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INVITED REVIEW

A roadmap for kidney care in Africa: An analysis of International Society of Nephrology–Global Kidney Health Atlas Africa data describing current gaps and opportunities

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ABSTRACT

Delivery of kidney care in Africa is significantly constrained by various factors. In this review, we used International Society of Nephrology–Global Kidney Health Atlas (ISN–GKHA) data for Africa to address sub-regional differences in care delivery in the continent with focus on infrastructure, workforce, and the economic aspects of kidney care. Forty-two African countries participated in the survey conducted in 2018. North Africa had the highest proportions of nephrologists [12.53 per million population (pmp)], nephrology trainees (2.19 pmp) and haemodialysis (HD) centres (8.58 pmp); whereas southern Africa had the highest proportions of peritoneal dialysis (PD) centres (0.89 pmp) and kidney transplant (KT) centres (0.29 pmp); West Africa had the greatest nephrology workforce shortages. The annual median costs of HD (US$22,731 [interquartile range (IQR): US$1,560–43,902]) and PD (US$34,165 [US$34,165–34,165]) were highest in Central Africa and only Algeria, Egypt and South Africa reported zero co-payment for all modalities of kidney replacement therapy in the public sector. Policies on chronic kidney disease and non-communicable diseases were scarcely available across all African sub-regions. The ISN–GKHA African data highlight a stark difference in kidney care measures between North and sub-Saharan Africa and also suggest the need for a more cohesive approach to policy formulations that support and protect patients with kidney disease in the continent, especially from the excessive costs associated with care. Using the World Health Organization (WHO) Global Action Plan for non-communicable diseases, this paper proposes an African roadmap for optimal kidney care.

Keywords: chronic kidney disease; kidney failure; dialysis; transplantation; cost; policy.

INTRODUCTION

The global annual mortality due to chronic kidney disease (CKD) is projected to reach 2.2 million in 2040, up from 1.2 million in 2017 [1]. Mortality related to CKD and kidney failure (KF) is particularly grim in Africa and likely to be multifactorial in origin, related to the prevalent healthcare systems and absence of universal health coverage (UHC) [2,3]. Ashuntantang et al. have shown in a pooled analysis of sub-Saharan African data that up to 96% of adults and 95% of children who could not access dialysis died, or were presumed to have died, within 3 months of dialysis initiation [3]. In another study, from Nigeria, only 6.1% of patients on dialysis were able to achieve more than 15 sessions – most died at home due to inability to pay for treatment [4].

The International Society of Nephrology (ISN)–Kidney Health Atlas (GKHA) programme recently reported ISN regional data on the status of kidney care across all ISN regions [5], which provided an overall snapshot of the state of affairs [6]. In this review, we provide both country-level data and sub-regional differences in availability, accessibility, and affordability of kidney care in Africa, and highlight the implications of these for patient outcomes. Finally, we discuss policy-level opportunities to improve kidney care and outcomes in the continent.

THE CURRENT STATE OF KIDNEY CARE IN AFRICA

Geography, political and economic landscape of Africa

Africa is the world's second-largest and second-most populous continent with a land mass of 30.3 million km^2 and a population of about 1.3 billion people [7]. In 2018, its population accounted for 16% of the global population and is projected to reach 2.5 billion by 2050 [8]. Colonisation deeply influenced the political landscape of Africa; decolonisation occurred mostly in the mid-to-late 1950s to 1975, following which the continent experienced repeated conflicts and wars. The 55 member states of the African Union (AU) are subdivided into 5 sub-regions: North Africa (7 countries), West Africa (15), Central Africa (10), East Africa (14), and southern Africa (10) [9]. Despite having an abundance of natural resources, Africa is the world's poorest and least-developed continent due to a variety of causes including political instability, high levels of corruption, failed planning, high levels of illiteracy, lack of access to global capital, and frequent tribal and military conflicts [10]. The gross domestic product (GDP) of Africa is much lower than for other world regions and varies widely within the continent (Figure 1). The numerous demographic, cultural, economic, and geopolitical challenges have stymied healthcare delivery in a continent overwhelmed with the double burden of communicable and non-communicable diseases (NCDs) [2].

General health services, policies, and funding in the African region

Health systems in Africa suffer from enormous shortages of skilled personnel, funding, services – including medicines and technologies – as well as the absence of policies and guidelines to achieve health goals [2,11,12]. In one survey, only one third of African countries reported having a national strategy in place for NCDs, compared to 80% in Oceania [11]. Although health spending in Africa continues

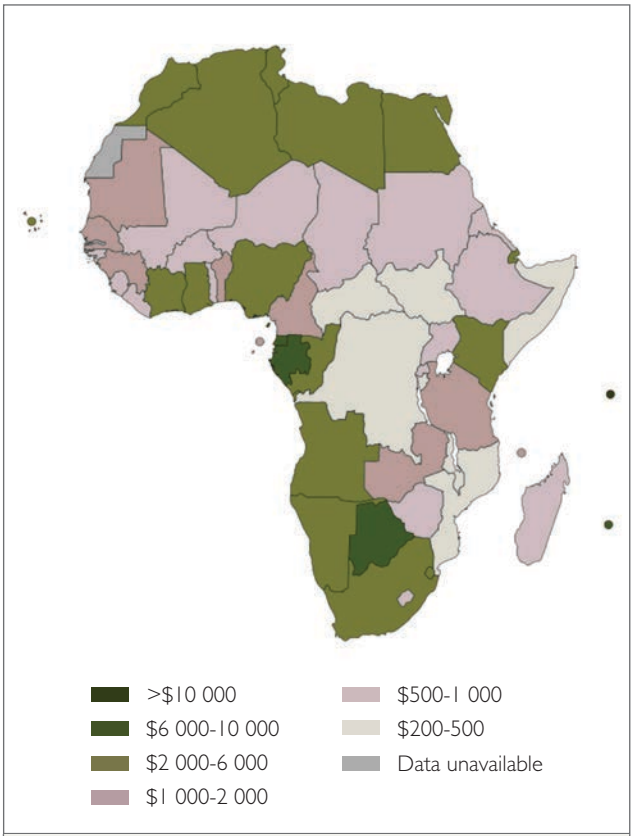

Figure 1. Map of Africa by 2020 nominal GDP per capita (US$).
From: https://en.wikipedia.org/wiki/List_of_African_countries_by_GDP_(nominal)

to increase, sub-Saharan Africa still has the lowest investment in health per capita – US$218 in 2014 (US$85 in Ethiopia, US$46 in DR Congo, US$936 in Namibia, and US$121 in Senegal – compared to US$5,221 in high-income countries captured more widely in the Survey [13]).

Burden and outcomes of CKD in Africa

In sub-Saharan Africa alone, disability-adjusted life years due to NCDs increased by 67% between 1990 and 2017. Estimates of the burden of CKD and KF in Africa have varied significantly depending on the methods used for assessment and the population involved [14]. One pooled analysis of studies from sub-Saharan Africa estimated the prevalence of CKD to be 13.9% (95% confidence interval [CI] 12.2–15.7%) among medium or high-quality studies with prevalence as high as 30% in Zimbabwe [1,14]. The high prevalence of CKD in Africa suggests an even larger population with CKD risk factors [15], which progresses to KF [3]. The main causes of CKD in the continent are somewhat different from the rest of the world, with glomerulonephritis and infections, including HIV/AIDS, accounting for a disproportionately large proportion of cases [14,16].

Kidney care capacity in Africa

Workforce for kidney care

From the Survey, the median number of nephrologists in Africa was 0.62 (0.24–1.56) pmp and ranged from 0.20 (0.14–0.30) pmp in East Africa to 12.53 (12.0–15.63) pmp in North Africa. The distribution of nephrology trainees also followed the same trend: 0.36 (0.06–0.92) pmp overall, 0.08 (0.06–0.11) pmp in East Africa and 2.19 (1.92–3.02) pmp in North Africa (Table 1). Nephrologists bore the predominant responsibility for delivery of KF care across most sub-regions, except in southern Africa where multidisciplinary teams were mostly responsible (n = 3 of 4 responses; 75%) for care of KF patients.

A relatively small nephrology workforce remains a major impediment to the provision of kidney care and the achievement of guideline targets for CKD and KF patients in Africa. Overall, nephrologists (n = 36; 88%) and interventional radiologists for HD access (n = 36; 88%) were the categories of the workforce with the highest shortages in Africa with variations across the different sub-regions. North Africa had the least workforce shortage (40), whereas West Africa had the greatest (137) (Supplementary Table S1). The nephrology workforce is heavily affected by the non-availability of training centres and training resources – such as libraries and journal subscriptions – as well as mentorship programmes; there is a continual brain drain of healthcare workers due to poor remuneration, political instability, and offers of more promising careers and financial and lifestyle opportunities elsewhere [17,18]. One study has estimated that lower-middle-income countries (LMICs) annually lose up to US$15.9 billion (95%CI: $3.4–38.2 billion) due to the migration of physicians to high-income countries (HICs), with the greatest total costs incurred by India, Nigeria, Pakistan, and South Africa [19]. Such migration of healthcare workers, beyond the economic loss of their services to their country, also contributes to underdevelopment of health systems and services and the enormous strain on public health delivery.

Some practical measures can be implemented to address the ongoing shortfall of nephrology personnel in Africa. For instance, task shifting and sharing has been promoted by the World Health Organization (WHO) to improve efficient use of available human resources for health in low- and lower-middle-income countries (LLMICs) that involves a rational redistribution of tasks among health workforce teams [20]. This strategy has been used in the management of other chronic conditions in resource-limited settings, including HIV/AIDS [21], diabetes [22] and hypertension [21]. Allied healthcare workers – such as nurses, pharmacists, and community health workers – can be trained to take up uncomplicated tasks, including specific roles in multidisciplinary clinics, hypertension centres, diagnostic tasks (such

Table 1. Distribution of workforce for delivery of kidney care by African sub-regions.

	Nephrologists - median (IQR) (PMP)	Nephrology trainees - median (IQR) (PMP)	Who bears primary clinical responsibility for the delivery of kidney failure care in your country? [n (%)]				
			Nephrologists	Primary care physicians	Nurse practitioners or specialised nurses	Multi-disciplinary teams	Health officers/ extension workers
Global	9.95 (1.23–22.72)	1.42 (0.35–3.70)	144 (92)	34 (22)	23 (15)	30 (19)	2 (1)
Africa	0.62 (0.24–1.56)	0.36 (0.06–0.92)	32 (78)	12 (29)	4 (10)	7 (17)	0(0)
African subregions							
Central Africa (n = 6)	0.80 (0.27–1.58)	0.16 (0.00–0.35)	6 (100)	3 (50)	2 (33)	1 (17)	0(0)
East Africa (n = 11)	0.20 (0.14–0.30)	0.08 (0.06–0.11)	7 (58)	5 (42)	0 (0)	1 (8)	0(0)
North Africa (n = 6)	12.53 (12.00–15.63)	2.19 (1.92–3.02)	6 (100)	1 (17)	0 (0)	1 (17)	0(0)
Southern Africa (n = 4)	0.85 (0.73–1.81)	0.90 (0.63–0.95)	1 (25)	0 (0)	0 (0)	3 (75)	0(0)
West Africa (n = 13)	0.66 (0.35–1.03)	0.49 (0.14–0.86)	12 (92)	3 (23)	2 (15)	1 (8)	0(0)

Abbreviations: IQR, interquartile range; pmp, per million population.

as urinalysis), and patient triage. To do this, training modules will need to be developed and protocols of diagnosis, treatment or referral should be in place. One study from Kenya showed that nurses participated in 21% of NCD consultations with varying roles that included assessing adherence, side effects, ordering blood tests, adding or stopping some medications, and referral back to the medical officer [23]. All of these were possible due to protocols and guidelines being in place and suggest that task shifting can relieve significant workforce gaps in Africa.

Other strategies to improve and retain the workforce should be used including improved coordination and support for nephrology training by the African Association of Nephrology (AFRAN) and country societies – these actions should include providing a nephrology curriculum to training institutions, guided by local needs [24], support for ISN regional training centres, ensuring workforce alignment with local priorities, and increased knowledge sharing. The last should feature inter-regional CMEs, open invitations to participate in clinical and basic science meetings, the efficient use of digital learning tools such as WhatsApp and as well as Zoom, as all as strengthening existing programmes and services (there is no need to initiate new and unsustainable programmes), continued advocacy for augmented funding of training programmes and institutions [18], and the integration of initiatives involving the respective ministries of health, education, and labour [25].

Funding, cost and affordability of KRT in Africa

Out-of-pocket expenditure was the predominant means of paying for HD and PD in West Africa (42%) and Central Africa (33%). The principal way of charging for HD and PD in southern Africa was through "public funding and free at point of delivery" in half of all cases and a mix of public and private funding for the other half (Supplementary Figure S1). There were also substantial variations in the means of funding for kidney transplantation (KT) medications across sub-regions, with North and East Africa having the highest proportions of publicly funded and free at point of delivery for such medication (Supplementary Figure S1). The annual costs of HD and PD were lowest in North Africa (HD: US$5,980 [IQR: US$5,282–9,152]; PD: US$6,895 [US$6,166–10,090] and were highest in Central Africa (HD: US$22,731 [US$1,560–43,902]; PD: US$34,165 [US$34,165–34,165]). The annual median costs of HD and PD for all sub-regions are shown in Figure 2. Data on co-payment for KRT were sparse, especially for PD and KT. Nine countries (21%) reported zero co-payment for HD, whereas 100% co-payment was reported by 5 countries (12%). Only Egypt, Algeria and South Africa reported zero co-payment for all three KRT modalities (Table 2). There was huge variability in affordability of KRT across Africa (Supplementary Figure S2).

Exorbitant out-of-pocket charges remain the main barrier to accessing the sparse services. Though the average cost of HD in Africa is commonly reported to be in the range

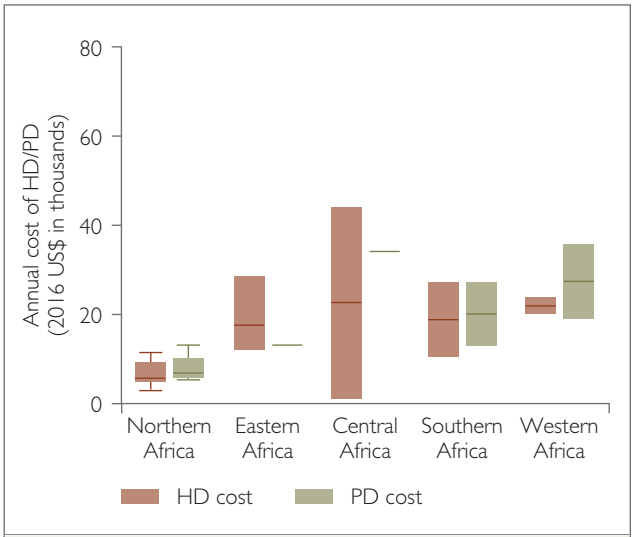

Figure 2. Annual cost of haemodialysis and peritoneal dialysis by African sub-region.
Abbreviations: HD, haemodialysis; PD, peritoneal dialysis; US$, US dollar.

US$100–150 per session [26], which compares poorly with the average income, with only seven African countries having a monthly minimum wage ≥US$200 [27]. The high cost, in the absence of UHC, makes KRT unsustainable. Using estimates of the number of individuals needing dialysis in 2010 and local corresponding charges, Crosby et al. estimated the cost of providing HD in Kenya, Nigeria and Senegal to be (in International dollars) Int$1.7 billion, Int$3.5 billion, and Int$450 million, respectively, equivalent to 15.2%, 55.8% and 35.8% of the total domestic government expenditure on health services of those countries. (One Int$ in the country cited would buy a comparable amount of goods and services as one US$ would cost in the United States [28].)

Interventions to lower the cost of kidney care in Africa therefore needs urgent attention. As CKD is potentially preventable through primary prevention of risk factors and by early identification, referral, and interventions, many have suggested that preventative strategies should be a strong focus in Africa [29]. Even this strategy could prove to be a particular challenge given the low availability and high cost of local diagnostic tests and essential medicines [15] (Supplementary Figures S3 and S4). Though preventative strategies could reduce the burden of advanced kidney disease, longer-term actions are still needed to manage the demands of these cases, albeit reduced. For instance, KT, the most cost-effective KRT modality, should be prioritised for the young KF population in Africa [30,31]. Other strategies to reduce cost could include dialyzer reuse technologies [32], strategic purchasing of equipment and disposables (such as PD fluids) through pooled procurement methods [33], and trials of incremental dial-

Table 2. Proportion of co-payment for KRT in Africa.

Country	World Bank income category	Co-payment for HD (%)	Co-payment for PD (%)	Co-payment for KT (%)
Benin	LIC	0	N/A	N/A
Burkina Faso	LIC	76-99	N/A	N/A
Burundi	LIC	1–25	N/A	N/A
Chad	LIC	100	N/A	N/A
Dem. Rep. Congo	LIC	76-99	100	N/A
Eritrea	LIC	N/A	N/A	N/A
Ethiopia	LIC	100	N/A	1–25
Gambia, The	LIC	0	N/A	N/A
Guinea	LIC	N/A	N/A	N/A
Liberia	LIC	N/A	N/A	N/A
Madagascar	LIC	76-99	76-99	N/A
Malawi	LIC	0	N/A	N/A
Mozambique	LIC	26–50	N/A	N/A
Niger	LIC	N/A	N/A	N/A
Rwanda	LIC	N/A	N/A	N/A
Sierra Leone	LIC	100	N/A	N/A
Somalia	LIC	0	N/A	N/A
Tanzania	LIC	1–25	N/A	1-25
Uganda	LIC	26–50	N/A	N/A
Zimbabwe	LIC	76-99	76-99	N/A
Cabo Verde	LMIC	0	N/A	N/A
Cameroon	LMIC	1–25	N/A	N/A
Congo, Rep.	LMIC	1–25	26-50	N/A
Cote d'Ivoire	LMIC	N/A	N/A	N/A
Egypt, Arab Rep.	LMIC	0	0	0
Ghana	LMIC	>75	N/A	100
Kenya	LMIC	1-25	26-50	51-75
Mauritania	LMIC	1-25	N/A	N/A
Morocco	LMIC	N/A	N/A	N/A
Nigeria	LMIC	100	N/A	100
Senegal	LMIC	1–25	1-25	N/A
Sudan	LMIC	1–25	1-25	26-50
Swaziland	LMIC	1–25	0	N/A
Zambia	LMIC	1–25	1-25	N/A
Algeria	UMIC	0	0	0
Angola	UMIC	0	0	N/A
Botswana	UMIC	100	100	N/A
Gabon	UMIC	1–25	N/A	N/A
Libya	UMIC	76-99	76-99	51–75
Namibia	UMIC	1–25	N/A	1–25
South Africa	UMIC	0	0	0
Tunisia	UMIC	1–25	1–25	1–25

Abbreviations: KRT, kidney replacement therapy; HD, haemodialysis; PD, peritoneal dialysis; KT, kidney transplantation; N/A not available; LIC, low-income country; LMIC, lower-middle-income country; UMIC, upper-middle-income country.

ysis treatments which have been shown to be non-inferior to standard thrice-weekly treatments, especially in those with residual kidney function [34]. Unfortunately, government policies and interventions to reduce kidney care cost in Africa are either unavailable or limited and restrictive. One study noted that the Nigerian government had approved its national health insurance scheme to cover the costs of the initial 6 sessions of HD with some advocating extending this to at least the first 3 months of treatment [16]. Such strategies are unlikely to make a significant difference to patient outcomes and may even cause psychological and emotional harm to patients and their caregivers when treatment is withdrawn due to lack of funds. Instead, efforts should target sustainable and significant long-term lowering of cost through well-organized advocacy strategies. Such actions should simplify and effectively articulate the high burden of kidney disease, the unbearable cost of kidney care, and the high morbidity and mortality associated with kidney disease [2,35]. These efforts should also be coordinated by nephrology societies with pressure applied at various levels of governance including provincial, national, sub-regional, and even up to the highest level of the African Union.

Availability and accessibility of KRT in Africa

Overall, maintenance HD was available in 41 countries, while maintenance PD was available in 21 and KT was provided in 14 of the countries that participated in the ISN–GKHA survey (Table 3). The availability of maintenance PD centres in Africa (0.09 [0.05–0.30] pmp) was more than 15-fold lower than the global median (1.27 [0.33–2.42] pmp), ranging from 0.17 [0.09–0.69] pmp in North Africa to 0.03 [0.02–0.03] pmp in Central Africa. However, maintenance PD was available in all participating countries in North Africa and in only 3 (23%) in West Africa (Table 3). Of all modalities offered for KRT, KT was least available (4 countries; 34%), being provided in all states surveyed in North Africa, in half of participating countries in southern Africa and in 25% and 23%, respectively, of those in East and West Africa (Table 3). Most countries (11 in all, 79%) have established only living-donor KT programmes. The median number of KT centres in southern Africa (0.29 [0.18–0.39] pmp) was higher than the median for the African region as a whole (0.15 [0.04–0.18] pmp).

Despite its availability, not all patients who need HD are able to access it. For instance, in North Africa, most people requiring HD can benefit from it compared to fewer in Central, southern and West Africa (Supplementary Figure S5). There were substantial inter-regional variations in accessibility to all forms of KRT, based on geography and patient characteristics.

Most HD and PD centres in Africa are located in big cities, so that patients in rural locations must travel large distances to access treatment [36]. In one study of a predominantly rural community in South Africa, HD patients travelled an average of 112 km (range: 3–301 km) to the nearest public dialysis facility, which serves more than 5 million inhabitants [37]. This fact underlines the need to improve and extend kidney care coverage across Africa, improving the nephrology workforce, lowering cost of care by undertaking

Table 3. Availability of kidney replacement therapy in Africa by sub-regions.

	Chronic HD [n (%)]	Chronic PD [n (%)]	HD centre density** (pmp)	PD centre density** (pmp)	KT availability	KT donor type [n (%)]			KT waitlist [n (%)]			KT centre density** (pmp)
						Deceased donors only	Live donors only	Deceased + Live	National	Regional only	None	
Global	156 (100)	119 (76)	4.46 (1.24–9.88)	1.27 (0.33–2.42)	114 (74)	0 (0)	32 (28)	82 (72)	70 (62)	22 (19)	21 (19)	0.42 (0.20–0.72)
Africa	41 (100)	21 (51)	0.53 (0.20–2.22)	0.09 (0.05–0.30)	14 (34)	0(0)	11 (79)	3 (21)	5 (36)	2 (14)	7 (50)	0.15 (0.04–0.18)
African subregions												
Central Africa	6 (100)	3 (50)	0.36 (0.15–0.99)	0.03 (0.02–0.03)	0 (0)	0(0)	1 (50)	1 (50)	2 (100)	0 (0)	0 (0)	–
East Africa	12 (100)	6 (50)	0.36 (0.15–0.99)	0.06 (0.04–0.19)	3 (25)	0(0)	3 (100)	0 (0)	0 (0)	1 (33)	2 (67)	0.04 (0.01–0.10)
North Africa	6 (100)	6 (100)	8.58 (3.02–9.62)	0.17 (0.09–0.69)	6 (100)	0(0)	4 (67)	2 (33)	3 (50)	1 (17)	2 (33)	0.17 (0.15–0.20)
Southern Africa	4 (100)	3 (75)	2.49 (2.10–3.71)	0.89 (0.29–0.92)	2 (50)	0(0)	3 (100)	0 (0)	0 (0)	0 (0)	3 (100)	0.29 (0.18–0.39)
West Afca	13 (100)	3 (23)	0.42 (0.25–0.87)	0.05 (0.04–0.07)	3 (23)	–	–	–	–	–	–	0.04 (0.04-0.10)

Abbreviations: HD, haemodialysis; PD, peritoneal dialysis; KT, kidney transplantation; pmp, per million population. **Median (interquartile range).

structural health systems reforms that ensures that everyone in Africa (whether urban or rural) have access to kidney care.

Given the limited resources and large need, some sort of prioritization is necessary. Measures that may be implemented include rationing maintenance dialysis, increasing PD use and expanding access to kidney transplantation. KRT rationing is practised in the South African public service [38] and could be one of the reasons why the country has one of the best kidney care services in sub-Saharan Africa. A limited number of publicly funded dialysis (both HD and PD) slots is available to a centre; as patients transition to KT (or death), other KF patients are included to fill the slots. This practice, however, is effective only if the criteria for filling the dialysis places are adhered to and public funding and resources are available to care for patients who transition to KT. Although many have reported that there are ethical issues associated with rationing, this system ensures availability and access to care for a small number of people in a transparent manner when the service's capacity is limited.

Access to care can also be improved by promoting PD, which is currently scarcely used in Africa (Table 3). The high cost of PD fluids, availability of PD catheters and the skills to insert them as well as inadequate patient and staff training are barriers to PD use in Africa. Proposals to increase peritoneal dialysis use include increasing the local production of dialysis fluids [39], enhanced procurement methods – for instance, strategic purchasing that includes bulk procurement, waiving customs duties and taxes – for imported fluids [40], policy initiatives that use a PD-first policy, and adopting incremental dialysis approaches.

Young patients should have unrestricted access to KT. Transplant surgeons and coordinators, tissue typing, immunosuppression, nephropathologists, radiologists, and access to dialysis are all expensive, difficult to support, and hence scarcely available in Africa. Thus, every kidney care centre in Africa need not have the capacity to provide KT. Instead, efforts should be made to strengthen existing centres or establish sub-regional or national centres to cater for KT-related issues. The first living donor KT in Central Africa was recently performed in Cameroon through collaboration with the University of Geneva, Switzerland (https://tinyurl.com/57d6522h). Such efforts should be heralded and supported by advocating that national and sub-regional governments ensure the means for sustaining this programme, which may potentially serve millions of people. Efforts are also needed to promote deceased-donor KT. Unfortunately, there are few beds in intensive care units in most African countries, so that government support is critical to the development of appropriate legislative mandates under which organ donation and transplant programmes can operate and thrive.

Monitoring and quality treatment for kidney diseases in Africa

The availability of tests varies for monitoring the complications of CKD, such as anaemia, mineral bone disease and electrolyte disturbances. Although haemoglobin assessment was available in all of the sub-regions surveyed, the assay of serum iron was available in only half the countries – it was highest in North Africa (83%) and lowest in West Africa (31%). The availability of treatment options for anaemia, mineral bone disease and hyperkalaemia is summarized in Supplementary Figure S3.

Home HD was not available in any sub-region in Africa and only 18 countries reported the ability to provide HD 3 times per week for 3–4 hours per session – this proportion was lowest in West Africa (n = 2; 15%). However, the availability of adequate PD exchanges (that is, 3–4 times daily) was present in only 17% of countries in Africa with none in Central and West Africa (Supplementary Table S2). Overall, in those treated with HD, only in 3% of countries were more than 75% of patients able to start treatment with a functioning vascular access, in 10% were more than 75% of patients able to start dialysis with a tunnelled catheter, and in 54% of countries was this proportion of patients able to start dialysis with a temporary catheter (Supplementary Table S3). More HD patients in North Africa were able to start dialysis with functional vascular access than in all other sub-regions and, in most of them, a higher proportion of patients started HD with a temporary catheter. All indices of quality and choice of KT provided were lower in Africa than the global median values and were either very low or mostly unavailable in Central Africa (Supplementary Table S2).

Capacity for early disease detection, monitoring and the use of appropriate interventions are the backbones of an efficient healthcare system, including those focused on disease prevention. CKD is a multifaceted disease with specialised requirements for highly specialized diagnostic tests – for instance, kidney biopsy and histology, urine, or serum biomarkers – frequent testing and monitoring of risk factors (such as glycated haemoglobin and HIV viral load), and the complications that arise from CKD (for instance, anaemia, calcium, and phosphate disturbance). Several tests and treatments (such as the use of potassium exchange resins) that would be considered basic in nephrology are often unavailable in many institutions in Africa [12]. Although their absence is considered to be related to their cost [12,15], other competing interests, such as provision of care for the excess burden of communicable diseases or

mismanagement of healthcare resources, may also contribute [2]. Countries with a double burden of communicable and non-communicable diseases, with individual vertical funding streams for these diseases and without integrated care models, often deprioritize NCDs [41]. Integrated approaches require leveraging existing care structures and increasing coordination between different tiers of health systems and the community. This could involve integrating NCD care with communicable disease care or using integrated approaches for NCDs. Healthcare practices using integrated care delivery have been reported to enhance patient satisfaction, increase perceived quality of care, enable access to services, and reduce cost [42].

Conservative kidney management in Africa

Although elements of conservative kidney management (CKM) are available in all sub-regions, there are variations in the provision of various components of CKM with low availability of some measures such as systematic support to care providers with additional training in CKM, and easy access to supportive care across settings (Supplementary Table S4). Although strategies should continue to seek cheap and affordable options of care, approaches that involve supportive care also need to be addressed to ensure adequate symptom management, psychological therapy, or family and social support for those not able to access KF treatment [42]. It has been recommended that awareness of CKM as a viable treatment modality for patients and families, healthcare providers, and policymakers needs to increase. Moreover, barriers to CKM availability, accessibility and quality should be identified so that strategies can be developed to increase capacity and policies developed to ensure that CKM is optimal and not seen as solely palliative care for those unable to receive KRT [43]. Measures of CKM, including shared decision-making tools, provision of psychological, cultural, and spiritual support, and easy access to conservative care across settings, were found to be very low or unavailable in several countries and sub-regions.

Non-communicable diseases and CKD policies in Africa

The presence of policies that address NCDs and CKD was generally low across all parts of the continent. The establishment of national NCDs strategies was greatest in West Africa (46%) and lowest in Central Africa (17%). Although CKD-specific policies were fewest in East Africa (8%), they were still low in North Africa (33%), which had the highest value (Supplementary Figure S6).

As CKD represents a major public health challenge, health policies which safeguard patients' fundamental rights of reaching the highest attainable standard of health are needed [44]. Unfortunately, CKD-specific strategies are not readily available in Africa – national strategies for chronic NCDs were in place in less than half the countries whereas in North Africa, with the highest availability of CKD-specific policies, these were present in only a third of countries (Supplementary Figure S6). The WHO recommends that detection, screening and treatment of NCDs, as well as palliative care, should be key components of a country's response to these diseases, which kill about 41 million people each year (approximately 71% of all deaths globally) [45]. Adoption of national NCD policies needs to be fast-tracked in countries that lack them as they can be used to hold policymakers accountable for providing care to patients and the general public. Approaches that integrate NCD strategies with existing practices to address communicable diseases can be used to fast-track the establishment of such policies.

Leaders in nephrology should initiate the establishment of such strategies in conjunction with specialists in other medical fields that integrate care of patients with kidney diseases. For instance, there would be scope for integrating acute dialysis policies with those for treating patients with acute diarrhoeal illnesses, leading to acute kidney injury. A 2011 ISN–GKHA review summarized policy recommendations as follows: increase the prioritization of kidney disease, develop effective advocacy groups for kidney disease, and leverage existing strategies and policies for kidney care [46].

One limitation of the ISN–GKHA studies in Africa relates to the non-participation of the only high-income country in the continent, namely, Seychelles. This would have enabled comparison of kidney care measures in this African nation with those of other high-income states in other sub-regions as well as with other resource-limited settings in Africa. However, with a population of less than 0.1 million people [47], it is unclear how applicable such a comparison would be with other African countries. Other limitations of the ISN–GKHA have been thoroughly covered elsewhere [5,6]. Although a previous study [6] has covered availability, accessibility, and affordability of kidney care in Africa, this review has provided a sub-regional perspective on these measures in Africa and suggested ways to improve them at a sub-regional level.

A SUGGESTED ROADMAP FOR OPTIMAL KIDNEY CARE CAPACITY IN AFRICA

The WHO's Global Action Plan for the prevention and control of NCDs provides a framework to be used by countries for implementing strategies for identifying, treating and controlling NCDs [48]. This framework has been adopted by most sub-Saharan African countries and by their NCD agencies and organizations. We have adapted

the strategies of this framework and here we propose a conceptual roadmap for optimal kidney care in Africa (Figure 3):

1. Elevate the priority accorded to the prevention and control of CKD through strengthened international cooperation and advocacy

- Enhanced partnerships across Africa should gather clinical, logistics and administrative experience from countries that have large and high-quality CKD care programmes, for example, Egypt, Algeria, and South Africa.
- All countries, and Africa as a whole, should seek recognition of CKD as a priority area of health care to be embedded within their national NCD strategy.
- Advocate population-level interventions for preventing CKD, such as reducing salt and sugar intake and obesity levels, increasing fruit and vegetable intake, stopping tobacco use, and promoting measures to increase physical activity.

2. Strengthen national capacity, leadership, governance, multisectoral action and partnerships to accelerate each country's response for the prevention and control of CKD

- Invest in young nephrologists from Africa to take on leadership roles in national and regional nephrology societies.
- Provide opportunities for training in the management on preventative strategies for CKD.
- Develop partnerships with international organisations and initiate leadership and mentorship training opportunities for young nephrologists in Africa – such as, for instance, the ISN emerging leaders programme and the ISN mentorship programme.

Prioritise CKD prevention & control	Strengthen national capacity, leadership & governance, for CKD	Reduce modifiable CKD risk factors	Strengthen health systems through people-centred PHC & UHC	Promote & support national capacity for high-quality CKD research	Monitor trends & determinants of CKD & evaluate progress in their prevention & control
• Enhanced partnerships to gather experience from countries with large and high-quality CKD care programs. • Recognise CKD as a priority area of healthcare. • Advocate population-level interventions for preventing CKD.	• Invest in young nephrologists for leadership roles. • Provide opportunities for training in management on preventive strategies for CKD. • Develop partnerships with international organization initiatives for leadership and mentorship training. • Identify local and international African mentors.	• Provide opportunities and improve strategies for early detection and treatment. • Develop and implement local and practical evidence-based guidelines for CKD. • Ensure availability of cheap, effective, and affordable essential medicines for control of CKD risk factors.	• Improve funding for CKD care at all levels. • Promote a task-sharing approach to improve workforce. • Integrate CKD detection, treatment, and control within existing services. • Improve infrastructure and efficient resource utilization. • Improve use of technologty (telenephrology, telepathology, etc.) for CKD care and training. • Exercise responsibility and accountability in ensuring the availability of CKD services. • Provide adequate compensation and incentives for health workers.	• Identify research priorities and build research capacity. • Enhance collaboration. • Promote systematic uptake of research findings and other evidence-based practices. • Promote research that informs resource-allocation and health systems improvement. • Support high-quality research to produce the evidence that will guide interventions.	• Develop, maintain, and strengthen kidney disease registries. • Contribute to dissemination of information on country and regional CKD trends.

Figure 3. Suggested roadmap for optimal kidney care capacity in Africa.
Abbreviations: CKD, chronic kidney disease; PHC, primary health care; UHC, universal health coverage. Adapted from the WHO's Global Action Plan for NCDs (2013–2020) [68].

- Identify local and international African nephrologists to serve as mentors for their younger counterparts.

3. Reduce modifiable risk factors for CKD and underlying social determinants through creation of a health-promoting environment

- Provide opportunities and improve strategies for detecting and treating CKD and common risk factors in Africa, for example, hypertension, diabetes mellitus and HIV/AIDS.
- Develop and implement local and practical evidence-based guidelines for various aspects of CKD diagnosis and care or adapt international guidelines to local contexts.
- Ensure the availability of cheap, effective and affordable essential medicines for the control of CKD risk factors.
- Promote health-enhancing environmental and occupational approaches to CKD prevention such as protection from exposure to pesticides and preventing water contamination.

4. Strengthen health systems to address the prevention and control of CKD and the underlying social determinants through people-centred primary health care and UHC. For example:

- Increase funding.
  - o AFRAN and national nephrology societies should advocate for increased healthcare budgets for NCDs and CKD to align with the WHO's Global Action Plan.
  - o Advocate for the allocation of appropriate funding to diagnose and treat early CKD and risk factors.
  - o Advocate for improved funding for advanced CKD, including the cost of dialysis, kidney transplant surgery and immunosuppression for kidney transplantation.
- Promote a task-sharing approach with adequately trained non-nephrologist healthcare workers to improve access to kidney care.
- Integrate CKD detection, treatment and control within existing health services and health initiatives and leverage existing programmes – for example, those for HIV/AIDS, malaria, TB, hypertension and diabetes care – and the response to the SARS-COVID pandemic.
- Improve existing infrastructure and use established resources more efficiently.
- Improve the use of technology – for instance, tele-nephrology and telepathology – for CKD care and training [49].
- Exercise responsibility and accountability in ensuring the availability of CKD services within the context of overall health system strengthening.
- Provide adequate compensation and incentives for health workers to serve underserviced areas including location, infrastructure, training and development and social support.

5. Promote and support national capacity for high-quality research and development for the prevention and control of CKD

- AFRAN and national nephrology societies should take responsibility for identifying research priorities, building national and international research networks and partnerships, and advocating for investment in research to support best practices in Africa.
- There is a need to enhance inter-centre and inter-regional collaborative approaches to improve nephrology research in Africa – for example, the CKD–Africa Collaboration, the Africa Research on Kidney Disease (ARK) study and the Human Heredity and Health in Africa (H3–Africa) study [50].
- Nephrology research in Africa should adopt methods that promote the systematic uptake of research findings and other evidence-based practices into routine practices, to improve quality and effectiveness of health services.
- There is a need to promote useful research for informing resource-allocation and the improvement of health systems.
- Support high-quality research to produce the evidence that will guide interventions.

6. Monitor the trends and determinants of CKD and evaluate progress in their prevention and control

- Develop, maintain, and strengthen national, sub-regional and continental kidney disease registries, including registries for CKD, dialysis, and transplantation.
- Contribute to the dissemination of information on country and continental CKD trends with respect to prevalence, cost, risk factors, outcome measures – for instance, mortality and patient-reported outcomes – and other determinants of kidney diseases by age, gender, disability and socio-economic groups.

CONCLUSIONS

Various studies and reviews have shown that there is low availability, accessibility, and affordability of measures of kidney care in Africa. However, this review goes beyond that to show how these measures are distributed on a sub-regional basis. Our findings highlight a stark difference in these measures between North and sub-Saharan Africa but above all suggest the need for a more cohesive approach to policy formulations that support and protect patients with kidney diseases in the continent, especially from the excessive costs associated with kidney care. Although AFRAN should lead and coordinate initiatives on policy development and strategies to improve kidney care in Africa, local nephrology societies and nephrology leaders in different countries should contribute to this, specifically on how to augment the workforce required, improve availability, and lower the cost of care.

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APPENDIXES

Table S1. Countries reporting a shortage of kidney care providers by subregion (n; %).

	Nephrologists	Transplant surgeons	Surgeons (HD access)	Surgeons (PD access)	Interventional radiologists (HD access)	Interventional radiologists (PD access)	Dietitians	Laboratory technicians	Radiologists (ultrasound)	Vascular access coordinators	Counselors/psychologists	Transplant coordinators	Dialysis nurses	Dialysis technicians	Shortage score**	No shortage
Africa (n = 41)	36 (88)	34 (83)	35 (85)	34 (83)	36 (88)	31 (76)	30 (73)	12 (29)	13 (32)	33 (80)	30 (73)	32 (78)	28 (68)	31 (76)		1 (2)
African subregions																
Central Africa (n = 6)	5 (83)	4 (67)	5 (83)	4 (67)	6 (100)	4 (67)	5 (83)	2 (33)	2 (33)	5 (83)	5 (83)	4 (67)	4 (67)	5 (83)	60	0 (0)
East Africa (n = 11)	11 (92)	12 (100)	10 (83)	12 (100)	11 (92)	10 (83)	8 (67)	4 (33)	3 (25)	10 (83)	8 (67)	11 (92)	8 (67)	9 (75)	127	1 (8)
North Africa (n = 6)	3 (50)	3 (50)	4 (67)	5 (83)	5 (83)	4 (67)	2 (33)	0 (0)	1 (17)	5 (83)	2 (33)	4 (67)	2 (33)	3 (50)	40	0 (0)
Southern Africa (n = 4)	4 (100)	4 (100)	4 (100)	3 (75)	3 (75)	3 (75)	4 (100)	1 (25)	3 (75)	3 (75)	4 (100)	4 (100)	4 (100)	4 (100)	48	0 (0)
West Africa (n = 13)	13 (100)	11 (85)	12 (92)	10 (77)	11 (85)	10 (77)	11 (85)	5 (38)	4 (31)	10 (77)	11 (85)	9 (69)	10 (77)	10 (77)	137	0 (0)

Abbreviations: HD, haemodialysis; PD, peritoneal dialysis. **Shortage score assessed as a count of all shortages for subregion..

Table S2. Quality of provided treatment** [n; (%)].

	Haemodialysis		Peritoneal dialysis		Transplantation					
	3x week/ 3-4x hours	Home HD	Adequate exchanges 3-4x day	URR and/ or Kt/V	Effective preventive therapy to control infections	Timely access to operating space	Appropriate immuno-suppression and anti-rejection treatment	Facilities for immuno-suppression drugs monitoring	Availability of standard organ procure-ment frame-works	Multi-disciplin-ary team
Global (n = 154)	118 (77)	20 (13)	91 (59)	90 (58)	106 (69)	98 (64)	110 (71)	95 (62)	83 (54)	98 (64)
Africa (n = 41)	18 (44)	0 (0)	7 (17)	11 (27)	9 (22)	6 (15)	10 (24)	10 (24)	5 (12)	13 (32)
African subregions										
Central Africa (n = 6)	4 (67)	0 (0)	0 (0)	1 (17)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (33)
East Africa (n = 12)	5 (42)	0 (0)	2 (17)	2 (17)	2 (17)	0 (0)	2 (17)	2 (17)	0 (0)	3 (25)
North Africa (n = 6)	5 (83)	0 (0)	4 (67)	5 (83)	5 (83)	3 (50)	4 (67)	5 (83)	3 (50)	5 (83)
Southern Africa (n = 4)	2 (50)	0 (0)	1 (25)	2 (50)	2 (50)	1 (25)	2 (50)	2 (50)	1 (25)	2 (50)
West Africa (n = 13)	2 (15)	0 (0)	0 (0)	1 (8)	0 (0)	2 (15)	2 (15)	1 (8)	1 (8)	1 (8)

Abbreviations: URR, urea reduction ration; HD, haemodialysis; Kt/V - dialysis adequacy.
**Quality of provided treatment is defined by the ability to provide optimal levels of conventional care.

Table S3. Access to haemodialysis in African subregions.

	Start dialysis with a functioning vascular access [n (%)]						Start dialysis with a tunnelled dialysis catheter [n (%)]						Start dialysis with a temporary dialysis catheter [n (%)]					
	n	0%	1-10%	11-50%	51-75%	>75%	n	0%	1-10%	11-50%	51-75%	>75%	n	0%	1-10%	11-50%	51-75%	>75%
Africa	40	5 (13)	25 (63)	7 (18)	2 (5)	1 (3)	39	8 (21)	21 (54)	4 (10)	2 (5)	4 (10)	39	1 (3)	6 (15)	5 (13)	6 (15)	21 (54)
African subregions																		
Central Africa	6	1 (17)	5 (83)	0 (0)	0 (0)	0 (0)	6	2 (33)	3 (50)	0 (0)	0 (0)	1 (17)	6	1 (17)	0 (0)	0 (0)	0 (0)	5 (83)
East Africa	12	2 (17)	7 (58)	2 (17)	0 (0)	1 (8)	12	2 (17)	5 (42)	2 (17)	1 (8)	2 (17)	12	0 (0)	3 (25)	2 (17)	0 (0)	7 (58)
North Africa	6	0 (0)	3 (50)	1 (17)	2 (33)	0 (0)	6	0 (0)	5 (83)	1 (17)	0 (0)	0 (0)	6	0 (0)	0 (0)	2 (33)	2 (33)	2 (33)
Southern Africa	4	0 (0)	3 (75)	1 (25)	0 (0)	0 (0)	3	0 (0)	2 (67)	1 (33)	0 (0)	0 (0)	3	0 (0)	1 (33)	0 (0)	0 (0)	2 (67)
West Africa	12	2 (17)	7 (58)	3 (25)	0 (0)	0 (0)	12	4 (33)	6 (50)	0 (0)	1 (8)	1 (8)	12	0 (0)	2 (17)	1 (8)	4 (33)	5 (42)

Table S4. Measures of conservative kidney management in Africa by subregion [n (%)].

	CKM available	Established choice–restricted conservative care	Established conservative care that is chosen or medically advised	Multidisciplinary team approach to care via shared decision making	Shared decision-making tools for patients and providers	Systematic active recognition and management of symptoms	Systematic provision of psychological, cultural, and spiritual support	Systematic provision to care providers of additional training in conservative care	Easy access to conservative care across settings
Africa (n = 41)	33 (80)	18 (44)	18 (44)	11 (27)	9 (22)	17 (41)	7 (17)	4 (10)	5 (12)
African subregions									
Central Africa (n = 6)	6 (100)	5 (83)	4 (67)	3 (50)	2 (33)	4 (67)	1 (17)	1 (17)	1 (17)
East Africa (n = 12)	9 (75)	4 (33)	6 (50)	4 (33)	3 (25)	5 (42)	2 (17)	0 (0)	1 (8)
North Africa (n = 6)	5 (83)	5 (83)	5 (83)	2 (33)	4 (67)	4 (67)	2 (33)	3 (50)	3 (50)
Southern Africa (n = 4)	2 (50)	1 (25)	2 (50)	1 (25)	0 (0)	0 (0)	1 (25)	0 (0)	0 (0)
West Africa (n = 13)	11 (85)	3 (23)	1 (8)	1 (8)	0 (0)	4 (31)	1 (8)	0 (0)	0 (0)

Abbreviations: CKM, conservative kidney management.

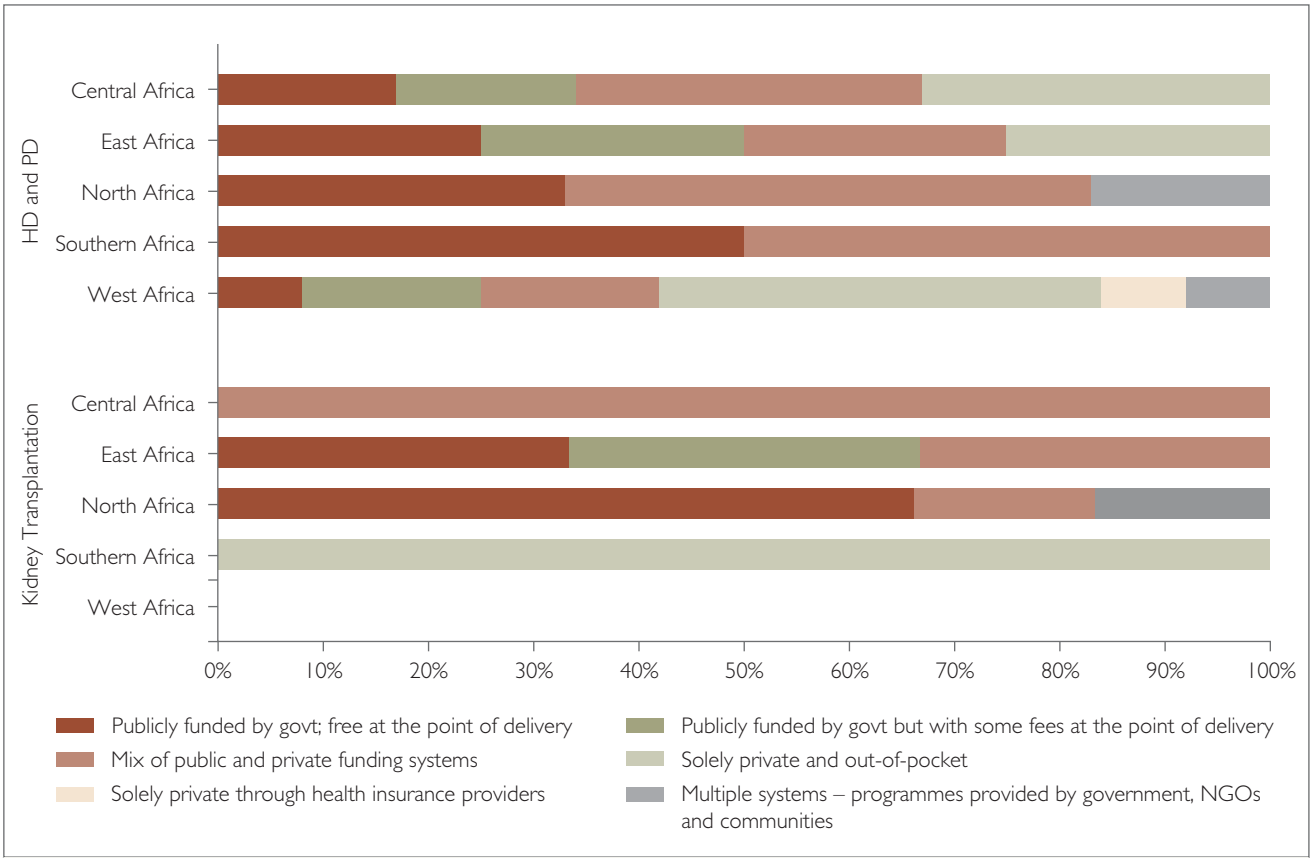


Figure S1. Methods of funding for kidney replacement therapy by African subregions.
Abbreviations: HD, haemodialysis; PD, peritoneal dialysis; NGO, non-governmental organisation.

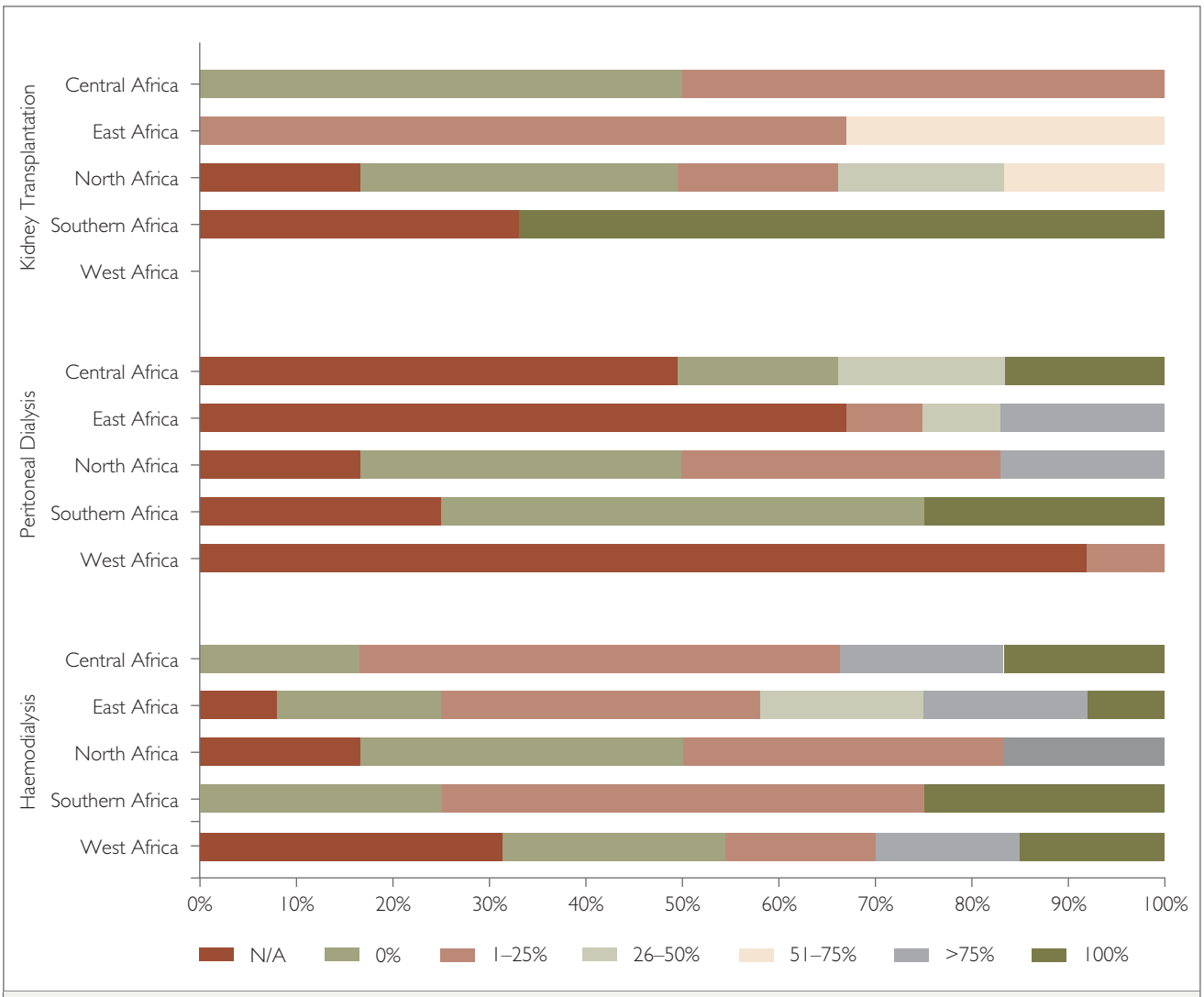
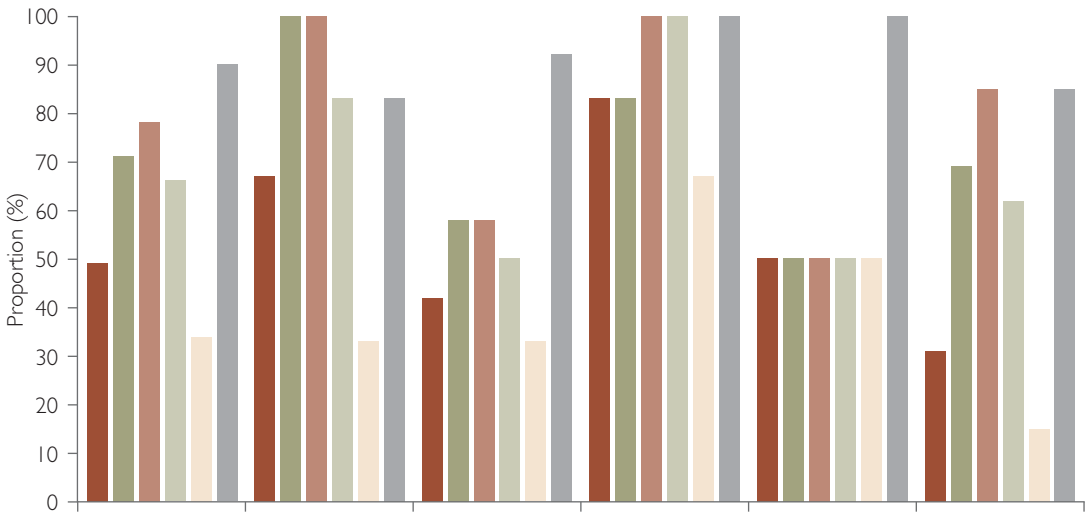
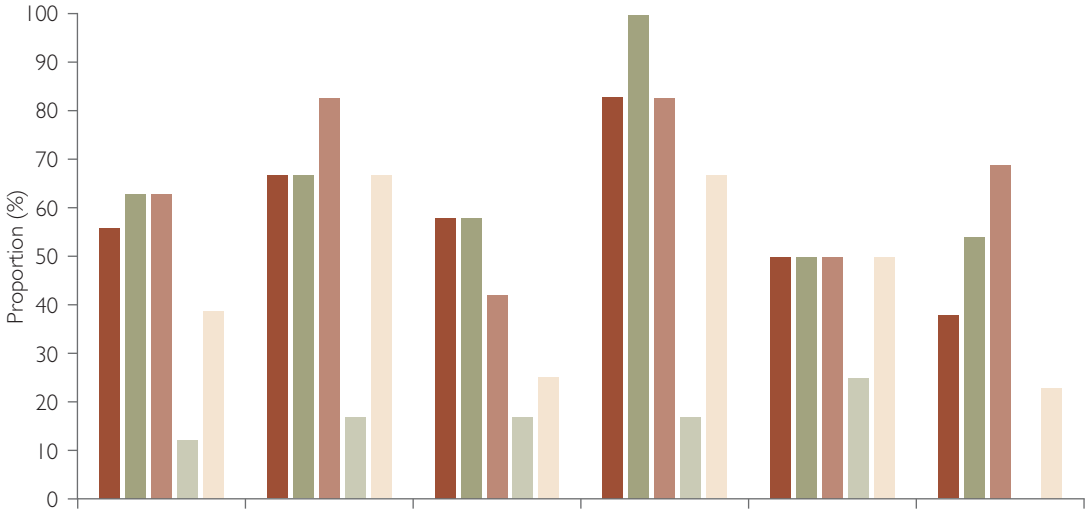


Figure S2. Percentage co-payment for kidney replacement therapy in Africa.



	Africa	Central Africa	East Africa	North Africa	Southern Africa	West Africa
Serum Fe	49	67	42	83	50	31
Inflammatory markers	71	100	58	83	50	69
Serum Ca	78	100	58	100	50	85
Serum PO_4	66	83	50	100	50	62
Serum PTH	34	33	33	67	50	15
Serum electrolytes	90	83	92	100	100	85

Figure S3. Availability of tests for monitoring chronic kidney disease in Africa.
Abbreviations: Fe, ferritin; Ca, calcium; PO_4, phosphate; PTH, parathyroid hormone.



	Africa	Central Africa	East Africa	North Africa	Southern Africa	West Africa
I/V Fe	56	67	58	83	50	38
EPO	63	67	58	100	50	54
Ca-based PO_4 binders	63	83	42	83	50	69
Non-Ca-based PO_4 binders	12	17	17	17	25	0
K exchange resins	39	67	25	67	50	23

Figure S4. Availability of treatment options for anaemia, metabolic bone disease, and hyperkalaemia in Africa.
Abbreviations: I/V Fe, intravenous iron; EPO, erythropoietin; Ca, calcium; PO_4, phosphate; K, potassium.

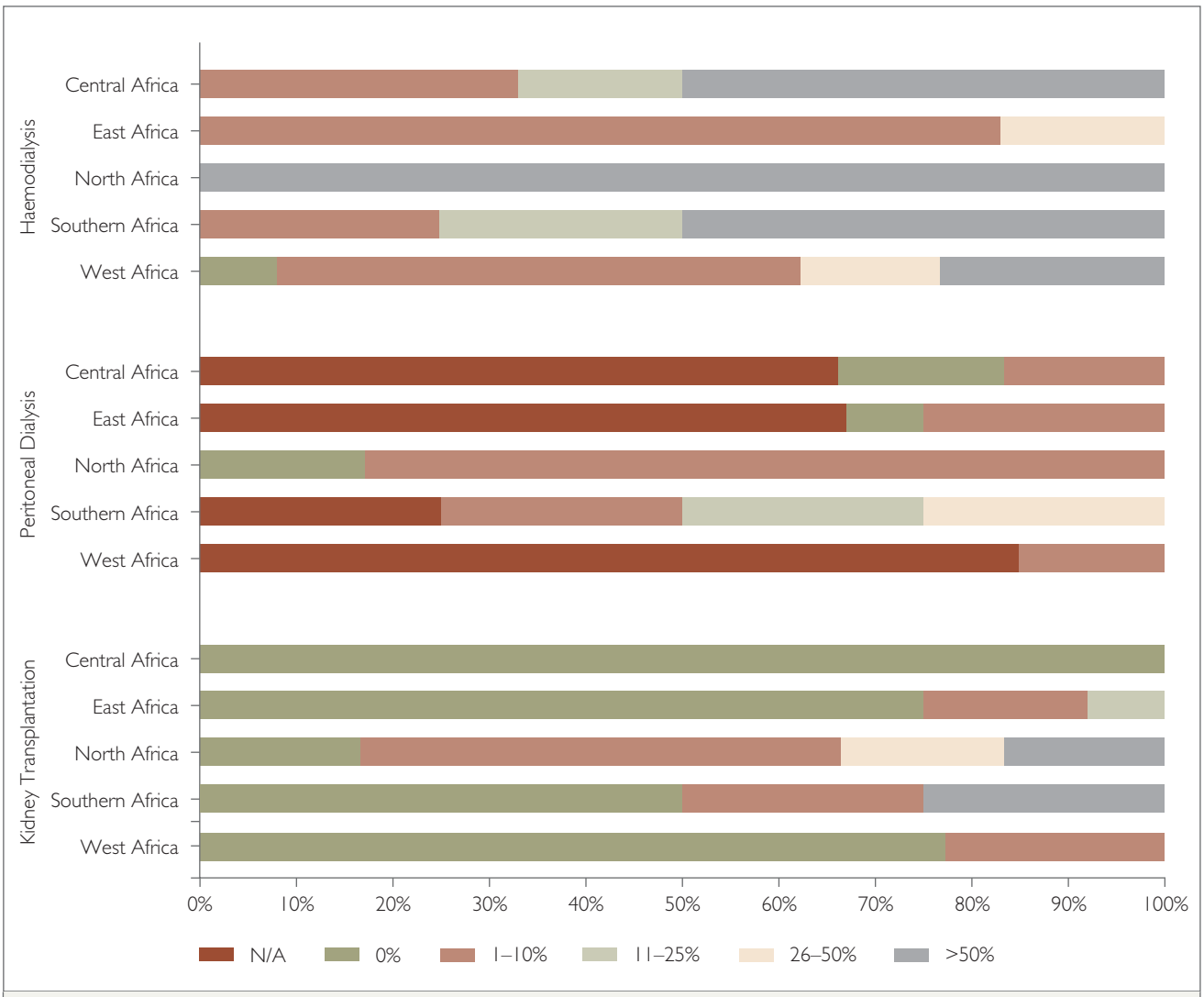


Figure S5. Accessibility to kidney replacement therapies in African subregions.

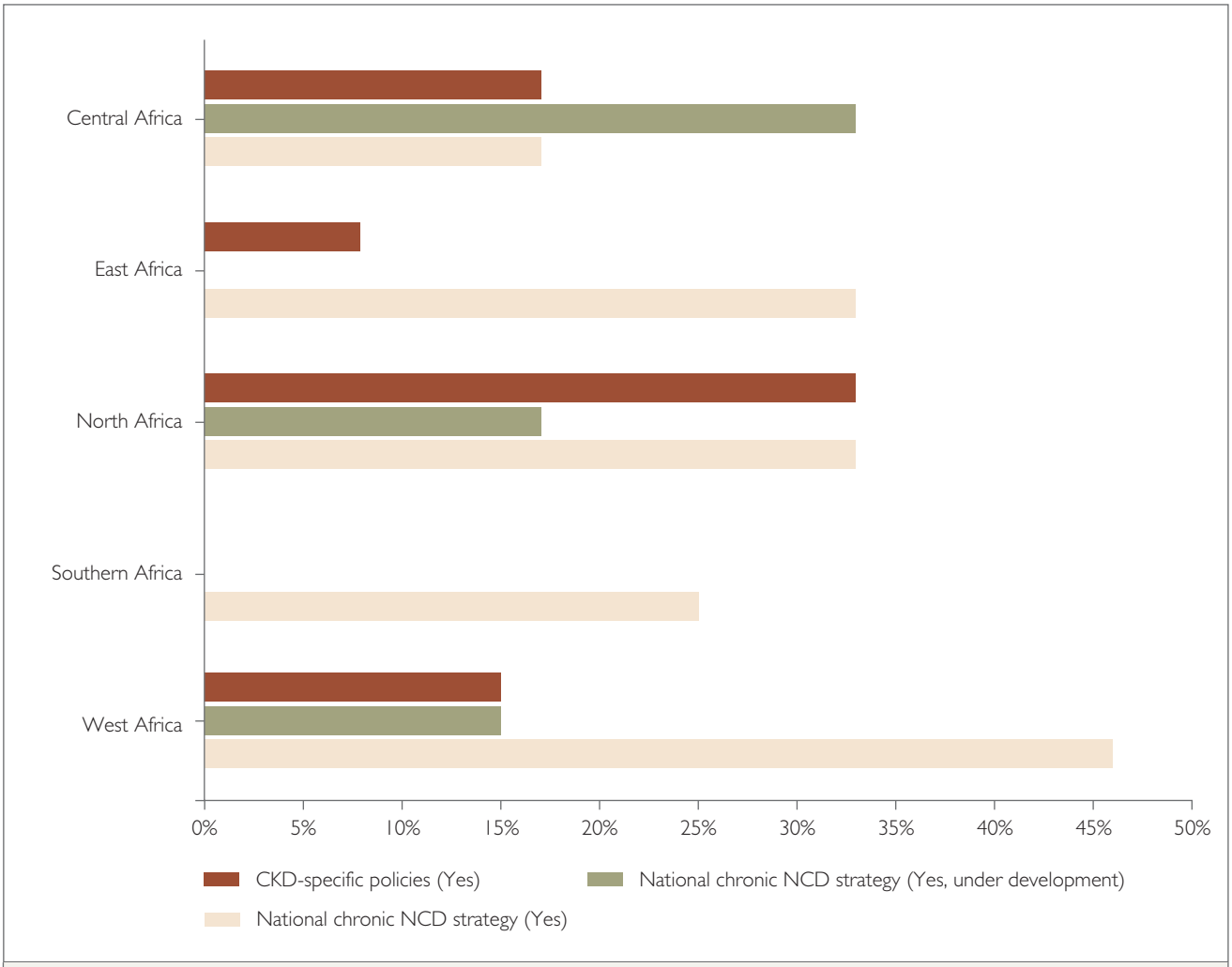


Figure S6. Availability of chronic kidney disease and non-communicable disease-specific policies in Africa.
Abbreviations: CKD, chronic kidney disease; NCD, non-communicable diseases.