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• Original Article •

Bibliometric analysis of ophthalmology training institutions, distribution and sub-specializations in Africa

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HIGHLIGHTS

1. Critical Discoveries and Outcomes

- There exist significant disparities in ophthalmology research output among African universities and the geographic concentration of high-performing researchers in specific institutions highlight opportunities and challenges for ophthalmology training in Africa.

2. Methodological Innovations

- A bibliometric analysis of Africa research output to infer the status and robustness of ophthalmology training and its relevance to region's eye care needs.

3. Prospective Applications and Future Directions

- There is an alignment between ophthalmology research priorities and Africa's disease burden. The gap in research capacity has implications for the quality of training and the development of locally relevant evidence-informed practice. Interdisciplinary collaboration may enhance the responsiveness of ophthalmology research in Africa to meet the continent's pressing eye health needs.

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Abstract: **Objective:** Africa faces a significant burden of avoidable blindness. Currently, there are 26.3 million visually impaired people in Africa, yet there are only 3 ophthalmologists per million population. The shortage of ophthalmology professionals is further exacerbated by the limited research infrastructure. This study aimed to conduct a bibliometric analysis to rank African ophthalmology training institutions. The purpose was to assess their research capacity and offer guidance to prospective trainees. **Methods:** A bibliometric analysis was conducted using Scopus database to evaluate research output from African ophthalmology training institutions. These institutions were identified through systematic searches of public directories and professional listings. Data were extracted on the top 50 ophthalmology researchers, including their H-index, citation counts, number of publications, and institutional affiliations. Countries and institutions were then ranked using these aggregate metrics. Additionally, the research output per million population was calculated using UN population data. **Results:** Research output was recorded from 30 training institutions across 11 African countries. South Africa achieved the highest national H-index (55), followed by Tanzania (52), Tunisia (41), and Egypt (39). Among the institutions, Kilimanjaro Christian Medical University College in Tanzania topped the institutional rankings with an H-index of 52, followed by University of Monastir in Tunisia, which had an H-index of 41. A temporal analysis revealed that there was minimal research activity before the 1980s, but a significant acceleration from the 1990s onwards. Geographically, research specialization varied. Northern Africa mainly focused on retinal and neuro-ophthalmology research, while Eastern Africa placed more emphasis on cataract and glaucoma studies. **Conclusions:** African ophthalmology research has shown rapid growth, but it remains geographically concentrated. These findings provide benchmarks for institutional assessment and highlight opportunities for strengthening research collaboration and capacity building across the African continent.

Keywords: ophthalmology; citation index; H-index; publication rate

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INTRODUCTION

Ophthalmology is a leading profession among the various eye care cadres at the forefront of the combat against the threat of avoidable blindness and visual impairment. This battle is deemed the fiercest in Africa, as the continent is the home to approximately 15.3% of the world's blind population. Among the 26.3 million visually impaired people in Africa, 20.4 million have low vision, and another 5.9 million are blind.^[1] There is a lack of corresponding infrastructure and human resources to combat blindness and visual impairment in this region. There are only 3 ophthalmologists per million population, and there is a

limited number of training institutions to train this group of eye care professionals.^[2] The shortage of ophthalmology professionals is further exacerbated by limited research infrastructure, which is critical for advancing evidence-based eye care practices.^[2] Research output from ophthalmology training institutions serves as the foundation for clinical guidelines, treatment protocols, and public health interventions that directly impact patient outcomes. In Africa, where the burden of preventable blindness remains disproportionately high,^[1] the role of academic institutions in generating locally relevant research cannot be overemphasized. These institutions not only train the next generation of ophthalmologists

but also act as research hubs that inform policy decisions and shape clinical practice across the continent. The foundation of ophthalmology practice relies on strong evidence generated from meticulous research led by academics. The contribution of Africa's ophthalmology academics to ophthalmology literature and their institutional participation is yet to be thoroughly explored.

Ophthalmology, as a medical specialty, is regarded as one of the most competitive among graduate physicians seeking career advancement.^[3] The main reasons are the flexible working hours, the satisfaction derived from helping improve people's vision, and the opportunity to perform surgical procedures.^[4] These motivations for pursuing Ophthalmology have persisted from one generation to the next.^[4] Prospective applicants often consider several factors when choosing a country and institution for their education. In medical training, where apprenticeship is deeply integrated with theoretical learning, the quality of mentorship becomes a particularly significant factor.

Against this backdrop, this study aimed to conduct a bibliometric analysis and ranking of ophthalmology training institutions, their distribution, and the host countries using their accumulated h-indices, publication rates, citation metrics, and productivity index. This serves as an initial step in assessing the landscape of ophthalmology training institutions, their distribution, and host countries. It also provides a platform for celebrating influential academic leaders and projecting the profession in the various institutions. Additionally, the study catalogues the research focuses of different institutions, which has the potential to foster collaboration and networking, thereby building synergy for training and enhancing the professional image.

METHODOLOGY

This study employed a bibliometric analysis to assess the research output of ophthalmology training institutions across Africa. Data collection focused on identifying relevant institutions, retrieving bibliometric indicators from a standardized scientific database, and

applying systematic procedures to screen, extract, and analyze the information.

Identification of ophthalmology training institutions

African institutions offering ophthalmology training programs were identified through a systematic search of public directories, official institutional websites, and professional body listings. To ensure accuracy, the list was repeatedly cross-verified with multiple sources. Only institutions confirmed to be active and offering ophthalmology training were retained for inclusion in the study.

Researcher inclusion criteria

Ophthalmology academics were included in the analysis if they had a formal affiliation with an African ophthalmology training institution since the launch of Scopus. This was regardless of whether they held concurrent positions at institutions outside Africa or spent limited physical time at the African institution. This inclusive approach was adopted to accurately represent the full scope of research output associated with African institutions, acknowledge contributions from global collaborators, and recognize the increasingly international nature of academic careers in ophthalmology. For each academic, institutional affiliation was determined based on their declared affiliation in published works indexed in Scopus. All publications where the academic listed an African ophthalmology training institution in their affiliation were included in our analysis, even if the academic had multiple institutional affiliations or later relocated to institutions outside Africa.

Bibliometric search strategy

Bibliometric data were retrieved exclusively from the Scopus database, which was selected for its comprehensive indexing of peer-reviewed scientific literature and rigorous content selection standards. The search process was divided into two phases. Initially, a broad keyword search was performed using a detailed list of ophthalmology-related terms, targeting article titles, abstracts, and keywords. In the second phase, institution-specific searches were conducted by

entering the name of each identified ophthalmology training institution into the affiliation field of the database.

Screening and selection process

The retrieved articles underwent a two-stage screening process. First, article titles were reviewed to assess their relevance to the field of ophthalmology. Subsequently, the affiliations of contributing authors were examined to confirm that at least one author was affiliated with a recognized ophthalmology institution. Only articles that met both criteria were included in the final dataset.

Data extraction and management

For each eligible author, key bibliometric indicators were extracted, including the author's full name, Scopus Author ID, institutional affiliation, country, gender, H-index, total citation count, number of documents, and the years of first and last publication. The extracted data were entered into a centralized Google Sheet, which was shared among all collaborators. This facilitated continuous quality control and the elimination of duplication.

Rationale for bibliometric indicators

The selection of bibliometric indicators was based on established practices in research evaluation and their relevance to assessing institutional research impact. The H-index was chosen as the primary ranking metric because it offers a balanced measure that takes into account both research productivity (number of publications) and research impact (citation frequency). It provides a more comprehensive assessment than either metric alone. Unlike simple publication counts, the H-index is less likely to be inflated by numerous low-impact publications, and unlike raw citation counts, it considers the breadth of an author's impactful work. Citation counts were included as a complementary metric to evaluate the overall impact and reach of research output, while publication rates offer insights into research productivity and consistency over time. Together, these metrics provide a multifaceted view of research performance that can inform decisions about

institutional reputation, collaboration opportunities, and training quality, which are crucial considerations for prospective ophthalmology trainees when selecting training programs.

Updating of records and data analysis

All records were updated on 31 March 2025 to ensure consistency in the citation metrics and to align with the latest Scopus database update. Subsequently, the compiled dataset was exported into Microsoft Excel, where descriptive statistics and ranking analyses were performed. The analysis procedures included ranking authors, aggregating metrics at the institutional and national levels, and resolving ties based on publication metrics.

Ranking of authors

Authors were ranked based on their H-index, which was used as the primary indicator of research impact.^[5] In cases where authors had identical h-indices, priority ranking was assigned to authors who achieved their publication output over a shorter active publishing period. Further ties were resolved by considering total citation counts and, if necessary, total document counts.

Grouping and analysis by institution and country

After identifying the top individual authors, their affiliations were used to group and evaluate institutions and host countries. The group metrics of the countries and institutions were calculated by pooling the publications of the various individual authors from the respective country or institutions. For each institution and country, aggregate metrics, including total citations, total number of documents, and group h-indices, which is the largest h such that at least h papers have each been cited $\geq h$ times,^[6-7] were evaluated to assess their overall contribution to ophthalmology research across Africa. Publications from all constituent authors were pooled per group, intra-group duplicates were removed so that co-authored papers were counted only once, and records were ordered by descending citation count. For the countries, research output per million population was

calculated by dividing publication counts by mid-year population (per million inhabitants) using United Nations World Population Prospects estimates.^[8] Temporal trend analysis was also conducted to assess the changes in institutional publication output from 1964 to 2025 by aggregating the publication counts into decadal intervals (1964–1969, 1970–1979 through to 2010–2019) with a final five-year interval (2020–2025).

RESULTS

Country-level research output

Based on the top 50 ophthalmology researchers in Africa, ophthalmology research output was recorded in 30 training institutions across 11 African countries. As shown in [Table 1](#), South Africa had the highest

national H-index (55), followed by Tanzania (52), Tunisia (41), and Egypt (39). The number of contributing universities per country ranged from one to nine, and the number of researchers ranged from one (e.g., Uganda, Ethiopia) to eleven (Tunisia). Total citations ranged from 1,226 (Uganda) to 13,572 (Tunisia), while Egypt had the highest publication rate per researcher (20.20). The table also presents each country's sub-regional classification and population data, with populations ranging from 12.2 million (Tunisia) to 227.9 million (Nigeria). Research output per million population varied significantly across countries, from 0.027 (Tunisia) to 1.497 (Ethiopia), providing a demographic context for understanding the distribution of research productivity across the continent.

Table 1 Research output and metrics by country

Rank	Country	h_{CO} -index ^a	Institutions	Ophthalmology Researchers	Citations _{CO}	Documents _{CO}	Pub Rate _{CO}	Sub-region	Population (million)	Research output per million population
1	South Africa	55	5	10	13,809	479	7.85	Southern Africa	63.21	0.132
2	Tanzania	52	1	3	9,714	355	8.66	East Africa	66.62	0.188
3	Tunisia	41	3	11	13,572	455	14.22	North Africa	12.2	0.027
5	Egypt	39	6	9	5,871	505	20.20	North Africa	114.5	0.227
4	Nigeria	39	9	9	8,778	369	8.02	West Africa	227.9	0.618
6	Kenya	27	1	2	7,537	83	3.61	East Africa	55.34	0.667
7	DR Congo	25	1	1	3,127	96	3.43	Central Africa	105.8	1.102
9	Malawi	22	1	1	1,689	92	5.41	Southeastern Africa	21.1	0.229
8	Ghana	22	1	2	1,730	67	2.03	West Africa	33.79	0.504
10	Ethiopia	21	1	1	7,096	86	7.82	East Africa	128.7	1.497
11	Uganda	12	1	1	1,226	38	5.43	East Africa	48.66	1.281

h_{CO} -index, H-index of country; Citations_{CO}, Citations of country; Papers_{CO}, Papers of country; Pub Rate_{CO}, Publication rate of country
a - Ties in the H-index was broken by high publication rate.

Institutional rankings

Ten institutions were identified as the leading ophthalmology research centers in Africa (Table 2). The Kilimanjaro Christian Medical University College in Tanzania reported the highest institutional H-index (52), followed by University of Monastir in Tunisia (H-index 41), and the University of KwaZulu-Natal in

South Africa (H-index 37). Among these institutions, the number of researchers within the top 50 ophthalmology academics in Africa ranged from one to nine. Document output ranged from 67 (University of Ghana) to 355 (Kilimanjaro Christian Medical University College)

Table 2 Top 10 African ophthalmology institutions based on research metrics

S/N	Institution	h_{IN} -index ^a	Country	Ophthalmology Researchers	Citations _{IN}	Documents _{IN}	Pub Rate _{IN}
1	Kilimanjaro Christian Medical University College	52	Tanzania	3	9,714	355	8.66
2	University of Monastir	41	Tunisia	9	12,680	301	9.41
3	University of KwaZulu-Natal	37	South Africa	2	6,134	126	5.73
4	University of the Witwatersrand	33	South Africa	4	3,662	155	2.54
5	Ain Shams University	29	Egypt	2	2,906	265	10.60
6	University of Nairobi	27	Kenya	2	7,537	83	3.61
7	Sefako Makgatho Health Sciences University	26	South Africa	2	2,775	75	1.67
8	University of Kinshasa	25	DR Congo	1	3,127	96	3.43
9	Kamuzu College of Health Sciences	22	Malawi	1	1,689	92	5.41
10	University of Ghana	22	Ghana	2	1,730	67	2.03

Citations_{IN}, Citations of Institution; h_{IN} -index, H-index of institution; Documents_{IN}, Documents of Institution; Pub Rate_{IN}, Publication rate of institution.

a - Ties in the H-index was broken by high publication rate

Temporal trends in research output

Figure 1 illustrates the publication trends across the top 10 African ophthalmology institutions from the 1960s to 2025. The data reveals a significant increase in research activity beginning in the 1990s, which accelerated through the 2000s and 2010s. Most institutions showed minimal or no publication activity before the 1980s, with notable growth patterns

emerging in the latter decades of the survey period.

Top-performing researchers in the various countries

This section highlights the top three ophthalmology researchers by H-index in each of the leading African countries, based on citation count, publication volume, and scientific impact. Notable

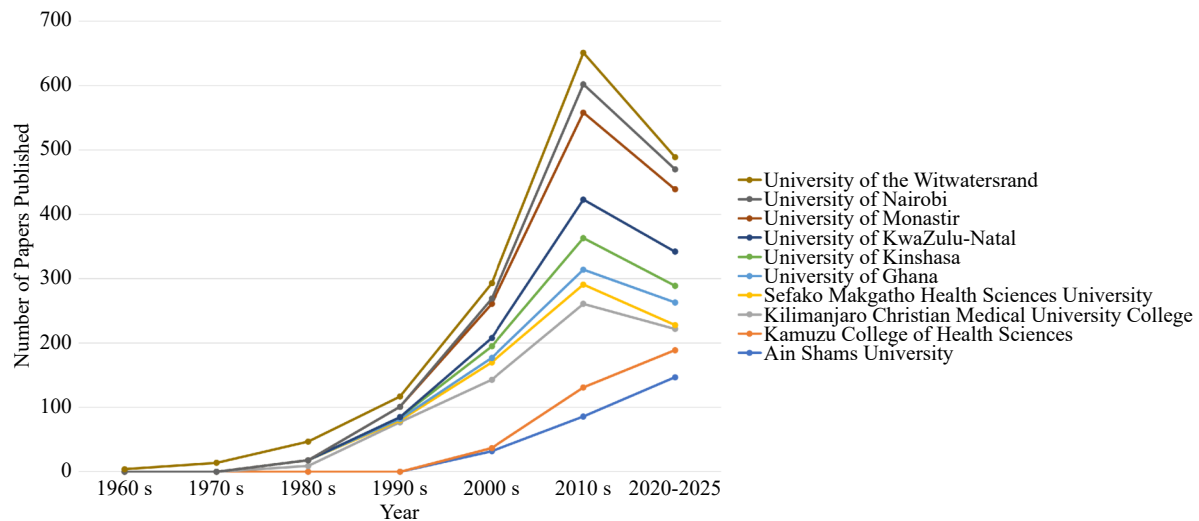


Figure 1 Temporal trend analysis of research output by the leading ophthalmology research institutions in Africa

trends and representation patterns are also reported.

South Africa

As shown in [Table 3](#), the top researcher is Gore Daniel M from the University of KwaZulu-Natal (H-index: 25, 59 documents, 2,040 citations). Grieshaber

Matthias C. from Sefako Makgatho Health Sciences University (H-index: 24, 64 documents, 2,183 citations). Visser Linda, also from the University of KwaZulu-Natal, appears as the third highest (H-index: 23, 69 documents, 4,154 citations), and is the only female researcher in the top three.

Table 3 Leading ophthalmology researchers in South Africa

Rank	Author Name	University	Citations	Documents	H-index	First Pub	Last Pub	Pub Years	Pub Rate
1	Gore Daniel M	University of KwaZulu-Natal	2,040	59	25	2006	2025	19	3.11
2	Grieshaber Matthias C.	Sefako Makgatho Health Sciences University	2,183	64	24	1998	2022	24	2.67
3	Visser Linda	University of KwaZulu-Natal	4,154	69	23	2003	2025	22	3.14
4	Carmichael Trevor	University of the Witwatersrand	1,449	49	21	1996	2024	28	1.75
5	Cook Colin D.	University of the Free State	1,230	50	20	1991	2022	31	1.61
6	Williams Susan	University of the Witwatersrand	1,253	38	17	2010	2025	15	2.53
7	Dahan E.	University of the Witwatersrand	1,208	37	15	1996	2015	19	1.95
8	Smit Derrick P	University of Stellenbosch	356	77	13	2008	2025	17	4.53
9	Stegmann Robert	Sefako Makgatho Health Sciences University	1,067	24	13	1996	2020	24	1.00
10	Welsh Neville H.	University of the Witwatersrand	455	48	13	1996	2025	29	1.66

Leading researchers in Tanzania

In Tanzania (Table 4), Paul D. Courtright and Susan Lewallen hold the top two positions, with H-indexes of 45 and 37, respectively. Lewallen is notably the leading female researcher in Tanzania and one of the most cited researchers in the entire dataset, having published 173 documents and received 5,687 citations. Courtright has recorded 265 publications,

6,807 citations, and an H-index of 45 over 29 years, with a publication rate of 9.14 papers per year. Both researchers are affiliated with Kilimanjaro Christian Medical University College. Third is William Makupa, also from the same institution, with 28 publications, 458 citations, and an H-index of 14 over 14 years, maintaining a publication rate of 2 papers per year.

Table 4 Leading ophthalmology researchers in Tanzania

Rank	Author Name	University	Citations	Documents	H-index	First Pub	Last Pub	Pub Years	Pub Rate
1	Courtright Paul D.	Kilimanjaro Christian Medical University College	6,807	265	45	1996	2025	29	9.14
2	Lewallen Susan	Kilimanjaro Christian Medical University College	5,687	173	37	1996	2023	27	6.41
3	Makupa William	Kilimanjaro Christian Medical University College	458	28	14	2011	2025	14	2.00

Tunisia

At the national level, researchers from the University of Monastir dominate (Table 5). The highest-ranking researcher is Khairallah Moncef (H-index: 40, 280 documents, 12,416 citations), who has been active since 1996. He is followed by Ben Yahia Salim (H-index: 25, 87 documents, 1,958 citations) and Kahloun Rim, who is noteworthy as a leading female researcher (H-index: 23, 59 documents, 4,282 citations). All three have maintained consistent publication activity over nearly two decades.

Nigeria

In Nigeria, the top researcher is Abiose, Adenike O. from Ahmadu Bello University (H-index: 21, 51 documents, 1,549 citations), representing a female lead in the national cohort. She is followed by Abdull Mohammed Mahdi (H-index: 19, 33 documents, 1,064 citations) and Ashaye, Adeyinka Olusola (H-index: 19, 74 documents, 1,318 citations). These three have been actively publishing since the early 2000s (Table 6).

Egypt

The top-ranking Egyptian researcher is Sallam, Ahmed B. of Ain Shams University (H-index: 25, 205

documents, 2,438 citations), with a remarkably high publication volume (Table 7). He is followed by Eleiwa, Taher K (H-index: 13, 45 documents, 523 citations) and Shoughy, Samir (H-index: 13, 35 documents, 733 citations). No female researchers appeared in the top three for Egypt.

Top researchers in Kenya, Ghana, DR Congo, Ethiopia, Malawi and Uganda

In Kenya, Stephen Gichuhi (University of Nairobi) recorded 58 publications, 6,244 citations, and an H-index of 23 over 22 years, with a publication rate of 2.6 papers per year. Kahaki Kimani from the University of Nairobi followed with 25 publications, 1,021 citations, and an H-index of 14 over 15 years (1.7 papers per year). In Ghana, Stephen Akafo from the University of Ghana produced 24 publications, 866 citations, and an H-index of 15 over 20 years (1.2 papers per year), while Vera Adobea Essuman from the University of Ghana contributed 43 publications, 802 citations, and an H-index of 13 over the same period, with a publication rate of 2.2 papers per year.

From DR Congo, Jean-Claude Mwanza from the University of Kinshasa authored 94 publications, receiving 3,080 citations with an H-index of 24 over

Table 5 Leading ophthalmology researchers in Tunisia

Rank	Author Name	University	Citations	Documents	H-index	First Pub	Last Pub	Pub Years	Pub Rate
1	Khairallar Moncef	University of Monastir	12,416	280	40	1996	2025	29	9.66
2	Ben Yahia Salim	University of Monastir	1,958	87	25	1997	2022	25	3.48
3	Kahloun Rim	University of Monastir	4,282	59	23	2006	2024	18	3.28
4	Zaouali Sonia	University of Monastir	1,345	54	21	2002	2019	17	3.18
5	Attia Sonia	University of Monastir	1,190	61	21	2002	2025	23	2.65
6	Jelliti Bechir	University of Monastir	1,022	60	19	2001	2025	24	2.50
7	Ksiao Imen	University of Monastir	733	65	13	2012	2025	13	5.00
8	Khochtali Sana	University of Monastir	625	78	13	2008	2025	17	4.59
9	Ghorbel, Mohamed	University of Sousse	634	133	13	1999	2025	26	5.12
10	Kort Fedra	University Tunis El Manar	266	26	11	2010	2017	8	3.25
11	Abroug Nesrine	University of Monastir	605	58	11	2014	2025	12	4.83

Table 6 Leading ophthalmology researchers in Nigeria

Rank	Author Name	University	Citations	Documents	H-index	First Pub	Last Pub	Pub Years	Pub Rate
1	Abiose, Adenike O.	Ahmadu Bello University	1,530	51	20	1996	2017	21	2.4
2	Ashaye, Adeyinka Olusola	Ladoke Akintola University of Technology	1,275	73	19	2000	2025	25	2.9
3	Abdull Mohammed Mahdi	Abubakar Tafawa Balewa University	934	31	18	2008	2023	15	2.1
4	Mpyet Caleb	University of Jos	922	65	17	1999	2025	26	2.5
5	Fasina Oluyemi	University of Ibadan	2,432	36	14	2008	2025	17	2.1
6	Aghaji Ada Ejealor	University of Nigeria, Nsukka	646	44	13	2007	2025	18	2.4
7	Ademola-Popoola, Dupe	University of Ilorin	1,183	42	13	2003	2025	22	1.9
8	Muhammad Nasiru	Usmanu Danfodiyo University	331	34	12	2007	2025	18	1.9
9	Babalola Olufemi Emmanuel	Bingham University	472	39	12	1996	2023	27	1.4

Table 7 Leading ophthalmology researchers in Egypt

Rank	Author Name	University	Citations	Documents	H-index	First Pub	Last Pub	Pub Years	Pub Rate
1	Sallam, Ahmed B.	Ain Shams University	2,438	205	25	2006	2025	19	10.79
2	Eleiwa, Taher K	Benha University	523	45	13	2019	2025	6	7.50
3	Shoughy, Samir	Damanhour Teaching Hospital	733	35	13	2014	2024	10	3.50
4	Helaly, Hany Ahmed	Alexandria University	455	27	13	2015	2025	10	2.70
5	El-Massry, Ahmed	Alexandria University	441	37	13	2010	2024	14	2.64
6	Shaheen, Mohamed Shafik	Alexandria University	430	23	13	2009	2025	16	1.44
7	Tawfik, Hatem A	Ain Shams University	471	60	12	2000	2025	25	2.40
8	Elnahry, Ayman G.	Cairo University	375	71	11	2018	2025	7	10.14
9	Abou Samra, Waleed Ali Moustafa	Mansoura University	260	19	11	2013	2025	13	1.46

27 years (3.5 papers per year). In Ethiopia, John H. Kempen from Addis Ababa University published 85 documents with 3,895 citations and an H-index of 21 over just 5 years, maintaining a high publication rate of 17 papers per year. From Malawi, Khumbo Kalua from Kamuzu College of Health Sciences produced 91 publications, 1,636 citations, and achieved an H-index of 21 over 16 years (5.7 papers per year). In Uganda, Arunga Simon from Mbarara University of Science & Technology contributed 38 publications, 1,148 citations, and an H-index of 11 over 7 years (5.4 papers per year).

Top 10 African universities and their ophthalmology research focus areas

Table 8 highlights the top 10 African universities and their key ophthalmology research focus areas. The University of Monastir in Tunisia leads in neuro-ophthalmology, retina, infectious diseases, and other specialties. Kilimanjaro Christian Medical University College in Tanzania focuses on cornea, cataract, glaucoma, and neuro-ophthalmology. South African institutions, including the University of the Witwatersrand, University of KwaZulu Natal, and

Sefako Makgatho Health Sciences University, have diverse research emphases ranging from pediatric ophthalmology to refractive surgery and public health. In Egypt, both Alexandria University and Ain Shams University contribute significantly to areas like regenerative medicine, oculoplastics, and retina. The University of Nairobi in Kenya emphasizes cataract, retina, and pediatric ophthalmology, while the University of Ghana covers a wide array of topics, including neuro-ophthalmology and imaging. Lastly, the University of Kinshasa in DR Congo focuses primarily on ocular imaging and glaucoma.

DISCUSSION

In Africa, dedicated ophthalmology training is mainly provided by postgraduate medical training programs. This requires individuals completing an undergraduate medical program before entering a residency training program in ophthalmology. Nevertheless, ophthalmology departments are essentially part of existing medical schools that have one or more affiliated hospitals.^[9] In addition to the demanding clinical and surgical training requirements,

Table 8 African universities and their research focus areas

University	Country	Research Focus Areas
Kilimanjaro Christian Medical University College	Tanzania	Cornea, Cataract & Lens, Glaucoma, Public Health & Occupational Ophthalmology, Neuro-ophthalmology
University of Monastir	Tunisia	Neuro-ophthalmology, Retina, Infectious Diseases & Inflammations, Imaging, Vitreous, Public Health & Occupational Ophthalmology, Cataract & Lens
University of KwaZulu-Natal	South Africa	Retina, Pediatric Ophthalmology, Infectious Diseases & Inflammation, Public Health & Occupational Ophthalmology, Cornea, Refractive Surgery, Contact Lens
University of the Witwatersrand	South Africa	Cornea, Pediatric Ophthalmology, Public Health & Occupational Ophthalmology, Glaucoma, Refractive Surgery
Ain Shams University	Egypt	Neuro-ophthalmology, Oculoplastics & Orbit, Imaging, Retina, Infectious Diseases & Inflammations, Public Health & Occupational Ophthalmology
University of Nairobi	Kenya	Cataract & Lens, Retina, Pediatric Ophthalmology, Public Health & Occupational Ophthalmology, Infectious Diseases & Inflammation
Sefako Makgatho Health Sciences University	South Africa	Glaucoma, Cornea, Neuro-ophthalmology, Contact Lens
University of Kinshasa	DR Congo	Ocular Imaging, Glaucoma
Kamuzu College of Health Sciences	Malawi	Neglected Tropical diseases, Cataract & Lens, Public Eye Health, Ocular Pharmacology,
University of Ghana	Ghana	Neuro-ophthalmology, Retina, Pediatric Ophthalmology, Infectious Diseases & Inflammations, Public Health & Occupational Ophthalmology, Glaucoma, Imaging

faculty members are also expected to excel in research, which serves as the foundation for evidence-based practice.^[10-11]

This bibliometric analysis uncovers significant disparities in ophthalmology research output among African training institutions, with important implications for understanding regional research capacity and institutional competitiveness. The leadership of South African institutions, particularly in terms of national H-index, along with the remarkable efficiency demonstrated by Tanzanian researchers, reflects variations in research infrastructure, funding, and international collaboration patterns across the

continent.^[12-13] The geographic concentration of high-performing researchers in specific institutions highlights both opportunities and challenges for ophthalmology training in Africa. While institutions like the Kilimanjaro Christian Medical University College and the University of Monastir have established themselves as research leaders, the limited representation from many African countries suggests potential gaps in research capacity that may impact training quality and the development of locally relevant evidence-based practices. Prospective applicants consider the reputation of a training institution in either one of these areas or a

combination of them.^[14] South Africa's leadership, with the highest national H-index (55), establishes it as the premier research destination. However, Tanzania's remarkable efficiency challenges conventional metrics, achieving an H-index of 52 and 9,714 citations with only three researchers at a single institution represents extraordinary individual researcher impact. This institution is also the host of the most influential ophthalmology figure in Africa, namely Courtright D. Paul.^[15] Tunisia's position demonstrates another model entirely, leveraging the largest researcher cohort (11 researchers) to generate the highest total citations (13,572). Egypt, with global academic reputation stemming from its ancient civilization^[16] has an exceptional publication rate of 20.20 papers per researcher, suggesting intensive productivity strategies. The distribution of research across 30 training institutions in 11 countries, with Nigeria contributing the most institutions (9), followed by Egypt (6) and South Africa (5), reflects varied approaches to building ophthalmology research capacity. The demographic analysis exposes fundamental disparities in research density that challenge assumptions about resource allocation and development potential.^[17] The variation in research output per million population, ranging from Tunisia's 0.027 to Ethiopia's 1.497, reveals dramatically different patterns of research engagement relative to population size. Countries like Ethiopia and DR Congo, with higher per capita research representation, suggest significant untapped potential for research expansion, while Tunisia's exceptionally low per capita output despite high absolute productivity indicates highly concentrated expertise that may benefit from broader institutional distribution. These demographic patterns have profound implications for understanding research sustainability and the potential for scaling ophthalmology training programs across different African contexts.^[17]

The temporal analysis reveals that African ophthalmology research is a relatively recent phenomenon, with most institutions showing minimal or no publication activity before the 80s. The data demonstrates a significant acceleration in research output beginning in the 90s and continuing through

the 2000s and 2010s, reflecting the maturation of medical education systems, increased research infrastructure development, and enhanced international collaboration capacity across the continent. This growth pattern suggests that African ophthalmology research has experienced exponential development over the past three decades, positioning current institutions for continued expansion in research productivity.^[10]

Research specialization shows that Tunisia and Egypt in the Northern part of Africa lean towards research on the retina, infectious eye diseases, and neuro-ophthalmology, while Tanzania and Kenya in the eastern part of Africa focuses on cataract, glaucoma, and public health research. On the other hand, South Africa exhibits diversity in its research specialization. This not only suggests an alignment with their geographical disease burden^[15] but also provides crucial information for prospective applicants considering ophthalmology as a career.^[14]

The alignment between ophthalmology research priorities and Africa's actual disease burden remains an essential consideration for effective academic and clinical advancements. Epidemiological data indicate that trachoma remains endemic in East Africa,^[18] yet ophthalmology institutions in the region predominantly focus on glaucoma and cataract research, suggesting a potential misalignment. Similarly, North African institutions emphasize retinal diseases and neuro-ophthalmology, which aligns with their advanced ophthalmic infrastructure, but diabetic retinopathy, an emerging public health concern, receives relatively less research attention.^[16] Comparative analysis with existing literature on blindness trends further reveals discrepancies between research specialization and disease prevalence,^[19-22] highlighting areas that warrant greater investigative focus. Addressing these gaps through strategic adjustments in research funding, curriculum development, and interdisciplinary collaboration may enhance the responsiveness of ophthalmology research in Africa to the continent's pressing eye health challenges.

Gender representation analysis reveals encouraging progress in some regions while highlighting persistent disparities in others. Tunisia

and South Africa showed the highest representation of female researchers among the leading academics. However, gender disparity remains an issue in several African countries such as Egypt^[23-24] (Table 7). Nigeria's leading female ophthalmology academic, Abiose, Adenike O., remains an inspiration and a role model for most female ophthalmologists in West Africa. Therefore, there is a need to enforce targeted recruitment and mentorship for female academics.^[25-27]

Research productivity was found to be unevenly distributed and, in some cases, explosive. For example, John H. Kempen of Ethiopia (Addis Ababa University) published 85 papers in five years at a rate of 17 papers per year, significantly influencing Ethiopia's ophthalmology bibliometric profile. Salam Ahmed B. of Egypt has over 201 papers and 2,537 citations, while Paul D. Courtright has demonstrated remarkable consistency with 265 publications over 29 years at a rate of 9.1 papers per year. These examples illustrate the potential for African researchers to achieve world-class productivity when supported by appropriate institutional frameworks.^[17]

When contextualizing Africa's ophthalmology research output within the global landscape, stark disparities become evident, reflecting broader structural and resource inequalities in academic medicine. A recent global analysis of ophthalmology publications from 2002-2022 reveals that Africa contributes only 0.8% of global ophthalmology research output, compared to North America 45.8%, Europe 30.7%, and Asia 28.9%,^[28] representing significant under-representation relative to Africa's population and disease burden. At the individual researcher level, comparative studies show substantial productivity gaps, with Canadian academic ophthalmologists averaging H-indices of 7.42 ± 7.98 ^[29] and US subspecialists averaging 9.87 ± 13.90 , with a mean average annual increase in H-index was 0.22 ± 0.21 ,^[30] contrasting with considerably lower baseline metrics observed in our African data. These intercontinental disparities stem from differences in research infrastructure, funding availability, and institutional support systems, as academic centers in developed regions benefit from substantial government funding, dedicated research time, and

established international collaborative networks that remain limited across most African training institutions.^[12-13] However, the concentration of high-performing African researchers in institutions such as Kilimanjaro Christian Medical University College and University of Monastir demonstrates that research excellence in Africa is achievable with targeted investment in infrastructure, faculty development, and sustainable funding mechanisms to bridge the current productivity gap with established academic centers globally.

Countries like Malawi, Ethiopia and DR Congo, though under-represented in terms of institutional count, featured some high-performing researchers with enviable global collaborative links. This clearly portrays that African ophthalmology institutions can leverage collaboration to enhance their research outlook and influence.^[31-35]

The population-adjusted analysis provides additional insights into research efficiency and capacity distribution across the continent (Table 1). While Tunisia leads in absolute research metrics, its research output per million population (0.027) ranks lowest, indicating high productivity concentrated in a small population. Conversely, Ethiopia (1.497) and DR Congo (1.102) demonstrate higher per capita research representation, suggesting broader population-based research engagement despite lower absolute numbers. This demographic perspective highlights the complex relationship between population size, research infrastructure, and academic productivity across African nations.

This study acknowledges some methodological limitations that may influence the interpretation of results. The exclusive reliance on the Scopus database, while providing comprehensive coverage of peer-reviewed literature, may result in the underrepresentation of research published in regional journals not indexed by Scopus, particularly those published in local African journals. Additionally, the predominance of English-language literature in Scopus may lead to systematic underestimation of research contributions from French-speaking (Francophone) and Arabic-speaking countries in North and West Africa, where significant ophthalmology

research maybe published in French or Arabic. However, the decision to use only Scopus, rather than multiple databases such as PubMed or African Journals Online, was made to ensure consistency in bibliometric indicators and avoid complications arising from different indexing standards and citation tracking methodologies across databases. Nevertheless, this approach may not fully capture the complete research landscape, particularly for institutions that primarily publish in non-English languages or in journals with limited international indexing. Moreover, this study does not explicitly assess collaborative research between African ophthalmology institutions and partners in other regions. By limiting the scope to intra-African output and subspecializations, the study may underestimate both the research capacity and the global influence of African institutions, thus presenting an incomplete picture of the field. Future research is warranted to investigate how financial support and partnerships between African ophthalmology institutions and international universities shape their contributions to the Sustainable Development Goals.

In conclusion, Kilimanjaro Christian Medical University College of Tanzania emerges as the most influential ophthalmology training institution in Africa, while South Africa demonstrates the most diverse research specialization. The temporal trends reveal rapid growth in African ophthalmology research since the 1990s, with demographic analysis highlighting significant variations in population-adjusted research productivity across the continent. These findings provide essential benchmarks for prospective ophthalmology trainees, institutional administrators, and policymakers seeking to understand and enhance ophthalmology research capacity in Africa.

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The data for this study are available upon reasonable request from the corresponding author.

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