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TITLE PAGE

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 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)[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) 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

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 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 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 m^2[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 m^2 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 m^2[15, 21, 71, 78, 84-86, 97, 99, 105, 107, 116, 121, 128, 129].

Paper quality

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]. The rest of the studies were of low quality.

Prevalence of CKD

Based on the prevalence of eGFR <60 ml/min/1.73m^2 and/or the presence albuminuria/proteinuria (the current definition of CKD by KDIGO)[127] reported in the 14 medium-high quality studies in **Table 2** the pooled prevalence of CKD in the general population 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% CI: 4.1-4.5%). Based on the treatment status, the prevalence of renal dysfunction was 4.7% (95 % CI: 4.5- 4.9%) among HIV patients not receiving treatment while the prevalence was 6.0% (95 % 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%), 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 medium quality), the pooled prevalence of CKD by the KDIGO definition was 37.7% (95%CI: 35.9-39.6%). The highest prevalence was in the South-East (55.1%), followed by the South (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%-

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 m^2[11, 94, 96, 118, 120, 124]. When CKD was diagnosed based on eGFR below 60 ml/min/1.73 m^2 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 Table) The diagnosis was biopsy-proven in sixteen studies[24, 30, 32, 34-36, 39, 45, 46, 49, 51, 54, 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 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.

AUTHORS' CONTRIBUTIONS:

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.

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 assessment
Abdelsatir S[128]	2013 Sudan North-east	All village inhabitants	389	Age (years): 41 ± 15 Male gender: 16.2% HTN: 39.6%, DM: 17% BMI category: (kg/m^2) <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
Fatiu A[62]	2011 Nigeria West	Market population	286	Age (years): 49.5 ± 5.7 Male gender: 9.8% HTN: 37.7% BMI (kg/m^2): 26.76 ± 5.28 <20 kg/m^2: 7.4% 20-25 kg/m^2: 33.4% > 25 kg/m$^{2:}$; 59%	Proteinuria ≥ +1	Midstream urine sample was tested by urinary strip	Not measured	**29.70%**	**Total prevalence (based on proteinuria prevalence): 29.7%**	Medium
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
Matsha T[11]	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
Seck SM[80]	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
Pruijm M[95]	2007 Seychelles 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

		Seychelle								
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
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/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	**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
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
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
Oluyombo 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%	**Total prevalence**: 18.8% **Prevalence by stage** Stage 1: 2.4% Stage 2: 4.1% Stage 3: 11.8% Stage 4: 0.5%	High
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					**1.7%** 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	Age (years): 39.12 ± 14.29 Male gender: 43.2% HTN: 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
Ayodele OE[66]	2011 Nigeria West	People at a major trade center, the public servant secretariat and the state broadcasting 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 m^2 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

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

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

	South				(IQR:100-120) mmHg DBP: median:70 (60-80) mmHg BMI categories: <18.5 kg/m^2: 18% 18.5- <25 kg/m^2: 66% 25-<30 kg/m^2: 12% ≥ 30 kg/m^2: 4%	decrease if eGFR <60 ml/min/1.73 m^2 at baseline					
Cailhol J [69]	2011, Burundi, Southeast	Outpatients HIV clinic	300	HIV-infected patients	Age (years): 40.1 (33-46.5) Male gender: 9.7% HTN: 2.7% DM: 2% BMI: median: 21.8 (19.3-24.2) kg/m^2	KDIGO	Proteinuria by urinary strip, CG, 186MDRD	Not mentioned	6.10%	**Total prevalence (MDRD): 45.7%** GG: 46.5% **Prevalence by Stages (using MDRD)** Stage 1: 30.2% Stage 2:13.5% Stage 3: 2% Stage 4 & 5: no patients	Low
Masimango MI[90]	2014, Congo, Central	Outpatient HIV clinic	235	HIV-infected patients	Age (years): 40.0 ± 10.7 Male gender: 27.8% HTN: 46.8%. DM: 1.7% BMI: 22.3 ± 3.8 kg/m2	Proteinuria≥ +1 by urinary strip or albuminuria ≥30 mg/dl	Proteinuria by urinary strip and ACR	Not measured	Proteinuria ≥+1: 41.3%	**Total prevalence (based on proteinuria): 41.3 %**	Low
Reid A[114]	2008, Uganda,	Three centeres in	3316	Untreated HIV-infected patients	age(years): 36.8 (IQR: 32.0–42.2) male gender:	eGFR<60 ml/min 1.73 m^2 on ≥2 consecutive	CG	Kinetic Jaffe	Not measured	**Total prevalence : 7%**	Medium

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

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

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

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

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

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

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

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
Janmohamed MN[76]	2013, Tanzania, East	diabetes mellitus clinic of Bugando Medical Centre in Mwanza	369	Consecutive diabetic patients	Age (years): 54 (IQR: 45-62) Male gender: 46.6% HTN: 57.5% BMI (kg/m^2): 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 m^2 or evidence of kidney damage (microalbuminuria or overt proteinuria).	Microalbuminuria, 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	Consecutive type 2 diabetic patients	Age (years): 53.7 ±9.3 Male gender: 37% HTN: 50% BMI (kg/m^2): 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	Endocrinology center at the National Institute of nutrition	689	Type 2 diabetic patients from computerized 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: 19.8%**	Low
Zajjari Y[99]	2012, Morocco, East	Military hospital	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	Consecutive type 2 diabetic patients	Age (years): 56.7 ±9.9 Male gender: 49% HTN: 50% BMI (kg/m^2): 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[100]	2004, South Africa, South	Groote Schuur Hospital Outpatients Diabetic Clinic or the Somerset Hospital	59	Consecutive 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

		Outpatients									
BouAziz[101]	2012, Tunisia, North	Basic Health Group of Sousse	115	73 type 2 diabetic patients and 42 healthy volunteers	Age (mean ±SE in years): 59.3 ±1.1 Male gender: 35% SBP (mean ±SE mmHg): 136.3 ±3.1 DBP (mean ±SE): 76.8 ±1.9 BMI (mean ±SE in kg/m^2): 30.5± 0.7 Duration of DM (years): 10.6 ±1	Microalbuminuria (defined as < 2.8 g/mmol for women and < 2.3 for men) and eGFR≤60 ml/min/1.73 m^2	Measurement of microalbuminuria, eGFR by MDRD	Not mentioned		**Total prevalence: 11%**	Low
Katchunga P[102]	2010, Congo, Central	Referral general hospital	98	Medical records of type 2 diabetic patients	Age (years): 58 ±10.4 Male gender: 35.7% HTN: 59.2% BMI (kg/m^2): 25.2± 4.7 Duration of DM (years): 17.3 ±8.5	KDIGO	Microalbuminuria (>20 mg/L and <200 mg/L) eGFR by MDRD	Not mentioned		**Total prevalence: 66%**	Low
Djrolo F[103]	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[85]	2011, Nigeria,	Tertiary hospital	40	Randomly selected	Age (years): 59.4 ± 11.25 Male gender: 37.5%	not mentioned	Proteinuria by urinary strip	Jaffe method	82.5% macroalbuminuria	**Total prevalence: 90%**	Low

	West			type 2 diabetic patients	HTN: 45%		and 24 hrs, eGFR by CG				
Mafundikwa A [86]	2007, Zimbabwe, South	Diabetic clinic	75	Consecutive Insulin-dependent diabetic patients	No available data	No available data	Proteinuria by urinary strips and 24-hour proteinuria		Overt proteinuria 21%. Microalbuminuria 12%.	**Total prevalence: 33%**	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/m^2): 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/m^2): 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]	2010, Congo, Central	Community based	229 (81 DM, 148 impaired fasting glucose)		Age (years): 53.1±16.3 Male gender: 33% SBP (mmHg): 128.0±5.7 DBP (mmHg): 78.5±13.4 BMI (kg/m^2): 22.6±5.2	eGFR of <60 mL/min/1.73 m^2	Urinary albumin by urinary strip and ACR, eGFR by 186MDRD	Kinetic Jaffe	29.6%	**Total prevalence: 29.6%** 10% of the patients had eGFR< 60 ml/min/1.73 m^2	Medium

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

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 [106]	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/m^2): 29.7 (range,12.2–67.4) BMI categories (kg/m^2): <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 [125]	2014 Nigeria West	Tertiary health centre	628	Records of 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/m^2): 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 ≥ 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[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	Albuminuria defined as (mg/mmol) microalbuminuria 3-30 macroalbuminuria >30	Quantitative assessment of albuminuria by ACR	not measured	21.3% microalbuminuria 4.1% macroalbuminuria	**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/m^2): 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 m^2	Medium

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 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	Proteinuria	CKD prevalence	Quality assessment
E.F K [15]	2013 Senegal West	Nephrology department of the Aristide Le Dantec University Hospital Center.	43	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 hospital	400	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 health care	252	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% DM: 5.95% BMI (kg/m^2): 28.67 ± 6.43 BMI categories (kg/m^2): <18: 2.38% >25.13: 71.83	1.73 m^2 with or without proteinuria.				**10.32%**	
Mo A [20]	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 m^2 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 m^2	Medium
Sumaili EK [19]	2009 Congo Central	Primary and secondary health care	527	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

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	Proteinuria by quantitative assessment and Scr measurement	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 albuminuria	**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	**Total prevalence (among those with Silica exposure): 100%**	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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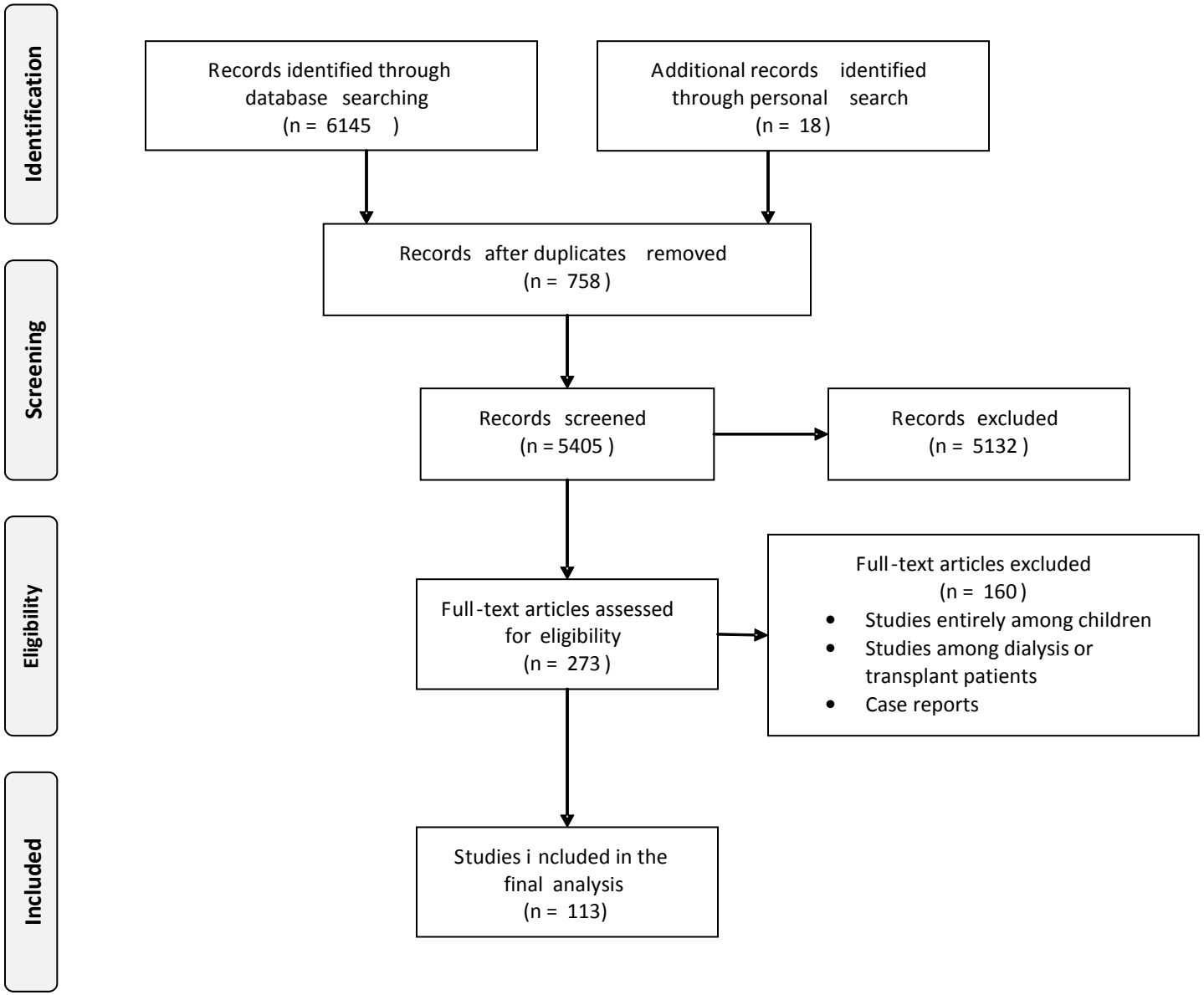

Fig 1

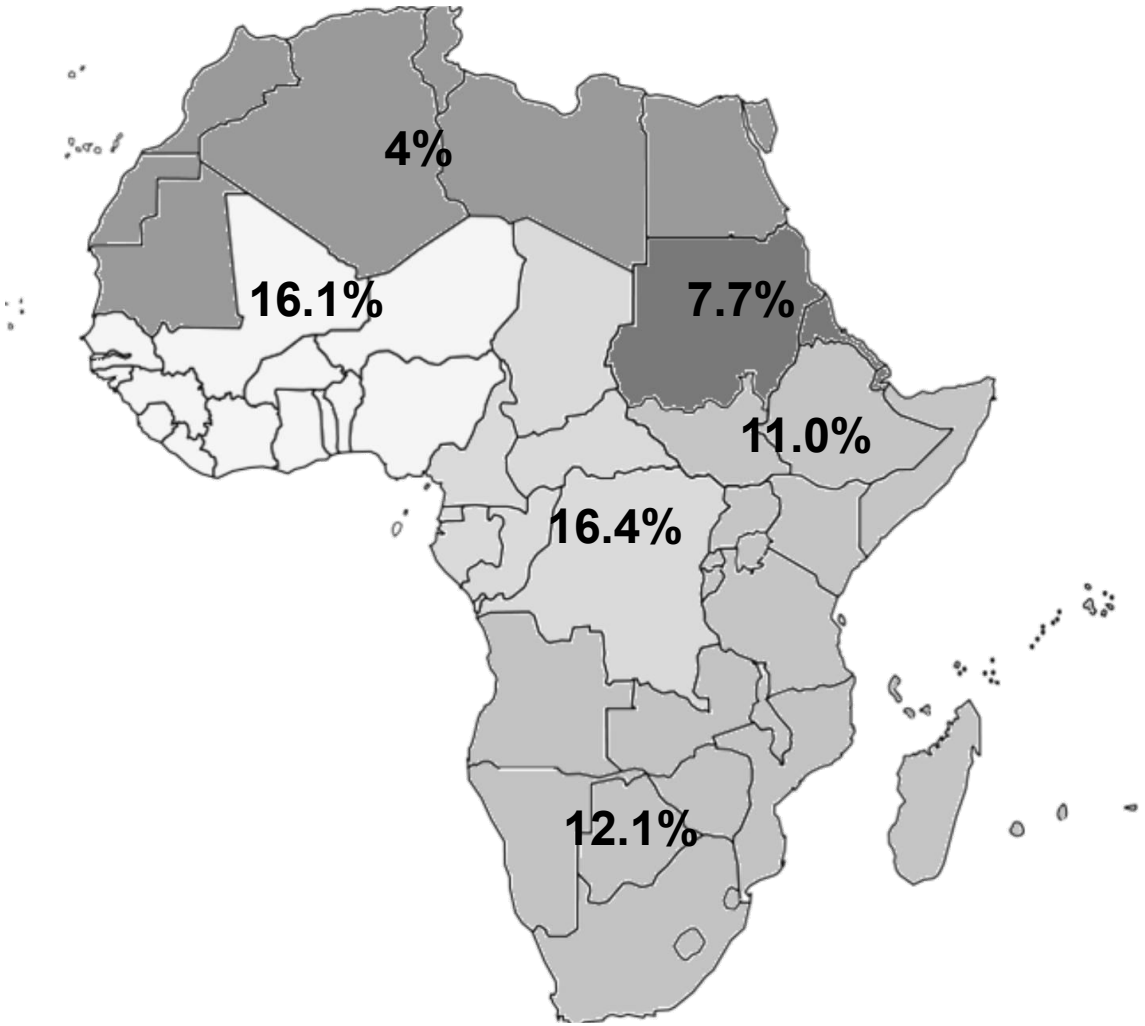

Fig 2

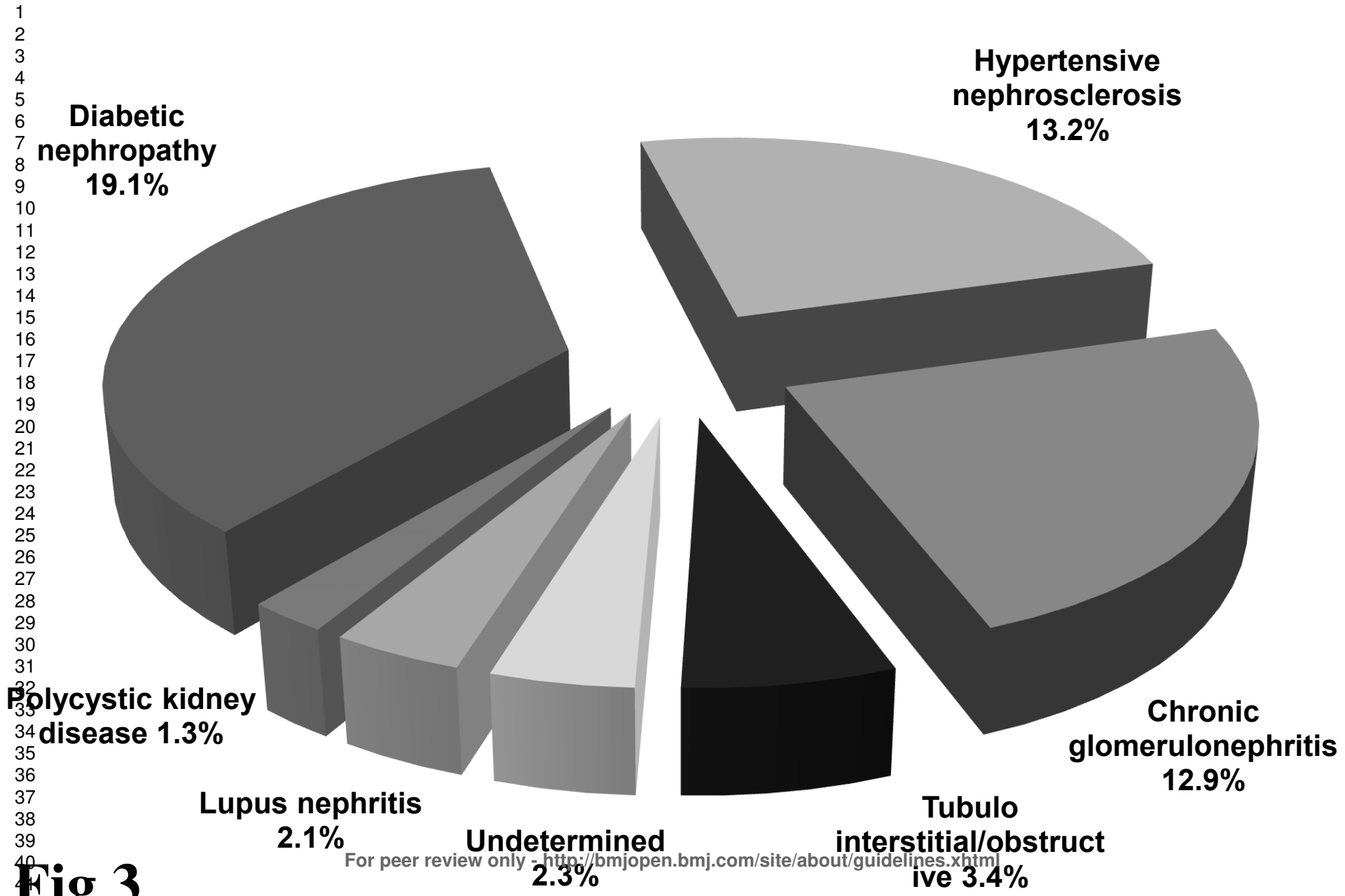

Fig 3

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 [23]	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 O[32]	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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TITLE PAGE

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 high-risk 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 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 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 CKD[8]. 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 factors[9]. 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) Guidelines[11]. 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 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 trials[15], diagnostic studies[16], and observational studies[17]. 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 exposure[22] and exposure to the nephrotoxic hair-dye, paraphenylenediamine[23]) and seven studies in family practice[24-26] or hospital-based[27-30] 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 proteinuria[25,97-104] whereas eleven studies used dipstick with confirmation by the protein-to-creatinine ratio or albumin-to-creatinine ratio[105-115]. 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 studies[29,30,76,80,82,83,86,90,95,97,102,105,111,113,124,126,130,131,136,142-152] 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-EPI[21,166]. 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 m^2 [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 m^2 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 m^2 [2,19,27,28,30,81,88,101-103,118,125,127,147,160,169,170].

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 [12,14,26,29,73,74,77-79,81,82,96,110,111,115,117,128,130,131,137,141,143-145,150-152,154,157,159-161,163,166,167]. The rest of the studies were of low quality.

Prevalence of CKD

Based on the prevalence of eGFR <60 ml/min/1.73m^2 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

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-Saharan area

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 [20]or 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 m^2 [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 m^2 and/or the presence of proteinuria or albuminuria[26 ,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 proteinuria[73-75 ,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 studies[33 ,39 ,41 ,43-45 ,48 ,54 ,55 ,58 ,60 ,63 ,67-70 ,72]. 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 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 period[171] 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 comparability[173], 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 CKD[175]. 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 population[9]. 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 Norway[178]. CKD prevalence in some Asian countries was higher than the estimates in the USA and in Europe, being 17.5% in Thailand[179], 15% in India[180], 13% in Japan[181], 11.9% in Taiwan[182], and 9.9% in China[183]. 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 CKD[186]. HIV/AIDS is pandemic in Africa, with a prevalence ranging from 0.5% in Senegal[187] to 27.4% in Swaziland[188]. 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[189]. 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].

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[191-195]. 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 patients[197] and genetic factor [198] may influence the replication capacities within the isolated renal reservoir and thus lead to a diversity in clinical presentations[80].

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[19]. This isolated figure is higher than that reported in other countries[199-201]. More than one third (39%) patients with rheumatoid arthritis had CKD[20] 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 Africa[203] and CKD was principally caused by chronic glomerulonephritis and hypertension in East and Tropical Africa[204 ,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 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[207]. 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 =32695, 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 assessment
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/m^2) <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
Fatiu A[73]	2011 Nigeria West	Market population	286	Age (years): 49.5 ± 5.7 Male gender: 9.8% Hypertension: 37.7% BMI (kg/m^2): 26.76 ± 5.28 <20 kg/m^2: 7.4% 20-25 kg/m^2: 33.4% > 25 kg/m$^{2:}$; 59%	Proteinuria ≥ +1	Midstream urine sample was tested by urinary strip	Not measured	**29.70%**	**Total prevalence (based on proteinuria prevalence): 29.7%**	Medium
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
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
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 Seychelles, 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

		of Seychelle								
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
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/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	**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
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
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
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%	**Total prevalence**: 18.8% **Prevalence by stage** Stage 1: 2.4% Stage 2: 4.1% Stage 3: 11.8% Stage 4: 0.5%	High
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

				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%.	
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
Ayodele OE[77]	2011 Nigeria West	People at a major trade center, the public servant secretariat and the state broadcasting 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
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
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 m^2 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[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/m^2):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
Kalyesubula 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/m^2) 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 Cameroon Central-West	Population of the Littoral region	500	Age (years): 45.3 ± 13.2 Male gender: 53.4% BMI (kg/m^2): 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 Cameroon 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
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/m^2):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/m^2): 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/m^2): 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

	, East	sampling of adult population in Mwanza city, Geita and Kahama		BMI(kg/m^2) categories: Underweight: 10.5% Normal: 71% Overweight: 11.8% Obese :6.6% Diabetes mellitus: 0.9% Hypertension: 17.3%						
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
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
Stanfier J [134]	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 once-measured eGFR ≤60 ml/min/1.73m^2	Quantitative assessment of albuminuria and eGFR by MDRD	IDMS	Not mentioned	**Total prevalence: 8%**	High
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

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

	East and South	Zimbabwe			SBP: median:110 (IQR:100-120) mmHg DBP: median:70 (60-80) mmHg BMI categories: <18.5 kg/m^2: 18% 18.5- <25 kg/m^2 : 66% 25-<30 kg/m^2 : 12% ≥ 30 kg/m^2: 4%	occasions >80 days apart or confirmed 25% decrease if eGFR <60 ml/min/1.73 m^2 at baseline					
Gailhol J [79]	2011, Burundi, East	Outpatients HIV clinic	300	HIV-infected patients	Age (years): 40.1 (33-46.5) Male gender:29.7% Hypertension: 2.7% DM: 2% BMI: median: 21.8 (19.3-24.2) kg/m^2	KDOQI	Proteinuria by urinary strip, CG, 186MDRD	Not mentioned	6.10%	**Total prevalence (MDRD): 45.7%** GG: 46.5% **Prevalence by Stages (using MDRD)** Stage 1: 30.2% Stage 2:13.5% Stage 3: 2% Stage 4 & 5: no patients	Medium
Masimango MI[107]	2014, Congo,	Outpatient HIV clinic	235	HIV-infected patients	Age (years): 40.0 ± 10.7	Proteinuria≥ +1 by urinary strip or	Proteinuria by urinary	Not measured	Proteinuria ≥+1: 41.3%	**Total prevalence (based on**	Low

	Central				Male gender: 27.8% Hypertension: 46.8%. DM: 1.7% BMI: 22.3 ± 3.8 kg/m2	albuminuria ≥30 mg/dl	strip and ACR			**proteinuria): 41.3 %**	
Reid A[145]	2008, Uganda, Zimbabwe, East and South	Three centeres in Uganda and Zimbabwe	3316	HIV-infected, ART-naive adults with CD4+ cell counts of<200 cells/mm3	age(years): 36.8 (IQR: 32.0–42.2) male gender: 35% SBP: median:110 (IQR: 100-120) mmHg DBP: median:70 (IQR: 60-80) mmHg BMI: median, 21.1 (IQR:19.1–23.6) kg/m^2	eGFR<60 ml/min 1.73 m^2 on ≥2 consecutive occasions >80 days apart or confirmed 25% decrease if eGFR <60 ml/min/1.73 m^2 at baseline	CG	Kinetic Jaffe	Not measured	**Total prevalence : 7%**	Medium
Fabian J[108]	2009, South Africa, South	HIV outpatient clinic at Johannesburg Hospital	578	HIV-infected naïve ART patients	Age (years): 37 (range 16–70 years) Male gender: 38% DM: 4.6% among	Proteinuria ≥ +1 by urinary strip or albuminuria ≥30 mg/dl	Proteinuria by urinary strip and PCR	Not measured	43.7% had proteinuria	**Total prevalence (based on proteinuria prevalence): 43.7%**	Low

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

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

Wools-Kaloustian K[80]	2007, Kenya, East	Academic Model for the Prevention and Treatment of HIV/AIDS (AMPATH) clinic	373	HIV-infected patients naive to ART	Age (years): 35.0 (range, 19–60) Male gender: 32.1% SBP: 104.7 (range, 80–140) mm/Hg	CrCl<60 ml/min/1.73 m^2	proteinuria by urinary strip, CG, full and abbreviated MDRD	Kinetic assay	6.2% (proteinuria ≥1+)	**Total prevalence :11.50%**	Low
Emem C[81]	2008, Nigeria, West	HIV/AIDS outpatient clinic	400	HIV-infected patients	Age (years): 34.6 ± 9.4 Male gender: 48.5% Hypertension: 13.2% BMI categories: <19.0 kg/m^2: 59.2 % 19-25 kg/m^2: 37.5% >25 kg/m^2: 3.3%	albuminuria +1 on at least two occasions (4 weeks apart) and or serum creatinine >1.5 mg/dl	Proteinuria or albuminuria by urinary strip and 24 hours proteinuria , CG	Not mentioned	38% proteinuria with dipstick 21.9% nephrotic range proteinuria	**Total prevalence :38.8 %** Among patients; 8.8% had CrCl <15 ml/min.	Medium
Wyatt C[82]	2011, Rwanda, East	Community based	891	677 HIV-infected and 214 HIV-uninfected	Age (years): 34 (IQR: 30–39) HIV +ve/43 (IQR:34–50) HIV -ve Male gender: 0	eGFR<60 ml/min/1.73 m^2/ or proteinuria +1 or greater	proteinuria by urinary strip, eGFR by MDRD, CKD-EPI,	Kinetic Jaffe	(9% among HIV + and7.2% among non-infected)	**Total prevalence among HIV +ve:9%** 2.7% had eGFR< 60 ml/min/1.73 m^2	Medium

					Hypertension: HIV+ve: 4.8%/ HIV-ve: 8.3% BMI (kg/m^2): HIV+ve: 20.9 (IQR: 19.0–23.3)/ HIV-ve: 20.5 (IQR: 18.5–23.3)		CG			CKD prevalence among HIV-ve: 7.2% 1.5% had eGFR< 60 ml/min/1.73 m^2	
FolefackKaze F[83]	2013, Cameroon, Central – West	HIV clinic of Yaoundé general hospital	104	All newly diagnosed HIV-infected patients naïve to HAART	Age (years): 35±10.7 Male gender: 32%	The presence of proteinuria +1 or more and eGFR< 60 ml/min based on the average of eGFR by 2 equations	Proteinuria by urinary strip, eGFR by CG, 175 MDRD	Kinetic Jaffe	36%	**Total prevalence :36%** Among patients; 3% had eGFR< 60 ml/min/1,73 m^2	Low
Struik G[84]	2011, Malawi, East	ART clinic in a central hospital in Malawi	526	Consecutive newly referred HIV-infected patients on ART	Age (years): 34.3 ± 9.3; Male gender: 43.5% Hypertension: 11.2% DM: 0.8%	any proteinuria (≥+1); heavy proteinuria (≥+2); any proteinuria (≥ +1) with renal dysfunction (e GFR <60 ml/min/1.73 m^2) and heavy	Proteinuria by urinary strip, eGFR by CG and MDRD	Not mentioned	23.3%	**Total prevalence: 23.3% Among patients with proteinuria; 5.3% had CrCl< 60 ml/minute**	Low

						proteinuria (≥+2) with renal dysfunction (CrCl < 60 mL/minute) and the absence of any alternative cause for renal dysfunction or proteinuria.					
Attolou V[118]	1998, Benin, West	National Central hospital	92	HIV-infected patients	Age(years): 22±4 Male gender: 68 %	Proteinuria > 0.5 g/24 hrs and SCr>14 mg/l	Serum creatinine measurement and 24-hour proteinuria	Not mentioned	Proteinuria >0.5 g/24 hrs in 23.33%	**Total prevalence:27.16%**	Low
Agaba EI[170]	2003, Nigeria, West	infections unit of the Jos University Teaching Hospital	126	Consecutive 79 AIDS patients and 57 controls		Not known	Not known	Not known	25% (AIDS group)	**Total prevalence among AIDS group:51.80%** CKD prevalence among control group: 12.2%	Low
Fana GT[100]	2011, Zimbabwe, South	Outpatient clinics	159	HIV-infected patients naïve to ART		CrCl < 60 ml/min. Proteinuria ≥ +1 and/or PCR > 20	Proteinuria by urinary strip and 24-hour	Not mentioned	45.90%	**Total prevalence : 45.9%** Among patients; 7.50% had CrCl<	Low

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

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

Anyabolu E[135]	2016, Nigeria, West	Federal Medical Centre	529	393 newly diagnosed drug-naïve HIV patients, 136 age and sex matched HIV-seronegative controls	Age (years); 38.84 ± 10.65 Male gender: 28% BMI categories: <18.5.0 kg/m^2: 7% 18.5-24.9 kg/m^2: 35% 25-29.9 kg/m^2: 32% ≥ 30 kg/m^2:23%	24-hours urine protein ≥0.300 g and/or GFR <60 ml/min	Quantitative assessment of protienuira, Scr, and eGFR	Not mentioned	Not mentioned	**Total prevalence among HIV +ve patients:22.9%** Prevalence among HIV -ve: 8.1%	Low
Ayokunle D[113]	2015, Nigeria, West	Medical Out-patient Department of University of Ilorin Teaching Hospital	335	227 newly-diagnosed, ART naïve patients with HIV/AIDS, 108age and sex matched control	Age (years): 40.3 ± 10.3 Male gender: 44% BMI (kg/m^2): 20.5 ± 4.8 among HIV patients , 26.7 ± 5.3 among control group SBP(mmHg): 111.9 ± 1 among HIV patients, 126.1 ± 12.0 among control group	albuminuria ≥ 30 mg/g and/or eGFR < 60 ml/ml/1.73m^2	Proteinuria by dipstick, and ACR and eGFR by MDRD	Kinetic Jaffe	Not mentioned	**Total prevalence among HIV patients: 47.6%** The prevalence among HIV –ve: 16.7%	Low

					DBP(mmHg): 72.9 ± 9.5 among HIV patients, 80.6 ± 6.8 among control group						
Ghadwick D[114]	2015, Ghana, West	Komfo Anokye Teaching Hospital	330	HIV patients on ART	Age(years): 39 (IQR: 35–46) Male gender: 25% BMI(kg/m^2): 22.9 (IQR: 20.5-26.6)	Proteinuria or CrCl<60ml/min	Proteinuria (dipsticks, PCR, and ACR) and GFR by CG	Not mentioned	37% by dipstick and 12% by PCR	**Total prevalence (proteinuria) : 37%** CrCl<60 ml/min among 7%	Low
EdwardsJ[166]	2015, Kenya, East	Two primary care clinics	2206	210 HIV+ve patients and 1996 HIV –ve	Age (years): HIV +ve: 43 (IQR: 39–50), HIV-ve: 49 (IQR:40–56) Male gender: HIV +ve: 31%, HIV-ve:28.7% Hypertension: HIV+ve:44%, HIV-ve: 33.2% Diabetes mellitus: HIV +ve: 5% , HIV –ve: 15.2%	CrCl<60 ml/min	eGFR by CKD-EPI	Not mentioned	Not measured	**Total prevalence: 12.1% HIV+ve: 17% HIv-ve: 11%**	Medium

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

Odongo P[94]	2015, Uganda, East	infectious diseases clinic of Gulu Regional Referral Hospital	361	Newly diagnosed HIV patients not receiving ART	Age (years): 31.4 ± 9.5 Male gender: 36.3% BMI(kg/m^2) <18: 33%	eGFR <60 ml/min per 1.73 m^2	Proteinuria by dipstick and eGFR by MDRD	Not mentioned	Proteinuria ≥ +1: 52%	**Total prevalence: 14.4%**	Low
Okafor U[136]	2016, Nigeria, West	University of Benin Teaching Hospital	383	HIV infected naïve patients	Age (years): 36.03 ± 9.08 Male gender: 41%	eGFR <60 ml/min per 1.73 m^2 and/or evidence of kidney injury as detected when the PCR (mg/g) was ≥200.	Quantitative assessment of proteinuria by PCR and eGFR by MDRD	Kinetic Jaffe	Not mentioned	**Total prevalence: 53.5%**	Low
Seape T[156]	2016, South Africa, South	Medical in-patients at the Chris Hani Baragwanath Hospital	100	HIV infected naïve patients	Age (years): 37.0±9.6 Male gender: 60% BMI(kg/m^2): 20.9 ±5.1	eGFR <60 ml/min per 1.73 m^2	eGFR by CG, MDRD, CKD-EPI	IDMS	Not measured	**Total prevalence: 16%**	Low
Wensink G[137]	2015, South Africa, South	Rural Medical Centre	903	HIV infected adult patients	Age (years): 40(IQR:34-48) Male gender: 31% Diabetes mellitus:	Albuminuria or eGFR <60 ml/min / 1.73 m^2	Albuminuria by ACR and eGFR by MDRD and	Not mentioned	21%	**Total prevalence (albuminuria): 21% 2% had eGFR< 60**	Medium

					4% Hypertension: 23%		CKD-EPI			**ml/min/1.73 m^2**	
Zachor H[157]	2016, South Africa, South	Outpatient infectious clinic at an academic hospital	650	HIV infected patients initiating ART	Age (years): 37.9±9.4 Male gender: 35.5% Diabetes mellitus:2.2% Hypertension: 7.8%	eGFR <60 ml/min per 1.73 m^2	eGFR by MDRD and CKD-EPI	IDMS	Not measured	**Total prevalence: 2 %**	Medium
Mekuria Y[150]	2016, Ethiopia, East	Jimma University Specialized Hospital	446	(223 HAART naïve and 223 HAART experienced)	Age (years): HAART naive: 38.25 ±10.8, HAART +ve: 35.14 ±9.2 Male gender: 37% BMI(kg/m^2) : HAART naïve: 20.7±3.2, HAART +ve: 21.6 ±3.5 Hypertension: 3.36% Diabetes mellitus: 21.4%	eGFR <60 ml/min per 1.73 m^2	eGFR by CG	Kinetic Jaffe	Not measured	**Total prevalence: 18.2%**	Medium

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	Creatinine assay	proteinuria	CKD prevalence	Quality assessment
Janmohamed MN[86]	2013, Tanzania, East	diabetes mellitus clinic of Bugando Medical Centre in Mwanza	369	Consecutive diabetic patients	Age (years): 54 (IQR: 45-62) Male gender: 46.6% Hypertension: 57.5% BMI (kg/m^2): 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 m^2 or evidence of kidney damage (microalbuminuria or overt proteinuria).	Microalbuminuria, 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/m^2): 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	Endocrinology center at the National Institute of nutrition	689	Type 2 diabetic patients from computerized 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	Consecutive type 2 diabetic patients	Age (years): 56.7 ±9.9 Male gender: 49% Hypertension: 50% BMI (kg/m^2): 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/m^2): (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≤60 ml/min/1.73 m^2	Measurement of microalbuminuria, eGFR by MDRD	Not mentioned		**Total prevalence: 11%**	Low

				volunteers	DBP (mean ±SE): 76.8 ±1.9 BMI (mean ±SE in kg/m^2): 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/m^2): 25.2± 4.7 Duration of DM (years): 17.3 ±8.5	KDOQI	Microalbuminuria (>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: 90%**	Low
Mafundikwa A [103]	2007, Zimbabwe, South	Diabetic clinic	75	Consecutive 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	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/m^2): 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/m^2): 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/m^2): 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 patients			186MDRD			ml/min/1.73 m^2	
Adebamowo S[151]	2016, Nigeria, Ghana, Kenya (sub-Saharan)	University medical centers and surrounding communities	4815	2208 Cases of type 2 DM 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/m^2): 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	Kinetic Jaffe	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		without HIV (149 DM and HIV; 504 DM without HIV)	Male gender: 32% Among diabetic patients without HIV Age (years): 51-60		MDRD				
Eghan B[138]	2007, Ghana, West	Outpatient diabetic clinic of the department of medicine at Komfo Anokye Teaching Hospital	109	Diabetic patients	Age (years): 54.1±10.9 Male gender: 28% Hypertension: 39% BMI(kg/m^2): 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

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/m^2): 29.7 (range,12.2–67.4) BMI categories (kg/m^2): <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	Records of 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/m^2): 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	Albuminuria defined as (mg/mmol) microalbuminuria 3-30 macroalbuminuria >30	Quantitative assessment of albuminuria by ACR	not measured	21.3% microalbuminuria 4.1% macroalbuminuria	**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/l	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/m^2): 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 m^2	Medium

Aryee C[139]	2016, Ghana, West	Komfo Anokye Teaching Hospital and the surrounding community	242	180 non-diabetic hypertensive patients and 61 age matched controls	Age (years): 22-87 Male gender:37% SBP (mmHg): hypertensive patients(on antihypertensive therapy:155.46±1.82, no antihypertensive therapy:152±3.27), control (117.38±0.96) DBP (mmHg): hypertensive patients(on antihypertensive therapy:101.46±0.94, no antihypertensive therapy: 100.50±1.34), control (73.28±0.77) BMI (kg/m^2): hypertensive patients(on antihypertensive therapy:29.52±0.39, no antihypertensive therapy: 29.8±0.71), control (29.36±0.65)	eGFR <60 ml/min/1.73m^2	Urine albumin excretion, and eGFR by CG , 186 MDRD, and CKD-EPI	Not mentioned	30%	**Total prevalence (CKD-EPI): 14.5%** Prevalence by MDRD:13.3% Prevalence by CG:16.6%	Low
Nabbaale J[140]	2015 Uganda East	out- patient hypertension clinic	256	Newly diagnosed eligible black adult hypertensive patients	Age (years): 54.3 ± 6.2 Male gender: 36.7%	Microalbumnuria as a random urine albumin level between 30 and 299 mg/dl.	Quantitative assessment of albumin in urine	Not measured	39.5%	**Total prevalence (based on microalbumin uria): 39.5%**	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 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	Proteinuria	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/m^2): 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	Patients attending the primary health care facilities	Age (years): 43.35± 12.80 Male gender: 16% Hypertension: 10% DM: 5.95% BMI (kg/m^2): 28.67 ± 6.43 BMI categories (kg/m^2): <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 m^2 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 m^2	Medium
Sumaili EK [25]	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

	Central	health care								stage 1: 4.2%, stage 2: 6.1%, stage 3: 18.3%, stage 4: 1.9%, stage 5: 5.7%	
Anyabolu E[30]	2016, Nigeria, West	Federal Medical Center	136	Subjects from medical out-patient department of the hospital.	Age (years): 38.58±11.79 Male gender: 27.9% BMI(kg/m^2): 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 and Milpark Hospitals	233	African patients with rheumatoid arthritis	Age (years): 57.1±10.8 Male gender: 17.2% BMI(kg/m^2): 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	194	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 m^2 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	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 [27]	South Africa South	hospital		the Renal Unit	Male gender: 51.1% Hypertension: 13.2% DM: 10.8%	µmol/L) and small kidneys on imaging without evidence of reversible causes	assessment and Scr measurement	mentioned	proteinuria >3.5 g/dl	**prevalence: 37.9%**	
Hamdouk M[104]	2011 Sudan East	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 albuminuria	**Total prevalence: 26.4%** 14% had Scr ≥2 mg/dl	Low
EL-Safty I[129]	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	**Total prevalence (among those with Silica exposure): 100%**	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

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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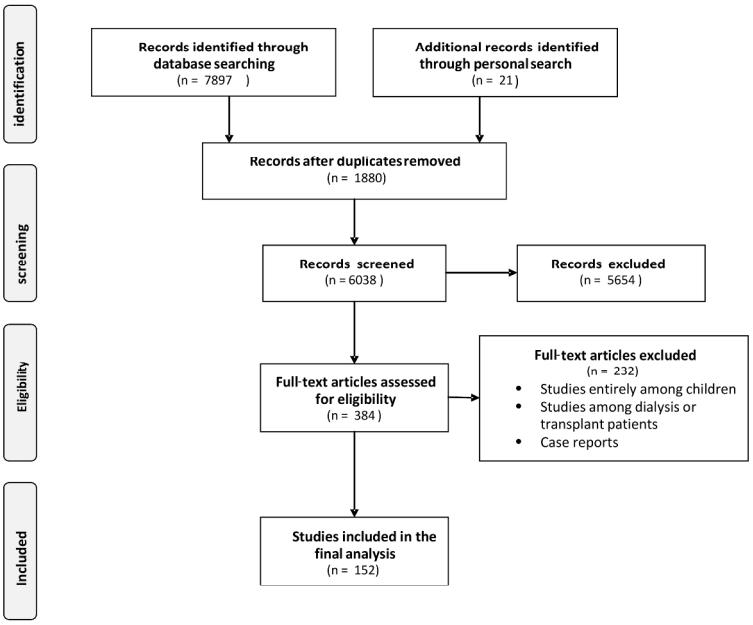

Fig 1

Fig1

254x190mm (300 x 300 DPI)

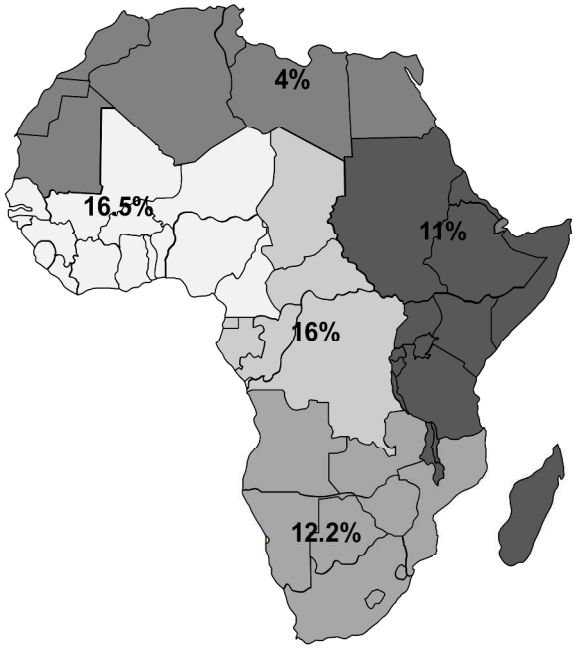

Fig 2

Fig2

254x190mm (300 x 300 DPI)

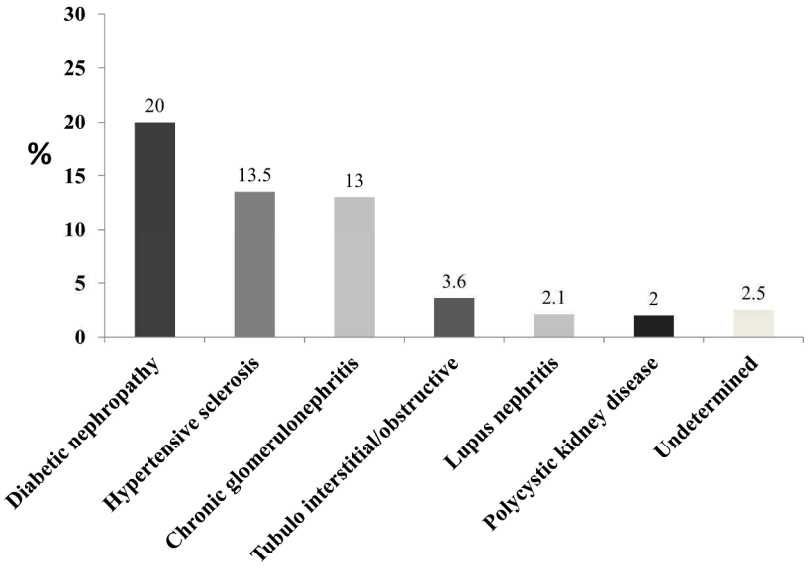

Fig 3

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	biopsy	causes of CKD
El Khayat S[31]	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[39]	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 known	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%
AbdErrahim E[42]	2001, Tunis, North	299	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: 67% MGN: 12.5% DN: 23.5% SLE: 55% undetermined: 7%
Afifi A[44]	2004, Egypt, North	3172	Age (years): 56.5±29.2	yes	DN: 14.5%
Afifi A[45]	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[46]	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[47]	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[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	DN: 13.4% H.scl: 42.8% obstructive: 14.9% SLE: 1% Ch.GN: 15.9% undetermined: 9.5%
Alebiosu C O[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	Tub.int: 2.2% H.scl: 31.1% Ch.GN: 43.7%
Amira CO[50]	2012, Nigeria, West	201	Age (years): 47.5±15.7 Male gender: 56.2 Hypertension: 42.8% DM: 13.4%	no	DN: 16.1% H.scl: 7.6% Ch.GN: 1.8% PKD: 2.9%
Arogunda de FA[51]	2011, Nigeria, West	760	Age(years): 36 (range:15-90) Male gender: 70.3% Hypertension: 72.4% SBP (mmHg): 160 (range:120 – 270) DBP (mmHg): 100 (range:50 – 209)	no	FSGS: 79.2%
Counil É[52]	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[53]	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	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 ± 25.5 DBP(mmHg): (male)84.2 ± 18.1. (female)81.0 ± 19.0		
Okpechi IG[55]	2013, South Africa, South	111	Age (years): 66.3 ± 5.7 Male gender: 47.7% Hypertension: 71% DM: 19.8%	yes	DN: 22.2% H.scl: 38.8% Ch.GN: 28.8% PKD: 2.7%
Laleye A[56]	2012, Benin, West	3783	Age (years): 47.2 (range:29 - 70) Male gender: 24% Hypertension: 59%	no	DN: 12.5% H.scl: 45% obstructive: 12.5% Ch.GN: 15.8% PKD: 3.3%
Okunola Y[57]	2013, Nigeria, West	300	Age (years): 49 ±16.25 Male gender: 68%	no	Ch.GN: 58%
Bello BT[58]	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[59]	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[60]	2010, South Africa, South	294	Age (years): 33.9 ± 12.0 Male gender: 45.2% Hypertension:39.8%	yes	Tub.int: 1.2% DN: 26.5% H.scl: 14.6% obstructive: 5% Ch.GN: 21.2%
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	DN: 41.5% H.scl: 14.6% Ch.GN: 16% undetermined: 15.55%
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	FSGS: 10.5% MGN: 35% H.scl: 18% SLE: 39%
Okpechi I[63]	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[64]	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[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 [68]	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

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

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 research, reporting bias).	12,14, 15

PRISMA 2009 Checklist

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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TITLE PAGE

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 high-risk 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 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 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 CKD[8]. 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 factors[9]. 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) Guidelines[11]. 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 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 trials[15], diagnostic studies[16], and observational studies[17]. 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 exposure[22] and exposure to the nephrotoxic hair-dye, paraphenylenediamine[23]) and seven studies in family practice[24-26] or hospital-based[27-30] 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 proteinuria[25 ,97-104] whereas eleven studies used dipstick with confirmation by the protein-to-creatinine ratio or albumin-to-creatinine ratio[105-115]. 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 studies[29 ,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-EPI[21 ,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 m^2 [2,12,14,20,80,93-96,111,117,119,139,146,148-159,161-164,166,167], 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 m^2 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 m^2 [2,19,27,28,30,81,88,101-103,118,125,127,147,160,169,170].

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 [12,14,26,29,73,74,77-79,81,82,96,110,111,115,117,128,130,131,137,141,143-145,150-152,154,157,159-161,163,166,167]. The rest of the studies were of low quality.

Prevalence of CKD

Based on the prevalence of eGFR <60 ml/min/1.73m^2 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

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-Saharan area

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 [20]or 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 m^2 [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 m^2 and/or the presence of proteinuria or albuminuria[26 ,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 proteinuria[73-75 ,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 studies[33 ,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%). The causes of CKD were undetermined/miscellaneous causes in one fifth of the patients (20%). (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

period[171] 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 comparability[173], 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 CKD[175]. 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. 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 judgment[176]. 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 population[9]. 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%[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 13.6% prevalence in the USA[178]. 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[179]. CKD prevalence in some Asian countries was higher than the estimates in the USA and in Europe, being 17.5% in Thailand[180], 15% in India[181], 13% in Japan[182], 11.9% in Taiwan[183], and 9.9% in China[184]. 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 CKD[187]. HIV/AIDS is pandemic in Africa, with a prevalence ranging from 0.5% in Senegal[188] to 27.4% in Swaziland[189]. 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[190]. 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 presentations[80].

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[19]. This isolated figure is higher than that reported in other countries[200-202]. More than one third (39%) patients with rheumatoid arthritis had CKD[20] 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 Africa[204] and CKD was principally caused by chronic

glomerulonephritis and hypertension in East and Tropical Africa[205 ,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 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[208]. 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.
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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 assessment
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/m^2) <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
Fatiu A[73]	2011 Nigeria West	Market population	286	Age (years): 49.5 ± 5.7 Male gender: 9.8% Hypertension: 37.7% BMI (kg/m^2): 26.76 ± 5.28 <20 kg/m^2: 7.4% 20-25 kg/m^2: 33.4% > 25 kg/m$^{2:}$; 59%	Proteinuria ≥ +1	Midstream urine sample was tested by urinary strip	Not measured	**29.70%**	**Total prevalence (based on proteinuria prevalence): 29.7%**	Medium
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
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
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 Seychelles, 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

		of Seychelle								
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
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/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	**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
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
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
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%	**Total prevalence**: 18.8% **Prevalence by stage** Stage 1: 2.4% Stage 2: 4.1% Stage 3: 11.8% Stage 4: 0.5%	High
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

				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%.	
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
Ayodele OE[77]	2011 Nigeria West	People at a major trade center, the public servant secretariat and the state broadcasting 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
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
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 m^2 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[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/m^2):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
Kalyesubula 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/m^2) 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 Cameroon Central-West	Population of the Littoral region	500	Age (years): 45.3 ± 13.2 Male gender: 53.4% BMI (kg/m^2): 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 Cameroon 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
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/m^2):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/m^2): 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/m^2): 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

	, East	sampling of adult population in Mwanza city, Geita and Kahama		BMI(kg/m^2) categories: Underweight: 10.5% Normal: 71% Overweight: 11.8% Obese :6.6% Diabetes mellitus: 0.9% Hypertension: 17.3%						
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
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
Stanfier J [134]	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 once-measured eGFR ≤60 ml/min/1.73m^2	Quantitative assessment of albuminuria and eGFR by MDRD	IDMS	Not mentioned	**Total prevalence: 8%**	High
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

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

	East and South	Zimbabwe			SBP: median:110 (IQR:100-120) mmHg DBP: median:70 (60-80) mmHg BMI categories: <18.5 kg/m^2: 18% 18.5- <25 kg/m^2 : 66% 25-<30 kg/m^2 : 12% ≥ 30 kg/m^2 : 4%	occasions >80 days apart or confirmed 25% decrease if eGFR <60 ml/min/1.73 m^2 at baseline					
Gailhol J [79]	2011, Burundi, East	Outpatients HIV clinic	300	HIV-infected patients	Age (years): 40.1 (33-46.5) Male gender:29.7% Hypertension: 2.7% DM: 2% BMI: median: 21.8 (19.3-24.2) kg/m^2	KDOQI	Proteinuria by urinary strip, CG, 186MDRD	Not mentioned	6.10%	**Total prevalence (MDRD): 45.7%** GG: 46.5% **Prevalence by Stages (using MDRD)** Stage 1: 30.2% Stage 2:13.5% Stage 3: 2% Stage 4 & 5: no patients	Medium
Masimango MI[107]	2014, Congo,	Outpatient HIV clinic	235	HIV-infected patients	Age (years): 40.0 ± 10.7	Proteinuria≥ +1 by urinary strip or	Proteinuria by urinary	Not measured	Proteinuria ≥+1: 41.3%	**Total prevalence (based on**	Low

	Central				Male gender: 27.8% Hypertension: 46.8%. DM: 1.7% BMI: 22.3 ± 3.8 kg/m2	albuminuria ≥30 mg/dl	strip and ACR			**proteinuria): 41.3 %**	
Reid A[145]	2008, Uganda, Zimbabwe, East and South	Three centeres in Uganda and Zimbabwe	3316	HIV-infected, ART-naive adults with CD4+ cell counts of<200 cells/mm3	age(years): 36.8 (IQR: 32.0–42.2) male gender: 35% SBP: median:110 (IQR: 100-120) mmHg DBP: median:70 (IQR: 60-80) mmHg BMI: median, 21.1 (IQR:19.1–23.6) kg/m^2	eGFR<60 ml/min 1.73 m^2 on ≥2 consecutive occasions >80 days apart or confirmed 25% decrease if eGFR <60 ml/min/1.73 m^2 at baseline	CG	Kinetic Jaffe	Not measured	**Total prevalence : 7%**	Medium
Fabian J[108]	2009, South Africa, South	HIV outpatient clinic at Johannesburg Hospital	578	HIV-infected naïve ART patients	Age (years): 37 (range 16–70 years) Male gender: 38% DM: 4.6% among	Proteinuria ≥ +1 by urinary strip or albuminuria ≥30 mg/dl	Proteinuria by urinary strip and PCR	Not measured	43.7% had proteinuria	**Total prevalence (based on proteinuria prevalence): 43.7%**	Low

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

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

Wools-Kaloustian K[80]	2007, Kenya, East	Academic Model for the Prevention and Treatment of HIV/AIDS (AMPATH) clinic	373	HIV-infected patients naive to ART	Age (years): 35.0 (range, 19–60) Male gender: 32.1% SBP: 104.7 (range, 80–140) mm/Hg	CrCl<60 ml/min/1.73 m^2	proteinuria by urinary strip, CG, full and abbreviated MDRD	Kinetic assay	6.2% (proteinuria ≥1+)	**Total prevalence :11.50%**	Low
Emem C[81]	2008, Nigeria, West	HIV/AIDS outpatient clinic	400	HIV-infected patients	Age (years): 34.6 ± 9.4 Male gender: 48.5% Hypertension: 13.2% BMI categories: <19.0 kg/m^2: 59.2 % 19-25 kg/m^2: 37.5% >25 kg/m^2: 3.3%	albuminuria +1 on at least two occasions (4 weeks apart) and or serum creatinine >1.5 mg/dl	Proteinuria or albuminuria by urinary strip and 24 hours proteinuria , CG	Not mentioned	38% proteinuria with dipstick 21.9% nephrotic range proteinuria	**Total prevalence :38.8 %** Among patients; 8.8% had CrCl <15 ml/min.	Medium
Wyatt C[82]	2011, Rwanda, East	Community based	891	677 HIV-infected and 214 HIV-uninfected	Age (years): 34 (IQR: 30–39) HIV +ve/43 (IQR:34–50) HIV -ve Male gender: 0	eGFR<60 ml/min/1.73 m^2/ or proteinuria +1 or greater	proteinuria by urinary strip, eGFR by MDRD, CKD-EPI,	Kinetic Jaffe	(9% among HIV + and7.2% among non-infected)	**Total prevalence among HIV +ve:9%** 2.7% had eGFR< 60 ml/min/1.73 m^2	Medium

					Hypertension: HIV+ve: 4.8%/ HIV-ve: 8.3% BMI (kg/m^2): HIV+ve: 20.9 (IQR: 19.0–23.3)/ HIV-ve: 20.5 (IQR: 18.5–23.3)		CG			CKD prevalence among HIV-ve: 7.2% 1.5% had eGFR< 60 ml/min/1.73 m^2	
FolefackKaze F[83]	2013, Cameroon, Central – West	HIV clinic of Yaoundé general hospital	104	All newly diagnosed HIV-infected patients naïve to HAART	Age (years): 35±10.7 Male gender: 32%	The presence of proteinuria +1 or more and eGFR< 60 ml/min based on the average of eGFR by 2 equations	Proteinuria by urinary strip, eGFR by CG, 175 MDRD	Kinetic Jaffe	36%	**Total prevalence :36%** Among patients; 3% had eGFR< 60 ml/min/1,73 m^2	Low
Struik G[84]	2011, Malawi, East	ART clinic in a central hospital in Malawi	526	Consecutive newly referred HIV-infected patients on ART	Age (years): 34.3 ± 9.3; Male gender: 43.5% Hypertension: 11.2% DM: 0.8%	any proteinuria (≥+1); heavy proteinuria (≥+2); any proteinuria (≥ +1) with renal dysfunction (e GFR <60 ml/min/1.73 m^2) and heavy	Proteinuria by urinary strip, eGFR by CG and MDRD	Not mentioned	23.3%	**Total prevalence: 23.3% Among patients with proteinuria; 5.3% had CrCl< 60 ml/minute**	Low

						proteinuria (≥+2) with renal dysfunction (CrCl < 60 mL/minute) and the absence of any alternative cause for renal dysfunction or proteinuria.					
Attolou V[118]	1998, Benin, West	National Central hospital	92	HIV-infected patients	Age(years): 22±4 Male gender: 68 %	Proteinuria > 0.5 g/24 hrs and SCr>14 mg/l	Serum creatinine measurement and 24-hour proteinuria	Not mentioned	Proteinuria >0.5 g/24 hrs in 23.33%	**Total prevalence:27.16%**	Low
Agaba EI[170]	2003, Nigeria, West	infections unit of the Jos University Teaching Hospital	126	Consecutive 79 AIDS patients and 57 controls		Not known	Not known	Not known	25% (AIDS group)	**Total prevalence among AIDS group:51.80%** CKD prevalence among control group: 12.2%	Low
Fana GT[100]	2011, Zimbabwe, South	Outpatient clinics	159	HIV-infected patients naïve to ART		CrCl < 60 ml/min. Proteinuria ≥ +1 and/or PCR > 20	Proteinuria by urinary strip and 24-hour	Not mentioned	45.90%	**Total prevalence : 45.9%** Among patients; 7.50% had CrCl<	Low

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

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

Anyabolu E[135]	2016, Nigeria, West	Federal Medical Centre	529	393 newly diagnosed drug-naïve HIV patients, 136 age and sex matched HIV-seronegative controls	Age (years); 38.84 ± 10.65 Male gender: 28% BMI categories: <18.5.0 kg/m^2: 7% 18.5-24.9 kg/m^2: 35% 25-29.9 kg/m^2: 32% ≥ 30 kg/m^2:23%	24-hours urine protein ≥0.300 g and/or GFR <60 ml/min	Quantitative assessment of protienuira, Scr, and eGFR	Not mentioned	Not mentioned	**Total prevalence among HIV +ve patients:22.9%** Prevalence among HIV -ve: 8.1%	Low
Ayokunle D[113]	2015, Nigeria, West	Medical Out-patient Department of University of Ilorin Teaching Hospital	335	227 newly-diagnosed, ART naïve patients with HIV/AIDS, 108age and sex matched control	Age (years): 40.3 ± 10.3 Male gender: 44% BMI (kg/m^2): 20.5 ± 4.8 among HIV patients , 26.7 ± 5.3 among control group SBP(mmHg): 111.9 ± 1 among HIV patients, 126.1 ± 12.0 among control group	albuminuria ≥ 30 mg/g and/or eGFR < 60 ml/ml/1.73m^2	Proteinuria by dipstick, and ACR and eGFR by MDRD	Kinetic Jaffe	Not mentioned	**Total prevalence among HIV patients: 47.6%** The prevalence among HIV –ve: 16.7%	Low

					DBP(mmHg): 72.9 ± 9.5 among HIV patients, 80.6 ± 6.8 among control group						
Ghadwick D[114]	2015, Ghana, West	Komfo Anokye Teaching Hospital	330	HIV patients on ART	Age(years): 39 (IQR: 35–46) Male gender: 25% BMI(kg/m^2): 22.9 (IQR: 20.5-26.6)	Proteinuria or CrCl<60ml/min	Proteinuria (dipsticks, PCR, and ACR) and GFR by CG	Not mentioned	37% by dipstick and 12% by PCR	**Total prevalence (proteinuria) : 37%** CrCl<60 ml/min among 7%	Low
EdwardsJ[166]	2015, Kenya, East	Two primary care clinics	2206	210 HIV+ve patients and 1996 HIV –ve	Age (years): HIV +ve: 43 (IQR: 39–50), HIV-ve: 49 (IQR:40–56) Male gender: HIV +ve: 31%, HIV-ve:28.7% Hypertension: HIV+ve:44%, HIV-ve: 33.2% Diabetes mellitus: HIV +ve: 5% , HIV –ve: 15.2%	CrCl<60 ml/min	eGFR by CKD-EPI	Not mentioned	Not measured	**Total prevalence: 12.1% HIV+ve: 17% HIv-ve: 11%**	Medium

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

Odongo P[94]	2015, Uganda, East	infectious diseases clinic of Gulu Regional Referral Hospital	361	Newly diagnosed HIV patients not receiving ART	Age (years): 31.4 ± 9.5 Male gender: 36.3% BMI(kg/m^2) <18: 33%	eGFR <60 ml/min per 1.73 m^2	Proteinuria by dipstick and eGFR by MDRD	Not mentioned	Proteinuria ≥ +1: 52%	**Total prevalence: 14.4%**	Low
Okafor U[136]	2016, Nigeria, West	University of Benin Teaching Hospital	383	HIV infected naïve patients	Age (years): 36.03 ± 9.08 Male gender: 41%	eGFR <60 ml/min per 1.73 m^2 and/or evidence of kidney injury as detected when the PCR (mg/g) was ≥200.	Quantitative assessment of proteinuria by PCR and eGFR by MDRD	Kinetic Jaffe	Not mentioned	**Total prevalence: 53.5%**	Low
Seape T[156]	2016, South Africa, South	Medical in-patients at the Chris Hani Baragwanath Hospital	100	HIV infected naïve patients	Age (years): 37.0±9.6 Male gender: 60% BMI(kg/m^2): 20.9 ±5.1	eGFR <60 ml/min per 1.73 m^2	eGFR by CG, MDRD, CKD-EPI	IDMS	Not measured	**Total prevalence: 16%**	Low
Wensink G[137]	2015, South Africa, South	Rural Medical Centre	903	HIV infected adult patients	Age (years): 40(IQR:34-48) Male gender: 31% Diabetes mellitus:	Albuminuria or eGFR <60 ml/min / 1.73 m^2	Albuminuria by ACR and eGFR by MDRD and	Not mentioned	21%	**Total prevalence (albuminuria): 21% 2% had eGFR< 60**	Medium

					4% Hypertension: 23%		CKD-EPI			**ml/min/1.73 m^2**	
Zachor H[157]	2016, South Africa, South	Outpatient infectious clinic at an academic hospital	650	HIV infected patients initiating ART	Age (years): 37.9±9.4 Male gender: 35.5% Diabetes mellitus:2.2% Hypertension: 7.8%	eGFR <60 ml/min per 1.73 m^2	eGFR by MDRD and CKD-EPI	IDMS	Not measured	**Total prevalence: 2 %**	Medium
Mekuria Y[150]	2016, Ethiopia, East	Jimma University Specialized Hospital	446	(223 HAART naïve and 223 HAART experienced)	Age (years): HAART naive: 38.25 ±10.8, HAART +ve: 35.14 ±9.2 Male gender: 37% BMI(kg/m^2) : HAART naïve: 20.7±3.2, HAART +ve: 21.6 ±3.5 Hypertension: 3.36% Diabetes mellitus: 21.4%	eGFR <60 ml/min per 1.73 m^2	eGFR by CG	Kinetic Jaffe	Not measured	**Total prevalence: 18.2%**	Medium

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	Creatinine assay	proteinuria	CKD prevalence	Quality assessment
Janmohamed MN[86]	2013, Tanzania, East	diabetes mellitus clinic of Bugando Medical Centre in Mwanza	369	Consecutive diabetic patients	Age (years): 54 (IQR: 45-62) Male gender: 46.6% Hypertension: 57.5% BMI (kg/m^2): 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 m^2 or evidence of kidney damage (microalbuminuria or overt proteinuria).	Microalbuminuria, 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/m^2): 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	Endocrinology center at the National Institute of nutrition	689	Type 2 diabetic patients from computerized 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	Consecutive type 2 diabetic patients	Age (years): 56.7 ±9.9 Male gender: 49% Hypertension: 50% BMI (kg/m^2): 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/m^2): (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≤60 ml/min/1.73 m^2	Measurement of microalbuminuria, eGFR by MDRD	Not mentioned		**Total prevalence: 11%**	Low

				volunteers	DBP (mean ±SE): 76.8 ±1.9 BMI (mean ±SE in kg/m^2): 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/m^2): 25.2± 4.7 Duration of DM (years): 17.3 ±8.5	KDOQI	Microalbuminuria (>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: 90%**	Low
Mafundikwa A [103]	2007, Zimbabwe, South	Diabetic clinic	75	Consecutive 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	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/m^2): 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/m^2): 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/m^2): 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 patients			186MDRD			ml/min/1.73 m^2	
Adebamowo S[151]	2016, Nigeria, Ghana, Kenya (sub-Saharan)	University medical centers and surrounding communities	4815	2208 Cases of type 2 DM 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/m^2): 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	Kinetic Jaffe	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		without HIV (149 DM and HIV; 504 DM without HIV)	Male gender: 32% Among diabetic patients without HIV Age (years): 51-60		MDRD				
Eghan B[138]	2007, Ghana, West	Outpatient diabetic clinic of the department of medicine at Komfo Anokye Teaching Hospital	109	Diabetic patients	Age (years): 54.1±10.9 Male gender: 28% Hypertension: 39% BMI(kg/m^2): 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

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/m^2): 29.7 (range,12.2–67.4) BMI categories (kg/m^2): <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	Records of 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/m^2): 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	Albuminuria defined as (mg/mmol) microalbuminuria 3-30 macroalbuminuria >30	Quantitative assessment of albuminuria by ACR	not measured	21.3% microalbuminuria 4.1% macroalbuminuria	**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/l	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/m^2): 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 m^2	Medium

Aryee C[139]	2016, Ghana, West	Komfo Anokye Teaching Hospital and the surrounding community	242	180 non-diabetic hypertensive patients and 61 age matched controls	Age (years): 22-87 Male gender:37% SBP (mmHg): hypertensive patients(on antihypertensive therapy:155.46±1.82, no antihypertensive therapy:152±3.27), control (117.38±0.96) DBP (mmHg): hypertensive patients(on antihypertensive therapy:101.46±0.94, no antihypertensive therapy: 100.50±1.34), control (73.28±0.77) BMI (kg/m^2): hypertensive patients(on antihypertensive therapy:29.52±0.39, no antihypertensive therapy: 29.8±0.71), control (29.36±0.65)	eGFR <60 ml/min/1.73m^2	Urine albumin excretion, and eGFR by CG , 186 MDRD, and CKD-EPI	Not mentioned	30%	**Total prevalence (CKD-EPI): 14.5%** Prevalence by MDRD:13.3% Prevalence by CG:16.6%	Low
Nabbaale J[140]	2015 Uganda East	out- patient hypertension clinic	256	Newly diagnosed eligible black adult hypertensive patients	Age (years): 54.3 ± 6.2 Male gender: 36.7%	Microalbumnuria as a random urine albumin level between 30 and 299 mg/dl.	Quantitative assessment of albumin in urine	Not measured	39.5%	**Total prevalence (based on microalbuminuria): 39.5%**	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 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	Proteinuria	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/m^2): 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	Patients attending the primary health care facilities	Age (years): 43.35± 12.80 Male gender: 16% Hypertension: 10% DM: 5.95% BMI (kg/m^2): 28.67 ± 6.43 BMI categories (kg/m^2): <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 m^2 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 m^2	Medium
Sumaili EK [25]	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

	Central	health care								stage 1: 4.2%, stage 2: 6.1%, stage 3: 18.3%, stage 4: 1.9%, stage 5: 5.7%	
Anyabolu E[30]	2016, Nigeria, West	Federal Medical Center	136	Subjects from medical out-patient department of the hospital.	Age (years): 38.58±11.79 Male gender: 27.9% BMI(kg/m^2): 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 and Milpark Hospitals	233	African patients with rheumatoid arthritis	Age (years): 57.1±10.8 Male gender: 17.2% BMI(kg/m^2): 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	194	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 m^2 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	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 [27]	South Africa South	hospital		the Renal Unit	Male gender: 51.1% Hypertension: 13.2% DM: 10.8%	µmol/L) and small kidneys on imaging without evidence of reversible causes	assessment and Scr measurement	mentioned	proteinuria >3.5 g/dl	**prevalence: 37.9%**	
Hamdouk M[104]	2011 Sudan East	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 albuminuria	**Total prevalence: 26.4%** 14% had Scr ≥2 mg/dl	Low
EL-Safty I[129]	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	**Total prevalence (among those with Silica exposure): 100%**	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

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

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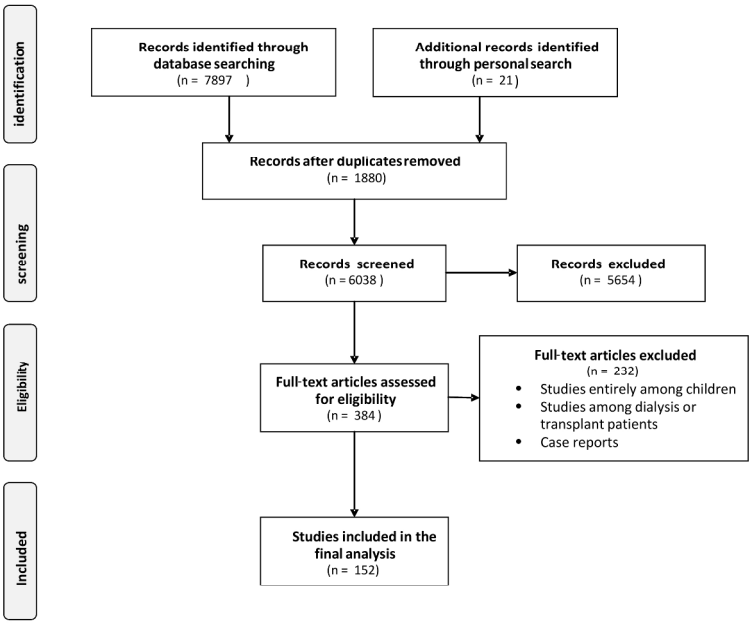

Fig 1

Fig1

254x190mm (300 x 300 DPI)

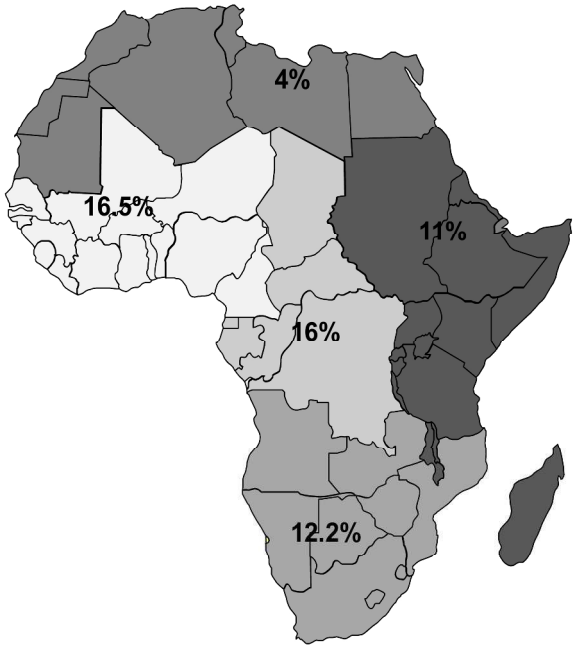

Fig 2

Fig2

254x190mm (300 x 300 DPI)

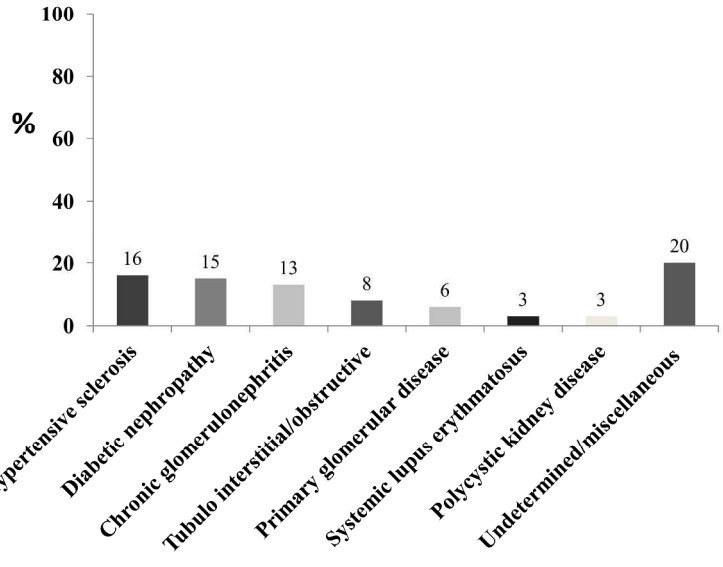

Fig 3

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

Study ID	Year Country Region	N	Population Characteristic	biopsy	causes of CKD
El Khayat S[31]	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% 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%
Afifi A[45]	1999, Egypt, North	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% 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%

Amira C[50]	2012, Nigeria, West	201	Age (years): 47.5±15.7 Male gender: 56.2 Hypertension: 42.8% DM: 13.4%	no	H.scl: 42.8% Ch.GN: 15.9% Obstructive uropathy: 14.9% DN: 13.4% PKD: 1% SLE: 1% Sickle cell nephropathy: 1% Analgesic nephropathy:0.5% Undetermined : 9.5%
Arogundade F[51]	2011, Nigeria, West	760	Age(years): 36 (range:15-90) Male gender: 70.3% Hypertension: 72.4% SBP (mmHg): 160 (range:120 – 270) DBP (mmHg): 100 (range:50 – 209)	no	Ch. GN: 43.7% H.scl: 31.1% Obstructive uropathy: 6.7% DN: 3.7% Tub.int: 2.2% PKD: 0.7% Undetermined : 12%
Counil É[52]	2008, Tunis, North	6397	Age (years): 51.4±18.0 Male gender: 56.5%	no	DN: 35% H.scl: 25.3% Tub.int: 19.7% Ch.GN: 13% PKD: 2.2% Undetermined:52.8%
Chijioke A[53]	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	H.scl:52.58% Ch.GN: 17.2% Tub.int: 17.1% PKD: 4.3% DN: 2.6% Chronic pyelonephritis: 2.6% Obstructive uropathy:1.7% Undetermined: 1.9%
Madala N[54]	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	H.scl: 75.2% DN: 29.8% HIV nephropathy: 28.6% Ch.GN: 7% Tub.int:6% Undetermined: 6%
Okpechi I[55]	2013, South Africa, South	111	Age (years): 66.3 ± 5.7 Male gender: 47.7% Hypertension: 71% DM: 19.8%	yes	MGN: 14.4% Mesangioproliferative GN:8.1% Crescentic GN: 7.2% 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% 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% Tub.int: 17.2% Miscellaneous: 8.1%

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%

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

Ibrahim S[69]	2012, Egypt, North	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% 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

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

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

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 research, reporting bias).	12,14, 15

PRISMA 2009 Checklist

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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TITLE PAGE

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 high-risk 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 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 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 CKD[8]. 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 factors[9]. 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) Guidelines[11]. 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 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 trials[15], diagnostic studies[16], and observational studies[17]. 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 exposure[22] and exposure to the nephrotoxic hair-dye, paraphenylenediamine[23]) and seven studies in family practice[24-26] or hospital-based[27-30] 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 proteinuria[25 ,97-104] whereas eleven studies used dipstick with confirmation by the protein-to-creatinine ratio or albumin-to-creatinine ratio[105-115]. 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 studies[29 ,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-EPI[21 ,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 m^2 [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 m^2 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 m^2 [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 [12,14,26,29,73,74,77-79,81,82,96,110,111,115,117,128,130,131,137,141,143-145,150-152,154,157,159-161,163,166,167]. The rest of the studies were of low quality.

Prevalence of CKD

Based on the prevalence of eGFR <60 ml/min/1.73m^2 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

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-Saharan area

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 [20]or 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 m^2 [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 m^2 and/or the presence of proteinuria or albuminuria[26,78,82,91,105,106,112,114,130-134,141]; 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 proteinuria[73-75,77,110,128]. 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 studies[33,39,41,43-45,48,54,55,58,60,63,67-70,72]. 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%). The causes of CKD were undetermined/miscellaneous causes in one fifth of the patients (20%). (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

period[171] 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 comparability[173], 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 CKD[175]. 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. 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 judgment[176]. 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 population[9]. 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%[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 13.6% prevalence in the USA[178]. 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[179]. CKD prevalence in some Asian countries was higher than the estimates in the USA and in Europe, being 17.5% in Thailand[180], 15% in India[181], 13% in Japan[182], 11.9% in Taiwan[183], and 9.9% in China[184]. 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 CKD[187]. HIV/AIDS is pandemic in Africa, with a prevalence ranging from 0.5% in Senegal[188] to 27.4% in Swaziland[189]. 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[190]. 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 presentations[80].

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[19]. This isolated figure is higher than that reported in other countries[200-202]. More than one third (39%) patients with rheumatoid arthritis had CKD[20] 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 Africa[204] and CKD was principally caused by chronic

glomerulonephritis and hypertension in East and Tropical Africa[205,206]. 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 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[208]. 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.
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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 assessment
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/m^2) <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
Fatiu A[73]	2011 Nigeria West	Market population	286	Age (years): 49.5 ± 5.7 Male gender: 9.8% Hypertension: 37.7% BMI (kg/m^2): 26.76 ± 5.28 <20 kg/m^2: 7.4% 20-25 kg/m^2: 33.4% > 25 kg/m$^{2:}$; 59%	Proteinuria ≥ +1	Midstream urine sample was tested by urinary strip	Not measured	**29.70%**	**Total prevalence (based on proteinuria prevalence): 29.7%**	Medium
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
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
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 Seychelles, 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

		of Seychelle								
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
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/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	**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
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
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
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%	**Total prevalence**: 18.8% **Prevalence by stage** Stage 1: 2.4% Stage 2: 4.1% Stage 3: 11.8% Stage 4: 0.5%	High
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

				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%.	
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
Ayodele OE[77]	2011 Nigeria West	People at a major trade center, the public servant secretariat and the state broadcasting 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
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
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 m^2 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[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/m^2):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
Kalyesubula 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/m^2) 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 Cameroon Central-West	Population of the Littoral region	500	Age (years): 45.3 ± 13.2 Male gender: 53.4% BMI (kg/m^2): 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 Cameroon 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
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/m^2):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/m^2): 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/m^2): 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

	, East	sampling of adult population in Mwanza city, Geita and Kahama		BMI(kg/m^2) categories: Underweight: 10.5% Normal: 71% Overweight: 11.8% Obese :6.6% Diabetes mellitus: 0.9% Hypertension: 17.3%						
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
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
Stanfier J [134]	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 once-measured eGFR ≤60 ml/min/1.73m^2	Quantitative assessment of albuminuria and eGFR by MDRD	IDMS	Not mentioned	**Total prevalence: 8%**	High
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

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

	East and South	Zimbabwe			SBP: median:110 (IQR:100-120) mmHg DBP: median:70 (60-80) mmHg BMI categories: <18.5 kg/m^2: 18% 18.5- <25 kg/m^2 : 66% 25-<30 kg/m^2 : 12% ≥ 30 kg/m^2: 4%	occasions >80 days apart or confirmed 25% decrease if eGFR <60 ml/min/1.73 m^2 at baseline					
Gailhol J [79]	2011, Burundi, East	Outpatients HIV clinic	300	HIV-infected patients	Age (years): 40.1 (33-46.5) Male gender:29.7% Hypertension: 2.7% DM: 2% BMI: median: 21.8 (19.3-24.2) kg/m^2	KDOQI	Proteinuria by urinary strip, CG, 186MDRD	Not mentioned	6.10%	**Total prevalence (MDRD): 45.7%** GG: 46.5% **Prevalence by Stages (using MDRD)** Stage 1: 30.2% Stage 2:13.5% Stage 3: 2% Stage 4 & 5: no patients	Medium
Masimango MI[107]	2014, Congo,	Outpatient HIV clinic	235	HIV-infected patients	Age (years): 40.0 ± 10.7	Proteinuria≥ +1 by urinary strip or	Proteinuria by urinary	Not measured	Proteinuria ≥+1: 41.3%	**Total prevalence (based on**	Low

	Central				Male gender: 27.8% Hypertension: 46.8%. DM: 1.7% BMI: 22.3 ± 3.8 kg/m2	albuminuria ≥30 mg/dl	strip and ACR			**proteinuria): 41.3 %**	
Reid A[145]	2008, Uganda, Zimbabwe, East and South	Three centeres in Uganda and Zimbabwe	3316	HIV-infected, ART-naive adults with CD4+ cell counts of<200 cells/mm3	age(years): 36.8 (IQR: 32.0–42.2) male gender: 35% SBP: median:110 (IQR: 100-120) mmHg DBP: median:70 (IQR: 60-80) mmHg BMI: median, 21.1 (IQR:19.1–23.6) kg/m^2	eGFR<60 ml/min 1.73 m^2 on ≥2 consecutive occasions >80 days apart or confirmed 25% decrease if eGFR <60 ml/min/1.73 m^2 at baseline	CG	Kinetic Jaffe	Not measured	**Total prevalence : 7%**	Medium
Fabian J[108]	2009, South Africa, South	HIV outpatient clinic at Johannesburg Hospital	578	HIV-infected naïve ART patients	Age (years): 37 (range 16–70 years) Male gender: 38% DM: 4.6% among	Proteinuria ≥ +1 by urinary strip or albuminuria ≥30 mg/dl	Proteinuria by urinary strip and PCR	Not measured	43.7% had proteinuria	**Total prevalence (based on proteinuria prevalence): 43.7%**	Low

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

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

Wools-Kaloustian K[80]	2007, Kenya, East	Academic Model for the Prevention and Treatment of HIV/AIDS (AMPATH) clinic	373	HIV-infected patients naive to ART	Age (years): 35.0 (range, 19–60) Male gender: 32.1% SBP: 104.7 (range, 80–140) mm/Hg	CrCl<60 ml/min/1.73 m^2	proteinuria by urinary strip, CG, full and abbreviated MDRD	Kinetic assay	6.2% (proteinuria ≥1+)	**Total prevalence :11.50%**	Low
Emem C[81]	2008, Nigeria, West	HIV/AIDS outpatient clinic	400	HIV-infected patients	Age (years): 34.6 ± 9.4 Male gender: 48.5% Hypertension: 13.2% BMI categories: <19.0 kg/m^2: 59.2 % 19-25 kg/m^2: 37.5% >25 kg/m^2: 3.3%	albuminuria +1 on at least two occasions (4 weeks apart) and or serum creatinine >1.5 mg/dl	Proteinuria or albuminuria by urinary strip and 24 hours proteinuria , CG	Not mentioned	38% proteinuria with dipstick 21.9% nephrotic range proteinuria	**Total prevalence :38.8 %** Among patients; 8.8% had CrCl <15 ml/min.	Medium
Wyatt C[82]	2011, Rwanda, East	Community based	891	677 HIV-infected and 214 HIV-uninfected	Age (years): 34 (IQR: 30–39) HIV +ve/43 (IQR:34–50) HIV -ve Male gender: 0	eGFR<60 ml/min/1.73 m^2/ or proteinuria +1 or greater	proteinuria by urinary strip, eGFR by MDRD, CKD-EPI,	Kinetic Jaffe	(9% among HIV + and7.2% among non-infected)	**Total prevalence among HIV +ve:9%** 2.7% had eGFR< 60 ml/min/1.73 m^2	Medium

					Hypertension: HIV+ve: 4.8%/ HIV-ve: 8.3% BMI (kg/m^2): HIV+ve: 20.9 (IQR: 19.0–23.3)/ HIV-ve: 20.5 (IQR: 18.5–23.3)		CG			CKD prevalence among HIV-ve: 7.2% 1.5% had eGFR< 60 ml/min/1.73 m^2	
FolefackKaze F[83]	2013, Cameroon, Central – West	HIV clinic of Yaoundé general hospital	104	All newly diagnosed HIV-infected patients naïve to HAART	Age (years): 35±10.7 Male gender: 32%	The presence of proteinuria +1 or more and eGFR< 60 ml/min based on the average of eGFR by 2 equations	Proteinuria by urinary strip, eGFR by CG, 175 MDRD	Kinetic Jaffe	36%	**Total prevalence :36%** Among patients; 3% had eGFR< 60 ml/min/1,73 m^2	Low
Struik G[84]	2011, Malawi, East	ART clinic in a central hospital in Malawi	526	Consecutive newly referred HIV-infected patients on ART	Age (years): 34.3 ± 9.3; Male gender: 43.5% Hypertension: 11.2% DM: 0.8%	any proteinuria (≥+1); heavy proteinuria (≥+2); any proteinuria (≥ +1) with renal dysfunction (e GFR <60 ml/min/1.73 m^2) and heavy	Proteinuria by urinary strip, eGFR by CG and MDRD	Not mentioned	23.3%	**Total prevalence: 23.3% Among patients with proteinuria; 5.3% had CrCl< 60 ml/minute**	Low

						proteinuria (≥+2) with renal dysfunction (CrCl < 60 mL/minute) and the absence of any alternative cause for renal dysfunction or proteinuria.					
Attolou V[118]	1998, Benin, West	National Central hospital	92	HIV-infected patients	Age(years): 22±4 Male gender: 68 %	Proteinuria > 0.5 g/24 hrs and SCr>14 mg/l	Serum creatinine measurement and 24-hour proteinuria	Not mentioned	Proteinuria >0.5 g/24 hrs in 23.33%	**Total prevalence:27.16%**	Low
Agaba EI[170]	2003, Nigeria, West	infections unit of the Jos University Teaching Hospital	126	Consecutive 79 AIDS patients and 57 controls		Not known	Not known	Not known	25% (AIDS group)	**Total prevalence among AIDS group:51.80%** CKD prevalence among control group: 12.2%	Low
Fana GT[100]	2011, Zimbabwe, South	Outpatient clinics	159	HIV-infected patients naïve to ART		CrCl < 60 ml/min. Proteinuria ≥ +1 and/or PCR > 20	Proteinuria by urinary strip and 24-hour	Not mentioned	45.90%	**Total prevalence : 45.9%** Among patients; 7.50% had CrCl<	Low

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

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

Anyabolu E[135]	2016, Nigeria, West	Federal Medical Centre	529	393 newly diagnosed drug-naïve HIV patients, 136 age and sex matched HIV-seronegative controls	Age (years); 38.84 ± 10.65 Male gender: 28% BMI categories: <18.5.0 kg/m^2: 7% 18.5-24.9 kg/m^2: 35% 25-29.9 kg/m^2: 32% ≥ 30 kg/m^2:23%	24-hours urine protein ≥0.300 g and/or GFR <60 ml/min	Quantitative assessment of protienuira, Scr, and eGFR	Not mentioned	Not mentioned	**Total prevalence among HIV +ve patients:22.9%** Prevalence among HIV -ve: 8.1%	Low
Ayokunle D[113]	2015, Nigeria, West	Medical Out-patient Department of University of Ilorin Teaching Hospital	335	227 newly-diagnosed, ART naïve patients with HIV/AIDS, 108age and sex matched control	Age (years): 40.3 ± 10.3 Male gender: 44% BMI (kg/m^2): 20.5 ± 4.8 among HIV patients , 26.7 ± 5.3 among control group SBP(mmHg): 111.9 ± 1 among HIV patients, 126.1 ± 12.0 among control group	albuminuria ≥ 30 mg/g and/or eGFR < 60 ml/ml/1.73m^2	Proteinuria by dipstick, and ACR and eGFR by MDRD	Kinetic Jaffe	Not mentioned	**Total prevalence among HIV patients: 47.6%** The prevalence among HIV –ve: 16.7%	Low

					DBP(mmHg): 72.9 ± 9.5 among HIV patients, 80.6 ± 6.8 among control group						
Ghadwick D[114]	2015, Ghana, West	Komfo Anokye Teaching Hospital	330	HIV patients on ART	Age(years): 39 (IQR: 35–46) Male gender: 25% BMI(kg/m^2): 22.9 (IQR: 20.5-26.6)	Proteinuria or CrCl<60ml/min	Proteinuria (dipsticks, PCR, and ACR) and GFR by CG	Not mentioned	37% by dipstick and 12% by PCR	**Total prevalence (proteinuria) : 37%** CrCl<60 ml/min among 7%	Low
EdwardsJ[166]	2015, Kenya, East	Two primary care clinics	2206	210 HIV+ve patients and 1996 HIV –ve	Age (years): HIV +ve: 43 (IQR: 39–50), HIV-ve: 49 (IQR:40–56) Male gender: HIV +ve: 31%, HIV-ve:28.7% Hypertension: HIV+ve:44%, HIV-ve: 33.2% Diabetes mellitus: HIV +ve: 5% , HIV –ve: 15.2%	CrCl<60 ml/min	eGFR by CKD-EPI	Not mentioned	Not measured	**Total prevalence: 12.1% HIV+ve: 17% HIv-ve: 11%**	Medium

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

		infectious diseases clinic of Gulu Regional Referral Hospital			Age (years): 31.4 ± 9.5 Male gender: 36.3% BMI(kg/m^2) <18: 33%			Not mentioned			Low
Odongo P[94]	2015, Uganda, East		361	Newly diagnosed HIV patients not receiving ART		eGFR <60 ml/min per 1.73 m^2	Proteinuria by dipstick and eGFR by MDRD		Proteinuria ≥ +1: 52%	**Total prevalence: 14.4%**	
		University of Benin Teaching Hospital			Age (years): 36.03 ± 9.08 Male gender: 41%	eGFR <60 ml/min per 1.73 m^2 and/or evidence of kidney injury as detected when the PCR (mg/g) was ≥200.	Quantitative assessment of proteinuria by PCR and eGFR by MDRD	Kinetic Jaffe			Low
Okafor U[136]	2016, Nigeria, West		383	HIV infected naïve patients					Not mentioned	**Total prevalence: 53.5%**	
		Medical in-patients at the Chris Hani Baragwanath Hospital			Age (years): 37.0±9.6 Male gender: 60% BMI(kg/m^2): 20.9 ±5.1			IDMS			Low
Seape T[156]	2016, South Africa, South		100	HIV infected naïve patients		eGFR <60 ml/min per 1.73 m^2	eGFR by CG, MDRD, CKD-EPI		Not measured	**Total prevalence: 16%**	
		Rural Medical Centre			Age (years): 40(IQR:34-48) Male gender: 31% Diabetes mellitus:						Medium
Wensink G[137]	2015, South Africa, South		903	HIV infected adult patients		Albuminuria or eGFR <60 ml/min / 1.73 m^2	Albuminuria by ACR and eGFR by MDRD and	Not mentioned	21%	**Total prevalence (albuminuria): 21%** **2% had eGFR< 60**	

					4% Hypertension: 23%		CKD-EPI			**ml/min/1.73 m^2**	
Zachor H[157]	2016, South Africa, South	Outpatient infectious clinic at an academic hospital	650	HIV infected patients initiating ART	Age (years): 37.9±9.4 Male gender: 35.5% Diabetes mellitus:2.2% Hypertension: 7.8%	eGFR <60 ml/min per 1.73 m^2	eGFR by MDRD and CKD-EPI	IDMS	Not measured	**Total prevalence: 2 %**	Medium
Mekuria Y[150]	2016, Ethiopia, East	Jimma University Specialized Hospital	446	(223 HAART naïve and 223 HAART experienced)	Age (years): HAART naive: 38.25 ±10.8, HAART +ve: 35.14 ±9.2 Male gender: 37% BMI(kg/m^2) : HAART naïve: 20.7±3.2, HAART +ve: 21.6 ±3.5 Hypertension: 3.36% Diabetes mellitus: 21.4%	eGFR <60 ml/min per 1.73 m^2	eGFR by CG	Kinetic Jaffe	Not measured	**Total prevalence: 18.2%**	Medium

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	Creatinine assay	proteinuria	CKD prevalence	Quality assessment
Janmohamed MN[86]	2013, Tanzania, East	diabetes mellitus clinic of Bugando Medical Centre in Mwanza	369	Consecutive diabetic patients	Age (years): 54 (IQR: 45-62) Male gender: 46.6% Hypertension: 57.5% BMI (kg/m^2): 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 m^2 or evidence of kidney damage (microalbuminuria or overt proteinuria).	Microalbuminuria, 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/m^2): 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	Endocrinology center at the National Institute of nutrition	689	Type 2 diabetic patients from computerized 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	Consecutive type 2 diabetic patients	Age (years): 56.7 ±9.9 Male gender: 49% Hypertension: 50% BMI (kg/m^2): 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/m^2): (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≤60 ml/min/1.73 m^2	Measurement of microalbuminuria, eGFR by MDRD	Not mentioned		**Total prevalence: 11%**	Low

				volunteers	DBP (mean ±SE): 76.8 ±1.9 BMI (mean ±SE in kg/m^2): 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/m^2): 25.2± 4.7 Duration of DM (years): 17.3 ±8.5	KDOQI	Microalbuminuria (>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: 90%**	Low
Mafundikwa A [103]	2007, Zimbabwe, South	Diabetic clinic	75	Consecutive 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	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/m^2): 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/m^2): 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/m^2): 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 patients			186MDRD			ml/min/1.73 m^2	
Adebamowo S[151]	2016, Nigeria, Ghana, Kenya (sub-Saharan)	University medical centers and surrounding communities	4815	2208 Cases of type 2 DM 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/m^2): 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	Kinetic Jaffe	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		without HIV (149 DM and HIV; 504 DM without HIV)	Male gender: 32% Among diabetic patients without HIV Age (years): 51-60		MDRD				
Eghan B[138]	2007, Ghana, West	Outpatient diabetic clinic of the department of medicine at Komfo Anokye Teaching Hospital	109	Diabetic patients	Age (years): 54.1±10.9 Male gender: 28% Hypertension: 39% BMI(kg/m^2): 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

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/m^2): 29.7 (range,12.2–67.4) BMI categories (kg/m^2): <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	Records of 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/m^2): 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	Albuminuria defined as (mg/mmol) microalbuminuria 3-30 macroalbuminuria >30	Quantitative assessment of albuminuria by ACR	not measured	21.3% microalbuminuria 4.1% macroalbuminuria	**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/l	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/m^2): 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 m^2	Medium

Aryee C[139]	2016, Ghana, West	Komfo Anokye Teaching Hospital and the surrounding community	242	180 non-diabetic hypertensive patients and 61 age matched controls	Age (years): 22-87 Male gender:37% SBP (mmHg): hypertensive patients(on antihypertensive therapy:155.46±1.82, no antihypertensive therapy:152±3.27), control (117.38±0.96) DBP (mmHg): hypertensive patients(on antihypertensive therapy:101.46±0.94, no antihypertensive therapy: 100.50±1.34), control (73.28±0.77) BMI (kg/m^2): hypertensive patients(on antihypertensive therapy:29.52±0.39, no antihypertensive therapy: 29.8±0.71), control (29.36±0.65)	eGFR <60 ml/min/1.73m^2	Urine albumin excretion, and eGFR by CG , 186 MDRD, and CKD-EPI	Not mentioned	30%	**Total prevalence (CKD-EPI): 14.5%** Prevalence by MDRD:13.3% Prevalence by CG:16.6%	Low
Nabbaale J[140]	2015 Uganda East	out- patient hypertension clinic	256	Newly diagnosed eligible black adult hypertensive patients	Age (years): 54.3 ± 6.2 Male gender: 36.7%	Microalbumnuria as a random urine albumin level between 30 and 299 mg/dl.	Quantitative assessment of albumin in urine	Not measured	39.5%	**Total prevalence (based on microalbumin uria): 39.5%**	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 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	Proteinuria	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/m^2): 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	Patients attending the primary health care facilities	Age (years): 43.35± 12.80 Male gender: 16% Hypertension: 10% DM: 5.95% BMI (kg/m^2): 28.67 ± 6.43 BMI categories (kg/m^2): <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 m^2 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 m^2	Medium
Sumaili EK [25]	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

	Central	health care								stage 1: 4.2%, stage 2: 6.1%, stage 3: 18.3%, stage 4: 1.9%, stage 5: 5.7%	
Anyabolu E[30]	2016, Nigeria, West	Federal Medical Center	136	Subjects from medical out-patient department of the hospital.	Age (years): 38.58±11.79 Male gender: 27.9% BMI(kg/m^2): 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 and Milpark Hospitals	233	African patients with rheumatoid arthritis	Age (years): 57.1±10.8 Male gender: 17.2% BMI(kg/m^2): 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	194	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 m^2 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	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 [27]	South Africa South	hospital		the Renal Unit	Male gender: 51.1% Hypertension: 13.2% DM: 10.8%	µmol/L) and small kidneys on imaging without evidence of reversible causes	assessment and Scr measurement	mentioned	proteinuria >3.5 g/dl	**prevalence: 37.9%**	
Hamdouk M[104]	2011 Sudan East	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 albuminuria	**Total prevalence: 26.4%** 14% had Scr ≥2 mg/dl	Low
EL-Safty I[129]	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	**Total prevalence (among those with Silica exposure): 100%**	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

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

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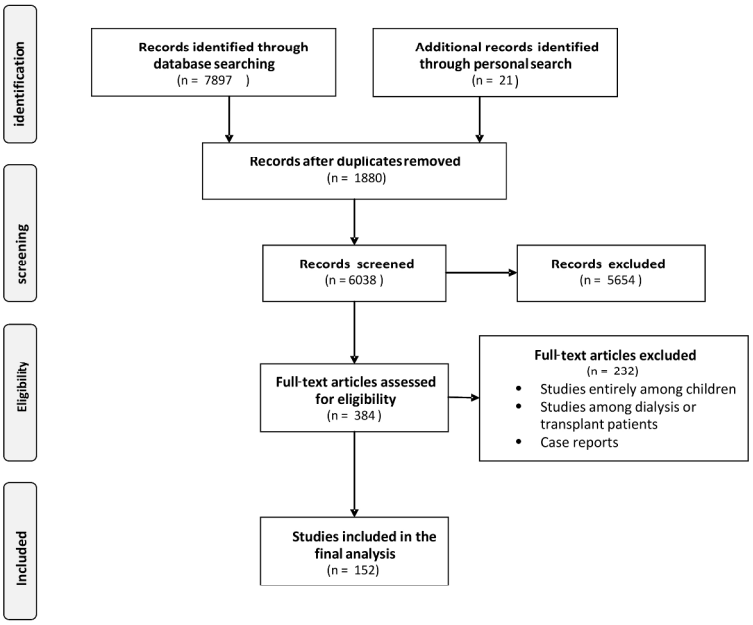

Fig 1

Fig1

254x190mm (300 x 300 DPI)

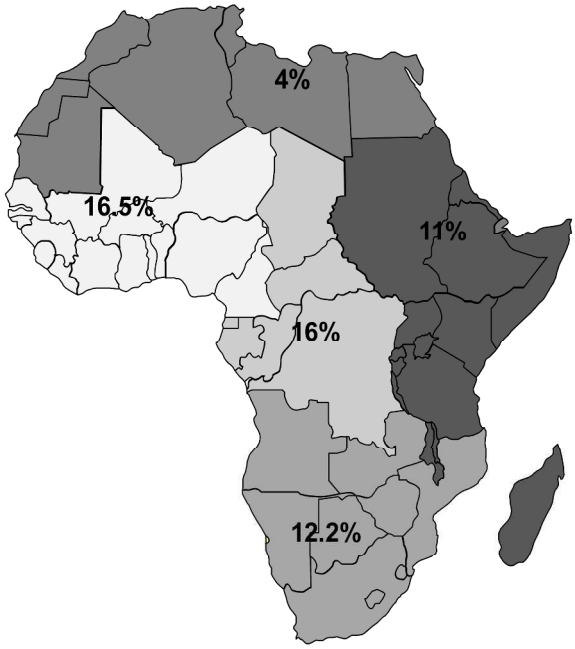

Fig 2

Fig2

254x190mm (300 x 300 DPI)

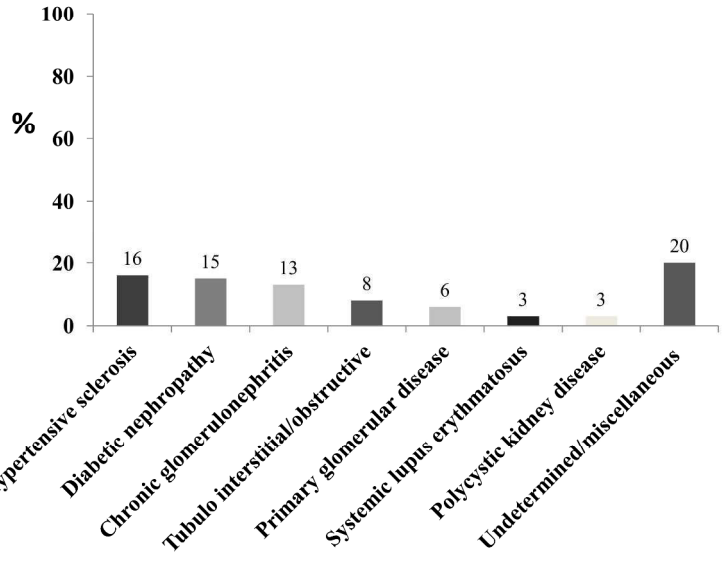

Fig 3

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

Study ID	Year Country Region	N	Population Characteristic	biopsy	causes of CKD
El Khayat S[31]	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% 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%
Afifi A[45]	1999, Egypt, North	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% 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%

Amira C[50]	2012, Nigeria, West	201	Age (years): 47.5±15.7 Male gender: 56.2 Hypertension: 42.8% DM: 13.4%	no	H.scl: 42.8% Ch.GN: 15.9% Obstructive uropathy: 14.9% DN: 13.4% PKD: 1% SLE: 1% Sickle cell nephropathy: 1% Analgesic nephropathy:0.5% Undetermined : 9.5%
Arogundade F[51]	2011, Nigeria, West	760	Age(years): 36 (range:15-90) Male gender: 70.3% Hypertension: 72.4% SBP (mmHg): 160 (range:120 – 270) DBP (mmHg): 100 (range:50 – 209)	no	Ch. GN: 43.7% H.scl: 31.1% Obstructive uropathy: 6.7% DN: 3.7% Tub.int: 2.2% PKD: 0.7% Undetermined : 12%
Counil É[52]	2008, Tunis, North	6397	Age (years): 51.4±18.0 Male gender: 56.5%	no	DN: 35% H.scl: 25.3% Tub.int: 19.7% Ch.GN: 13% PKD: 2.2% Undetermined:52.8%
Chijioke A[53]	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	H.scl:52.58% Ch.GN: 17.2% Tub.int: 17.1% PKD: 4.3% DN: 2.6% Chronic pyelonephritis: 2.6% Obstructive uropathy:1.7% Undetermined: 1.9%
Madala N[54]	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	H.scl: 75.2% DN: 29.8% HIV nephropathy: 28.6% Ch.GN: 7% Tub.int:6% Undetermined: 6%
Okpechi I[55]	2013, South Africa, South	111	Age (years): 66.3 ± 5.7 Male gender: 47.7% Hypertension: 71% DM: 19.8%	yes	MGN: 14.4% Mesangioproliferative GN:8.1% Crescentic GN: 7.2% 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% 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% Tub.int: 17.2% Miscellaneous: 8.1%

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%

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

Ibrahim S[69]	2012, Egypt, North	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% 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

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

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

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 research, reporting bias).	12,14, 15

PRISMA 2009 Checklist

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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TITLE PAGE

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

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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 high-risk 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 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 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 CKD[8]. 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 factors[9]. 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) Guidelines[11]. 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 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 trials[15], diagnostic studies[16], and observational studies[17]. 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 patients[19], one study in rheumatoid arthritis patients [20], one study among sickle cell anemia patients [21], two in specific occupational settings (silica exposure[22] and exposure to the nephrotoxic hair-dye, paraphenylenediamine[23]) and seven studies in family practice[24-26] or hospital-based[27-30] 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 proteinuria[25 ,97-104] whereas eleven studies used dipstick with confirmation by the protein-to-creatinine ratio or albumin-to-creatinine ratio[105-115]. 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 studies[29 ,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-EPI[21 ,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 m^2 [2,12,14,20,80,93-96,111,117,119,139,146,148-159,161-164,166,167], 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 m^2 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 m^2 [2,19,27,28,30,81,88,101-103,118,125,127,147,160,169,170].

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 [12,14,26,29,73,74,77-79,81,82,96,110,111,115,117,128,130,131,137,141,143-145,150-152,154,157,159-161,163,166,167]. 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 m^2 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 m^2 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 m^2 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 $m^{2;}$ 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 $m^{2.}$, 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 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 (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 m^2 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 [20]or 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].

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 studies[33 ,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%). The causes of CKD were undetermined/miscellaneous causes in one fifth of the patients (20%). (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 period[171] 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 comparability[173], 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 CKD[175]. 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 women[176 ,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 studies[79 ,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 judgment[178]. 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 population[9]. 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%[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 13.6% prevalence in the USA[180]. 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[181]. CKD prevalence in some Asian countries was higher than the estimates in the USA and in Europe, being 17.5% in Thailand[182], 15% in India[183], 13% in Japan[184], 11.9% in Taiwan[185], and 9.9% in China[186]. 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 CKD[189]. HIV/AIDS is pandemic in Africa, with a prevalence ranging from 0.5% in Senegal[190] to 27.4% in Swaziland[191]. 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[192]. 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 patients[200] and genetic factor [201] may influence the replication capacities within the isolated renal reservoir and thus lead to a diversity in clinical presentations[80].

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[19]. This isolated figure is higher than that reported in other countries[202-204]. More than one third (39%) patients with rheumatoid arthritis had CKD[20] 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 Africa[206] and CKD was principally caused by chronic glomerulonephritis and hypertension in East and Tropical Africa[207 ,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 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[210]. 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.
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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 assessment
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/m^2) <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
Fatiu A[73]	2011 Nigeria West	Market population	286	Age (years): 49.5 ± 5.7 Male gender: 9.8% Hypertension: 37.7% BMI (kg/m^2): 26.76 ± 5.28 <20 kg/m^2: 7.4% 20-25 kg/m^2: 33.4% > 25 kg/m$^{2:}$; 59%	Proteinuria ≥ +1	Midstream urine sample was tested by urinary strip	Not measured	**29.70%**	**Total prevalence (based on proteinuria prevalence): 29.7%**	Medium
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
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
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 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

		sample inhabitants of Seychelle								
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
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/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	**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
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%** **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
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
Oluyombo R[105]	2013 Nigeria West	Multistage 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

		of Households of Ilie		DM: 0.6%	dipstick proteinuria)	MDRD			Stage 1: 2.4% Stage 2: 4.1% Stage 3: 11.8% Stage 4: 0.5%	
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 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
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%** **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
Ayodele OE[77]	2011 Nigeria West	People at a major trade center, the public servant secretariat and the state broadcasting 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
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
Gharbi M[106]	2012 Morocco North	Stratified random sampling	10524	Age (years): range, 25-70 Male gender: (50%), Hypertension : 16.7%	eGFR < 60 ml/ min/1.73 m^2 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

		of population in two towns			≥ ++ 1 or haematuria: ≥ ++1) or diabetes type 1 associated with microalbuminuria					
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) **Prevalence by age:** ≤ 65 years: 49.1% >65 years: 40.7% **Prevalence by gender:** Females: 64% Males: 33%	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/m^2):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
Kalyesubula 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/m^2) 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 Cameroon Central-West	Population of the Littoral region	500	Age (years): 45.3 ± 13.2 Male gender: 53.4% BMI (kg/m^2): 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
Kaze F[112]	2015 Cameroon 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] **Prevalence by gender:** Females: 15.4% Males: 10.2%	High
Laurence E[130]	2016 South Africa South	Teachers from public schools	489	Age (years): 46.3 ± 8.5 Male gender: 30% BMI(kg/m^2):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

		in in the urban area of the Metro South Education District		Hypertension: 48.5% Diabetes mellitus: 10.1%						
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/m^2): 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
Mogueo A[131]	2015 South Africa South	Household residents of BellVille	902	Age (years): 55±15 Male gender: 23% BMI(kg/m^2): 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
Peck R[148]	2016, Tanzania, East	Stratified multistage sampling of adult population in Mwanza city, Geita and Kahama	1043	Age (years):35.5 ± 15.3 Male gender: 45.7% BMI(kg/m^2) 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
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
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%** **Prevalence by age:** 18–39 years: 7.6% 40–59 years:5.4% 60+ years: 7.7% **Prevalence by gender**	High

									Females: 6.2% Males: 7.9%	
Stanifer J [134]	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 once-measured 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
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

Author	Year, Country, Region	Location	N	Study group	Population characteristics	Definition of CKD	Method of outcome assessment	Creatinine assay	Proteinuria	CKD prevalence	Quality assessment
Wkba O[142]	2013, Ghana, West	ART clinic at the regional hospital	442	HIV (276 HAART-naïve patients 166 on HAART)	Age (years): HAART-naïve (33.42 ± 0.88), On HAART (36.91 ± 0.77) Male gender: HAART-naive (28.3%), On HAART (22.3%)	eGFR < 60 mL/min/1.73 m^2 for > 3months	CG, 186 MDRD, CKD-EPI	Kinetic Jaffe	Not measured	**Total prevalence (CKD-EPI): 10.2%** HAART naive: 8.7% CG, 9.1% MDRD, **8.7% CKD-EPI** On HAART: 14.5% CG, 12.6% MDRD, **12.6% CKD-EPI Prevalence by gender: Females: HAART-Naïve (7.5%), HAART (14%) Males: HAART-Naïve (11.5%), HAART (8.1%)**	Low
Stöhr W[143]	2011, Uganda,	Three centeres in	3316	HIV-infected patients initiating	Age (years): 36.8 (32-42.2)	eGFR<60 ml/min/1.73 m^2	CG	Kinetic Jaffe	Not measured	**Total prevalence : 7.2%**	Medium

	Zimbabwe, East and South	Uganda and Zimbabwe		ART	Male gender: 35% SBP: median:110 (IQR:100-120) mmHg DBP: median:70 (60-80) mmHg BMI: 21.1 (19.1–23.6) kg/m^2	on ≥ 2 consecutive visits 80 days apart or confirmed 25% decrease if eGFR <60 ml/min/1.73 m^2 at baseline					
Stöhr W[144]	2008, Uganda, Zimbabwe, East and South	Three centeres in Uganda and Zimbabwe	3316	HIV-infected patients on ART	Age (years): 36.8 (32-42.2) Male gender: 35% SBP: median:110 (IQR:100-120) mmHg DBP: median:70 (60-80) mmHg BMI categories: <18.5 kg/m^2: 18% 18.5- <25 kg/m^2 : 66% 25-<30 kg/m^2 : 12% ≥ 30 kg/m^2 : 4%	eGFR<60 ml/min 1.73 m^2 on ≥2 consecutive occasions >80 days apart or confirmed 25% decrease if eGFR <60 ml/min/1.73 m^2 at baseline	186 MDRD, CG	Kinetic Jaffe	Not measured	**Total prevalence (MDRD):**3.1**%** , CG 7.4%	Medium
Cailhol J [79]	2011, Burundi,	Outpatients HIV clinic	300	HIV-infected patients	Age (years): 40.1 (33-46.5) Male	KDOQI	Proteinuria by urinary	Not mentioned	6.10%	**Total prevalence (MDRD): 45.7%**	Medium

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

					DBP: median:70 (IQR: 60-80) mmHg BMI: median, 21.1 (IQR:19.1–23.6) kg/m^2	decrease if eGFR <60 ml/min/1.73 m^2 at baseline					
Fabian J[108]	2009, South Africa, South	HIV outpatient clinic at Johannesburg Hospital	578	HIV-infected naïve ART patients	Age (years): 37 (range 16–70 years) Male gender: 38% DM: 4.6% among group with microalbuminuria	Proteinuria ≥ +1 by urinary strip or albuminuria ≥30 mg/dl	Proteinuria by urinary strip and PCR	Not measured	43.7% had proteinuria	**Total prevalence (based on proteinuria prevalence): 43.7%**	Low
Lucas G[154]	2010, Uganda, East	All consenting individuals residing in every household in 50 Rakai District communities	1960	1202 HIV-infected patients and 664 HIV –ve age- and sex-matched controls	Age (years): HIV-ve, 28 (IQR: 24–35), HIV+ve: 30 (IQR: 25–36) Male gender: HIV-ve: (38.7%), HIV+ve (36.4%)	eGFR< 60ml/min/1.73 m^2	MDRD	IDMS-calibrated	Not measured	**Total prevalence among HIV+ve : 0.7%**	Medium
Jao J[160]	2011, sub-Saharan,	Primary health care units	2495	HIV-infected patients before ART	Age (years): 30 (IQR: 27–35) Male gender: 30%	CrCl <50 ml/min	CG,186 MDRD, CKD-EPI	Not mentioned	Not measured	**Total prevalence (CKD-EPI with coefficient for**	Medium

					BMI:22.8 (IQR: 20.4–25.6) kg/m^2					**black race): 2.5%** CG: 3.4% (MDRD with coefficient for black race): 2.5% **Prevalence by age:** <30 years: 29.8% 30-39 years:57.1% ≥ 40 years: 13.1% **Prevalence by gender**: **Females: 66.7%**	
Longo A[99]	2012, Congo, Central	Consecutive HIV patients from clinic	300	HIV-infected (ART treated=264) (ART naïve =36)	Age (years): 43 ± 9 Male gender: 23% Hypertension: 13% BMI:24 ± 5 (kg/m^2	eGFR< 60 ml/min/1.73 m^2/ or proteinuria defined as 1+ or greater	proteinuria by dipstick and 24-hour proteinuria, eGFR by MDRD, CG	Kinetic Jaffe and IDMS	20.50%	**Total prevalence : 20.5% 3% of the patients had eGFR< 60 ml/min/1.73 m^2 by MDRD**	Low
Sarfo F[109]	2013, Ghana, West	HIV clinic	3137	HIV-infected patients starting ART	Age (years): 38 (32-45) Male gender: 33% BMI: 20.3 (IQR: 17.6-22.7) kg/m^2	eGFR <60 ml/min/1.73 m^2; or proteinuria ≥+ 1 (confirmed by uPCR > 45	Proteinuria by urinary strip, ACR, PCR, eGFR by CG, MDRD,	Not mentioned		**Total prevalence (CKD-EPI):13.8%**	Low

						mg/mmol)	CKD-EPI				
Gupta S[161]	2011, Cameroon, Central-West	Electronic medical records of patients from 18 sites throughout Western Kenya	7383	HIV patients without ART	Age (years): 35.5 (29.3-44.0) Male gender: 26.9%	eGFR<60 ml/min/1.73 m^2	CG, MDRD	Not mentioned		**Total prevalence (MDRD): 9.4%** CG: 20.2% **Prevalence by gender;** Females: 79.1%	Medium
Okpechi MH[146]	2013, Congo, Central	Ambulatory Treatment Center	562	Newly diagnosed HIV patients	Age (years): 38.84 (IQR: 33.18-46.23) Male gender: 33.9% BMI: 20.31 (IQR: 17.97-22.89) kg/m^2	eGFR< 60 ml/min/1.73m^2	186MDRD	Kinetic Jaffe	Not measured	**Total prevalence :8.5%**	Low
Wools-Kaloustian K[80]	2007, Kenya, East	Academic Model for the Prevention and Treatment of HIV/AIDS (AMPATH) clinic	373	HIV-infected patients naive to ART	Age (years): 35.0 (range, 19–60) Male gender: 32.1% SBP: 104.7 (range, 80–140) mm/Hg	CrCl<60 ml/min/1.73 m^2	proteinuria by urinary strip, CG, full and abbreviated MDRD	Kinetic assay	6.2% (proteinuria ≥1+)	**Total prevalence :11.50%**	Low

Emem C[81]	2008, Nigeria, West	HIV/AIDS outpatient clinic	400	HIV-infected patients	Age (years): 34.6 ± 9.4 Male gender: 48.5% Hypertension: 13.2% BMI categories: <19.0 kg/m^2: 59.2 % 19-25 kg/m^2: 37.5% >25 kg/m^2: 3.3%	albuminuria +1 on at least two occasions (4 weeks apart) and or serum creatinine >1.5 mg/dl	Proteinuria or albuminuria by urinary strip and 24 hours proteinuria , CG	Not mentioned	38% proteinuria with dipstick 21.9% nephrotic range proteinuria	**Total prevalence :38.8 %** Among patients; 8.8% had CrCl <15 ml/min.	Medium
Wyatt C[82]	2011, Rwanda, East	Community based	891	677 HIV-infected and 214 HIV-uninfected	Age (years): 34 (IQR: 30–39) HIV +ve/43 (IQR:34–50) HIV -ve Male gender: 0 Hypertension: HIV+ve: 4.8%/ HIV-ve: 8.3% BMI (kg/m^2): HIV+ve: 20.9 (IQR: 19.0–23.3)/ HIV-ve: 20.5 (IQR: 18.5–23.3)	eGFR<60 ml/min/1.73 m^2/ or proteinuria +1 or greater	proteinuria by urinary strip, eGFR by MDRD, CKD-EPI, CG	Kinetic Jaffe	(9% among HIV + and7.2% among non-infected)	**Total prevalence among HIV +ve:9%** 2.7% had eGFR< 60 ml/min/1.73 m^2 CKD prevalence among HIV-ve: 7.2% 1.5% had eGFR< 60 ml/min/1.73 m^2	Medium

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

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

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

				men; HIV-infected patients eligible for ART	women, 33 (IQR: 28–39) Male gender: 33%						
Mulenga L[163]	2008, Zambia, South	Clinic	25249	HIV-infected, ART-naïve adults initiating treatment	Age (years): normal CrCl, 33.7±7.9, decreased CrCl, 38.5±9.9 Male gender: 39.7%	CrCl< 60 ml/min	Absolute Scr, eGFR by CG and MDRD	Not mentioned	Not measured	**Total prevalence (MDRD): 3.2%** :	Medium
Adedeji T[158]	2015, Nigeria, West	The University of Ilorin Teaching hospital,	183	Newly diagnosed HIV-infected ART naïve patients	Age (years): 37.9+ 10.5 Male gender: 42.6% BMI (kg/m^2): 20.88+ 3.56	eGFR< 60 ml/min/1.73m^2	Absolute Scr, eGFR by MDRD	Kinetic Jaffe and IDMS	Not measured	**Total prevalence: 24%**	Low
Anyabolu E[135]	2016, Nigeria, West	Federal Medical Centre	529	393 newly diagnosed drug-naïve HIV patients, 136 age and sex matched HIV-seronegative	Age (years); 38.84 ± 10.65 Male gender: 28% BMI categories: <18.5.0 kg/m^2: 7% 18.5-24.9 kg/m^2: 35%	24-hours urine protein ≥0.300 g and/or GFR <60 ml/min	Quantitative assessment of protienuira, Scr, and eGFR	Not mentioned	Not mentioned	**Total prevalence among HIV +ve patients:22.9%** Prevalence among HIV -ve: 8.1%	Low

				controls	25-29.9 kg/m^2: 32% ≥ 30 kg/m^2:23%						
Ayokunle D[113]	2015, Nigeria, West	Medical Out-patient Department of University of Ilorin Teaching Hospital	335	227 newly-diagnosed, ART naïve patients with HIV/AIDS, 108age and sex matched control	Age (years): 40.3 ± 10.3 Male gender: 44% BMI (kg/m^2): 20.5 ± 4.8 among HIV patients , 26.7 ± 5.3 among control group SBP(mmHg): 111.9 ± 1 among HIV patients, 126.1 ± 12.0 among control group DBP(mmHg): 72.9 ± 9.5 among HIV patients, 80.6 ± 6.8 among control group	albuminuria ≥ 30 mg/g and/or eGFR < 60 ml/ml/1.73m^2	Proteinuria by dipstick, and ACR and eGFR by MDRD	Kinetic Jaffe	Not mentioned	**Total prevalence among HIV patients: 47.6%** The prevalence among HIV –ve: 16.7%	Low
Chadwick D[114]	2015, Ghana,	Komfo Anokye	330	HIV patients on ART	Age(years): 39 (IQR: 35–46)	Proteinuria or CrCl<60ml/min	Proteinuria (dipsticks,	Not mentioned	37% by dipstick and	**Total prevalence (proteinuria) :**	Low

	West	Teaching Hospital			Male gender: 25% BMI(kg/m^2): 22.9 (IQR: 20.5-26.6)		PCR, and ACR) and GFR by CG		12% by PCR	**37%** CrCl<60 ml/min among 7%	
EdwardsJ[166]	2015, Kenya, East	Two primary care clinics	2206	210 HIV+ve patients and 1996 HIV –ve	Age (years): HIV +ve: 43 (IQR: 39–50), HIV-ve: 49 (IQR:40–56) Male gender: HIV +ve: 31%, HIV-ve:28.7% Hypertension: HIV+ve:44%, HIV-ve: 33.2% Diabetes mellitus: HIV +ve: 5% , HIV –ve: 15.2%	CrCl<60 ml/min	eGFR by CKD-EPI	Not mentioned	Not measured	**Total prevalence: 12.1% HIV+ve: 17% HIv-ve: 11%**	Medium
Glaser N[14]	2016, Malawi, East	Lighthouse Clinic	363	116 HIV +ve ART-naïve patients and 247 HIV-ve patients	Age (years): 31 (IQR:26–39) Male gender: 52%	eGFR< 60 ml/min	eGFR by CG, MDRD, and CKD-EPI with and without correction factor	IDMS calibrated creatinine and cystatin-C	Not measured	**Total prevalence among HIV+ve (creatinine based CKD-EPI):1.9%**	Medium

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

	Uganda, East	diseases clinic of Gulu Regional Referral Hospital		HIV patients not receiving ART	± 9.5 Male gender: 36.3% BMI(kg/m^2) <18: 33%	ml/min per 1.73 m^2	by dipstick and eGFR by MDRD	mentioned	≥ +1: 52%	**14.4% Prevalence by gender:** Females: 16.5% Males: 10.4%	
Okafor U[136]	2016, Nigeria, West	University of Benin Teaching Hospital	383	HIV infected naïve patients	Age (years): 36.03 ± 9.08 Male gender: 41%	eGFR <60 ml/min per 1.73 m^2 and/or evidence of kidney injury as detected when the PCR (mg/g) was ≥200.	Quantitative assessment of proteinuria by PCR and eGFR by MDRD	Kinetic Jaffe	Not mentioned	**Total prevalence: 53.5%**	Low
Seape T[156]	2016, South Africa, South	Medical in-patients at the Chris Hani Baragwanath Hospital	100	HIV infected naïve patients	Age (years): 37.0±9.6 Male gender: 60% BMI(kg/m^2): 20.9 ±5.1	eGFR <60 ml/min per 1.73 m^2	eGFR by CG, MDRD, CKD-EPI	IDMS	Not measured	**Total prevalence: 16%**	Low
Wensink G[137]	2015, South Africa, South	Rural Medical Centre	903	HIV infected adult patients	Age (years): 40(IQR:34-48) Male gender: 31% Diabetes mellitus: 4%	Albuminuria or eGFR <60 ml/min / 1.73 m^2	Albuminuria by ACR and eGFR by MDRD and CKD-EPI	Not mentioned	21%	**Total prevalence (albuminuria): 21% 2% had eGFR< 60 ml/min/1.73 m^2**	Medium

					Hypertension: 23%						
Zachor H[157]	2016, South Africa, South	Outpatient infectious clinic at an academic hospital	650	HIV infected patients initiating ART	Age (years): 37.9±9.4 Male gender: 35.5% Diabetes mellitus:2.2% Hypertension: 7.8%	eGFR <60 ml/min per 1.73 m^2	eGFR by MDRD and CKD-EPI	IDMS	Not measured	**Total prevalence: 2 %**	Medium
Mekuria Y[150]	2016, Ethiopia, East	Jimma University Specialized Hospital	446	(223 HAART naïve and 223 HAART experienced)	Age (years): HAART naive: 38.25 ±10.8, HAART +ve: 35.14 ±9.2 Male gender: 37% BMI(kg/m^2) : HAART naïve: 20.7±3.2, HAART +ve: 21.6 ±3.5 Hypertension: 3.36% Diabetes mellitus: 21.4%	eGFR <60 ml/min per 1.73 m^2	eGFR by CG	Kinetic Jaffe	Not measured	**Total prevalence: 18.2%**	Medium

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	Creatinine assay	proteinuria	CKD prevalence	Quality assessment
Janmohamed MN[86]	2013, Tanzania, East	diabetes mellitus clinic of Bugando Medical Centre in Mwanza	369	Consecutive diabetic patients	Age (years): 54 (IQR: 45-62) Male gender: 46.6% Hypertension: 57.5% BMI (kg/m^2): 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 m^2 or evidence of kidney damage (microalbuminuria or overt proteinuria).	Microalbuminuria, 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/m^2): 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	Endocrinology center at the National Institute of nutrition	689	Type 2 diabetic patients from computerized 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	Consecutive type 2 diabetic patients	Age (years): 56.7 ±9.9 Male gender: 49% Hypertension: 50% BMI (kg/m^2): 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/m^2): (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≤60 ml/min/1.73 m^2	Measurement of microalbuminuria, eGFR by MDRD	Not mentioned		**Total prevalence: 11%**	Low

				volunteers	DBP (mean ±SE): 76.8 ±1.9 BMI (mean ±SE in kg/m^2): 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/m^2): 25.2± 4.7 Duration of DM (years): 17.3 ±8.5	KDOQI	Microalbuminuria (>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: 90%**	Low
Mafundikwa A [103]	2007, Zimbabwe, South	Diabetic clinic	75	Consecutive 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	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/m^2): 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/m^2): 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/m^2): 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 patients			186MDRD			ml/min/1.73 m^2	
Adebamowo S[151]	2016, Nigeria, Ghana, Kenya (sub-Saharan)	University medical centers and surrounding communities	4815	2208 Cases of type 2 DM 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/m^2): 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	Kinetic Jaffe	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		without HIV (149 DM and HIV; 504 DM without HIV)	Male gender: 32% Among diabetic patients without HIV Age (years): 51-60		MDRD				
Eghan B[138]	2007, Ghana, West	Outpatient diabetic clinic of the department of medicine at Komfo Anokye Teaching Hospital	109	Diabetic patients	Age (years): 54.1±10.9 Male gender: 28% Hypertension: 39% BMI(kg/m^2): 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%** **Prevalence by gender:** **Males: 31.9%**	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 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/m^2): 29.7 (range,12.2–67.4) BMI categories (kg/m^2): <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	Records of 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/m^2): 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

										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%**	
Lengani A[127]	2000 Burkina Faso West	department of Cardiology or Internal medicine	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 history with clinical manifestations	Measurement of scr, 24-hour proteinuria	Not mentioned		**Total prevalence: 50.8%**	Low
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	100 General	1091	Random	Age (years): >=35 years	Albuminuria defined	Quantitative	not	21.3%	**Total**	Medium

	South Africa South	practice centres		hypertensive patients	Male gender: 48.5% BMI: 23.6% of the patients had a normal BMI 41.9% were overweight and 34.2% were frankly obese	as (mg/mmol) microalbuminuria 3-30 macroalbuminuria >30	assessment of albuminuria by ACR	measured	microalbuminuria 4.1% macroalbuminuria	**prevalence (based on albumnuria): 25.4%**	
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/l	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/m^2): 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 m^2	Medium
Aryee C[139]	2016, Ghana, West	Komfo Anokye Teaching Hospital and the surrounding community	242	180 non-diabetic hypertensive patients and 61 age matched controls	Age (years): 22-87 Male gender:37% SBP (mmHg): hypertensive patients(on antihypertensive therapy:155.46±1.82, no antihypertensive therapy:152±3.27), control (117.38±0.96) DBP (mmHg): hypertensive patients(on antihypertensive	eGFR <60 ml/min/1.73m^2	Urine albumin excretion, and eGFR by CG , 186 MDRD, and CKD-EPI	Not mentioned	30%	**Total prevalence (CKD-EPI): 14.5%** Prevalence by MDRD:13.3% Prevalence by CG:16.6%	Low

					therapy:101.46±0.94, no antihypertensive therapy: 100.50±1.34), control (73.28±0.77) BMI (kg/m^2): hypertensive patients(on antihypertensive therapy:29.52±0.39, no antihypertensive therapy: 29.8±0.71), control (29.36±0.65)						
Nabbaale J[140]	2015 Uganda East	out- patient hypertension clinic	256	Newly diagnosed eligible black adult hypertensive patients	Age (years): 54.3 ± 6.2 Male gender: 36.7%	Microalbumnuria as a random urine albumin level between 30 and 299 mg/dl.	Quantitative assessment of albumin in urine	Not measured	39.5%	**Total prevalence (based on microalbuminuria): 39.5%**	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 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	Proteinuria	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 Aristide Le Dantec University Hospital Center.			Hypertension: 30%	without hematuria/ renal insufficiency/ abnormal renal biopsy				**72%**	
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/m^2): 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, West	Nephrology out-patient clinic at Lagos University Teaching Hospital	469	(230 first degree relatives of patients with CKD and 230 age- and gender-matched controls with no personal or family history of CKD)	Age (years): 33.49 ± 12.0 BMI(kg/m^2): first degree relatives: 25.5 ± 5.3, controls: 23.8 ± 4.0 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	Reduced eGFR	Albumnuria by ACR and eGFR by MDRD	Not mentioned	46%	**Total prevalence: 4%**	Low
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

	Sudan East	health care		primary health care facilities	Male gender: 16% Hypertension: 10% DM: 5.95% BMI (kg/m^2): 28.67 ± 6.43 BMI categories (kg/m^2): <18: 2.38% >25.13: 71.83	mL/min/ 1.73 m^2 with or without proteinuria.	strip and eGFR by MDRD	mentioned		**prevalence: 10.32%**	
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 m^2 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 m^2	Medium
Sumaili EK [25]	2009 Congo Central	Primary and secondary health care	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** stage 1: 4.2%, stage 2: 6.1%, stage 3: 18.3%, stage 4: 1.9%, stage	High

										5: 5.7%	
Anyabolu E[30]	2016, Nigeria, West	Federal Medical Center	136	Subjects from medical out-patient department of the hospital.	Age (years): 38.58±11.79 Male gender: 27.9% BMI(kg/m^2): 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 and Milpark Hospitals	233	African patients with rheumatoid arthritis	Age (years): 57.1±10.8 Male gender: 17.2% BMI(kg/m^2): 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	194	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 m^2 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 [27]	2010 South Africa South	Tertiary hospital	1216	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	Proteinuria by quantitative assessment and Scr measurement	Not mentioned	16.7% proteinuria >3.5 g/dl	**Total prevalence: 37.9%**	Low
Hamdouk M[104]	2011 Sudan	hairdressing saloons	72	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 renal biopsy		a	**26.4%** 14% had Scr ≥2 mg/dl	
EL-Safty I[129]	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	**Total prevalence (among those with Silica exposure): 100%**	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

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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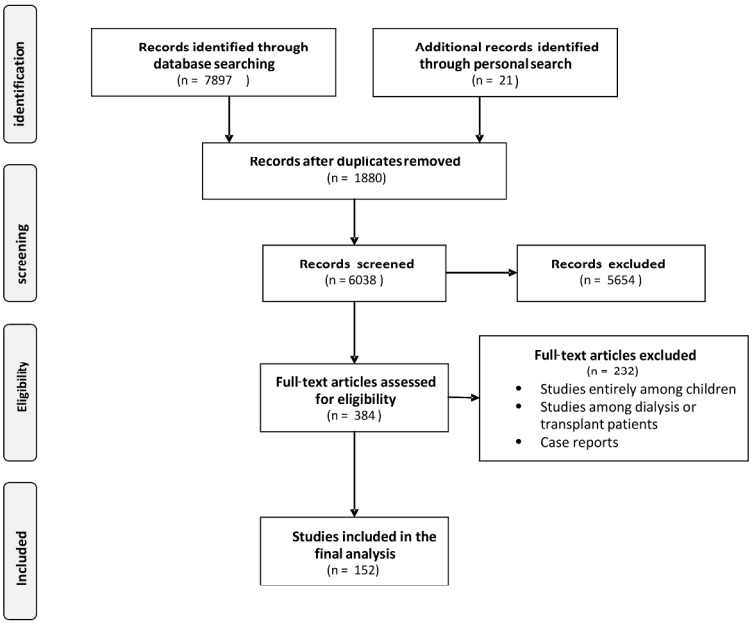

Fig 1

Fig1

254x190mm (300 x 300 DPI)

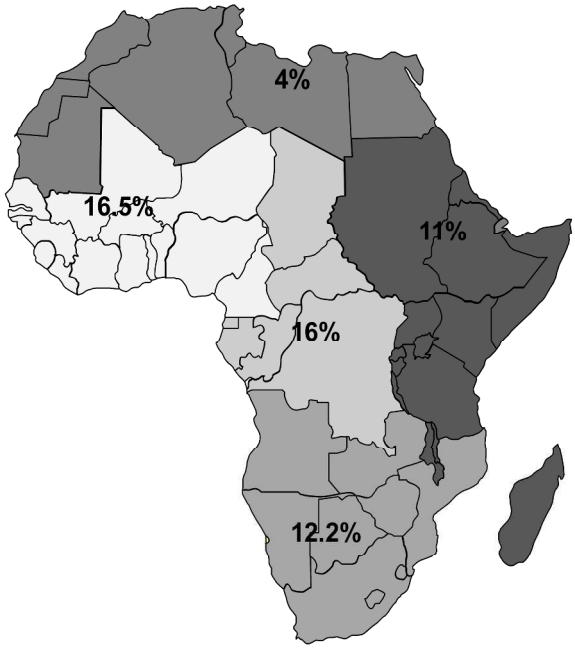

Fig 2

Fig2

254x190mm (300 x 300 DPI)

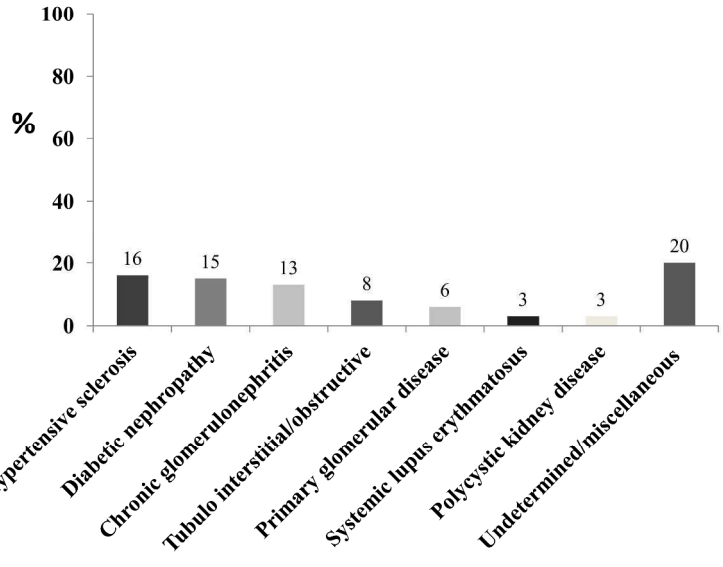

Fig 3

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

Study ID	Year Country Region	N	Population Characteristic	biopsy	causes of CKD
El Khayat S[31]	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% 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%
Afifi A[45]	1999, Egypt, North	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% 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%

Amira C[50]	2012, Nigeria, West	201	Age (years): 47.5±15.7 Male gender: 56.2 Hypertension: 42.8% DM: 13.4%	no	H.scl: 42.8% Ch.GN: 15.9% Obstructive uropathy: 14.9% DN: 13.4% PKD: 1% SLE: 1% Sickle cell nephropathy: 1% Analgesic nephropathy:0.5% Undetermined : 9.5%
Arogundade F[51]	2011, Nigeria, West	760	Age(years): 36 (range:15-90) Male gender: 70.3% Hypertension: 72.4% SBP (mmHg): 160 (range:120 – 270) DBP (mmHg): 100 (range:50 – 209)	no	Ch. GN: 43.7% H.scl: 31.1% Obstructive uropathy: 6.7% DN: 3.7% Tub.int: 2.2% PKD: 0.7% Undetermined : 12%
Counil É[52]	2008, Tunis, North	6397	Age (years): 51.4±18.0 Male gender: 56.5%	no	DN: 35% H.scl: 25.3% Tub.int: 19.7% Ch.GN: 13% PKD: 2.2% Undetermined:52.8%
Chijioke A[53]	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	H.scl:52.58% Ch.GN: 17.2% Tub.int: 17.1% PKD: 4.3% DN: 2.6% Chronic pyelonephritis: 2.6% Obstructive uropathy:1.7% Undetermined: 1.9%
Madala N[54]	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	H.scl: 75.2% DN: 29.8% HIV nephropathy: 28.6% Ch.GN: 7% Tub.int:6% Undetermined: 6%
Okpechi I[55]	2013, South Africa, South	111	Age (years): 66.3 ± 5.7 Male gender: 47.7% Hypertension: 71% DM: 19.8%	yes	MGN: 14.4% Mesangioproliferative GN:8.1% Crescentic GN: 7.2% 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% 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% Tub.int: 17.2% Miscellaneous: 8.1%

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%

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

Ibrahim S[69]	2012, Egypt, North	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% 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

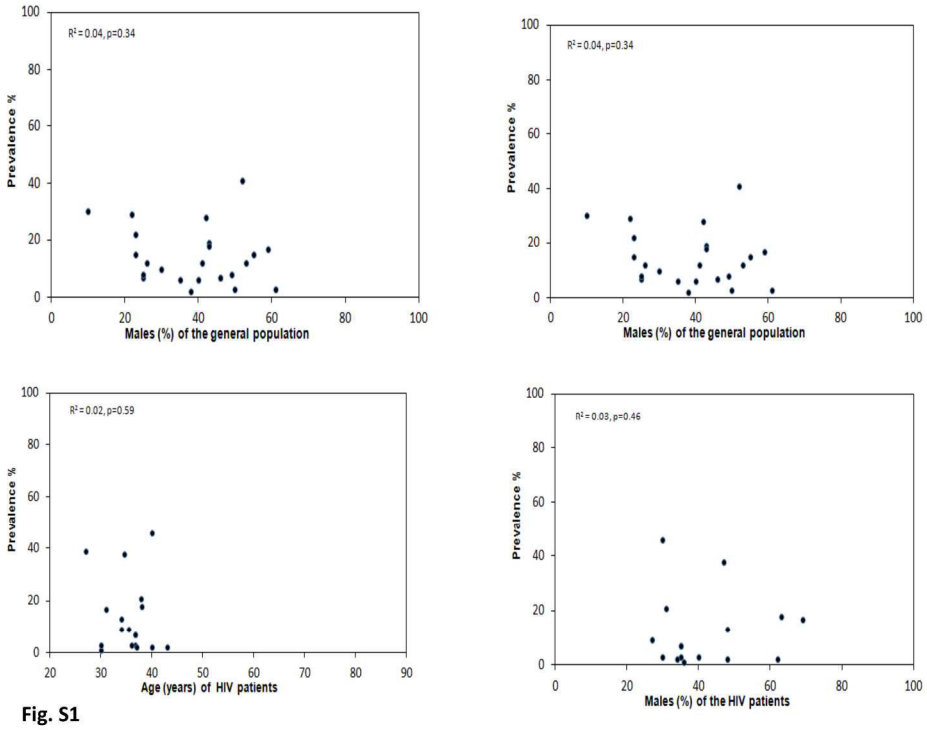

Fig. S1

254x190mm (300 x 300 DPI)

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

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

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 research, reporting bias).	12,14, 15

PRISMA 2009 Checklist

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

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. doi:10.1371/journal.pmed1000097

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