Hierarchy of Scientific Evidence and Thematic Analysis of African Neurosurgery Research – a Scoping Review

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Abstract

Background

African neurosurgical practice is faced with numerous challenges. Although there have been improvements in recent years, some problems persist. Research can help identify these problems and propose solutions for the growth of African neurosurgery. In this study, we decided to evaluate the landscape of African research.

Methods

PubMed, Embase, and Web of Science were searched from inception to April 24, 2020. Duplicate articles were excluded, and at least two authors reviewed non-duplicate articles on Rayyan. After data had been extracted, they were analyzed to generate descriptive statistics (number of articles and articles per local neurosurgeon). The Kruskal Wallis test and Spearman's correlation were used for bivariate data analyses.

Results

The authors reviewed 667 articles on neurosurgery in 34 (63%, n=54) African countries. Malawi (4.50), South Africa (3.33), and Benin (2.33) had the highest number of articles per local neurosurgeon (after excluding articles by foreign researchers). Foreign researchers published 1.0 (IQR=2.5) articles per country. Articles were published in World Neurosurgery (120, 18.0%), South African Medical Journal (44, 6.6%), and Journal of Neurosurgery Pediatrics (34, 5.1%). The articles were on pediatric neurosurgery (167, 25.0%) and neurotrauma (129, 19.3%). Also, the majority (411, 61.6%) of studies were cross-sectional.

Conclusion

African neurosurgeons produce a median of 0.4 articles and publish in well-established journals. Collaboration with foreign researchers significantly increases local research output. In the future, we should assess the impact of this research.

Background

Neurosurgical practice in Africa differs from practice in other regions by its burden of disease, demographics, and availability of resources.[1–4] For example, African countries have the third greatest burden of neurosurgical diseases, but most African countries have less than one neurosurgeon per 200,000 people.[5, 6] Fortunately, over the past decade, African neurosurgery has reached substantial milestones, increasing access to care and improving the management of neurosurgical diseases.[7–10] Despite these improvements, challenges still exist. Neurosurgeons in low-resource settings have to find innovative ways to use their limited resources, but their practice must be evidence-based to improve service delivery and patient outcomes. However, evidence-based medicine is often a research product conducted in high-income countries that may not be generalizable to the African neurosurgery practice.

Thus, quality and locally sourced research are essential to evidence-based practice in African neurosurgery.[11, 12]

Research can identify challenges and inform the development of context-specific solutions.[12, 13] Research findings are used to develop clinical guidelines, health policies, and advocacy pieces.[14–16] In the case of Africa, research can identify the barriers to universal neurosurgical care, propose countermeasures to these challenges, and augment the ascension of African neurosurgery.[17] African neurosurgery research has highlighted socioeconomic or biological factors that affect disease progression, referral patterns, treatment compliance, and long-term patient outcomes.[18–20] Furthermore, research can improve the quality of practice and postgraduate medical education. Patients are more likely to consult neurosurgeons who are academically proficient than those with little academic experience, and prospective trainees prefer to train at academic neurosurgery centers.[21–24] As they increase access to neurosurgical care and training, African neurosurgical training centers will need to differentiate themselves to attract patients and trainees. The same incentives exist for individual neurosurgeons as research is a professional currency that facilitates career advancement and confers respect.[25]

In this study, we assess the landscape of African neurosurgery research. The term African neurosurgery research refers to research on neurosurgical practice and diseases in Africa. We describe the publication trends, identify academic neurosurgery hotspots, and quantify the subspecialty themes covered by African neurosurgery research. Knowledge of African neurosurgery research history and current state research can help guide future efforts to build research capacity in African nations.

Methods

In this descriptive bibliometric analysis, we searched PubMed, Embase, and Web of Science from inception to April 24, 2020. An author (USK) developed the search strategy (**Supplemental File 1**) was developed by an author (USK) with formal training in systematic searches. All articles about neurosurgical practice in Africa (North, West, East, Central, and South) were included in the search without language limits. We included articles about the disease (epidemiology, management, prognosis), practice, education, and research in Africa irrespective of the authors' affiliations. Later, we did supplemental hand searches of Google Scholar and ResearchGate, oriented by experts' suggestions and the citations of some of the articles found during the database search.

We uploaded the records on Rayyan (https://rayyan.qcri.org/) and excluded duplicate citations. Each article was screened by two of eight authors (USK, SN, YZ, DS, NDB, DMK, BC, CK). Following the title and abstract screening, the reviewers were unblinded to identify and resolve conflicts. A third author resolved conflicts if the two authors could not agree.

The selected citations were then exported to a Google Form (Google, USA) for data extraction (first author affiliation, study setting, study design, and thematic analysis) by four authors (USK, SN, YZ, and DS). One

author (IE) checked the validity of the data independently. The data were then analyzed with SPSS v26 (IBM, USA).

Summary descriptive statistics were generated for the first author affiliation, year of publication, journals, study design, and themes. The number of articles per local neurosurgeon (i.e., a neurosurgeon practicing at a local institution) was calculated by dividing the total number of articles for a country by the number of local neurosurgeons obtained from the most recent World Federation of Neurosurgical Societies' workforce survey.[26] We then ran bivariate analyses (Kruskal Wallis test and Spearman's correlation). For these analyses, we grouped countries into subregions: Central Africa, East Africa, North Africa, Southern Africa, and West Africa. An alpha value < 0.05 was considered statistically significant.

Results

Literature search

We identified 3215 articles and excluded 499 duplicates. After title and abstract screening, we excluded 2476 citations that did not meet the inclusion criteria. After the full-text screening, we excluded 61 additional articles. We then extracted data from 667 articles (Fig. 1).

Descriptive analysis

Most African countries (34, 63.0%) had a neurosurgery article, and the first African neurosurgery article was published in the Lancet by Kenneth Eden in December 1943.[27] The median number of articles per country was 6.0 (IQR = 15.5). South Africa (126, 18.9%), Uganda (91, 13.6%), Nigeria (68, 9.6%), and Tanzania (56, 8.4%) had the most publications. Most first authors were from the USA (142, 21.3%), South Africa (116, 17.4%), Nigeria (67, 10.0%), and Morocco (31, 4.6%) (Fig. 2). Also, the median number of articles by local neurosurgeons was 6.0 (IQR = 13.0). Uganda (7.58), Malawi (6.0), and Tanzania (5.6) had the highest average articles per local neurosurgeon. Foreign researchers contributed a median of 1.0 (IQR = 2.5) articles in each African country. The proportion of articles by foreign researchers was greatest in Sierra Leone (100%), South Sudan (100%), Angola (100%), and Uganda (79.1%). After excluding the contributions of foreign first authors, the median number of articles per local neurosurgeon was 0.4 (IQR = 0.8). Malawi (4.50), South Africa (3.3), and Benin (2.3) had the highest number of first author articles per local neurosurgeon (Table 1).

Table 1
Neurosurgery research output by study setting

Country	Number of articles (n = 667, (%))	Publication of the first article (Year)	Articles per local neurosurgeon	Percentage of articles published by foreigners (%)	Articles per local neurosurgeon after excluding foreign publications
South Africa	126 (18.9)	1966	3.82	12.7	3.33
Uganda	91 (13.6)	1969	7.58	79.1	1.58
Unspecified	73 (10.9)	1944	-	74	-
Nigeria	68 (10.2)	1977	1.94	2.9	1.89
Tanzania	56 (8.4)	1982	5.6	73.2	1.5
Ethiopia	30 (4.5)	1992	1.07	33.3	0.71
Morocco	30 (4.5)	1990	0.2	3.3	0.19
Kenya	23 (3.4)	1963	0.64	30.4	0.44
Tunisia	21 (3.1)	1943	0.29	4.8	0.27
Senegal	17 (2.5)	1970	0.85	5.9	0.8
Benin	14 (2.1)	1984	2.33	0	2.33
Egypt	14 (2.1)	1973	0.04	28.6	0.03
Malawi	12 (1.8)	1997	6	25	4.5
Zimbabwe	12 (1.8)	1975	0.86	16.7	0.71
Cameroon	7 (1.0)	1998	0.33	0	0.33
Rwanda	7 (1.0)	1997	1	42.9	0.57
Togo	7 (1.0)	1994	1.17	0	1.17
Burkina Faso	6 (0.9)	2002	0.86	0	0.86
DRC*	6 (0.9)	1979	1	16.7	0.83
Mali	6 (0.9)	2005	0.38	0	0.38
Ghana	5 (0.7)	2005	0.24	20	0.19
Guinea	5 (0.7)	2012	1.25	0	1.25
Sudan	5 (0.7)	1973	0.25	0	0.25
Algeria	4 (0.6)	1977	0.04	25	0.03

*DRC: Democratic Republic of Congo

Country	Number of articles (n = 667, (%))	Publication of the first article (Year)	Articles per local neurosurgeon	Percentage of articles published by foreigners (%)	Articles per local neurosurgeon after excluding foreign publications
Côte d'Ivoire	4 (0.6)	1994	0.36	0	0.36
Niger	4 (0.6)	2010	0.44	0	0.44
Zambia	3 (0.4)	1988	0.38	33.3	0.25
Gabon	2 (0.3)	1997	0.4	0	0.4
Madagascar	2 (0.3)	2017	0.33	0	0.33
Mozambique	2 (0.3)	2001	0.25	0	0.25
Angola	1 (0.1)	2019	0.07	100	0
Congo, Republic	1 (0.1)	2017	0.2	0	0.2
Mauritania	1 (0.1)	2018	0.1	0	0.1
Sierra Leone	1 (0.1)	2015	NAN	100	NAN
South Sudan	1 (0.1)	2020	1	100	0

*DRC: Democratic Republic of Congo

The most frequent themes for the articles were pediatric neurosurgery (167, 25.0%), neurotrauma (129, 19.3%), practice and instrumentation (74, 11.1%), and global neurosurgery (65, 9.7%) (Fig. 3).

In general, the number of publications has been increasing, and the increase has been most remarkable since 2006 (Fig. 4).

Articles were commonly published in World Neurosurgery (120, 18.0%), South African Medical Journal (44, 6.6%), Journal of Neurosurgery Pediatrics (34, 5.1%), and Pan African Medical Journal (25, 3.7%)

Table 2
Top 30 target journals for the publication of African neurosurgery research

Journal	Frequency (n = 667, (%))
World Neurosurgery (Ex-Surgical Neurology)	120 (18.0)
South African Medical Journal	44 (6.6)
Journal of Neurosurgery Pediatrics	34 (5.5)
Pan African Medical Journal	25 (3.7)
Child's Nervous System	25 (3.7)
Journal of Neurosurgery	24 (3.6)
Neurochirurgie	22 (3.3)
Neurosurgical Focus	15 (2.2)
British Journal of Neurosurgery	12 (1.8)
Neurosurgery	11 (1.6)
Ethiopian Medical Journal	8 (1.2)
Pediatric Neurosurgery	8 (1.2)
Journal of Neurosciences in Rural Practice	7 (1.0)
Academic Emergency Medicine	6 (0.9)
East African Medical Journal	6 (0.9)
Dakar Medical	5 (0.7)
La Tunisie Médicale	5 (0.7)
Mali Médical	5 (0.7)
Surgical Neurology International	5 (0.7)
African Journal of Neurological Sciences	5 (0.7)
African Journal of Pediatric Surgery	4 (0.6)
Médecine Tropicale	4 (0.6)
The Central African Journal of Medicine	4 (0.6)
Tropical Doctor	4 (0.6)
BMC Neurology	4 (0.6)
Acta Neurochirurgica	3 (0.4)
	3 (0.4)

Journal	Frequency (n = 667, (%))
African Health Sciences	3 (0.4)
Annals of Global Health	3 (0.4)
Ethiopian Journal of Health Sciences	3 (0.4)
Spinal Cord	

Most (411, 61.6%) articles were cross-sectional studies. Commentaries/editorials/letters to the editor (96, 14.4%), cohort studies (48, 7.2%), and case reports (44, 6.6%) were the second, third, and fourth most frequent study types, respectively (Table 3).

Table 3
African neurosurgical articles by the hierarchy of evidence

Hierarchy of evidence	Frequency (n = 667, (%))
Cross-sectional	411 (61.6)
Commentary	96 (14.4)
Cohort	48 (7.2)
Case report	44 (6.6)
Literature review	38 (5.7)
Case-series	7 (1.0)
RCT	7 (1.0)
Systematic review	5 (0.7)
Qualitative	4 (0.6)
Case-control	2 (0.3)
Cost-effectiveness	2(0.3)
Mixed methods	1(0.1)
Narrative review	1 (0.1)
Quasi-experimental	1(0.1)

Bivariate analysis

East Africa had the highest median number of first author articles per local neurosurgeons, followed by West Africa, Southern Africa, Central Africa, and North Africa (**Supplemental file 2**) ($P = 0.01$). However, we should note that East Africa had the highest median percentage of articles by foreign researchers, followed by Southern Africa and North Africa ($P = 0.02$) (**Supplemental file 3**). The number of articles by local neurosurgeons was positively correlated with the number of articles by foreign researchers ($R = 0.50$, $P = 0.002$) and the number of years since the first article was published ($R = 0.76$, $P < 0.001$).

Discussion

This is the first comprehensive descriptive bibliometric analysis of African neurosurgery research. Akhaddar did a similar study, but the two studies differ in many ways.[28] The first difference is the database search. While we searched PubMed, Embase, and Web of Science, Akhaddar's search was limited to Pubmed. Next, we did not apply date restrictions to our search. In contrast, Akhaddar limited his search to articles published after 1999. Finally, we had two authors reviewing each article independently to improve reliability, reproducibility, and validity. This was not the case in Akhaddar's search.

South Africa ranked among the three most productive African countries with and without foreign first author contributions. Like South Africa, Uganda had a significant research output; however, when foreign first author contributions were excluded, it dropped to the fifth rank. In Akhaddar's analysis, South Africa and Uganda were first and third, respectively.[28] South Africa's ranking is understandable given its long and rich academic neurosurgery history.[29] In the case of Uganda, its high research output is associated with current and past partnerships with American and British neurosurgical institutions. Two of the most notable partners have been CURE Uganda and Duke Global Neurosurgery and Neurology.[30] CURE Uganda in particular, has contributed significantly to the development of endoscopic third ventriculostomy and choroid plexus cauterization.[31] Together, the two American partners have contributed at least 72 articles to Uganda's neurosurgery research. Our results suggest that foreign researcher involvement produces more research and leads to local neurosurgeons being more academically productive. This highlights the importance of international research collaborations in advancing African neurosurgery research. In those countries where foreign authors dominate, we would like to see a transition toward local authors taking up the key authorship positions.

Academic neurosurgery is an essential aspect of our field, but it is less developed in Africa. The median number of articles per African neurosurgeon was 0.4, much lower than their North American, European, and Asian colleagues.[24, 32, 33] The model academic neurosurgeon should excel in "clinical work, teaching, research, and administration"; however, these require a considerable amount of resources.[34] One of these resources is protected time for research. In a recent survey of young African neurosurgeons and trainees, only 29.5% reported having protected research time. The time research takes away from operations and consultations must be compensated, especially in Africa. African neurosurgeons perform more operations and consultations per neurosurgeon than their colleagues in high-income countries.[26] The focus on direct clinical activities comes at the cost of not reviewing patient outcomes promptly and not exploring therapeutic alternatives most suited to the local population. For neurosurgeons to devote

time to research, they must build teams to assist them in each activity;[34] however, they must be funded for these teams to work as intended. Ironically, the opportunity for funded positions for Western neurosurgeons to work in lower-income countries means that the curation of African neurosurgical practice in the medical literature is more likely to be done by visiting fellows than local surgeons in some of the African units. Unfortunately, funding is the biggest barrier to medical research in Africa.[35, 36] Hence, to increase the research output in Africa, we must develop innovative funding strategies. The funds can equally be used to improve information management systems and expand existing research opportunities for early career researchers. This, of course, must happen against a backdrop of overall neurosurgical and surgical system strengthening, including the strategic increase in the number of neurosurgeons and anesthesiologists. To this point, the enthusiastic uptake by many African countries in strengthening surgical systems complements research capacity-building efforts.

Articles were focused on pediatric neurosurgery (25.0%), neurotrauma (19.3%), and global neurosurgery (9.7%). The number of pediatric neurosurgery and neurotrauma articles can be explained by the burden of these disease categories in Africa. Hydrocephalus and neural tube defects represent 22.3% of all neurosurgical cases, whereas traumatic brain and spine injuries constitute 39.2%.[5] As for global neurosurgery, the movement has gained momentum following the publication in 2015 of the Lancet Commission on Global Surgery report and the World Health Assembly resolution on emergency and essential surgery.[37] Since these documents were published, more journals, conferences, and academic institutions recognize the importance of global neurosurgery.[16] The World Federation of Neurosurgical Societies (WFNS), for example, has created a Global Neurosurgery Committee to coordinate initiatives that increase access to timely and affordable neurosurgical care.[38] Moreover, the WFNS has created a committee to liaise with the World Health Organization.[39] Together, these initiatives encourage the establishment of global neurosurgery as a practice and a major topic for research.

Eight of the top ten target journals were foreign specialty journals, and these journals housed 39.7% of African neurosurgery research. These eight journals are among the most respected and impactful core neurosurgery journals in the world.[40] The proportion of articles in these journals is a testament to the quality of African neurosurgery research. The ranking of World Neurosurgery is not surprising given its scope, large readership, and the possibility to publish without paying charges.[41] Also, the presence of two pediatric neurosurgery journals is logical given the number of pediatric neurosurgery articles. Four regional journals were among the top 15 journals, and none of them was a specialty journal. The first regional specialty journal, the African Journal of Neurological Sciences, ranked twentieth, and although it has more articles published, we did not find them in our database search. This is because the African Journal of Neurological Sciences is not indexed on PubMed, EMBASE, or Web of Science. We found this journal's articles in the supplemental hand search after performing a backward citation analysis of indexed articles. Similarly, the Egyptian Journal of Neurosurgery, one of the continent's premier specialty journals, is not indexed in these databases. African neurosurgeons should encourage the development of regional specialty journals by submitting research and volunteering as reviewers. Also, funders should support research efforts but also editorial efforts and the establishment of local journals. These solutions

will help increase the quantity and quality of publications in these regional journals, thereby increasing the chances of getting indexed in international databases.[42]

The African context is so particular that local neurosurgeons need to adapt international guidelines to their context. However, this adaptation must be informed by appraised scientific evidence. Appraised scientific evidence favors standardization in practice, and the rejection of erroneous practices improves patient outcomes and highlights gaps in the literature.[43] Most studies (69.1%) were observational, and we did not find an evidence-based clinical guideline for neurosurgical practice specific to Africa. Beyond publication, scientific findings should inform daily practice, and for this to happen, African neurosurgeons must organize evidence-based neurosurgery activities. The generation of evidence-based practice guidelines is a multistep process that involves planning, literature searches, organization of meetings, appraisal, writing, peer review, and dissemination.[44] Professional societies have the resources and credibility to coordinate these efforts and should therefore spearhead these projects.

We recognize a few limitations to our study. First, our definition of African neurosurgery research excludes research published by African neurosurgeons on practice in other regions. These include research that African neurosurgeons might have published while in residency, observership, or fellowship training. As a result, our results do not encompass the entirety of African neurosurgery research. However, we must note that trying to identify articles published by African neurosurgeons while in a different country would have been a time-consuming and likely unrealistic task that would not provide information on the research productivity of neurosurgeons practicing within the context of African countries. There is no doubt that many African neurosurgeons have contributed substantially to neurosurgery literature; however, this is not reflected in the indexed literature. Unindexed platforms have inchoate search algorithms that do not allow a reproducible and comprehensive boolean search. Some document sources like Google Scholar contain duplicate articles, include abstracts and even grey literature. As a result, we only used Google Scholar for supplemental hand research (as mentioned in the methods). Also, Google Scholar does not provide some of the bibliometric metadata needed for our analysis. Our findings highlight two facts: no African specialty journals are indexed on databases, and most African neurosurgeons publish in non-indexed journals. We must correct these issues immediately - the articles published by these brilliant academic neurosurgeons should be made available to the world. The African neurosurgery community must push for the indexation of African journals on major databases. Another reason the full body of work in Africa is not accurately represented is the authors' affiliation. Many prolific African neurosurgeons have worked at non-African academic institutions. As such, some of their contributions would not be captured in our search strategy. Our decision to identify African neurosurgeons based on their affiliations is based on previous research. When calculating the academic productivity of neurosurgeons and institutions, it is customary to include the contributions of neurosurgeons irrespective of nationality but rather based on affiliation.[2,37]

Next, we divided the total number of articles by the current number of neurosurgeons to calculate the number of articles per local neurosurgeon. The result, therefore, does not reflect the productivity of current neurosurgeons. Countries that have experienced a recent increase in their number of neurosurgeons are

disadvantaged because their new practitioners have not had enough time to contribute to the local research. Nevertheless, we believe our calculation of articles per local neurosurgeon is a proxy of academic output. In addition, our search of online databases could have biased our findings, given that few African journals are indexed in the major international databases.[45] Finally, we did not evaluate the impact of the studies with citation metrics. We will be discussing the impact of these studies in the second part of this study. Despite all the limitations, our study gives an insight into the landscape of neurosurgery research in Africa.

Conclusions

The East African and Southern African countries contribute the most to continental neurosurgery research. Furthermore, foreign American and British institutions contribute significantly to African neurosurgery research. Although there has been an improvement in the academic output in Africa, the region still lags behind other regions. Also, most studies are observational and are published in foreign specialty journals. The African neurosurgical community should support academic neurosurgeons and develop evidence-based clinical guidelines because they will identify and standardize high-impact and low-cost practices that will benefit patients.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

USK conceptualized the study, investigated, curated, analyzed, and visualized the data, wrote the original draft of the manuscript, and administered the project. SN, YZ, DS, MLR, AA, NDAB, KDMK, BC, KBP, CK, and IE investigated, validated, and wrote the original manuscript draft. All authors have read and approved the manuscript.

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Figures

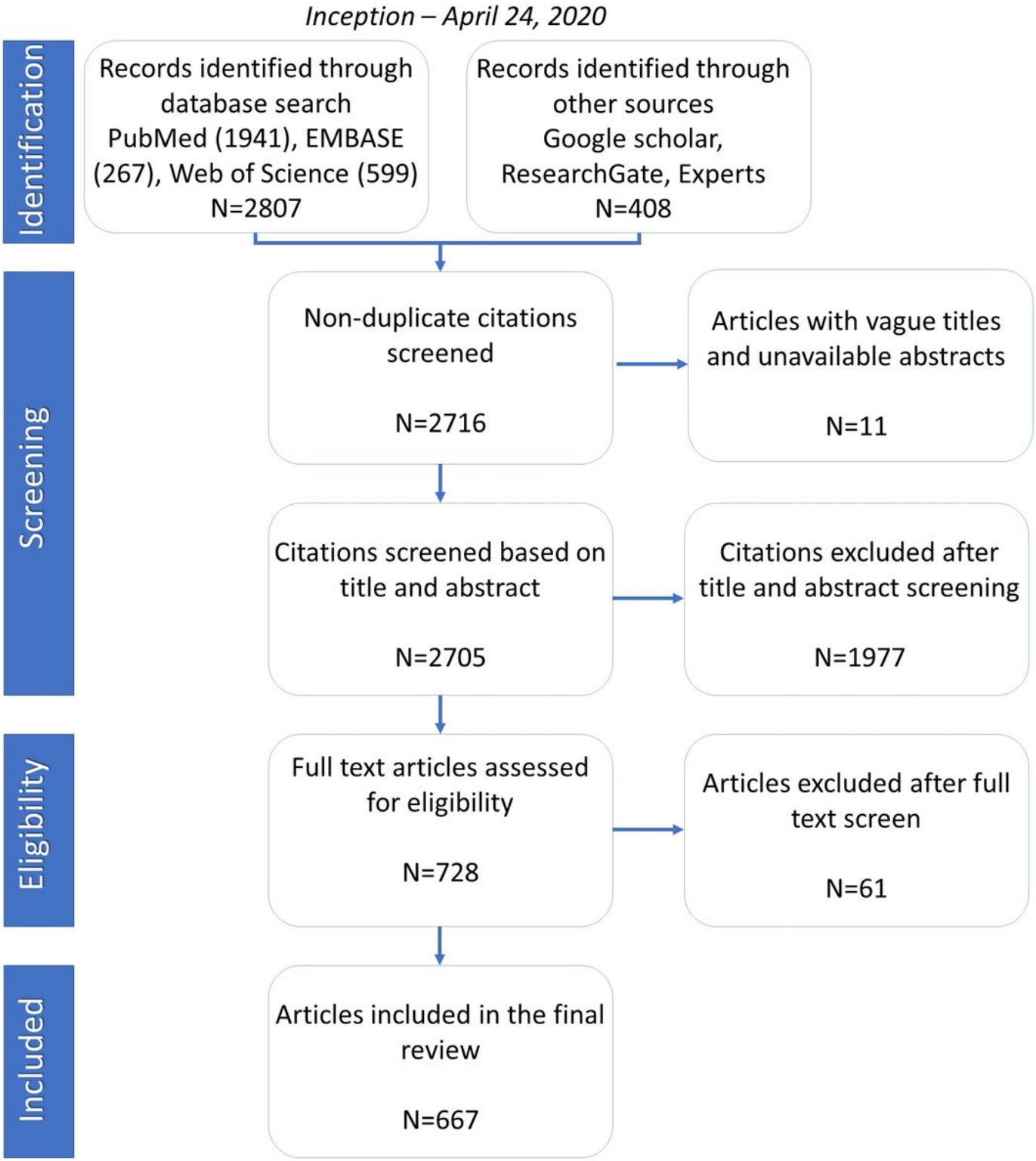

Figure 1

Article selection flowchart

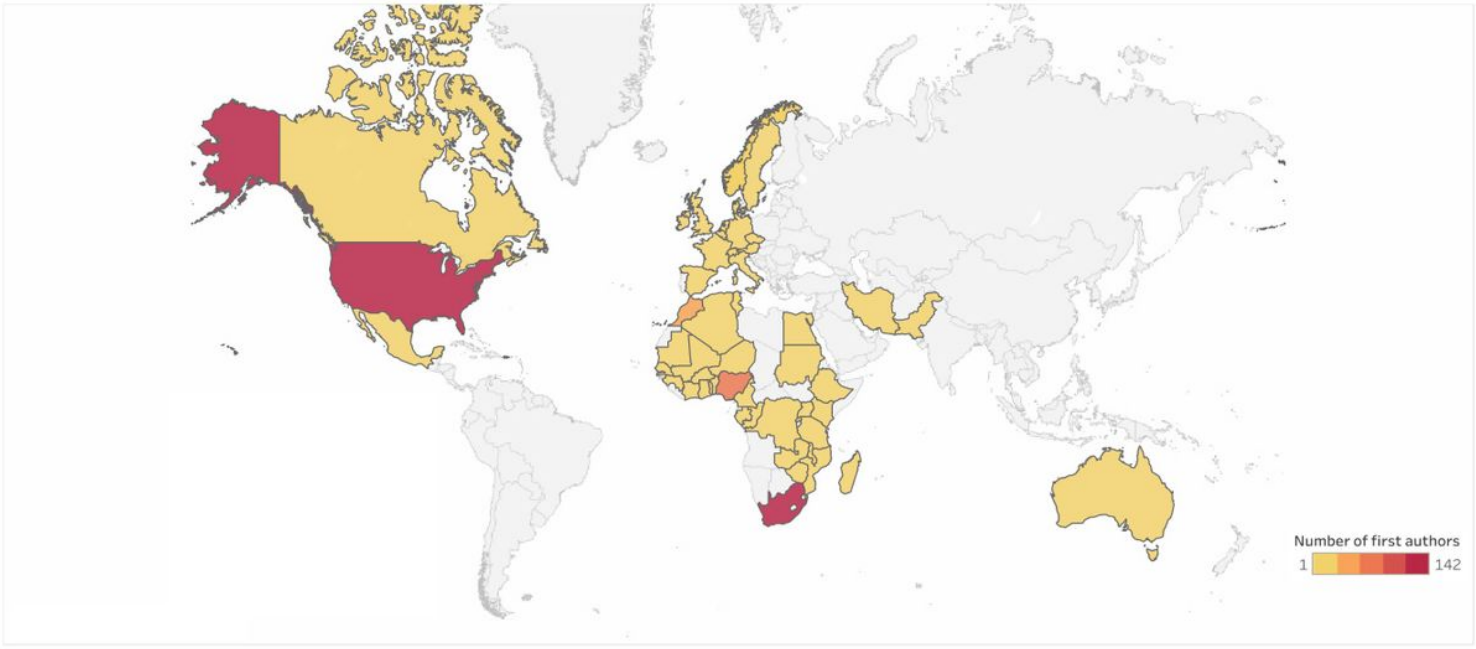

Figure 2

First author affiliations for African neurosurgery research Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

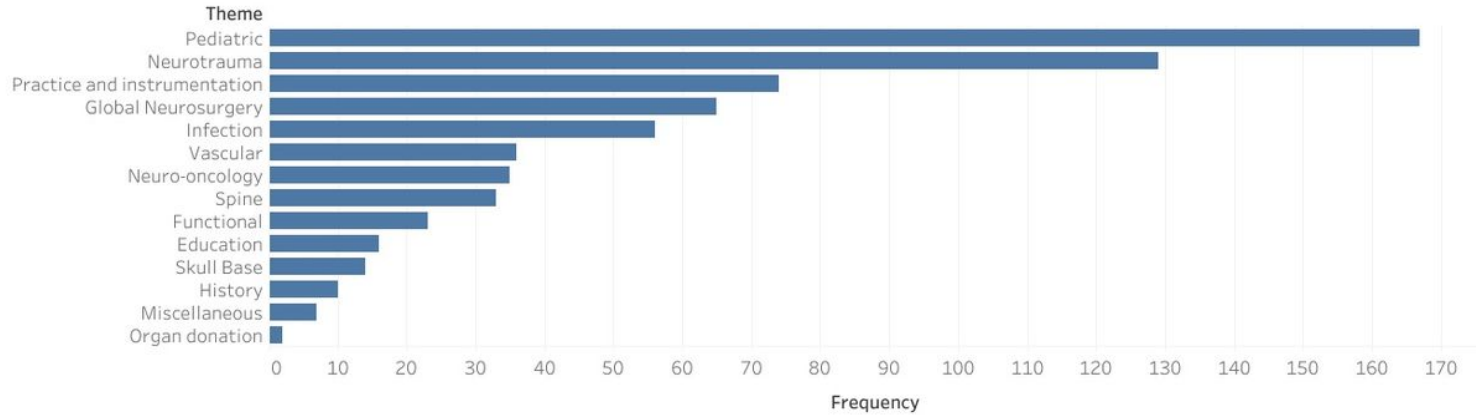

Figure 3

Thematic analysis of African neurosurgery publications by neurosurgical subspecialty

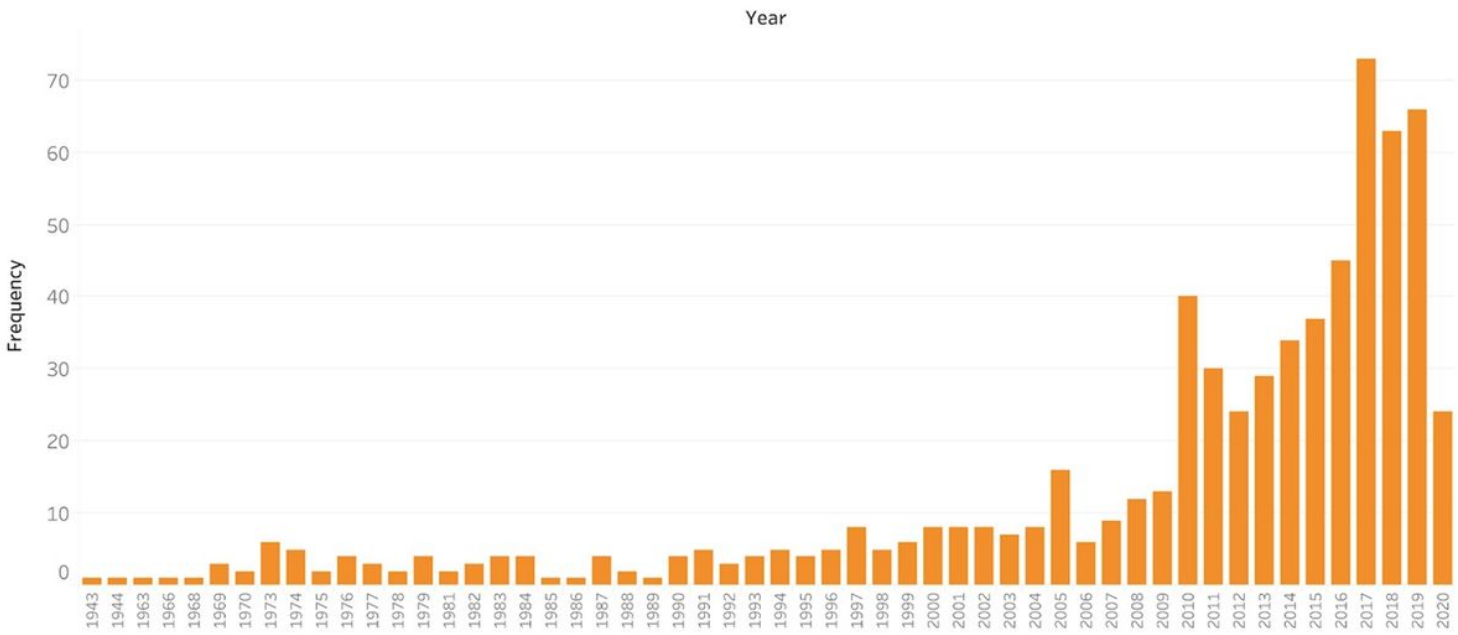

Figure 4

Publication trend of African neurosurgery research

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