

The Status of Neuroscience in East Africa: A Narrative Review

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ABSTRACT

Background: The rising prevalence of neurological disorders in East Africa highlights a significant disparity between the escalating disease burden and the region's capacity for neuroscience research and healthcare provision. Factors such as inadequate training, limited funding, insufficient research infrastructure, and brain drain of skilled professionals exacerbate this gap. **Objective:** This narrative review examines the current state of neuroscience in East Africa, identifies key challenges, explores recent innovations, and proposes strategic solutions to enhance neuroscience research, education, and healthcare delivery in the region. **Methods:** A narrative review approach was adopted, involving a comprehensive analysis of published literature, regional reports, and relevant case studies. Sources included peer-reviewed journals, organizational reports, and data from neuroscience initiatives and collaborations. Emphasis was placed on identifying systemic barriers, successful interventions, and actionable recommendations for improving neuroscience in East Africa. **Findings:** Innovative diagnostic and treatment techniques, such as neuroimaging and telemedicine, have shown promise in addressing some challenges. Regional and international collaborations, including initiatives by organizations such as the Society of Neuroscientists of Africa (SoNA), Pan African Association of Neurological Sciences (PAANS), and East African Association of Neurological Surgeons (EAANS), have contributed significantly to advancing neuroscience research and education. However, these efforts remain insufficient in addressing the broader systemic challenges. **Conclusions:** Addressing the challenges in neuroscience research and healthcare in East Africa requires a multifaceted approach emphasizing educational enhancement, investment in indigenous biodiversity research, and improved funding and infrastructure. Strengthened regional and international partnerships are critical for building sustainable neuroscience capacities, ultimately improving the management and treatment of neurological disorders in the region.

Keywords: East Africa, Neuroscience, Research Infrastructure, Brain Drain

INTRODUCTION

Neuroscience has emerged as a pivotal field in understanding the complex mechanisms underlying neurological disorders and developing innovative treatments. Despite significant global advances in this area, East Africa faces unique challenges that underscore the importance of tailored research and education strategies to address its specific needs. There are more neurological disorders in the area because people are living longer, fewer children are dying, and people are changing what they eat, how they live, and what they do for fun. This is a big problem for public health (1). However, East Africa's capacity for neuroscience research and healthcare provision has not kept up with the increasing disease burden. This discrepancy highlights a critical gap in the local scientific infrastructure, characterised by inadequate training programs, limited funding, deficient research facilities, and a notable brain drain of skilled professionals seeking opportunities abroad (2,3).

The importance of this issue transcends its direct health implications, influencing the region's overall social and economic growth. Neurological disorders, including epilepsy, stroke, and neurodegenerative diseases such as Alzheimer's, significantly impact patients' quality of life and impose substantial burdens on families and healthcare systems. In spite of these problems, East Africa's neuroscience potential is still very much untapped. Current research and efforts are yielding interesting results, but they are not meeting the region's full needs (2).

This article aims to assess the current state of neuroscience in East Africa, identify specific obstacles and barriers to progress, and highlight recent discoveries and advancements. Examine effective programs and case studies of neurodevelopment in the region and delineate viable solutions and future approaches that could substantially improve neuroscience teaching, research, and patient care in East Africa.

METHODS

We conducted a review of published literature regarding neuroscience in East Africa, using electronic databases: PubMed, Google Scholar, and Scopus. Our search strategy included Medical Subject Headings (MeSH) terms and keywords targeting geographical descriptors ("Eastern Africa" with specific country names) and neuroscience-related

terms, including neuroscience domains (neurology, neurophysiology, neurosurgery) and research-specific terms (reviews, publications, and systematic reviews). Inclusion criteria included published articles between 2010 and 2015.

RESULTS

Neurological disorders in East Africa

Neurological disorders represent a major source of disability and economic burden worldwide. In 2016, these disorders accounted for 11.6% of Disability-Adjusted

Life Years (DALYs) and were the leading cause of mortality globally at 16.5%. Research conducted in 2009 across multiple hospitals in the region revealed an overall

point prevalence of neurological illnesses of approximately 3.3% in Uganda, 7.5% in Kenya, and 8.5% in Tanzania. Ethiopia recorded a rate of 24.7% across two tertiary institutions (4). Data regarding specific neurological disorders in the region is scarce. A study from Muhimbili Medical Centre in Tanzania indicated that recurrent headaches constituted 20.6% of all new referrals to the adult neurology clinic over a two-year period (5). In the broader sub-Saharan Africa region, epilepsy represents a considerable cause of mortality, with a median prevalence of 14.2 per 1000, and over 90% of affected individuals being under 20 years of age (4, 5). The pooled prevalence of dementia in Sub-Saharan Africa is reported to be 5.0%, with an annual incidence of 2.0% (4). The numbers show a bigger problem, and it's possible that the real number of cases in Sub-Saharan Africa (SSA) is lower than what is known because of slow diagnoses and old technology.

The true incidence of these disorders in East Africa is unknown owing to delayed diagnosis or the use of conventional technology that may not detect these conditions. The most typically reported disorders in SSA include peripheral neuropathy, persistent headaches, epilepsy, pain syndromes, stroke, and tremors/Parkinson's disease (4). Neuroinfections such as Human Immunodeficiency Virus (HIV), TB, meningitis, cerebral malaria, rabies, and tetanus play an important part in the genesis of these ailments, causing between 26.7% and 43% of neurological disorders (4). This points to a critical need for enhanced diagnostic capabilities and broader healthcare strategies.

Neuroscience education and training

In the last decade, significant milestones have been achieved in neuroscience training in the East African region, with a significant number of universities providing training in neurosurgery, neurology and psychiatry in the region. In 2006, the first residency program in neurology was started in Addis Ababa, Ethiopia; since then, 80 neurologists have graduated from the program, which

transformed the home hospitals (Zewditu Memorial Hospital and Tikur Anbessa Specialised Hospital) into national referral centres in that country. Neurology fellowship is also provided at the Aga Khan University Hospital and in Kenya. Multiple training programs are run on a regular basis by different organisations in the region, including the Brain and Mind Institute, Africa Health Collaborative and the World Federation of Neurology. Despite the improvement in education and training in clinical neuroscience in the region, there is no published information regarding postgraduate neuroscience training.

Over the past decade, notable advancements have occurred in neuroscience training within the East African region, with numerous universities offering programs in neurosurgery, neurology, and psychiatry (6). In 2006, the inaugural residency program in neurology commenced in Addis Ababa, Ethiopia. Since its inception, 80 neurologists have graduated from this program, resulting in the transformation of Zewditu Memorial Hospital and Tikur Anbessa Specialist Hospital into national referral centres within the country (7). The Aga Khan University Hospital offers a neurology fellowship in Kenya (8). Various organisations in the region, including the Brain and Mind Institute, Africa Health Collaborative, and the World Federation of Neurology, conduct multiple training programs regularly. Although there have been advancements in education and training in clinical neurosciences within the region, there is a lack of published information concerning postgraduate training in neuroscience.

A lot of problems exist in Africa when it comes to neuroscience education and research. These problems include not enough money, lab space, advanced technologies, and easy access to information. It's also hard to get scientific results around the world (9, 10). Africa faces a constrained neuroscience workforce that carries a substantial share of the administrative, clinical, and teaching responsibilities (11–13). The continent

exhibits the lowest global ratio of neurologists to population, with figures ranging from 1 neurologist per 600,000 to 7 million individuals (3). Conversely, a single neurosurgeon attends to roughly 3.3 million individuals. The average number of neurosurgeons per 100,000 people in seven Sub-Saharan countries is about 0.03 (12). This is a trend that can be seen in many areas of neuroscience, such as neuro-oncology, neuropathology, and neuropsychiatrists. The deficiency primarily arises from two factors: limited training opportunities and a substantial brain drain to developed countries, resulting in a depletion of scientific expertise in Africa (10).

The region's neuroscience education landscape is marked by a lack of comprehensive programs and curricula. Current programs frequently exhibit fragmentation, failing to encompass the comprehensive scope required to address the evolving complexities of neuroscience. A study shows that there are major problems with the current educational options, including a lack of advanced neuroscience topics, not enough hands-on training, and limited access to cutting-edge research methods (9). The recognised problems make it harder to build a strong pipeline of well-trained neuroscientists who can help solve the region's growing neurological health problems.

The educational shortcomings can be attributed to several factors: insufficient funding for curricular development, a lack of qualified educators with specialised neuroscience expertise, and inadequate infrastructure for advanced scientific research (15). Moreover, the limited existing programs frequently do not incorporate interdisciplinary approaches essential for a comprehensive understanding and treatment of neurological conditions. To address these gaps, comprehensive curriculum reviews and innovative teaching methodologies are essential.

Opportunities for career advancement in neuroscience within the academia and healthcare sectors in East Africa are scarce,

further compounded by the brain drain phenomenon. Many neuroscientists in East Africa and Africa as a whole are compelled to seek opportunities abroad due to better research funding, superior facilities, and more promising career prospects (10). This migration depletes the already limited pool of neuroscientific expertise in the region, undermining efforts to build a sustainable research ecosystem (14). To reverse this trend, it is crucial to create a supportive environment for career development in neuroscience. This entails enhancing funding opportunities for research, establishing clear career pathways within academia and healthcare sectors, and fostering an environment that encourages innovation and collaboration. Additionally, targeted initiatives to attract and retain neuroscientists, such as competitive salaries, research grants, and professional development programs, can significantly mitigate the brain drain and strengthen the neuroscience community in East Africa.

Research

Neuroscience research in East Africa is severely constrained by a lack of adequate funding and state-of-the-art research infrastructure. Examination of current funding levels and sources reveals a heavy reliance on external funding bodies, with minimal investment from local governments or private sectors (15). This external dependency creates sustainability challenges and often dictates research priorities that may not align with regional needs.

Existing neuroscience research projects on the continent are mostly led and funded by international researchers and institutions. It is estimated that up to 70% of all publications from Sub-Saharan Africa have non-African-based authors; 46% of Africa's 256 top neuroscience studies report overseas financing, namely from the USA (36%), the United Kingdom (25%), and France (11%). In East Africa, a study showed that only 3 of 37 (8%) identified publications report domestic funding; this is highly dissimilar to South African countries, where 73% of domestic

funding was reported in publications (11, 16). While the low rates of domestic funding and African-led research are concerning, these reports show that there exists significant international support for African neuroscience research and underscore Africa's position as a significant source of transformational data.

East Africa is lagging in neuroscience research compared to other African regions; a study published in 2016 found that the highest number of neuroscience publications came from South Africa (27.12%), followed by Egypt (19.68%). Kenya was the 8th highest producer of publications, accounting for only 2.29%, and was the only East African country in the top ten (9). A similar study in 2021 showed Egypt leading at 28%, followed by South Africa at 23%, Nigeria at 11%, Morocco at 8%, and Tunisia at 7%. These countries account for more than 3 in every four publications. East African countries such as Kenya, Ethiopia, and Tanzania make up only 2–3% of reported publications. This discrepancy among African countries may be associated with GDP and varying levels of governmental support for research; there is also more research output from countries like South Africa with more domestic funding (11).

The state of research facilities is another critical barrier, with many institutions lacking access to advanced laboratory equipment, cutting-edge technologies, and robust data management systems (9). Such limitations not only impede high-quality research but also restrict the region's ability to participate in international scientific collaborations. To foster a vibrant neuroscience research environment, it is imperative to increase investment in research infrastructure, diversify funding sources, and advocate for policies that prioritise scientific research and innovation. Favourable government policies and directives have also contributed to the growth of health research in general and, consequently, neuroscience projects (9).

To get past the problems and difficulties in neuroscience education and research in East Africa, we need to do a number of things. These include putting more money into

research and education infrastructure, allocating funds strategically, and putting in place policies that encourage and keep talented people in the area. Collaborative efforts at the national and international levels will be essential to catalyse meaningful progress and harness the full potential of neuroscience to address the pressing health challenges facing East Africa.

Technological advancements

Neuroimaging techniques have proven vital, especially in the diagnosis and treatment of neurological disorders, with the exception of their use in research. A study by Aderinto et al. noted that techniques such as CT and MRI have been used in the diagnosis and management of cerebrovascular diseases in Africa (10), with CT being more widely available and of lower cost than MRI. South Africa, Kenya, and other African countries have bought brain scanning machines like the 3T MRI and functional MRI scanners to get more detailed pictures of the brain and study how it works in neurocognitive disorders and schizophrenia. This has led to more research in this area (2).

The advent of telemedicine, which involves the use of telecommunications for the efficient and effective provision of medical information and services, could be pivotal in mobilising and optimising the limited number of neurologists available. Tele-neurology, the practice of neurology through telemedicine, offers numerous potential advantages. These include enhanced outreach for medical practices, reduced travel costs and time for both patients and physicians, broader educational opportunities and ongoing medical training for healthcare providers, as well as individual and group education for patients regarding their neurological conditions (17).

Investing in animal models indigenous to East Africa offers a unique opportunity to enhance neuroscience research in the region. With its diverse ecosystem and rich biodiversity, East Africa presents a wealth of potential animal models for studying neuro-pharmacology

(18). Taking advantage of this variety could lead to completely new ways of learning about how native plant species affect the brain and how they might be used in drug development (19–23). Additionally, the region's genetic heterogeneity provides fertile ground for genetic studies using animal models that can later be extrapolated into clinical trials (24). For example, new research in Kenya has found new polymorphs of genes linked to neurological disorders. This shows that rodent models can be useful for genetic studies (18). Animal models used in research in Kenya have been used to look into many topics, including how morphine can make people angry and how it can help with pain. This shows how useful these models are for understanding complicated neurobiological processes (25–30). Furthermore, by utilising animals found in East Africa, researchers can ensure that their findings are generalisable to the local population and beyond. This approach not only enhances the relevance of neuroscience research in the region but also contributes to global scientific knowledge. This approach bridges gaps in scientific knowledge and fosters scientific innovation and capacity building in the region.

Regional and international collaborations

There has been tremendous effort in the promotion of neuroscience research by different organisational bodies across Africa, such as the Pan African Association of Neurological Sciences (PAANS), the Society of Neuroscientists of Africa (SONA), the National Institute of Health (NIH), the African chapters of Neuroscience Society, and the more recent African Academy of Neurology (AFAN), among others (9). Within East Africa specifically, programs such as the Kenya Medical Research Institute (KEMRI) - Welcome Trust and the Brain and Mind Institute (in Kenya) have been essential in accomplishing the same goal. Some of these institutions have committed to studying neurological disorders, critical in the advancement of neuroscience research (10). Moreover, these organizations attract research grants from local and international

funding agencies and establish training centres and workshops.

The diverse courses provided by entities like the International Brain Research Organisation (IBRO), including the IBRO symposium on Parkinson's disease conducted in Kenya (2022), familiarise the neuroscience community with various techniques, environments, and expertise, thereby augmenting their research capabilities. These programs have also facilitated collaboration between international organisations and local institutions, such as the University of Nairobi and the Institute of Primate Research (IBRO). Conversely, initiatives like the Showcasing African Neuroscience project have afforded African neuroscientists a platform to deliberate and formulate policies aimed at developing neuroscience on the continent (31). Furthermore, many institutions, including the Dana Foundation, have allocated funding to enhance public knowledge about brain function and neurological illnesses. This has been accomplished through efforts including scientific symposiums and the annual Brain Awareness Week events in March, which involve high school students. These efforts have unequivocally improved neuroscience education (1).

The World Federation of Neurosurgical Societies (WFNS) recognised that centres of excellence for teaching neurosurgeons have also been established in Kenya aimed at improving the field of neurosurgery and neuroscience in the country (16). The collaborations also set up initiatives aimed at acquainting pre-university students in Africa with paths in neuroscience and related fields. The WFNS has been very important in improving neurosurgical training and care in East Africa. It has done this by endorsing and funding regional training programs, such as the Consortium of Collaborative Neurosurgical Sites of Training in East, Central, and Southern Africa (C-CNS-ECSAR) as a reference training site in 2012. This accreditation established a robust framework for training neurosurgeons within Africa, reducing dependency on foreign institutions.

Additionally, WFNS has provided scholarships, including an annual stipend of USD 6,000 per resident, to support neurosurgical trainees, facilitating the growth of a locally trained neurosurgical workforce. The collaboration between WFNS and the regional training programs has resulted in the graduation of 19 neurosurgeons, significantly contributing to the development of neurosurgery in the region (32).

Inter-university collaborations between institutions in East Africa and abroad are increasingly aimed at enhancing neuroscience training and research. Notably, the University of Nairobi (UoN) and the University of Connecticut (UCONN) have initiated efforts to strengthen their collaboration in research and innovation, with a particular focus on neuroscience (33). Additionally, the Brain and Mind Institute has collaborated with several universities in Kenya, marking a significant step towards advancing neuroscience research and practice in the country (34). Furthermore, the African Mental Health Research Initiative (AMARI), a joint organisation comprising four institutions in Ethiopia, Malawi, South Africa,

and Zimbabwe, has contributed to the development of neuroscience research skills, particularly benefiting researchers in Ethiopia (10).

International scientific collaboration is of key significance in the integration of the global research community and has proven to be helpful despite the obstacles associated with it. African researchers who have collaborated with foreign co-authors have received more citations, with their research work being published in high-impact factor journals, thus increasing the visibility of African neuroscience research (16). This could potentially attract funding from international agencies and even increase support from the local government. Moreover, these collaborations provide access to advanced, top-notch technologies and better infrastructure, further advancing neuroscience education and high-quality research (10). Nevertheless, since most African countries lack these cutting-edge systems, neuroscience enthusiasts have adapted to existing technologies, developing specialised research methodologies that fit their work.

CONCLUSION

The escalating prevalence of neurological disorders in East Africa poses a significant public health obstacle. This is compounded by the region's insufficient capability for neuroscience research and healthcare delivery. However, despite encountering various obstacles, such as insufficient training, limited funding, inadequate research infrastructure, and brain drain, innovative techniques like neuroimaging

and telemedicine exhibit the potential to bridge some of these gaps. Furthermore, regional and international partnerships, spearheaded by institutions like PAANS, SONA, and EAANS, have played a vital role in alleviating the severe shortage of neuroscience experts and furnishing the required resources for education and research.

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