The prevalence of chronic kidney disease (CKD) continues to rise globally. However, this has been found to be disproportionately higher in several low-income and low-to-middle-income countries. 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. Other studies have also shown that Africa has the lowest contributions to biomedical publications when all world regions are considered. 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. 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 [n = ...]
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...
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 (GDP), 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, 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...
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).

Although various studies have shown a higher number of nephrologists to be from the North African region compared to other African regions,9,51 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.32,53 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.54 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 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.
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. 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; 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. 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%). 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

| Factors | Univariable model | Multivariable final model |
|---------|------------------|--------------------------|
| 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 | 0.269 |
| Literacy rate | 0.35 (−0.94 to 1.63) | 0.602 |

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

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| Factors | Univariable model | Multivariable final model |
|---------|------------------|--------------------------|
| First continent of the author | Outside of Africa 1209 | 436 (36.1) | 0.35 (0.23–0.55) | <0.0001 | 1.13 (0.54–2.33) | 0.750 |
| Africa | 56 (61.5) | 1 |
| Types of papers | Others 1051 | 417 (39.7) | 1.66 (1.25–2.23) | <0.0001 |
| Original articles | 127 (67.9) | 1 |
| Continent of the journal | Outside of Africa 782 | 368 (16.2) | 0.09 (0.07–0.12) | <0.0001 | 0.08 (0.06–0.11) | <0.0001 |
| Africa | 25 (35.8) | 1 |
| Scope of the journal | Others 904 | 300 (33.2) | 1 |
| Specific to nephrology/urology | 354 (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 (1.84–3.20) | <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 11.13 (1.09–1.18) | <0.0001 | 1.11 (1.05–1.17) | 0.0004 |
| Number of inhabitants in the country | ≤50 x 10^6 443 | 141 (31.8) | 1 |
| >50 x 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.

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