Outcomes in adults and children with end-stage kidney disease requiring dialysis in sub-Saharan Africa: a systematic review

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Summary

Background The burden of end-stage kidney disease (ESKD) in sub-Saharan Africa is unknown but is probably high. Access to dialysis for ESKD is limited by insufficient infrastructure and catastrophic out-of-pocket costs. Most patients remain undiagnosed, untreated, and die. We did a systematic literature review to assess outcomes of patients who reach dialysis and the quality of dialysis received.

Methods We searched PubMed, African Journals Online, WHO Global Health Library, and Web of Science for articles in English or French from sub-Saharan Africa reporting dialysis outcomes in patients with ESKD published between Jan 1, 1990, and Dec 22, 2015. No studies were excluded to best represent the current situation in sub-Saharan Africa. Outcomes of interest included access to dialysis, mortality, duration of dialysis, and markers of dialysis quality in patients with ESKD. Data were analysed descriptively and reported using narrative synthesis.

Findings Studies were all of medium to low quality. We identified 4339 studies, 68 of which met inclusion criteria, comprising 24 456 adults and 809 children. In the pooled analysis, 390 (96%) of 406 adults and 133 (95%) of 140 children who could not access dialysis died or were presumed to have died. Among those dialysed, 2747 (88%) of 3122 adults in incident ESKD cohorts, 496 (16%) of 3197 adults in prevalent ESKD cohorts, and 107 (36%) of 294 children with ESKD died or were presumed to have died. 2508 (84%) of 2990 adults in incident ESKD cohorts discontinued dialysis compared with 64 (5%) of 1364 adults in prevalent ESKD cohorts. 41 (1%) of 4483 adults in incident ESKD cohorts, 2280 (19%) of 12 125 adults in prevalent ESKD cohorts, and 71 (19%) of 381 children with ESKD received transplants. 16 studies reported on management of anaemia, 17 on dialysis frequency, eight on dialysis accuracy, and 22 on vascular access for dialysis

Interpretation Most patients with ESKD starting dialysis in sub-Saharan Africa discontinue treatment and die. Further work is needed to develop equitable and sustainable strategies to manage individuals with ESKD in sub-Saharan Africa.

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Introduction

Chronic kidney disease (CKD) is an increasing, but still underappreciated, contributor to the global burden of disease.[1] Best estimates from sub-Saharan Africa suggest 12–23% of adults have CKD and are therefore at risk of developing end-stage kidney disease (ESKD).[2–4] Since symptoms are largely non-specific and manifest late, diagnosis of CKD, especially at an early treatable stage, is easily missed.

Once the kidneys fail, renal replacement therapy by dialysis or transplantation is the only means of survival. Findings from studies in the past 5 years[5,6] have suggested that between 2·3 million and 3·2 million people die yearly as a result of no access to dialysis. Estimation of the anticipated incidence of ESKD based on the prevalence of hypertension and diabetes suggests that only 1·5% of those requiring renal replacement therapy in sub-Saharan Africa receive it.[5] Others reported a gap between those who require and receive dialysis of over 84% in sub-Saharan Africa.[6] There is no African renal registry, but reported dialysis incidence tends to be higher than prevalence in sub-Saharan Africa, suggesting high mortality among patients with ESKD.[5–8] Where available, haemodialysis predominates because of frequent unavailability and higher costs of peritoneal dialysis and little availability of transplantation.[9,10] In South Africa and Sudan, governments provide dialysis for ESKD. In South Africa, state-funded dialysis is accessed through a rationing process; in Sudan dialysis is offered to all, but at a reduced frequency (haemodialysis two instead of three times per week).[11,12] In other sub-Saharan African countries, most expenses are paid out of pocket.[12–15] Therefore, in most of sub-Saharan Africa, patients with prevalent ESKD represent the elite few with enough resources to access long-term renal replacement therapy.

Dialysis outcomes are associated with the quality of dialysis delivered, which depends on the amount (ie, dose), duration, and frequency of dialysis; management of complications including anaemia; blood pressure; phosphate control; and laboratory monitoring. In haemodialysis, type of vascular access also affects morbidity and mortality.

We did a systematic review to explore outcomes and quality of dialysis in patients with incident and prevalent

Research in context

Evidence before this study

Data on epidemiology and outcomes of end-stage kidney disease (ESKD) in sub-Saharan Africa are sparse. We did a systematic review of the literature to understand outcomes in patients with ESKD managed under existing circumstances in sub-Saharan Africa. We searched PubMed, African Journals Online, the WHO Global Health Library, and Web of Science between Jan 1, 1990, and Dec 22, 2015, with relevant medical subject headings. Additional references were found through screening of reference lists from identified articles. All retrieved and selected articles were published in English or French. No previous systematic reviews on this topic were identified.

Added value of this study

This study is, to our knowledge, the first to systematically analyse outcomes and quality of dialysis received in patients with ESKD in sub-Saharan Africa from several countries and centres. We found high mortality among patients with incident ESKD. Mortality was lower in patients with prevalent ESKD who had dialysis, which provides reason for optimism, but raises the important ethical question of how such dialysis could be sustainable on a broader scale in low-income countries with other health priorities and where opportunity costs (ie, the proportion of budget allocated to dialysis is not available for allocation to other health issues) are high. The quality of dialysis delivered is generally low, mostly because of economic factors.

Implications of all the available evidence

The increasing numbers of publications from sub-Saharan Africa in recent years is testament to the growing expertise in the region. As expertise grows, the health system must adapt; therefore, studies such as this are important initial steps to raise awareness of the clinical problem of ESKD as well as the large ongoing knowledge gaps among policy makers and the international community.

ESKD in sub-Saharan Africa. Understanding the local realities of management of ESKD is important to highlight the daily clinical and moral dilemmas faced by clinicians, patients, and families when dialysis is paid for out of pocket, and to inform pragmatic policy development about ESKD care in resource-limited settings.

Methods

Search strategy and selection criteria

We registered our systematic literature review with PROSPERO (CRD42015015690) and completed it according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.[16] We searched PubMed, African Journals Online, the WHO Global Health Library, and Web of Science from Jan 1, 1990, to Dec 22, 2015, with relevant medical subject headings (appendix p 1). The search was restricted to publications in English and French. Additional references were identified through bibliography searches. Criteria for inclusion were all studies reporting outcomes related to access to dialysis, mortality, duration of dialysis, and markers of dialysis quality in patients with ESKD who needed or received dialysis in sub-Saharan Africa. Articles focusing exclusively on specific outcomes or subpopulations, such as infections, and those reporting transplantation outcomes were excluded, as were case reports (appendix p 1). Two authors (FA and VAL) screened titles and abstracts for eligibility. Articles meeting inclusion criteria and obtainable as full texts were reviewed in detail. Incident cohorts were defined as those reporting outcomes in patients with a new diagnosis of ESKD who needed, but either started or did not receive, dialysis. Prevalent ESKD cohorts were defined as those reporting outcomes in patients receiving long-term dialysis.

See Online for appendix

Quality assessment and data extraction

Study quality was assessed independently by two authors (VAL plus GA, CO, WAO, FA, or AN), as described previously (appendix pp 2–3).[3,17] All articles meeting inclusion criteria were included in an attempt to minimise further bias and to reflect the current situation in sub-Saharan Africa, as reported previously.[17] Individual study data were extracted into Microsoft Excel (Redmond, WA, USA; appendix p 4).

Data analysis

In view of the variability in definitions of ESKD, length of follow-up, proportions of loss to follow-up, study sizes, and outcomes reported per study, data were analysed descriptively and reported using narrative synthesis.[18,19] Where possible, outcomes were reported within time-frames for perspective; however, these data were not routinely available. Study populations were stratified by participant age (adult or paediatric) and by incident or prevalent cohorts. Outcomes were analysed separately for adults with incident and prevalent ESKD to test the hypothesis that outcomes are improved among patients with ESKD in sub-Saharan Africa who can achieve long-term dialysis. Similarly, in view of more scarce resources and probably a lower ability to pay for ESKD care for children than adults in sub-Saharan Africa, outcomes in adult and paediatric populations were analysed separately. Data were reported as pooled estimates of outcome frequencies; however, in view of the variability between studies, the same outcomes are also reported in parallel as means (with SDs) of frequencies reported in individual studies, to show the breadth of interstudy variability of the various outcomes. Study denominators vary depending on the outcomes reported. Adults with incident and those with prevalent ESKD are reported separately; children were analysed overall because of the

small number of studies. Statistical analyses were not done because of the intrinsic differences between adults with incident versus prevalent ESKD and between adults and children, rendering comparisons artificial.

Role of the funding source

There was no funding source for this study. All authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

4339 records were found, of which 1151 were excluded; 386 of 3188 screened studies underwent full review (figure 1), including one registry report from South Africa. No study was of high quality, mainly because participants were not representative of the larger ESKD population and because of missing data. 68 studies (56 adult, 12 paediatric) from 15 countries satisfied inclusion criteria, 49 of which were published from 2010 onwards. 34 of the 68 studies met medium-quality criteria. 26 adult and ten paediatric studies included patients with incident ESKD, 30 adult and two paediatric studies included patients with prevalent ESKD (appendix pp 5–11), and 37 adult and two paediatric studies included only patients who received dialysis. Ten studies provided details of missing data. 16 adult studies were prospective, seven cross-sectional, and 33 retrospective. Two paediatric studies were prospective and ten retrospective. Study duration ranged from 0·08 years to 19 years. All 12 paediatric and 26 of the adult studies were from academic hospitals; 24 adult studies were from city hospitals or haemodialysis units; three were from private dialysis units; and three reported whole-country data. 24 456 adults (10 354 with incident and 14 102 with prevalent ESKD) and 809 children (736 incident and 73 prevalent) were included in analyses (table 1).[12,13]

Mean patient ages ranged from 35·6 years (SD 13·2) to 58·2 years (SD 15·0) in adult studies and from 9·8 years (range 3 months to 17 years) to 11·5 years (SD 3·0) in paediatric studies. Males predominated among adults and children (table 1). The term CKD was often used synonymously with ESKD. The definitions of CKD and ESKD used are reported in table 1. The causes of CKD

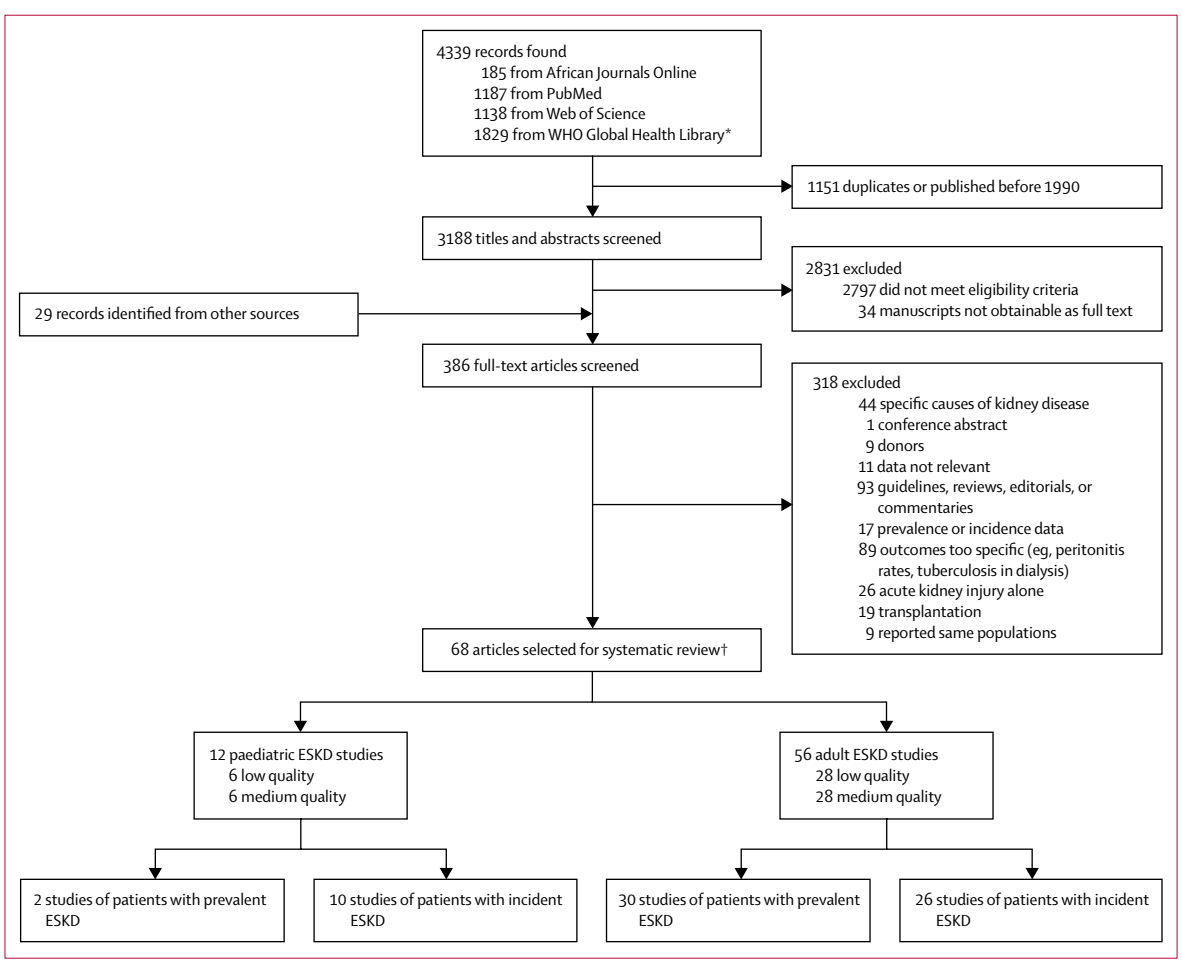

Figure 1: **Study selection**
ESKD=end-stage kidney disease. *Includes African Index Medicus. †39 had receipt of dialysis as an inclusion criterion.

	Adult studies			Paediatric studies (n=12)
	Overall (n=56)	Incident ESKD (n=26)	Prevalent ESKD (n=30)	
Number of countries	14	8	12	4
Patient inclusion period	1976–2014	1976–2013	1987–2014	1995–2013
Total number of patients with CKD or ESKD	24 456	10 354	14 102	809
In South Africa and Sudan only	15 063	2586	12 477	398
Excluding South Africa and Sudan	9393	7768	1625	411
Study duration (years)*	4·0 (4·5)	5·8 (5·1)	2·1 (2·3)	6·1 (2·8)
Sex†				
Male	13 655/22 152 (62%)	5682/9401 (60%)	7973/12 751 (63%)	439/748 (59%)
Female	8497/22 152 (38%)	3719/9401 (40%)	4778/12 751 (37%)	309/748 (41%)
Male:female ratio, individual studies†	1·98 (1·09)	1·72 (0·78)	2·20 (1·39)	1·46 (0·34)
Definitions of CKD or ESKD used				
Clinical	7	7	0	2
Laboratory (creatinine thresholds)	9	9	0	6
ESKD, glomerular filtration rate <15 mL/min	7	7	0	0
KDIGO or KDOQI	4	4	0	3
Dialysis requirement	41	11	30	2
Not mentioned	1	1	0	3

Data are mean (SD) or n/N (%), unless otherwise specified. CKD=chronic kidney disease. ESKD=end-stage kidney disease. KDIGO=Kidney Disease Improving Global Outcomes. KDOQI=Kidney Disease Outcomes Quality Initiative. *Data missing for four studies in adults with prevalent ESKD and one paediatric study. †Data missing for ten studies in adults (five incident ESKD and five prevalent ESKD) and four in children.

Table 1: **Study populations**

and ESKD were reported in 40 adult and 12 paediatric studies (appendix p 12).

The proportion of patients with incident ESKD who were able to access dialysis is outlined in table 2. Pooled analysis showed that 4221 of 8253 adults (51%; 15 studies) and 211 of 347 children (61%; eight studies) received at least one dialysis session. The mean percent access to dialysis across individual studies was 39·1% (SD 25·7) in adults and 47·4% (30·6) in children. Of 3692 adults with incident ESKD, 2980 (81%) received haemodialysis and 712 (19%) received peritoneal dialysis (16 studies); these numbers were 11 186 (84%) and and 2194 (16%) among 13 380 adults with prevalent ESKD (26 studies), and 128 (46%) and 149 (54%) among 277 children (ten studies).

Dialysis duration was reported in 35 adult and eight paediatric studies (table 2). Among those who started dialysis, 2572 of 4354 adults (59%; 23 studies) and 94 of 192 children (49%; six studies) discontinued dialysis. In adults, 2508 of 2990 (84%; 13 studies) incident and 64 of 1364 (5%; ten studies) prevalent patients discontinued dialysis after a mean of 6·5 (SD 5·3) sessions. The pooled proportion of children discontinuing dialysis was 94 of 192 (49%; six studies), and the mean percentage was 76·2% (SD 33·6). The proportions of adults and children continuing dialysis for at least 3 months and at least 12 months are shown in table 2. The pooled proportion of adults with prevalent ESKD remaining on dialysis for at least 3 months was 3029 of 3575 (85%; ten studies) and the mean of individual study frequencies was 63·4% (SD 24·0), compared with a pooled proportion of 295 of 3104 (10%; 16 studies) and mean of individual study frequencies of 14·1% (SD 12·6) in adults with incident ESKD. The durations of dialysis received in individual studies are shown in the appendix (pp 5–11). Compared with the full cohort, when studies from South Africa and Sudan were excluded, the proportions of people who discontinued dialysis were higher among both adults and children (78% and 86%, respectively; appendix p 13).

In the pooled analyses, overall known study mortality was higher in adults (3446 [32%] of 10 874; 35 studies) than in children (159 [24%] of 656; ten studies) and in incident (2966 [39%] of 7677; 17 studies) than in prevalent (480 [15%] of 3197; 18 studies) adult cohorts. However, overall study mortality might not represent ESKD mortality, because some studies included patients with CKD who did not require dialysis, and most did not account for patients lost to follow-up or leaving hospital against medical advice. 27 of 143 children (19%; three studies) had left hospital against medical advice, whereas 557 of 3087 adults (18%; 12 studies) and 188 of 675 children (28%; eight studies) were lost to follow-up (table 3). We presumed that these patients probably died without further treatment. Including these patients and those who discontinued dialysis in the pooled analysis, known and presumed mortality occurred in 5128 of 9057 adults (57%; 39 studies) and 266 of 426 children (62% 11 studies). Mortality was higher among adults with incident (4632 [79%] of 5860; 21 studies) than among those with prevalent ESKD (496 [16%] of 3197; 18 studies).

	Adult studies			Paediatric studies
	Overall	Incident	Prevalent	
Access to dialysis				
Pooled	4221/8253 (51%; 15)	4221/8253 (51%; 15)	NA	211/347 (61%; 8)
Individual studies	39·1% (25·7; 16)	39·1% (25·7; 16)	NA	47·4% (30·6; 8)
Not dialysed although indicated				
Pooled	3277/6797 (48%; 11)	3277/6797 (48%; 11)	NA	106/323 (33%; 7)
Individual studies	56·6% (19·5; 11)	56·6% (19·5; 11)	NA	41·6% (21·4; 7)
Known to stop dialysis although needed				
Pooled	2572/4354 (59%; 23)	2508/2990 (84%; 13)	64/1364 (5%; 10)	94/192 (49%; 6)
Individual studies	51·4% (41·4; 23)	79·7% (27·5; 13)	14·7% (23·0; 10)	76·2% (33·6; 6)
Continued dialysis ≥3 months*				
Pooled	3324/6589 (50%; 26)	295/3014 (10%; 16)	3029/3575 (85%; 10)	66/190 (35%; 7)
Individual studies	33·1% (32·9; 26)	14·1% (21·6; 16)	63·4% (24·0; 10)	29·6% (38·2; 7)
Continued dialysis ≥12 months†				
Pooled	1598/3560 (45%; 13)	19/1472 (1%; 6)	1579/2088 (76%; 7)	3/6 (50%; 1)
Individual studies	36·4% (38·3; 13)	1·5% (2·3; 6)	66·3% (25·8; 7)	No data
Recovery of enough renal function to come off dialysis				
Pooled	34/1765 (2%; 9)	5/64 (8%; 3)	29/1701 (2%; 6)	2/20 (10%; 3)
Individual studies	4·9% (7·1; 9)	7·3% (12·6; 3)	3·7% (3·4; 6)	22·2% (38·5; 3)
Transplant received				
Pooled	2321/16 608 (14%; 24)	41/4483 (1%; 11)	2280/12 125 (19%; 13)	71/381 (19%; 9)
Individual studies	6·3% (8·4; 24)	1·7% (1·3; 11)	10·3% (9·9; 13)	19·0% (26·6; 9)

Data are n/N (%; number of studies) or mean (SD; number of studies). NA=not applicable. *Countries reporting dialysis duration ≥3 months: Burkina Faso, Cameroon, Democratic Republic of the Congo, Ethiopia, Ghana, Malawi, Nigeria, Senegal, South Africa, and Sudan. †Countries reporting dialysis duration ≥12 months: Cameroon, Ethiopia, Ghana, Nigeria, Senegal, South Africa, Sudan.

Table 2: **Renal replacement therapy for end-stage kidney disease**

Leading causes of death were uraemia, volume overload (ie, too much water in their bodies that they could not excrete because of kidney failure), hypertension, discontinuation of dialysis, no vascular access, heart failure, stroke, or infections.[20–26]

Overall pooled mortality among patients with ESKD who received dialysis was similar among adults (1302 [31%] of 4228; 25 studies) and children (90 [32%] of 284; ten studies), but was higher among adults with incident ESKD (822 [80%] of 1031; seven studies) compared with prevalent ESKD (480 [15%] of 3197; 18 studies; table 3). Among patients who needed but did not receive dialysis, pooled known and presumed mortality was similar in adults (390 [96%] of 406; three studies) and children (133 [95%] of 140; nine studies). Among adults with incident ESKD, the difference in known and presumed mortality between those who did and did not receive dialysis was small (2747 [88%] of 3122, 14 studies *vs* 390 [96%] of 406; three studies). When South Africa and Sudan were excluded from the analyses, pooled mortality among adults and children who received dialysis increased further (appendix p 14). Pooled known and presumed mortality was similar between adult patients with prevalent ESKD who received peritoneal dialysis (121 [19%] of 650; seven studies) or haemodialysis (301 [16%] of 1884; nine studies; appendix p 15).

15 adult studies reported use of intravenous iron or erythropoietin for renal anaemia (appendix p 16). Access to both drugs was scarce, leaving patients mainly reliant on blood transfusions (mean 61·5% [SD 15·2]; six studies). Use of any intravenous iron (1870 [65%] of 2898; three studies *vs* 30 [25%] of 120; one study) or erythropoietin (2425 [74%] of 3287; nine studies *vs* 65 [19%] of 348; three studies) was higher in prevalent versus incident cohorts. Means of individual study proportions were generally lower than pooled proportions. One paediatric study reported use of erythropoietin for less than 1 week in two of 24 children and blood transfusion in five of 25 children.[27] Use of phosphate binders was reported in two of 42 and 19 of 45 patients in two adult studies.[28,29] Haemodialysis vascular access was described in 22 adult studies. Overall, the mean proportion of patients with arteriovenous fistula was 15·6% [SD 9·7] at the start of dialysis, but rose among prevalent patients over time (from 16·5% [10·9] to 61·3% [26·2]; appendix p 16). No study described regular laboratory monitoring. Four studies reported use of four 2 L exchanges daily for continuous ambulatory peritoneal dialysis (usual dose), and one study described use of a peritoneal dialysis cycler.[30–33] Frequency of haemodialysis was described in 17 studies (figure 2).[12,24,26,34–47] Most patients with prevalent ESKD received two 4 h sessions per week, but some received dialysis

	Adult studies			Paediatric studies
	Overall	Incident	Prevalent	
Known and presumed mortality*				
Pooled	5128/9057 (57%; 39)	4632/5860 (79%; 21)	496/3197 (16%; 18)	266/426 (62%; 11)
Individual studies	53·0% (34·0; 39)	79·6% (19·0; 21)	21·9% (15·9; 18)	70·4% (29·8; 11)
Mortality without dialysis although indicated				
Known†				
Pooled	NA	185/212 (87%; 2)	NA	43/51 (84%; 4)
Individual studies	NA	80·1% (13·1; 2)	NA	81·7% (15·8; 4)
Known and presumed*				
Pooled	NA	390/406 (96%; 3)	NA	133/140 (95%; 9)
Individual studies	NA	95·6% (7·6; 3)	NA	96·2% (8·0; 9)
Mortality with dialysis				
Known†				
Pooled	1302/4228 (31%; 25)	822/1031 (80%; 7)	480/3197 (15%; 18)	90/284 (32%; 10)
Individual studies	32·1% (27·1; 25)	60·0% (31·0; 7)	21·2% (15·7; 18)	50·5% (32·2; 10)
Known and presumed*				
Pooled	3243/6319 (51%; 32)	2747/3122 (88%; 14)	496/3197 (16%; 18)	107/294 (36%; 10)
Individual studies	48·7% (35·3; 32)	83·0% (19·4; 14)	21·9% (15·9; 18)	57·3% (35·1; 10)
Left hospital against medical advice, pooled	ND	ND	ND	27/143 (19%; 3)
Lost to follow-up, pooled	557/3087 (18%; 12)	443/1633 (27%; 7)	114/1454 (8%; 5)	188/675 (28%; 8)

Data are n/N (%; number of studies) or mean (SD; number of studies). NA=not applicable. ND=no data. *Patients with end-stage kidney disease who were known to have died plus those who left hospital against medical advice, were lost to follow-up, or stopped dialysis although indicated and therefore are presumed to have died without further treatment. †Patients known to have died.

Table 3: **Mortality in children and adults with end-stage kidney disease**

intermittently as resources permitted. Eight adult studies reported monitoring of dialysis adequacy, which was infrequent and often suboptimum (appendix p 17). The delivered dialysis dose tended to be higher among those receiving peritoneal dialysis than haemodialysis.

Nine adult and three paediatric studies described recovery of enough renal function for patients to discontinue dialysis. In pooled analyses, five of 64 adults with incident ESKD (8%; three studies) and two of 20 children (10%; three studies) came off dialysis (table 2). 2321 of 16 608 adults (14%; 24 studies) and 71 of 381 children (19%; nine studies) received a kidney transplant. A transplant was received by more adults with prevalent than with incident ESKD (2280 [19%] of 12 125 *vs* 41 [1%] of 4483). Transplantations were often done outside the country (data not shown). When studies from South Africa and Sudan were excluded, the proportion of patients receiving a transplant decreased substantially, to 54 (1%) of 4808 adults and four (3%) of 158 children (appendix p 13).

Discussion

The public health impact of ESKD does not lie exclusively in the numbers of patients affected, but also in the diagnostic and therapeutic challenges of management, which impose a substantial burden on individuals and the health system in resource-limited settings. So far, mostly single-centre studies have highlighted the local challenges in management of ESKD in sub-Saharan Africa. In this systematic review, we show that, even among the few people who reach a diagnosis of ESKD in sub-Saharan Africa, presumed and known mortality among adults and children was high, and was over 95% when patients were unable to access dialysis. Among patients who did start dialysis, mortality remained high, largely because of late presentation, frequent dialysis discontinuation, and suboptimum dialysis quality. Overall, only around 10% of adults with incident ESKD and 35% of children remained on dialysis for at least 3 months. Worldwide, higher mortality is noted within the first 120 days of starting dialysis compared with later months, which is largely attributed to comorbid illness, patient age, withdrawal from dialysis, or poor care before dialysis.[48] Although some of these criteria might explain the differences in mortality between patients with incident versus prevalent ESKD in sub-Saharan Africa, the attrition described in most studies was a result of the inability to pay for dialysis, occurring usually within the first 2 weeks of initiation (mean cost US$100–150 per haemodialysis session).[24,49] The adult ESKD population in sub-Saharan Africa tends to be young with few comorbidities; therefore, when patients do manage to pay for long-term dialysis, even though dialysis quality might be suboptimal, outcomes are much improved, with over 75% of patients with prevalent ESKD remaining on dialysis for over 1 year. Outcomes in children were generally between those noted

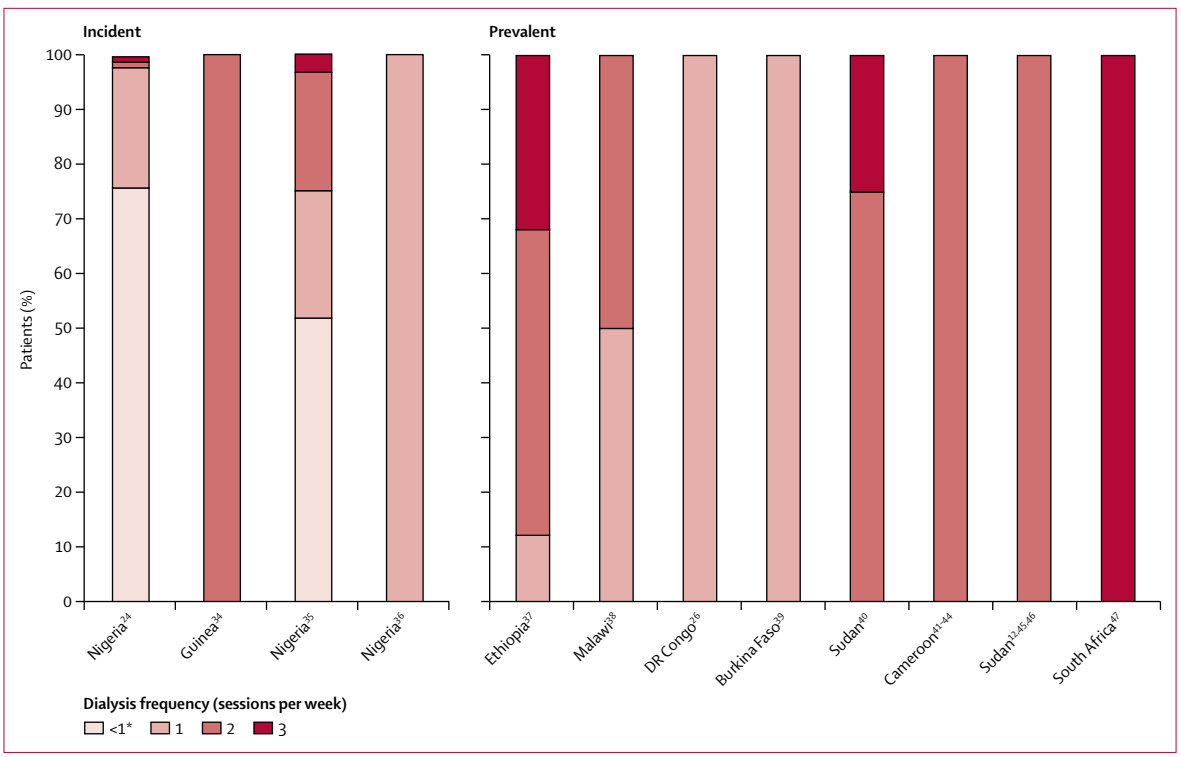

Figure 2: **Proportion of dialysis sessions received per week in incident and prevalent haemodialysis populations by country**
The standard haemodialysis dose is three sessions of 4 h per week, but varied in some studies. Each column represents data from one study or country; studies from the same country are shown separately when the dialysis frequencies differed. *Ranged from one dialysis session only to one session every 2 weeks to 2 months.

for adults with incident and prevalent ESKD; however, a high proportion of children left hospital against medical advice, suggesting that families make affordability decisions soon after diagnosis and there is little long-term dialysis available for children outside of South Africa and Sudan. Prospective studies are needed to identify differences in causes of death, reasons for dialysis discontinuation, and factors associated with dialysis continuation among patients with incident and prevalent ESKD and in children with ESKD in sub-Saharan Africa, to inform clinical decision making and policy development around ESKD care.

This systematic review complements our recent review on the outcomes of patients with acute kidney injury in sub-Saharan Africa, where access to dialysis and survival were also low.[17] The numbers of patients with acute kidney injury and ESKD who remain undiagnosed are unknown. Both reviews show that, even among patients who have resources to reach a diagnosis of kidney failure, dialysis is largely out of reach. Much attention has been focused recently on the diagnosis and management (including dialysis) of acute kidney injury because this disorder is less costly than ESKD.[50] Although this strategy might be efficient, this narrow focus raises equity questions for patients with other kidney diseases. Awareness must be raised about the plight of all patients with kidney failure in sub-Saharan Africa.

Recent publications have estimated the large unmet need for dialysis and a systematic review addressed the scarcity of trained staff in sub-Saharan Africa.[5,6,51–55] Where dialysis is available, even where partial government subsidies exist, many patients stop treatment and die once their resources are depleted because vascular access, laboratory and radiological testing, drug treatment, or transportation are not covered.[33,38,41,56,57] Such high attrition rates raise ethical questions about offering patients dialysis when their resources are known to be inadequate to sustain treatment. However, some patients, being fully informed, still wish to try. In countries where full dialysis costs are covered by the government, although individual outcomes are improved, access is still limited by official rationing (South Africa), out-of-pocket costs needed for transportation and drugs (Sudan), and insufficient dialysis infrastructure to treat all those in need.[11,12,22,31]

The quality of dialysis delivered is also resource-dependent, and many patients cannot afford, or dialysis centres cannot provide, regular dialysis. Dialysis quality, as measured by use of erythropoiesis-stimulating drugs; permanent vascular access; dialysis dose; dialysis adequacy; and access to transplantation, was poor even among those able to afford long-term dialysis. One study[35] described repeated femoral vein catheterisation as the predominant form of dialysis access in 105 of

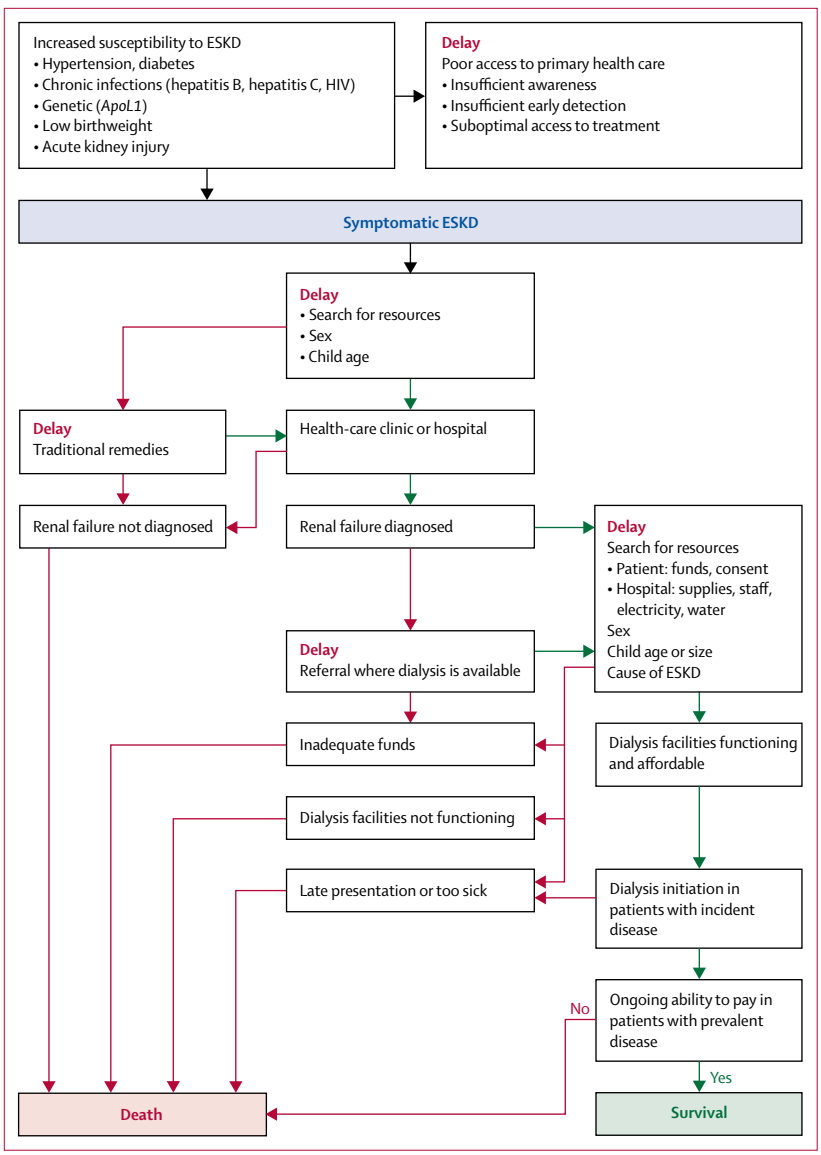

Figure 3: **Barriers to care in end-stage kidney disease**
Flow diagram showing barriers in access to dialysis contributing to mortality in ESKD in many sub-Saharan African countries. Green arrows show factors present to facilitate diagnosis of ESKD or referral for or access to dialysis; red arrows show absence of these factors. Most barriers are related to access to care, access to diagnosis, out-of-pocket payments needed, and infrastructural resources. ESKD=end-stage kidney disease. Figure adapted from Olowu and colleagues.[17]

120 patients because of cost. Measurement of dialysis adequacy was rarely reported. However, when measured in Sudan, a proportion of patients achieved target adequacy despite the lower haemodialysis dose, and dialysis quality might be better with peritoneal dialysis under the circumstances.[12,45] This finding should provide a rationale to advocate more affordable peritoneal dialysis for ESKD.[10,33,58]

Common barriers contributing to mortality in ESKD in sub-Saharan Africa are shown in figure 3. The most common patient barriers to accessing dialysis and achieving adequate dialysis quality are the unaffordable costs of dialysis, transportation, drug treatment, vascular access, and transplantation workup.[12,29,35,49] In view of the unexpected low prevalence of HIV as a cause of ESKD, some underlying diseases and comorbid conditions might also represent barriers.[11,49,59] Female sex is a systematic barrier to access to ESKD care in sub-Saharan Africa.[60] In the reviewed studies, young children were under-represented, potentially because of unwillingness to pay and paucity of facilities for infants.[61] Infrastructural barriers include the scarcity of dialysis facilities, which when available are predominantly in urban centres, might be dependent on donated outdated equipment that cannot be maintained, are often affected by staff and stock shortages, and cannot meet the clinical need.[33,38,62,63] Identification of common barriers occurring in daily practice is important to stimulate debate about pragmatic approaches to prevention, diagnosis, and management of ESKD in sub-Saharan Africa.

This systematic review has important limitations and several strengths. In view of the scarcity of high-quality studies, all papers were included in an attempt to reduce further bias by exclusion. The diagnosis of ESKD was not uniform across studies and in view of the clinical circumstances in much of sub-Saharan Africa, the distinction between acute kidney injury and ESKD was not always possible. Therefore, some patients with acute kidney injury might have been incorrectly diagnosed as having ESKD. Erroneous inclusion of patients with acute kidney injury could have biased the outcomes towards underestimation of mortality in ESKD, especially among adults with incident ESKD. Not all studies reported on all outcomes; therefore, denominators vary for each analysis, but the data presented represent the best available and patient numbers are high, which are important strengths. The finding that about 40–50% of patients in the identified studies received dialysis at least once is probably a substantial overestimate of the true figure, as reported in 2015.[6] Almost all studies were from centres with dialysis facilities and therefore represent only patients who received a diagnosis of ESKD and had reached a dialysis unit. Thus, publication bias exists in terms of access to dialysis, but outcomes reported remain relevant. The outcomes and dialysis quality measures are poor and represent the daily reality of dialysis practice in many countries in sub-Saharan Africa. Dialysis duration and mortality rates were reported with varying follow-up times in individual studies. However, we believe that the small proportions of patients remaining on long-term dialysis is probably a valid indirect indicator of dialysis duration and high early mortality in patients with ESKD. Differences between pooled proportions and means of individual study frequencies for some outcomes show variability between studies. These differences are likely to reflect differences in study size, but also probably reflect many other factors such as local logistics, infrastructure, skill, geographical location, and distribution of poverty or affluence of patients included,

which will have affected study outcomes. The overall heterogeneity of the data emphasises the urgent need for good systematic data collection on incidence and prevalence of ESKD as well as the need to perform and publish higher quality studies in the region. Despite the data only representing 15 countries in sub-Saharan Africa, the consistency of problems encountered and poor patient outcomes across studies suggest generalisability of these findings. Despite the inherent limitations, this systematic review provides important insights to encourage and inform policy development and health-system-wide planning to address ESKD in sub-Saharan Africa.

Dialysis facilities and dialysis populations are expanding in sub-Saharan Africa.[15] The consequences for the individual, in terms of catastrophic expenditure and life or death, and for the health system, in terms of opportunity costs and equity, cannot be ignored. Few countries in sub-Saharan Africa have official policies for renal replacement therapy, and some governments are reluctant to broach the debate about coverage of renal replacement therapy, which is fraught with ethical dilemmas. Without formalised criteria or official guidelines, access to dialysis is haphazard, often depending on luck if facilities are available, and ability to pay. The burden of so-called choice between life and death is shifted to individual clinicians, patients, and families, imposing substantial moral distress.[64] However, before development of ESKD policies, existing knowledge gaps about the local burden of disease, outcomes, assessment of current treatment capacity, and the socioeconomic implications of kidney disease must be filled.[65] Engaging in public debate about the justice implications of starting expensive programmes such as dialysis, which deliver acceptable quality care, in environments where opportunity costs are likely to be very high is important to develop sustainable and equitable solutions for patients with kidney disease.

Contributors

GA reviewed and scored articles, planned the study, analysed data, and wrote the manuscript. CO, WAO, and AN reviewed and scored articles, planned the study, and reviewed and revised the manuscript. FA did the literature search, reviewed and scored articles, planned the study, and reviewed and revised the manuscript. JP and SN planned the study and reviewed and revised the manuscript. VAL did the literature search, reviewed and scored articles, planned the study, analysed data, and wrote the manuscript.

Declaration of interests

We declare no competing interests.

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