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Socioeconomic Determinants, Regional Differences, and Quality of Nephrology Research in Africa

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The prevalence of chronic kidney disease (CKD) continues to rise globally.[1,2] However, this has been found to be disproportionately higher in several low-income and low-to-middle–income countries.[1,3] Providing adequate kidney care for CKD patients depends on numerous factors, including an understanding of disease epidemiology, disease outcomes, response to treatment, and prognostic factors, as well as the availability of various items necessary to provide care for such patients. These elements are established and frequently updated through various forms of rigorous research. The International Society of Nephrology (ISN) first Global Kidney Health Atlas (GKHA) reported that Africa was consistently lagging behind other world regions in the capacity to participate in clinical trials or observational studies in nephrology.[4] Other studies have also shown that Africa has the lowest contributions to biomedical publications when all world regions are considered.[5] Several factors are linked to biomedical research outputs, and include the available national funding structures for research and development, number of higher institutions of learning, availability of research infrastructure, training, mentorship and peer networks for research.[6,7] The aim of this descriptive study is to provide a brief report on the quantity and quality of published research in nephrology from Africa (by country and region) over a period spanning 5 decades.

RESULTS

We identified 17,256 records from bibliographic searches; after removing duplicates (771), we screened 16,151 titles and abstracts and identified eligible 1326 articles (Figure 1, Supplementary Table S1). The number of publications increased over the study period and peaked in 2015 (Figure 2a). Included articles were from 34 African countries, and the top 5 publishing countries were Nigeria (31.1%), Egypt (13.3%), South Africa (11.9%), Morocco (5.4%), and Tunisia (4.8%) (Table 1, Figure 2b). When considered based on the number of physicians per 1000 population, Nigeria, South Africa, Egypt, Tunisia, and Morocco were still the top 5 countries. However, when based on number of articles per 10 million population, the 5 countries were Seychelles (105.6), Tunisia (54.6), South Africa (27.9), Senegal (25.2), and Nigeria (21.6). With reference to the first author (and study setting), the proportion of articles published by region were as follows: West Africa, 39.1%; North Africa, 28.7%; Southern Africa, 12.1%; East Africa, 7.7%; and Central Africa, 3.6%. The others were from non-African first authors (Figure 3a).

Table 2 summarizes the types and study designs of included articles. There were 1051 (79.3%) original research (made up of cross-sectional studies [n = 841, 80.0%], cohort studies [n = 114, 10.9%], case-control studies [n = 91, 8.7%], and randomized control trials

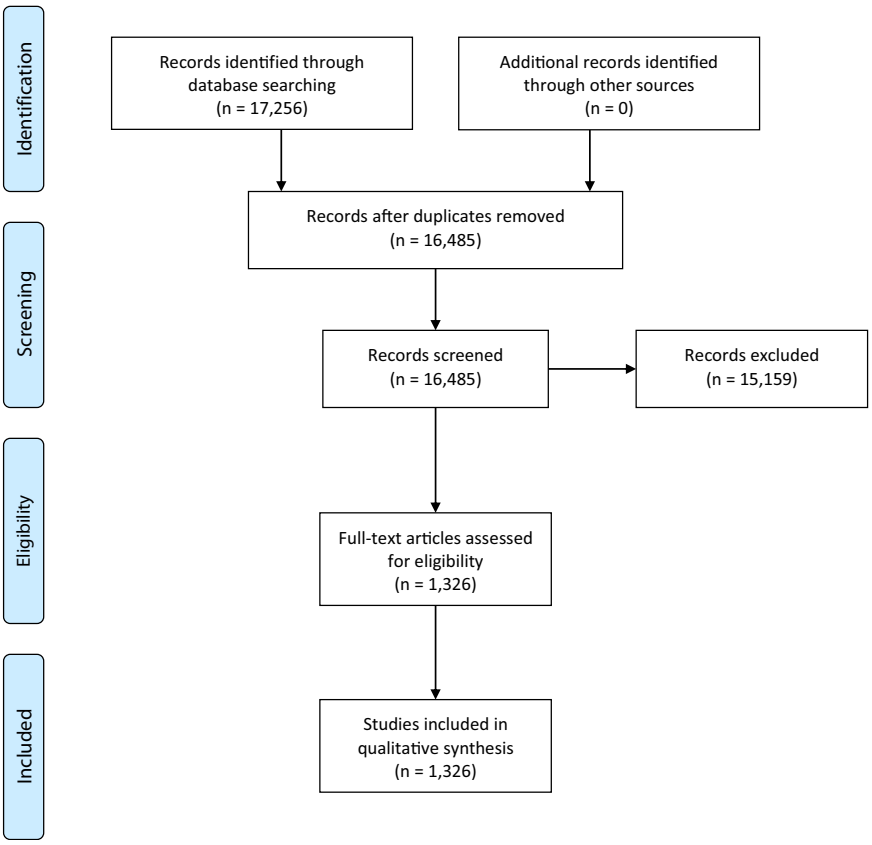

Figure 1. Study selection flowchart.

[n = 5, 0.5%] (Table 2). Articles published in journals with an impact factor (IF) or Scimago Journal Rank (SJR) were 37.3% (median IF = 1.56, interquartile range [IQR] = 0.92−2.39) and 79.6% (median SJR = 0.32, IQR = 0.19−0.65), respectively. Nigeria (21.6%), South Africa (20.8%), and Egypt (14.7%) had the most articles in a journal with an IF (Table 1, Figure 3b). Only 31.8% of the articles were published in a journal with a nephrological or urological scope, and 59.0% were published in journals based in Africa (Table 2).

Using multivariable linear regression, population was the only sociodemographic factor associated with

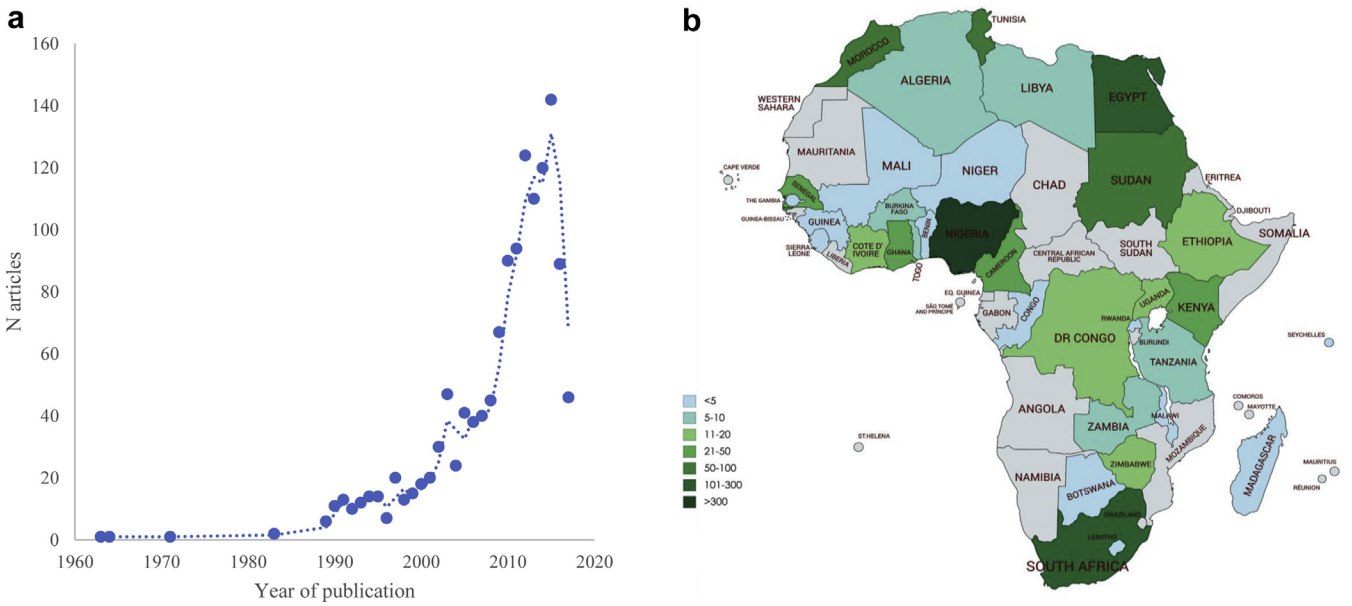

Figure 2. (a) Trends in number of articles published in Africa. (b) Number of articles published per country in Africa.

Table 1. Sociodemographic details, quality and quantity of articles published from included countries in Africa

Country	Population	GDP	HDI	Literacy rate	No. of physicians (pmp)	No. of articles (%)	No. of articles in IF journals (%)	No. of RCTs (%)
Nigeria	189,374,685	6267	0.529	51.6	28.9	412 (31.1)	107 (21.6)	0 (0.0)
Egypt	97,553,151	11,381	0.692	75.2	54.5	176 (13.3)	73 (14.7)	2 (40.0)
South Africa	56,067,477	13,472	0.665	94.1	76.2	158 (11.9)	103 (20.8)	0 (0.0)
Morocco	35,739,580	7838	0.647	69.4	51.0	71 (5.4)	18 (3.6)	0 (0.0)
Tunisia	11,532,127	11,599	0.725	79.0	134.0	63 (4.8)	27 (5.5)	1 (20.0)
Sudan	40,533,330	5895	0.490	53.5	22.0	57 (4.3)	8 (1.6)	0 (0.0)
Senegal	15,850,567	2742	0.496	43.3	7.2	40 (3.0)	5 (1.0)	0 (0.0)
Kenya	49,699,862	3156	0.555	78.7	14.0	35 (2.6)	4 (0.8)	0 (0.0)
Cameroon	24,053,727	3286	0.518	71.3	19.0	25 (1.9)	15 (3.0)	0 (0.0)
Ghana	28,833,629	4294	0.579	71.5	15.0	21 (1.6)	9 (1.8)	0 (0.0)
Democratic Republic of Congo	81,339,988	5719	0.435	79.3	11.0	19 (1.4)	18 (3.6)	0 (0.0)
Ivory Coast	24,294,750	3720	0.474	43.9	12.0	16 (1.2)	8 (1.6)	0 (0.0)
Uganda	42,862,958	2695	0.493	70.2	8.0	15 (1.1)	12 (2.4)	0 (0.0)
Ethiopia	104,957,438	1735	0.448	39.0	3.0	13 (1.0)	3 (0.6)	0 (0.0)
Zimbabwe	16,529,904	2006	0.516	88.7	16.0	12 (0.9)	2 (0.4)	0 (0.0)
Tanzania	57,310,019	2787	0.531	77.9	2.0	10 (0.8)	4 (0.8)	0 (0.0)
Zambia	17,094,130	3922	0.579	83.0	12.0	10 (0.8)	3 (0.6)	0 (0.0)
Togo	7,797,694	1491	0.487	63.8	4.0	9 (0.7)	1 (0.2)	0 (0.0)
Libya	6,374,616	9800	0.716	60.2	129.0	7 (0.5)	2 (0.4)	0 (0.0)
Algeria	41,318,142	13,053	0.703	69.8	95.2	6 (0.5)	2 (0.4)	0 (0.0)
Burkina Faso	19,193,382	1720	0.402	34.6	6.0	6 (0.5)	3 (0.6)	0 (0.0)
Benin	11,175,692	2219	0.485	32.9	4.0	5 (0.4)	0 (0.0)	0 (0.0)
Mali	18,541,980	2117	0.442	33.1	8.0	4 (0.3)	0 (0.0)	0 (0.0)
Republic of Congo	81,339,988	5719	0.592	79.3	20.0	4 (0.3)	3 (0.6)	0 (0.0)
Guinea	12,717,176	1311	0.424	32.0	12.0	3 (0.2)	0 (0.0)	0 (0.0)
Botswana	2,291,661	16,735	0.698	81.2	40.0	2 (0.2)	2 (0.4)	0 (0.0)
Madagascar	25,570,895	1506	0.512	71.6	29.0	2 (0.2)	0 (0.0)	0 (0.0)
Malawi	18,622,104	1169	0.476	62.1	2.0	2 (0.2)	1 (0.2)	0 (0.0)
Gambia	2,100,568	1689	0.452	41.9	11.0	1 (0.1)	1 (0.2)	0 (0.0)
Lesotho	2,203,821	3029	0.497	76.6	5.0	1 (0.1)	1 (0.2)	0 (0.0)
Niger	21,477,348	978	0.353	15.5	3.0	1 (0.1)	0 (0.0)	0 (0.0)
Rwanda	12,208,407	1913	0.498	68.3	5.0	1 (0.1)	0 (0.0)	0 (0.0)
Seychelles	94,737	28,391	0.782	93.9	151.0	1 (0.1)	1 (0.2)	0 (0.0)
Sierra Leone	7,557,212	1473	0.420	32.4	3.0	1 (0.1)	0 (0.0)	0 (0.0)
Outside Africa	NA	NA	NA	NA	NA	91 (6.9)	56 (11.3)	2 (40.0)

GDP, gross domestic product; HDI, human development index, IF, impact factor; NA, not applicable; pmp, per million population; RCTs, randomized controlled trials.

publications by country (β-coefficient = 1.26, 95% confidence interval [CI] = 0.85−1.68, $P < 0.0001$) (Table 3). Factors associated with publications in a journal with an IF were as follows: the continent of the journal (adjusted odds ratio [aOR] = 0.08, 95% CI = 0.06−0.11, $P < 0.0001$), level of income (aOR = 3.59, 95% CI = 2.12−6.08, $P < 0.0001$), literacy rate (aOR = 1.01, 1.01−1.03, $P = 0.004$), number of physicians (aOR = 0.60, 95% CI = 0.37−0.98, $P = 0.042$), population size (aOR = 2.55, 95% CI = 1.82−3.57, $P < 0.0001$), and number of authors listed in the publication (aOR = 1.11, 95% CI = 1.05−1.17, $P = 0.0004$) (Table 4).

DISCUSSION

This study was carried out to assess the quality and quantity of nephrology research from Africa over the past 5 decades. Our study showed the following: (i) Nigeria (and West Africa), with a very large population, have the highest numbers of nephrology publications: (ii) a relatively low quality of research as evidenced by the low number of randomized controlled trials (RCTs) and publications in journals with low Ifs; and (iii) no correlation among gross domestic product (GPD), human development index (HDI), and literacy rate with number of publications per country in Africa.

The reasons for West Africa (and Nigeria) having the highest number of publications may be related to the larger size of the population (and therefore the number of researchers), higher number of medical schools in the region compared to other African regions, [8] and the large number of biomedical journals in West Africa and Nigeria compared to other regions (https://www.ajol.info/index.php/index/browse/category). Thus, although African Journals OnLine (AJOL) hosts 525

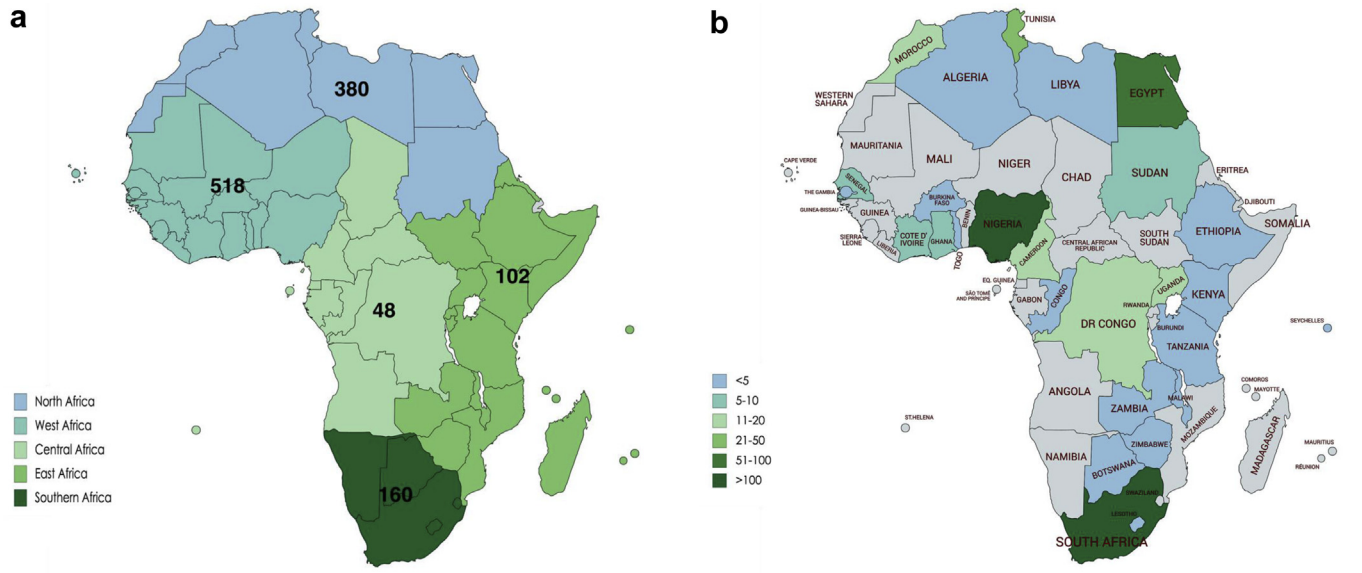

Figure 3. (a) Number of articles per region in Africa. (b) Number of articles published in journals with an impact factor in Africa.

different journals, 42.3% are in Nigeria, which might increase publication opportunities for researchers from Nigeria and West Africa. This could explain why 59% and 68.2% of nephrology publications on the continent are published in journals hosted within Africa and journals with scope outside of nephrology/urology, respectively (Table 2).

Table 2. Types of published articles, study designs, and journal metrics of included articles

Type	n (%)
Article types (n = 1326)	
Cross-sectional[a]	841 (63.4)
Case report	165 (12.4)
Cohort[a]	114 (8.6)
Case control[a]	91 (6.9)
Review	62 (4.7)
Randomized controlled trial[a]	5 (0.4)
Case series	17 (1.3)
Letter	16 (1.2)
Commentary	10 (0.8)
Editorial	4 (0.3)
Images	1 (0.08)
Study design (n = 1051)	
Prospective	582 (55.4)
Retrospective	299 (28.5)
Prospective and retrospective	1 (0.1)
Unclear	169 (16.1)
Journal metrics	
Impact factor (n = 495), median [IQR]	1.56 [0.92–2.39]
SJR (n = 1056), median [IQR]	0.32 [0.19–0.65]
Journal scope (n = 1326)	
Nephrology/urology	422 (31.8)
Others	904 (68.2)
Journal location (n = 1326)	
Journals based in Africa	782 (59.0)
Journal based outside of Africa	544 (41.0)

IQR, interquartile range; SJR, scientific journal ranking.
[a]Published original articles.

Although various studies have shown a higher number of nephrologists to be from the North African region compared to other African regions,[9,S1] the relatively lower number of published studies from North Africa compared to West Africa may be related to language, as most of countries in North Africa are predominantly Arabic- or French-speaking nations. "Brain-drain" of nephrologists with research capacity could also be a contributing factor to the low number and quality of nephrology research outputs from Africa.[S2,S3] Many qualified researchers may leave Africa for "greener pastures" in other continents often because of socioeconomic constraints, lack of infrastructure, and desire for personal fulfilment.[S4] Although brain drain remains a hefty challenge for developing sustainable research programs in Africa, this can be turned into an opportunity to improve research in Africa, given the number of African-origin nephrology researchers working outside of the continent. The skills of nephrology researchers who have left Africa, irrespective of their locations, can be harnessed to provide training and mentoring and to improve skills and collaboration at local levels to enhance both quantity and quality of research. The initial ways to do this could include invitations and participations at local nephrology meetings, development of research protocols, joint supervision of nephrology trainees, and joint applications for research grants for research. Such partnerships can become immensely critical toward contributing and improving Africa's healthcare systems and research.

Table 3. Factors associated with the number of publications per country

Factors	Univariable linear regression		Multivariable linear regression	
	Crude β-coefficient (95% CI)	*P* value	Adjusted β-coefficient (95% CI)	*P* value
Population	1.28 (0.86 to 1.69)	<0.0001	1.26 (0.85 to 1.68)	<0.0001
GDP	0.002 (−0.002 to 0.007)	0.228		
HDI	155.6 (−84.4 to 395.6)	0.213		
Physicians	32.2 (−31.4 to 95.8)	0.329	25.4 (−18.9 to 69.7)	0.269
Literacy rate	0.35 (−0.94 to 1.63)	0.602		

CI, confidence interval; GDP, gross domestic product; HDI, human development index.

Research quality is difficult to quantify; however, given the rigorous editorial and peer review processes of many journals, publications in journals with high impact factors as well as RCTs tend to be appropriately regarded with quality. There were only 0.4% nephrology RCTs recorded over the period of our study.[S5–S9] Only a few centers in Africa (mainly South Africa, Egypt, Algeria, and Morocco) have the human and infrastructural capacity to participate in research clinical trials[S10]; however, these trials are usually driven by pharmaceutical companies, highlighting the gaps in conducting RCTs in Africa.

Notwithstanding that we did not find an association between economic indicators (GDP and HDI) and publication counts, these factors have been known to correlate with scientific productivity.[S11,S12] Data from the World Bank shows that most African countries either do not have data on research and development or spend less than 0.5% of national budget on research and development (compared to high-income countries that spend well over 2%).[S13] Although most African countries are faced with a double burden of infectious and noncommunicable diseases as well as poverty, there needs to be a substantial increase in spending for healthcare and for scientific research and development; this will have positive outcomes for nephrology research in Africa.

There are a few limitations of our study. Our search was limited to PubMed and AJOL; hence, research in other databases could have been missed. However, we are confident to have captured most articles published in the study period. Also, our study is limited by

Table 4. Factors associated with publishing in a journal with an impact factor

Factors	n	n (%)	Univariate model		Multivariate final model	
			Crude odds ratio (95% CI)	*P*	Adjusted odds ratio (95% CI)	*P*
First continent of the author						
Outside of Africa	91	56 (61.5)	1			
Africa	1209	436 (36.1)	0.35 (0.23–0.55)	<0.0001	1.13 (0.54–2.33)	0.750
Types of papers						
Others	275	78 (28.4)	1			
Original articles	1051	417 (39.7)	1.66 (1.25–2.23)	<0.0001		
Continent of the journal						
Outside of Africa	542	127 (67.9)	1			
Africa	782	368 (16.2)	0.09 (0.07–0.12)	<0.0001	0.08 (0.06–0.11)	<0.0001
Scope of the journal						
Others	904	300 (33.2)	1			
Specific to nephrology/urology	422	195 (46.2)	1.73 (1.37–2.19)	<0.0001		
Country level of income						
Low- and low-middle	1044	327 (31.2)	1			
Upper-middle and high	255	165 (64.7)	4.02 (3.01–5.36)	<0.0001	3.59 (2.12–6.08)	<0.0001
Country level of HDI						
Low and medium	1139	403 (35.4)	1			
High and very high	160	89 (55.6)	2.29 (1.64–3.20)	<0.0001		
Level of literacy						
By increase of 10%			1.03 (1.03–1.04)	<0.0001	1.01 (1.01–1.03)	0.004
Number of physicians by 100,000 people						
By increase of 0.25			2.17 (1.59–2.95)	<0.0001	0.60 (0.37–0.98)	0.042
Year of publication						
≤2000	141	68 (48.2)	1			
2000–2009	370	140 (37.8)	0.65 (0.44–0.97)			
2010–2017	815	287 (35.2)	0.58 (0.41–0.84)	0.013		
Number of authors						
By increase of 3			1.13 (1.09–1.18)	<0.0001	1.11 (1.05–1.17)	0.0004
Number of inhabitants in the country						
$\leq 50 \times 10^6$	443	141 (31.8)	1			
$>50 \times 10^6$	856	351 (41.0)	1.49 (1.17–1.90)	0.001	2.55 (1.82–3.57)	<0.0001

excluding research on kidney disease in conditions known to increase kidney disease risk in Africans (e.g., hypertension, diabetes, and HIV). We did this because research related to these risk factors often describe other associated systemic complications, thus categorizing them as "general medicine." Finally, although we used "first author" details to describe the country of origin of the research, in every case, we verified the country of the study setting as the country of the research. For review articles in which the African author(s) were not first, last, or corresponding authors, the article was not counted as African research. Despite these limitations, our study still captures the essence of the current state of nephrology research in Africa, thus advocating for measures that improve the amount and quality of nephrology research from the continent. This requires an increase in resource allocation for kidney disease research and training.

DISCLOSURE

All the authors declared no competing interests.

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SUPPLEMENTARY MATERIAL

Supplementary File (PDF)

Supplementary Methods.

Supplementary References.

Table S1. PubMed search strategy for nephrology publications in Africa.

REFERENCES

1. Liyanage T, Ninomiya T, Jha V, et al. Worldwide access to treatment for end-stage kidney disease: a systematic review. *Lancet*. 2015;385:1975–1982.
2. Bello AK, Levin A, Tonelli M, et al. Assessment of global kidney health care status. *JAMA*. 2017;317:1864–1881.
3. Xie Y, Bowe B, Mokdad AH, et al. Analysis of the Global Burden of Disease study highlights the global, regional, and national trends of chronic kidney disease epidemiology from 1990 to 2016. *Kidney Int*. 2018;94:567–581.
4. Okpechi IG, Alrukhaimi M, Ashuntantang GE, et al. Global capacity for clinical research in nephrology: a survey by the International Society of Nephrology. *Kidney Int Suppl*. 2018;8:82–89.
5. Soteriades ES, Rosmarakis ES, Paraschakis K, Falagas ME. Research contribution of different world regions in the top 50 biomedical journals (1995–2002). *FASEB J*. 2006;20:29–34.
6. Horton R. North and south: bridging the information gap. *Lancet*. 2000;355:2231–2236.
7. Meo SA, Al Masri AA, Usmani AM, et al. Impact of GDP, spending on R&D, number of universities and scientific journals on research publications among Asian countries. *PLoS One*. 2013;8, e66449.
8. World Federation for Medical Education and the Foundation for Advancement of International Medical Education and Research. World Directory of Medical Schools. Available at: www.wdoms.org/; 2016. Updated June 1, 2016. Accessed July 7, 2020.
9. Osman MA, Alrukhaimi M, Ashuntantang GE, et al. Global nephrology workforce: gaps and opportunities toward a sustainable kidney care system. *Kidney Int Suppl*. 2018;8:52–63.