbuminuria(45.8%)	Total prevalence:83.7%	Low
Wanjohi FW ⁸⁷	2002, Kenya, East	Outpatient diabetic clinic at Kenyatta National Hospital	100	Type 2 diabetic patients	Age (years): 53.7 ±9.3 Male gender: 37% Hypertension: 50% BMI (kg/m²): 27.8±6.0 Duration of DM (months): 10.3±7.5	Albuminuria > 20 mg/ L	Albuminuria by urinary strip, CG	Not mentioned	26% had albuminuria	Total prevalence(based on albuminuria): 26%	Low

Bouzid C ¹¹⁹	2011, Tunis, North	nutrition	689	diabetic patients from computeri zed hospital	Age (years): 60±11 Male gender: 39% Hypertension: 84.6% (renal insufficiency), 57.2% (no renal disease) Duration of DM (years): 11±8	eGFR<60 ml/min	CG, 24-hour proteinuria	Not mentioned	10.1% macroalbumnuria, 13% microalbuminuria	Total prevalence: 19.8%	Low
Choukem SP ⁸⁸	2012, Cameroon, Central- West	Two main referral centres	420	Consecuti ve type 2 diabetic patients	Age (years): 56.7 ±9.9 Male gender: 49% Hypertension: 50% BMI (kg/m²): 28.5 ±5.2 Duration of DM (years): 4 (IQR: 1-9)	CrCl < 90 ml/min/1.73 m ²	Proteinuria by urinary strip/eGFR by CG	Not mentioned		Total prevalence: 31%	Low
Keeton G ¹²⁰	2004, South Africa, South	Groote Schuur Hospital Outpatients Diabetic Clinic or the Somerset Hospital Outpatients	59	Type 2 diabetic patients	Age (years): 62 ±9.4 Male gender: 36% BMI (kg/m²): (31± 6) Duration of DM (years): 17 (Range: 14-33)	Double Scr level	Proteinuria by PCR, and serum creatinine	Not mentioned		Total prevalence: 66.1%	Low
BouAziz ¹²¹	2012, Tunisia, North	Basic Health Group of Sousse	115	73 type 2 diabetic patients and 42 healthy	Age (mean ±SE in years): 59.3 ±1.1 Male gender: 35% SBP (mean ±SE mmHg): 136.3 ±3.1	ml/min/1.73 m ²	Measurement of microalbuminu ria, eGFR by MDRD	Not mentioned		Total prevalence:	Low

				volunteers	DBP (mean ±SE): 76.8						1
					±1.9						
					BMI (mean ±SE in kg/m ²):						
					30.5± 0.7						
					Duration of DM (years):						
					10.6 ±1						
		Referral		Medical	Age (years): 58 ±10.4		Microalbumin				Low
	2010,	general		records of	Male gender: 35.7%		uria (>20 mg/L				
Katchunga		hospital	98	type 2	Hypertension: 59.2%	KDOQI	and <200	Not		Total prevalence:	
P ¹²²	Congo,		90	diabetic	BMI (kg/m ²): 25.2 ± 4.7	KDOQI	mg/L)	mentioned		66%	
	Central			patients	Duration of DM (years):		eGFR by				
					17.3 ±8.5		MDRD				
		National		Type 1	Age (years): 53.3(range,	101				T	Low
		University		and 2	21-90)					Total prevalence (
Djrolo F ¹²³	2001, Benin,	hospital centre	152	diabetic	Male gender: 65.8%	Presence of proteinuria	24-hour	Not	28%	based on	
	West			patients	Duration of DM (years):		proteinuria	measured		proetinuria level):	
					<1 – 16 or more					28%	
		Tertiary		Randomly							Low
	2011,	hospital		selected	Age (years): 59.4 ± 11.25		Proteinuria by				Low
Balogun		nospitai	40			mot montioned	urinary strip	Jaffe	82.5%	Total prevalence:	
WO ¹⁰²	Nigeria,		40	type 2	Male gender: 37.5%	not mentioned	and 24 hrs,	method	macroalbuminuria	90%	
	West			diabetic	Hypertension: 45%		eGFR by CG				
				patients							
Mafundikwa	2007,	Diabetic clinic	-	Consecuti			Proteinuria by		Overt proteinuria	Total prevalence:	Low
A 103	Zimbabwe,		75	ve Insulin-	No available data	No available data	urinary strips		21%.	33%	
	South			dependent			and 24-hour		Microalbuminuria	/-	
							1				

			diabetic patients			proteinuria		12%.		
Lutale J ¹²⁴	2007, Tanzania, East	Outpatient diabetic clinic	91 Type 1 and 153 type 2 diabetic patients	45% type 1 DM 55% type 2DM Age (years): type 1, 21(14– 44.8), type 2, 53 (23.5–85) Male gender: 55% hypertension: 42% BMI (kg/m²): 19.3 ± 3.8 (type 1), 27.8 ± 4.8 (type 2) Duration of DM (years): 3(Range: 0-25)	KDOQI	Quantitative assessment of albuminuria, CrCl by CG	Kinetic Jaffe	Type 1: microalbuminuria was 12.1% and macroalbuminuria 1.1%. Type 2: microalbuminuria 9.8% Macroalbuminuria 7.2%	Total prevalence: 18.5% 4.6% of Type 1 patients and 22% of Type 2 had eGFR < 60 ml/min/1.73 m ²	Low
Gill G ¹²⁵	2008, Ethiopia, East	Diabetic clinic at Mekelle Hospital	All diabetic patients	Age (years): 41±16 Male gender: 70% Hypertension: 5% BMI (kg/m²): 20.6±5.4 Duration of DM (years): 7±6	Nephropathy was considered present if the urinary ACR was >25.0mg/mmol and retinopathy was present. Microalbuminuria was diagnosed if the ACR was >2.5 and <25.0mg/mmol in men and >3.5 and <25.0mg/mmol in women.	ACR, Scr	Not mentioned	51% microalbuminuria	Total prevalence : 51%,	Low
Makulo R ¹¹¹	2010, Congo, Central	Community based	81 Diabetic and 148 impaired fasting	Age (years): 53.1±16.3 Male gender: 33% SBP (mmHg): 128.0±5.7 DBP (mmHg): 78.5±13.4 BMI (kg/m²): 22.6±5.2	eGFR of <60 mL/min/1.73 m ²	Urinary albumin by urinary strip and ACR, eGFR by	Kinetic Jaffe	29.6%	Total prevalence: 29.6% 10% of the patients had eGFR< 60	Medium

				glucose			186MDRD			ml/min/1.73 m ²	
				patients							
Adebamowo S ¹⁵¹	2016, Nigeria, Ghana, Kenya (sub- Saharan)	University medical centers and surrounding communities	4815	type 2 DM and 2607 controls	Age (years): 48±15 Male gender:41% Hypertension: (68.3% of type 2 DM, and 35.3% of diabetic-free) BMI(kg/m²): 26.9 ± 5.4 (diabetic patients) 25.5 ± 5.7 (non-diabetics)	eGFR of <60 ml/min/1.73 m ²	eGFR by MDRD and CKD-EPI	Kinetic Jaffe	Not measured	Total prevalence (MDRD): 9% 13.4% of type 2DM and 4.8% of diabetic free	Medium
Fetch V ⁹⁵	2016, Cameroon, Central-West	out-patient section of the endocrine unit of the Douala General Hospital	636	Cases of type 2 DM	Age (years): 56.5 ± 10.6 Male gender: 53.1% BMI (kg/m²): 29.3 ± 14.7 Hypertension: 62.2%	eGFR of <60 ml/min/1.73 m ²	Proteinuria by dipsticks and eGFR by 186 MDRD		68.4% among anemic patients , 57.6% non anemic	Total prevalence:	Low
Fiseha T ¹⁵²	2014, Ethiopia, East	Follow-up clinic at Butajira hospital	214	Diabetic patients	Age (years): 45 ± 14.5 Male gender: 57.5% SBP(mmHg): 121 ± 17 DBP(mmHg): 79 ± 10 BMI(kg/m²): 25.26 ± 4.35	eGFR of <60 ml/min/1.73 m ²	eGFR by CG and 186 MDRD	Kinetic Jaffe	Not measured	Total prevalence (MDRD): 18.2% Prevalence (CG):23.8%	Medium
Pillay S ⁹⁶	2016, South Africa,	All patients seen at Edendale	653	Diabetic patients with or	Among diabetic patients with HIV: Age(years): 50-70	eGFR of <60 ml/min/1.73 m ²	Proteinuria by dipstick and eGFR by 186	Kinetic Jaffe	18%	Total prevalence : 18.8%	Medium

	T 0 1	T		La	Tar. 1 200/		1 (DDD	ı			
	South	Hospital		without	Male gender: 32%		MDRD				
		diabetic clinic		HIV (149	Among diabetic patients						
				DM and	without HIV						
				HIV; 504	Age (years): 51-60						
				DM							
				without							
				HIV)	-						
		Outpatient		Diabetic	A						Low
		diabetic clinic		patients	100					Total prevalence(
		of the			Age (years): 54.1±10.9		Albuminuria			based on	
	2007,	department of			Male gender: 28%	microalbuminuria	by urine	Not		microalbuminuria	
Eghan B ¹³⁸	Ghana,	medicine at	109		Hypertension: 39%	if urine albumin excretion was	albumin	mentioned	43.1%): 43.1%	
	West	Komfo			BMI(kg/m ²): 26.3 ± 4.4	30–300 mg/day	excretion and			Prevalence by	
		Anokye					eGFR by CG			gender:	
		Teaching								Males: 31.9%	
		Hospital									

DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault, CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative

Table 5: Studies on CKD among hypertensive patients

Study ID	Year Country Region	Location	N	Study group	Population characteristics	Definition of CKD	Method of outcome assessment	Creatinine assay	Proteinuria	CKD prevalence	Quality assessment
Osafo C ¹²⁶	2011 Ghana, West	four polyclinics	712	Hypertensive patients	Age (years): 59 (range,19–90) Male gender: 21.3% DM: 14.7% SBP (mmHg): 150 (range,100–280) DBP (mmHg): 90 (range, 60–160) BMI (kg/m²): 29.7 (range,12.2–67.4) BMI categories (kg/m²): <25: 22.3% 25-29.9: 26% >30: 45.7%	KDOQI	Proteinuria by PCR (men>0.3 women>0.2 mg/mg) eGFR by MDRD	Kinetic Jaffe	28.90%	Total prevalence: 46.90% Prevalence by stage: Stage 1-2: 19.1% Stage 3-5: 27.8% Prevalence by gender: Females: 46.6% Males: 48%	Low
Ajayi S ¹⁶⁴	2014 Nigeria, West	Tertiary health centre	628	hypertensive and	Age (years): 49.71±13.22 Male gender : 49% DM: 8.6% SBP (mmHg): 135.9 ± 27.4 DBP (mmHg): 87.0 ± 16.3 BMI (kg/m²): 27.8 ± 8.7	eGFR <60 mL/min/1.73 m ²	eGFR by MDRD	Not mentioned	Not measured	Total prevalence: 38.5% Prevalence by age: <20 years:	Low

		department		Hypertensive	000/	Serum creatinine ≥			0.1% 21–40 years: 31.5% 41–60 years: 34.7% 61–75 years: 40% >75 years: 62.9% Prevalence by gender: Females:57% Males: 18.9%	Low
Lengani A ¹²⁷	2000 Burkina Faso West	of Cardiology or Internal medicine	342	patients	Age (years): 50.6 ±13.8 Male gender: 58%	650 μmol/l and or blood urea >=35 mml/l plus long history with clinical manifestations	Measurement of scr, 24-hour proteinuria Not mentioned		Total prevalence: 50.8%	
Nwankwo E ¹⁶⁵	2006 Nigeria West	University of Maiduguri Teaching Hospital	185	All hospitalized hypertensive patients	Age (years): 44.6 ± 14.9 Male gender: 49%	Scr >135 μmol/l	Measurement of Not Scr mentioned	Not measured	Total prevalence: 45.50%	Low
Rayner B ¹²⁸	2006	100 General	1091	Random	Age (years): >=35 years	Albuminuria defined	Quantitative not	21.3%	Total	Medium

	South Africa	practice		hypertensive	Male gender: 48.5%	as (mg/mmol)	assessment of	measured	microalbuminu	prevalence (
	South	centres		patients	BMI: 23.6% of the patients had	microalbuminuria 3-	albuminuria by		ria 4.1%	based on	
					a normal BMI	30	ACR		macroalbumin	albumnuria):	
					41.9% were overweight and 34.2%	macroalbuminuria			uria	25.4%	
					were frankly obese	>30					
	1999	Komfo		Hypertensive	Age (years): 50.5 ±13.0		Proteinuria by			Total	Low
Plange-Rhule		Anokye	448	patients	Male gender: 36%	Plasma creatinine		Not	25 500/		
J 89	Ghana, West	Teaching	448		SBP (mmHg): 165.0 ±27.8	≥140mol/l	urinary strips and serum creatinine	mentioned	25.50%	prevalence: 30.2%	
	West	Hospital			DBP (mmHg): 101.9 ±17.9		serum creatinine			30.2%	
		seven		Hypertensive	60	Persistent				Total	Medium
		central		patients	Age (years): 50.4 ± 6.6	proteinuria on				prevalence:	
		government			Male gender: 64%	Urinalysis in the				13.4%	
Addo J ¹⁴¹	2009	ministries in	219		SBP (mmHg):156.0 ±21.5	absence of urinary	Proteinuria and	Enzymatic	13.4%		
Addo J	Ghana , West	Accra	219		DBP (mmHg): 95 ±13	tract infection	eGFR by MDRD	assessment	13.4%	4.1% had eGFR< 60	
					BMI (kg/m ²): 27.5 ± 5.4	and/or impaired					
						GFR<60 ml/min/				ml/min/1.73	
						1.73 m ²				m ²	
		Komfo		180 non-diabetic	Age (years): 22-87					Total	Low
		Anokye		hypertensive	Male gender:37%					prevalence	
		Teaching		patients and 61	SBP (mmHg): hypertensive patients(on		Urine albumin			(CKD-EPI):	
Aryee C ¹³⁹	2016, Ghana,	Hospital and	242	age matched	antihypertensive therapy:155.46±1.82,	eGFR <60	excretion, and eGFR	Not	30%	14.5%	
Alyee C	West	the	242	controls	no antihypertensive therapy:152±3.27),	ml/min/1.73m ²	by CG , 186 MDRD,	mentioned	3 U70	Prevalence by	
		surrounding			control (117.38±0.96)		and CKD-EPI			MDRD:13.3%	
		community			DBP (mmHg): hypertensive patients(Prevalence by	
					on antihypertensive					CG:16.6%	

			out nations			therapy:101.46±0.94, no antihypertensive therapy: 100.50±1.34), control (73.28±0.77) BMI (kg/m²): hypertensive patients(on antihypertensive therapy:29.52±0.39, no antihypertensive therapy: 29.8±0.71), control (29.36±0.65)				Tatal	Low
			out- patient		Newly diagnosed		Microalbumnuria as a			Total	Low
		2015	hypertension		eligible black	Age (years): 54.3 ± 6.2	random urine albumin	Quantitative	Not	prevalence (
Nab	baale J ¹⁴⁰	Uganda	clinic	256	adult	Male gender: 36.7%		assessment of	39.5%	based on	
		East			hypertensive patients	C/F	level between 30 and 299 mg/dl.	albumin in urine	measured	microalbumin uria): 39.5%	

DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault,

CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative

Table 6: Studies on CKD among other populations

Table 6: Studies on CKD among other populations											
Study ID	Year Country Region	Location	N	Study group	Population Characteristics	Definition of CKD	Method of outcome assessment	Creatinine assay	Proteinuri a	CKD prevalence	Quality assessment
E.F K ¹⁹	2013 Senegal	Nephrology department	43	Lupus patients	Age (years): 32.9 Male gender: 7%	Proteinuria > 0.5 g/ 24 hours with or	24-hour proteinuria and eGFR by CG	Not mentioned	51%	Total prevalence:	Low

	West	of the		Hypertension: 30%	without hematuria/				72%	
		Aristide Le			renal insufficiency/					
		Dantec			abnormal renal					
		University			biopsy					
		Hospital								
		Center.								
		The	Relatives of ESRD						Total	medium
		Nephrology	patients						prevalence	
		department at							57%	
		the Main							Prevalence	
	2009	Alexandria		Age (years): 35.2±11.6					by stage:	
Abd	Egypt	University 400		Male gender: 50.8% Hypertension: 60%	KDOQI	Proteinuria by urinary	Kinetic Jaffe	21.3%	Stage 1: 9%	
ElHafeez S ²⁹	North	hospital		DM: 11.5% BMI(kg/m ²): 28.5±5.89		strips, 186 MDRD			Stage 2:	
									44%	
					1/0				Stage 3: 4%	
					, 6				Stage 4:	
									0.3%	
		Nephrology	(230 first degree relatives							Low
		out-patient	of patients with CKD and	Age (years): 33.49 ± 12.0 BMI(kg/m ²): first degree		4 5				
	2015,	clinic at	230 age- and gender-	relatives: 25.5 ± 5.3 , controls: 23.8 ± 4.0					Total	
Raji Y ²⁸	Nigeria,	Lagos 469	matched controls with no	SBP(mmHg): first degree relatives: 116.5 ± 22.5,	Reduced eGFR	Albumnuria by ACR and		46%	prevalence:	
	West	University	personal or family history	controls: 112.1 ± 18.1 DBP(mmHg): first degree		eGFR by MDRD	mentioned		4%	
		Teaching	of CKD)	relatives: 74.9 ± 12.7 , controls: 71.4 ± 10.5						
		Hospital								
ElSharif M ²⁴	2013	Primary 252	Patients attending the	Age (years): 43.35± 12.80	eGFR of < 60	Proteinuria by urinary	Not	24.21%	Total	Low
	<u> </u>									

	Sudan	health care		primary	Male gender: 16%	mL/min/	strip and eGFR by MDRD	mentioned		prevalence:	
	East			health care facilities	Hypertension: 10%	$1.73 ext{ m}^2 ext{ with or}$				10.32%	
					DM: 5.95%	without proteinuria.					
					BMI (kg/m ²): 28.67 ± 6.43	•					
					BMI categories (kg/m ²):						
					<18: 2.38%						
					>25.13: 71.83						
		Family		Newly registered patients		Persistently					Medium
		practice clinic		who attended the Family		abnormal ACR				Total	Wicdiani
		practice clinic			A > (> 50 52 + 12 02						
				Practice Clinic	Age (years): 50.52 + 13.03	irrespective of GFR				prevalence:	
	2009				Male gender: 27.2%	level or persistent				14.4%	
Mo A ²⁶	Nigeria		250		32% elevated SBP, 30%	eGFR < 60	Proteinuria by urinary		14.4%	10.4% had	
	West				elevated DBP	mL/min/1.73 m ²	strip, eGFR by MDRD	IDMS		persistent	
					DM: 6%	irrespective of the				eGFR< 60	
					Obesity: 32%	presence or absence				ml/min/1.73	
						of Kidney damage				m ²	
						after 3 months					
		Primary and		At risk population						Total prevalence:	High
		secondary		randomly selected						36%	
		health care								Prevalence by stage	
Sumaili	2009 FK				Age (years): 53.9 ± 15.5					stage 1: 4.2%,	
25	Congo		527		Male gender: 43% Hypertension: 58.2%	KDOQI	Proteinuria by urinary strip, 24-hour proteinuria,	Kinetic Jaffe	19%	stage 2:	
	Central				DM: 54.5% Obesity: 16%		175 MDRD			6.1%, stage	
					,					3: 18.3%,	
										stage 4:	
										1.9%, stage	

										5: 5.7%	
Anyabolu E ³⁰	2016, Nigeria, West	Federal Medical Center	36	Subjects from medical out-patient department of the hospital.	Age (years): 38.58±11.79 Male gender: 27.9% BMI(kg/m²): 25.51±6.47	Proteinuria as 24 hours protein ≥ 0.300g and impaired renal filtration function as CrCl <90mls/min	Proteinuria by quantitative assessment and Scr	Kinetic Jaffe	14.1% had proteinuria	Total prevalence: 14.1%	Low
Dessein P ²⁰	2015, South Africa, South	Charlotte Maxeke Johannesburg 2 and Milpark Hospitals	33	African patients with rheumatoid arthritis	Age (years): 57.1±10.8 Male gender: 17.2% BMI(kg/m²): 27.4±6.0 Hypertension: 57.5% Diabetes mellitus: 12.5%	eGFR< 60ml/min/1.73m ²	eGFR by CG, MDRD, CKD-EPI	Kinetic Jaffe and IDMS calibrated	Not measured	Total prevalence: 39%	Low
Ephraim R ²¹	2015, Ghana, West	Tema General Hospital	94	Patients with sickle cell anemia	Age (years): 23.25 ± 12.04 Male gender: 43.3% SBP(mmHg): 110.06 ± 8.27 DBP(mmHg): 67.16 ± 8.23 BMI (kg/m ²): 18.85 ± 11.19	(eGFR < 60 mL/min/ 1.73 m² or evidence of kidney damage as albuminuria, or overt proteinuria	Proteinuria by dipstick and eGFR by CKD-EPI	IDMS	13.4%	39.2%	Low
van Rensburg B	2010 South Africa South	Tertiary hospital	216	New patients referred to the Renal Unit	Age (years): 39.6 ± 15.9 Male gender: 51.1% Hypertension: 13.2% DM: 10.8%	Elevated SCr(>130 μmol/L) and small kidneys on imaging without evidence of reversible causes	•	Not mentioned	16.7% proteinuria >3.5 g/dl	Total prevalence: 37.9%	Low
Hamdouk M ¹⁰⁴	2011 Sudan	hairdressing 7 saloons	2	Hairdressers	Age (years): 40±8 Male gender: 0%	Scr level≥2 mg/dl	Proteinuria by urinary strip and 24 hrs	Not mentioned	26.4% had albuminuri	Total prevalence:	Low

	East				Hypertension: 19.4%		Scr measurement and		a	26.4%	
							renal biopsy			14% had Scr	
										≥2 mg/dl	
		male workers		Male workers attending						Total	Low
		attending the		the out-patient clinic of					93% among	prevalence (
	2003	out-patient		the Health Insurance	Age (years): 39.83±7.27		Assessment of proteinuria		non-silica	among	
EL-Safty I ¹²⁹	Egypt	clinic	81	Organization	Male gender: 100%	Elevated proteinuria	Î	Not measured	exposed	those with	
	North	of the Health		Workers (29 non-	Hypertension: 19.4%		quantitatively		100% silica	Silica	
		Insurance		silicotics, 24					exposed	exposure):	
		Organization		silicotics and 28 referent)						100%	

DM: diabetes mellitus, BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, IDMS: Isotope dilution mass spectrometry, MDRD: Modification of Diet in Renal Disease, CG: Cockroft Gault,

CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration, IQR: inter-quartile range, KDOQI: Kidney Disease Outcome Quality Initiative

Titles and legends

Fig. 1 Flow diagram of the study selection

Fig. 2 Prevalence of CKD among entire general population. Estimates from this figure should be presented with caution as it is bound to be imprecise and inaccurate due to its tentative way of estimation

Fig. 3 Main causes of CKD

Supporting information

S1 Table: Search strategy adopted in PubMed and Ovid MEDLINE

S2 Table: Studies among CKD patients

Fig. S1: The relation between the CKD prevalence with age and gender among general population

and high risk groups (HIV, diabetics, and hypertensive)

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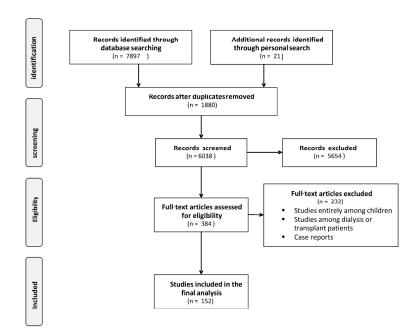


Fig 1

Fig1
254x190mm (300 x 300 DPI)

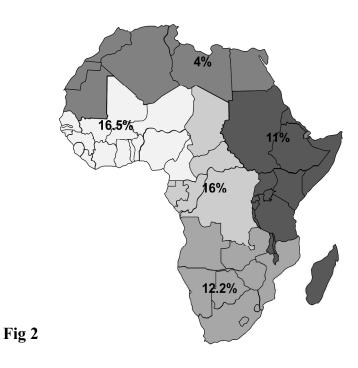


Fig2
254x190mm (300 x 300 DPI)

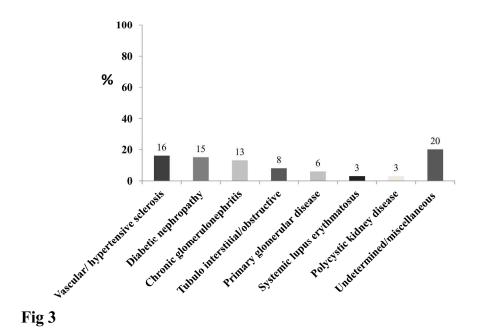


Fig 3
254x190mm (300 x 300 DPI)

S1 Table. Search strategy adopted in PubMed and Ovid MEDLINE

- 1. exp Renal Dialysis/
- 2. (hemodialysis or haemodialysis).tw.
- 3. (hemofiltration or haemofiltration).tw.
- 4. (hemodiafiltration or haemodiafiltration).tw.
- 5. dialysis.tw.
- 6. (CAPD or CCPD or APD).tw.
- 7. Renal Insufficiency/
- 8. Kidney Failure/
- 9. exp Renal Insufficiency, Chronic/
- 10. Kidney Diseases/
- 11. Uremia/
- 12. (end-stage renal or end-stage kidney or endstage renal or endstage kidney).tw.
- 13. (ESRF or ESKF or ESRD or ESKD).tw.
- 14. (chronic kidney or chronic renal).tw.
- 15. (CKF or CKD or CRF or CRD).tw.
- 16. (predialysis or pre-dialysis).tw.
- 17. ur?emi\$.tw.
- 18. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17
- 19. afric\$.ti,ab,kw,tw,mp.
- 20. 18 and 19

S2 Table: Studies among CKD patients

	Year				
	Country	N		biopsy	causes of CKD
Study ID	Region		Population Characteristic		
El Khayat	2013, Morocco, North	134	Age(years): 54.4±18.1 Male gender: 58.65%	no	DN: 44.02% H.scl: 11.2% Tub.int: 9.7% SLE: 5% Ch.GN: 3.7% Undetermined: 26.11%
Seck S ³²	2013, Senegal, West	60	Age (years): 70.5±54.6 Male gender: 52% Hypertension: 20% SBP (mmHg): 167 ± 78 DBP (mmHg): 95 ± 55 DM: 18%	no	H.scl: 30% DN: 25%
Seck S ³³	2008, Senegal, West	118	Age (years): 39.28±16.4 Male gender: 56% SBP (mmHg): 160±15 DBP (mmHg): 90±15	yes	Ch.GN: 35% Vascular nephropathy: 20.2% Tub.int: 12% DN: 10.5% PKD: 4.2% Autoimmune: 4.2% Neoplasm: 1.6% H.scl: 0.8% Undetermined: 11.5%
Bourquia A ³⁴	2002, Morocco, North	420	Age (years): 46±3 Male gender: 52%	no	PKD: 6.5%
Ouattara B ³⁵	2011, Ivory Coast, West	301	Age (years): 44±10 Male gender: 56% Hypertension: 33.5% DM: 12.3%	no	Nephroangiosclerosis:25.2% HIV nephropathy:17% Interstitial nephritis: 10.3% DN: 9.6% Ch.GN: 6.6% PKD:2.3% Undetermined: 29.2%
Lengani A ³⁶	1997, Burkina Faso, West	174	Age (years): 36±15 Male gender: 63% Hypertension: 64.9%	no	Ch.GN: 42.5% Vascular nephropathy: 23.6% Tub.int: 16.1% PKD: 1% Undetermined: 16.8%
Afifi A ³⁷	2005, Egypt, North	220	Not known	no	DN: 28.2% H.scl: 25.5% Obstructive uropathy: 13.5% Cystitis: 6.8% Simple cyst: 4.5% Undetermined: 29.5%
Diouf B ³⁸	2000, Senegal, West	261	Age (years): 44(range:15-88) Male gender: 46%	no	Nephroangiosclerosis: 25% DN: 20.5% Ch.GN: 15% Undetermined: 34%
Niang A ³⁹	2008, Senegal, West	258	Age (years): 28 (range:15-79) Male gender: 75% Hypertension: 12.2%	yes	FSGS: 52% MGN: 12% Minimal change diseases: 7.7%
Sabi K ⁴⁰	2011, Togo, West	398	Age (years): mean: 42.6	not	Ch.GN: 40.2%

			Male gender: 57%	known	Tub.int: 20.9%
			Male gender: 37%	KIIOWII	Nephroangiosclerosis: 17.6%
Ulasi I ⁴¹	2010, Nigeria, West	1538	Age (years): 42.55±15.43 Male gender: 65% Hypertension: 17.2% DM: 11.8%	yes	H.scl: 17.2% Ch.GN:14.6% DN:11.8% Undetermined:51.6% Others: 4.6%
AbdErrahim E ⁴²	2001, Tunis, North	1471	Age (years): 38.3±14.6 Male gender: 69%	no	DN: 20.3%
Abdou N ⁴³	2003, Senegal, West	115	Age (years): 28 (IQR:5-60) Male gender: 56%	yes	FSGS: 46.9% MGN:8.7% Minimal change disease:6.1% Endocapillary GN: 2.6% Mesangioproliferative: 1.7% Extracapillary GN:1.7% IgA nephropathy:1.7% SLE: 13% H.scl: 2% Undetermined: 7% Others:11%
Afifi A ⁴⁴	2004, Egypt, North	3172	Age (years): 56.5±29.2	yes	DN: 14.5%
7111171	2001, 25790, 110101	4905	Age (years): 45.6±14.2 Male gender: 62.4%	yes	H.scl: 28% Ch.GN: 16.2% Obstructive uropathy: 15% DN: 8.9%
Afifi A ⁴⁵	1999, Egypt, North				PKD: 3% Undetermined: 16.2%
Agaba E ⁴⁶	2009, Nigeria, West	130	Age (years): 41±16 Male gender: 68%	no	Ch.GN: 39% H.scl: 34.6% DN: 11.8% PKD: 6.9% Undetermined: 7.7%
Alashek W ⁴⁷	2012, Libya, North	2417	Age (years): 49 (range: 36-61) Male gender: 58%	no	DN: 26.5% Ch.GN: 21.2% H.scl: 14.6% Congenital and hereditary: 12.3% PKD: 6.3% Obstructive uropathy: 5% Chronic pyleonephritis: 2% Interstitial nephritis: 1.2% Autoimmune disease: 0.7% Other: 2.9% undetermined: 7.3%
Alasia D ⁴⁸	2012 , Nigeria, West	320	Age (years): 46.2±17.6 Male gender: 63% SBP (mmHg): 171.2±31.9 DBP(mmHg): 102.5±27.4	yes	Ch.GN: 45.7% H.scl: 29.8% DN: 17.5% PKD: 3% Obstructive uropathy: 2% Undetermined: 2%
Alebiosu C ⁴⁹	2006, Nigeria, West	153	Age (years): 39.6±14.8 Male gender: 59% Hypertension: 38.5% SBP (mmHg): 167.3±15.5 DBP (mmHg): 106±28.9 DM: 13.1%	no	Ch.GN: 41.2% H.scl: 26.1% DN: 13.1%

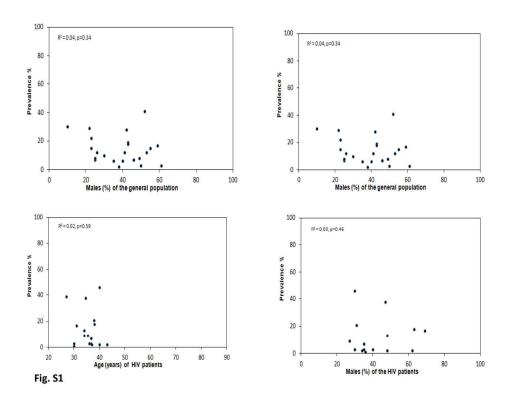
	1		Т	1	
			Age (years): 47.5±15.7		H.scl: 42.8%
			Male gender: 56.2		Ch.GN: 15.9%
			Hypertension: 42.8%		Obstructive uropathy: 14.9%
			DM: 13.4%		DN: 13.4%
		201		no	PKD: 1%
					SLE: 1%
					Sickle cell nephropathy: 1%
	2012, Nigeria,				Analgesic nephropathy: 0.5%
Amira C ⁵⁰	West				Undetermined: 9.5%
7 Hillia C	W CSt		Age(years): 36 (range:15-90)		Ch. GN: 43.7%
			Male gender: 70.3%		H.scl: 31.1%
			Hypertension: 72.4%		
		760			Obstructive uropathy: 6.7% DN: 3.7%
		700	SBP (mmHg): 160	no	
A 1. 1.	2011 N.		(range:120 – 270)		Tub.int: 2.2%
Arogundade F ⁵¹	2011, Nigeria,		DBP (mmHg): 100 (range:50		PKD: 0.7%
F	West		- 209)		Undetermined: 12%
			Age (years): 51.4±18.0		DN: 35%
			Male gender: 56.5%		H.scl: 25.3%
		6397		no	Tub.int: 19.7%
		0377		110	Ch.GN: 13%
4.50					PKD: 2.2%
Counil É ⁵²	2008, Tunis, North				Undetermined:52.8%
			Age (years): Male:		H.scl:52.58%
			50.89±13.43 and Female:		Ch.GN: 17.2%
			48.22±14.70		Tub.int: 17.1%
		116	Male gender: 61.2%		PKD: 4.3%
		116	SBP(mmHg): 153.41±27.12	no	DN: 2.6%
			DBP (mmHg): 93.92±17.19		Chronic pyelonephritis: 2.6%
	2012, Nigeria				Obstructive uropathy:1.7%
Chijioke A ⁵³	,West				Undetermined: 1.9%
,	,		Age (years): 47.1±17.0		H.scl: 75.2%
			Male gender: 45%		DN: 29.8%
			SBP (mmHg): (male) 144.6 ±		HIV nephropathy: 28.6%
	2014, South	302	28.3. (female)141.1 ± 25.5	yes	Ch.GN: 7%
	Africa,		DBP(mmHg): (male)84.2 ±		Tub.int:6%
Madala N ⁵⁴	South		18.1. (female)81.0 ± 19.0		Undetermined: 6%
Triudala 14	South		Age (years): 66.3 ± 5.7		MGN: 14.4%
			Male gender: 47.7%		Mesangioproliferative GN:8.1%
			Hypertension: 71%		Crescentic GN: 7.2%
			DM: 19.8%		
			DIVI. 19.070		Mesangiocapillary GN: 3.6% Post infectious GN: 2.7%
					FSGS:1.8%
					IgAN nephropathy: 0.9%
					DN:12.6%
					Ch.GN: 5.4%
		111		yes	SLE: 4.5%
				"	H.scl: 3.6%
					Amyloidosis: 2.7%
					Myeloma: 2.7%
					Crescentric GN: 1.8%
					HIV nephropathy:0.9%
					Thrombocytopenic purpura:0.9%
					Hemolytic uremic: 0.9%
	2013, South				Tub.int: 17.2%
	Africa,				Miscellaneous: 8.1%
Okpechi I ⁵⁵	South				

Laleye A ⁵⁶	2012, Benin, West	3783	Age (years): 47.2 (range:29 - 70) Male gender: 24% Hypertension: 59%	no	PKD: 1.8%
Okunola Y ⁵⁷	2013, Nigeria, West	300	Age (years): 49 ±16.25 Male gender: 68%	no	H.Scl: 38.8% Ch.GN: 28.8% DN:22.5% PKD:2.7% SLE: 1.1% Undetermined: 6.1%
Bello B ⁵⁸	2013, Nigeria, West	120	Age (years): 47 + 14 Male gender: 60% SBP(mmHg): 162 ± 32 DBP(mmHg): 94.9 ± 19.6	yes	H.scl: 45% Ch.GN: 15.8% DN: 12.5% Obstructive uropathy: 12.5% PKD: 3.3% Ch. Pyelonephritis: 2.5% SLE: 1.7% Analgesic nephropathy: 1.7% Sickle cell nephropathy: 1.7% Toxic nephropathy: 0.8% Undetermined: 2.5%
El-Minshawy O ⁵⁹	2011, Egypt, North	800	Age(years): 46 ± 13 Male gender: 65%	no	H.scl: 20% Obstructive uropathy: 15% Ch.GN: 11% SLE: 9% DN: 8% Analgesic nephropathy: 5% Chronic pyelonephritis: 5% Undetermined: 27%
Okpechi I ⁶⁰	2010, South Africa, South	294	Age (years): 33.9 ± 12.0 Male gender: 45.2% Hypertension:39.8%	yes	Cresentic GN: 5% Ch GN: 15.7% FSGS: 15.7% IgA nephropathy: 1.7% Minimal change disease: 6.6% Mesangiocapillary GN: 19% MGN: 14.9% Mesangial proliferative GN: 12.4% Postinfectious GN: 9% HIV nephropathy: 42.8% SLE: 13.3% DN: 9.2% MGN: 6.9% Ch.GN: 5.85% Mesnagiocapillary: 4.6% Others: 17.4%
Madala N ⁶¹	2012, South Africa, South	148	Age(years): 41.4 ± 13.1 Male gender: 37.2% SBP (mmHg): African (133.6 ± 20.2). Indian (130.1 ± 20.6) DBP (mmHg): African:(133.6 ± 20.2). Indian (130.1 ± 20.6)	no	Ch.GN: 39.2% H.scl: 34.4% DN: 7.4% PKD:6.8% Undetermined: 3.4%
El Farouki M ⁶²	2013, Morocco, North	207	Age (years): 52.43 ± 15.48 Male gender: 64.3% Hypertension: 73.9% DM:41.5%	no	DN: 41.5% Ch.GN: 16% Tub.int: 14% H.scl: 12%

			<u> </u>		PKD: 1%
					Undetermined: 15.5%
			Age (years): 36.8 ±14.0		Mesangiocapillary: 20.4%
			Male gender: 45.2%		Mesangioproliferative:19.2%
			Whate gender: 45.270		MGN:18.5%
					Crescentric GN: 11.4%
					FSGS: 10.5%
					Post infectious: 8.2%
		1284		yes	Minimal change: 6%
		1201		<i>y</i> c _s	IgA nephropathy: 5.8%
					SLE: 19%
					Infection related: 15%
					Vascular causes:9%
62	2011, South				Hereditary: 6%
Okpechi I ⁶³	Africa, South				Undetermined: 3.5%
			Age (years): 47 ± 13		Nephrosclerosis: 40.3%
			Male gender: 55%		Ch.GN: 21%
		62		no	DN: 19.4%
		02		110	PKD: 3.2%
64	2014, Senegal,				Tub.int: 1.6%
Niang A ⁶⁴	West				Undetermined: 14.5%
			Age (years): 47.4±15		DN: 27.4%
			Male gender: 62%		H.scl: 10.5%
					Ch.GN: 8%
					Nephrolithiasis: 7.3%
					Amyloidosis: 6.8%
		124		no	Chronic interstitial nephrtitis: 6.4% PKD: 4%
					Ischemic: 3.2%
					SLE: 0.8%
	2008, Libya,				Familial: 0.8%
Buargub M ⁶⁵	North				Undetermined: 30.6%
	2010, Nigeria,	126	Age (years): 47.4 ± 16.2		
Chijioke A ⁶⁶	West	436	Male gender: 57%	no	PKD: 15.4%
			Age (years): 45.78± 17.16		H.sclerosis: 14.29%
			Male gender: 67.8%		Obstructive uropathy: 11.61%
					Ch.GN: 9.8%
		224		yes	DN: 8.04%
				7	Anaglesic nephropathy: 1.34%
					Renovascular: 0.45%
E1.1 :6.3.67	2011 6 1 5				PKD: 0.9%
Elsharif M ⁶⁷	2011, Sudan, East		007 170		Undetermined: 53.57%
			Age (years): 89% <50 years.		SLE: 24.7%
			8.5% 50–60 years and 3%>		MGN: 10.9%
			50 years		FSGS: 6.8%
			Male gender: 52%		Mesangiocapillary GN: 6.7%
					Acute interstitial nephritis: 6.25%
					Membaranous nephropathy: 5.4%
		437		yes	Crescentric GN: 5.4%
					Chronic interstitial nephrtitis:4.5%
					Minimal change disease: 3.8%
					focal proliferative GN: 3.6%
					Amyloidosis: 2.7%
E11.1 3.68	2012 E - 37 - 1				Nephrosclerosis: 1.13%
Elkhatib M ⁶⁸	2012, Egypt, North		<u> </u>		Undetermined: 3.6%

		924	Age (years): 26.5 ± 14.6 years Male gender: 47%	yes	FSGS: 28.57% mesangioproliferative GN: 20.02% MGN: 14% Minimal change disease: 8.55% Amyloidosis: 5.52% Diffuse proliferative GN: 5.20% Focal proliferative GN: 3.68%
Ibrahim S ⁶⁹	2012, Egypt, North				DN:0.22%
Ayach G ⁷⁰	2011, Morocco, North	386	Age (years): 19 (IQR:12-25) Male gender: 61%	yes	MGN :79.20% FSGS: 9.10% Extramembranous glomerulonephritis:9.10% Renal amyloidosis: 2.6%.
Ramilitiana B ⁷¹	2016, Madagascar, East	239	Age (years): 45.5(range: 16-82) Male gender: 40% Diabetes mellitus: 12.6%	No	Ch.GN: 40.1% H.Scl: 35.6% DN:12.6% Tub.int: 10.46%
Zajjari Y ⁷²	2012, Morocco, North	16	Age (years): 60 (47-79) Male gender: 81.3% Hypertension: 56.3%	Yes	DN: 25%

Tub. Int: tubulo-interstital, DN: diabetic nephropathy, H. Scl: hypertensive sclerosis, Ch. GN: chronic glomerulonephritis, PKD: polycystic kidney disease, DM: diabetes mellitus, SLE: sytemic lupus erthmatosus, FSGS: focal segemental glomerulosclerosis, MGN: membaronus gloemrulonephritis



254x190mm (300 x 300 DPI)



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PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3,4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	N/A
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4,5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4,5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	4, supplementary table 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4,5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	4,5
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	4,5
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	5,6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6



PRISMA 2009 Checklist

2						
3 4 5	Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	6		
6		•	Page 1 of 2			
7 8 9	Section/topic	#	Checklist item	Reported on page #		
10 11 12	Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6		
1:	Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.			
10	RESULTS					
13 18 19	Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	6,7,17, Fig.1		
20 20 20 20 20 20 20	2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Tables(2-4, supplementary table 2) P:19- 51		
20 20 20 20 20 20 20 20 20 20 20 20 20 2	7	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Tables(2-4, supplementary table 2) P:19-51		
30 31	Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	6-11, 18-51		
3	Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A		
3:	Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Tables 2,3 and 4, P: 19- 51		
39		23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A		
4	DISCUSSION					
4; 4; 4;		24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	11		
49	Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified researchies biដូទ្យ://bmjopen.bmj.com/site/about/guidelines.xhtml	12,14, 15		

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PRISMA 2009 Checklist

3 [4	Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	16			
3	FUNDING						
, 3 9	Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	54			

11 From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. 12 doi:10.1371/journal.pmed1000097

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