

MRI TRAINING IN AFRICA

G.I. Ogbole¹, A.E. Adepoju¹, A. Ibrahim², T.O. Togunwa^{1,3}, F.A. Nkeakam¹

1. Department of Radiology, Faculty of Clinical Sciences, College of Medicine, University of Ibadan, Ibadan, Oyo, Nigeria.
2. Faculty of Basic Medical Sciences, University of Ilorin, Ilorin, Kwara State, Nigeria.
3. College Research and Innovation Hub, University College Hospital, Ibadan, Oyo, Nigeria.

Correspondence:

Prof. G.I. Ogbole

Department of Radiology,
Faculty of Clinical Sciences,
College of Medicine,
University of Ibadan,
Ibadan, Oyo, Nigeria.
Email: gogobole@gmail.com

Submission Date: 29th Aug., 2023

Date of Acceptance: 30th Oct., 2023

Publication Date: 1st Nov., 2023

ABSTRACT

Introduction: This article presents an overview of MRI training in Africa, emphasizing its current status and the obstacles it encounters, with a report from a recent MRI workshop held in Uganda in September 2022.

Africa's medical imaging sector faces unique challenges due to limited access to advanced technology, skilled professionals, and educational resources. While some regions have made notable strides in establishing MRI training programs, others struggle with a shortage of qualified MRI technicians and radiologists. These disparities underscore the urgent need for a more equitable distribution of resources and expertise across the continent.

The aim of the MRI workshop was to initiate actions to address these challenges. This workshop leveraged the expertise of MRI clinicians and scientists to devise strategies for enhancing MRI training in Africa. The report outlines the key outcomes, recommendations, and initiatives resulting from this collaborative endeavor.

Conclusion: This report offers a crucial overview of MRI training in Africa, highlighting its challenges and disparities. It emphasizes the necessity of coordinated efforts to improve MRI education, ultimately contributing to enhanced healthcare outcomes for Africa's population

Keywords: MRI, Workshop, Africa, Training, Low-Field

INTRODUCTION

Magnetic Resonance Imaging (MRI) has been limited in Sub-Saharan Africa due to resource constraints and a scarcity of trained professionals.¹ To address these challenges, the first Sub-Saharan Africa MRI Workshop was organized in Uganda, funded by the Chan Zuckerberg Initiative (CZI). The workshop brought together delegates from multiple African countries to enhance their knowledge and skills in MRI technology. It aimed to equip participants with essential skills in operating MRI equipment and understanding its clinical applications, including low-field MRI construction principles. The collaborative environment facilitated knowledge exchange and networking, fostering future collaborations and research engagements.

The workshop included theoretical and practical sessions on MRI physics, image acquisition techniques, and specialized applications in various medical disciplines. The hands-on training sessions allowed participants to observe and manipulate MRI scanner parts and understand principles of image acquisition and interpretation under guidance by renowned instructors from within and outside Africa. The success of the workshop holds promise for the region, empowering healthcare professionals and improving

diagnostic capabilities, patient care, and medical research opportunities in Sub-Saharan Africa.

The experiences and lessons learned from the workshop may serve as a foundation for future initiatives, collaborations, and potential policy developments. By strengthening MRI capabilities in the African region, the workshop aims to bridge healthcare disparities between Sub-Saharan Africa and other parts of the world. It highlights the importance of increasing access to advanced imaging technologies, improving infrastructure, and expanding the pool of trained professionals in low-resource settings like Africa. This premier Sub-Saharan African MRI Workshop is a crucial step towards advancing healthcare practices in the region and promoting equity in healthcare services and outcomes. It may also help to address some of the related educational challenges facing MRI training programs in Africa.

CHALLENGES OF MRI ADVANCEMENT AND UTILITY IN AFRICA

The growth in MRI technology and its use in Africa faces several challenges and they majorly include:



Figure 1: Participants at the 1st sub-Saharan low field MRI workshop at Mbarara University of science and technology Uganda; September 2022

Infrastructure and Equipment: Limited availability of advanced MRI equipment and outdated infrastructure pose significant challenges. Many healthcare facilities lack access to high-quality MRI scanners, limiting timely and accurate diagnoses of many non-communicable diseases. Additionally, archiving and retrieval of imaging data poses a huge problem, which is an extended problem from lack of stable internet connectivity for image access, storage and retrieval.

High Cost: MRI machines and their maintenance are expensive, making it difficult for many healthcare facilities in Africa to afford them.² The cost of consumables, such as contrast agents, can also be prohibitive, limiting accessibility to a wider population such as the dwellers in the rural areas and poor communities. A survey of MRI coverage in West Africa reported that 100% of all MRI machines were in the urban areas only.¹ This was largely responsible for limiting accessibility to the wider population.

Dearth of Skilled Personnel: compared to its population of more than 1.5 billion, Africa has a severe shortage of skilled MRI personnel in all disciplines, including radiologists, technologists, and radiographers, who possess the necessary expertise in operating and interpreting MRI scans.^{3,4} This shortage of skilled personnel not only hinders the effective utilization of MRI technology but also impedes its overall advancement in terms of research and development. Furthermore, the issue of brain drain exacerbates this challenge, as many MRI experts choose to leave Africa in search of a better research environment and higher remuneration. WHO health workforce support and safeguards list of 2023 reported that about 80% of Africa is experiencing medical staff shortages and high rates of healthcare professionals are leaving for other countries.⁵

Limited Education and Training: A significant challenge in the growth of MRI technology and its use in Africa is the limited availability of education and training resources. Many African countries face a scarcity of comprehensive educational materials and training programs specifically designed for MRI technology.^{6,7} This lack of accessible and tailored training opportunities poses difficulties for MRI scientists seeking to acquire the necessary expertise in new and emerging MRI imaging techniques and procedures.

Poor Maintenance and Technical Support: Regular maintenance and availability of technical support are essential for uninterrupted MRI services. However, obtaining the required technical support and spare parts can be difficult in many regions of Africa, leading to extended downtime for MRI machines.^{2,6}

Inadequate Power Supply: Clean, consistent and reliable electricity supply is crucial for MRI scanner operations. The frequent power outages and voltage fluctuations in most regions of sub Saharan Africa disrupt MRI services and pose risks of damage to the equipment and a resultant high cost to maintain systems with alternative powers sources.⁶

UPSCALING OF LOW-FIELD MRI TRAINING IN CONSTRAINED SETTINGS

The untapped potential of low-field MRI in Africa presents a significant opportunity for the growth and development of MRI science in the region. It has the potential to greatly enhance access to diagnostic imaging services for patients in Africa and improve research, training, and mentorship opportunities. Low-field MRI systems offer distinct advantages in low-resource settings like Sub-Saharan Africa, including lower costs, easier maintenance, and lower power requirements compared to high-field MRI systems.

Furthermore, the limited availability of MRI scanners in many African states, coupled with the brain drain challenge mentioned earlier, leads to a lack of exposure and knowledge about the MRI technology among radiology residents and other MRI scientists resulting in limited research activity during their training. The scarcity of African MRI expert societies exacerbates this situation, as there are few opportunities for researchers to exchange ideas, innovate, and raise awareness about MRI science. Consequently, the gap in MRI literature and education in Africa continues to widen.

While comprehensive data on the state of radiology education infrastructure in Africa is limited, it is clear that the specific needs differ among regions. South Africa's Cape University Body Imaging Centre (CUBIC) stands out as one of the few facilities equipped with the necessary educational and technical resources to offer MRI training. The establishment of more such centers throughout Africa is imperative to facilitate the growth and progression of MRI science. These centers would play a pivotal role in educating new MRI scientists and bolstering the capabilities of the MRI workforce across the continent. Nevertheless, various hurdles must be surmounted, and increased funding for MRI research and education is indispensable for Africa to unlock the full potential of MRI technology and address the challenges at hand.

OVERCOMING BARRIERS IN MRI ADVANCEMENT IN AFRICA

To overcome barriers to MRI research and training in Africa, African MRI scientists must work together to ensure that they:

- Strengthen educational infrastructure by establishing dedicated MRI training centers with the necessary resources and collaborations with international institutions.
- Develop a tailored curriculum that covers MRI physics, image interpretation, safety protocols, and advanced techniques.
- Promote research collaboration through networks, platforms, conferences, workshops, and online forums.
- Retain and attract talent by offering competitive salaries, professional development opportunities, and supportive research environments. Provide research grants, fellowships, and scholarships.
- Advocate for funding by collaborating with governmental bodies, healthcare organizations, and philanthropic foundations.
- Emphasize policy and advocacy to prioritize MRI research and training, encouraging investment in healthcare infrastructure and development of supportive policies.

Implementing these strategies will overcome barriers, enhance capacity, improve access to imaging, and advance MRI science in Africa.

CREATING AN MRI RESEARCH CONDUCTIVE ENVIRONMENT FOR AFRICA

Having the right environmental and research space is essential to MRI research, training, and mentorship in Africa, therefore the following initiatives should be implemented to cause a paradigm shift:

Region-Centric Solutions: Developing strategies tailored to the specific needs and challenges of different regions in Africa, considering variations in resources, infrastructure, and healthcare systems since Africa is largely heterogeneous and diverse.

Conductive Environment and Funding: Fashioning a supportive environment for MRI research by investing in sustainable energy solutions to ensure a reliable power supply for MRI machines. Governments and organizations should provide sufficient funding for research and training programs, including grants and financial support for acquiring and maintaining MRI equipment.

Collaboration and Inclusion: Fostering collaboration among research institutions, equipment vendors, and industry stakeholders to leverage their expertise and resources. Promote inclusion by engaging African researchers, clinicians, and educators in global research networks, capacity building fellowships, and mentoring programs.

Alternate Power Supply: Developing strategies for ensuring reliable power supply to MRI facilities, including exploring alternate power sources such as solar energy or backup power systems to overcome challenges associated with inconsistent electricity supply.

Sustainable MRI Training and Mentorship Programs: Establishing comprehensive training and mentorship programs that cover all aspects of low-field MRI, including technical operation, interpretation, safety protocols, and research methodologies. These programs should prioritize hands-on practical training and provide opportunities for professional development.

Leveraging Low-Field MRI for Healthcare and Research: Promoting the use of low-field MRI as a transformative tool in healthcare, education, and research in Africa. Encourage research studies focusing on African populations to advance the understanding of diseases and disorders specific to the region.

Contributions from The Low-Field MRI Workshop in Uganda

The Low-Field MRI Workshop had the goal of enhancing MRI knowledge and promoting its use in Africa. This workshop was jointly organized by the Strengthening MRI Access, Research and Training in (SMART) AFRICA NETWORK project, Mbarara University of Science and Technology (MUST), Leiden University Medical Center (LUMC), Consortium for Advancement of MRI Education and Research in

MRI related professions, with participants from Botswana, Gambia, Ghana, Kenya, Rwanda, Zimbabwe, Uganda, and Nigeria.

The CZI_SMART Africa project awarded travel grants to international participants from Ghana, Botswana, Nigeria, Rwanda, and Zimbabwe, while also providing local scholarships to Ugandan MR scientists. The topics covered during the workshop included; Pulse sequence programming, Image quality, MRI technology basics,



Figure 2: A member of the resource faculty showcasing one of the steps, specifically the installation of more than 4500 miniature magnets.

Africa (CAMERA), and the University of Ibadan. The event took place at the Biomedical Engineering department of MUST, Uganda from September 26 to 30, 2022, offering both theoretical and practical sessions focused on the construction of a low-field MRI scanner, a pioneering initiative in Africa led by a team from LUMC. The MRI Training workshop program received over 50 applications from diverse

medical imaging analysis, Gradient functions, MRI Safety, Functional MRI in pediatric studies, and MR imaging anatomy. Practical were the demonstration and observation of the construction of a Low-Field MRI scanner provided an opportunity for extensive Q&A sessions. Increasing access to and utilizing low-field MRI in Africa offers numerous advantages. Low-field machines are more affordable and accessible to



Figure 3: A group of participants and resource persons, during the construction phase of the Low-Field MRI machine and listening to a practical demonstration session.

hospitals and clinics, particularly in rural areas, compared to high-field machines. This affordability improves patient access to diagnostic imaging services. Additionally, low-field MRI machines are easier to maintain and repair, as local personnel can be trained, reducing the need for overseas specialists.

Workshops like this provide valuable hands-on training for MRI scientists and engineers and equips them with the necessary skills to operate low-field MRI machines. By offering training and technical support, these workshops contribute to strengthening healthcare systems in Africa, enhancing their resilience and capacity to provide high-quality care.

Moreover, low-field MRI machines are portable, enabling imaging services to reach remote and underserved areas. They are also more energy-efficient, reducing the carbon footprint of imaging services. The establishment of low-field MRI workshops in Africa not only supports local economies by creating jobs and generating income but also raises awareness about the benefits of MRI technology and promotes the adoption of low-field scanners in clinical practice. This, in turn, fosters MRI research and innovation by removing previous barriers.

Continuing efforts to improve MRI research and training in Africa, the SMART Africa initiative has awarded seed grants to five African scientists for MRI-related studies. Furthermore, the second edition of the CZI funded MRI workshop is scheduled for September 25-29, 2023, in Accra, Ghana and would represent the pre-conference program of the first scientific meeting of the newly established African Chapter of the International Society for Magnetic Resonance in Medicine (ISMRM_ AC). This meeting is expected to bring together over 150 MRI scientists and clinicians.

WORKSHOP HOSTING CHALLENGES

Fund Transfer: Low and middle incomes countries in Africa still battles with Inter-Country fund transfer as the African banking system is still developing this was an obstacle that was encountered during the planning of the workshop.

Epileptic Power Supply: Stable and reliable supply is remains crucially lacking in most African countries, Uganda where the conference was held was not exempted as this disrupted some of the workshop activities.

Poor Internet Connectivity: Unlike most developed countries, majority of African countries suffers from low internet bandwidth and this also made it difficult

to have a smooth presentation from one of our virtual resource persons.

Despite logistical challenges related to fund transfers within the African banking system and limited internet connectivity, the workshop was largely successful with reports from our post-workshop evaluation showing that 95% of the attendees were positively impacted by the workshop and 90% indicated that it has positively influenced their future career plans.

CONCLUSION

The establishment of MRI research, educational, and mentorship programs in Africa is of paramount importance for the region's advancement in the field of medical imaging. By making the necessary investments and providing support, Africa can lay a robust foundation in MRI science, thus making a positive impact on the health and overall well-being of its populace. The creation of regional MRI Training Centers will serve as hubs for collaboration, innovation, and the provision of training and mentorship opportunities for researchers and practitioners alike. We aspire to see these suggestions taken into serious consideration and put into action, which will, in turn, position Africa as a significant contributor to the global progress and innovation in MRI research.

ACKNOWLEDGMENT

Our heartfelt gratitude goes out to the following individuals whose contributions were instrumental in making the workshop a resounding success. We extend our appreciation to Dr. Johnes Obungoloch, the Dean of the Faculty of Applied Sciences and Technology at Mbarara University of Science and Technology (MUST), Mbarara, Uganda, and his entire team at the MRI Laboratory. We also acknowledge and thank Prof. Steven Schiff of Yale University and Prof. Andrew Webb of Leiden University, along with their dedicated team, which includes Dr. Thomas O'Reilly, Dr. Joshua Harper, and Wouter Teeuwisse. Their efforts not only resulted in the assembly of Africa's pioneering ultra-low-field MRI system but also enriched the workshop with their expertise.

Furthermore, our sincere thanks go to Dr. Sairam Geethanath and Chinonye Okorie for their invaluable mentorship provided to the participants.

It is important to acknowledge that the workshop received funding from the Chan Zuckerberg Initiative (CZI) DAF, an advised fund of Silicon Valley Community Foundation, with Grant number: 2021-240505 (5022). This support was instrumental in making the workshop a reality.

REFERENCE

1. **Ogbole GI**, Adeyomoye AO, Badu-Pepurah A, *et al.* Survey of magnetic resonance imaging availability in West Africa. *Pan Afr Med J.* 2018;30:240.
2. **Saidu SA**, Umar FK. The challenges of running magnetic resonance imaging services in the tertiary health centers of Nigeria. *Kanem Journal of Medical Sciences.* 2016;10(2):83-87.
3. **Ogbole G**, Adeleye A, Adeyinka A, Ogunseyinde O. Magnetic resonance imaging: Clinical experience with an open low-field-strength scanner in a resource challenged African state. *J Neurosci Rural Pract.* 2012;3(2):137-143.
4. **Sanal HT**, Cardoso F, Chen L, Chung C. Office-based versus high-field strength MRI: diagnostic and technical considerations. *Sports Med Arthrosc Rev.* 2009;17(1):31-39.
5. WHO. WHO health workforce support and safeguards list 2023. Technical document 2023.
6. **Anazodo UC**, Ng JJ, Ehiogu B, Obungoloch J, *et al.* A framework for advancing sustainable magnetic resonance imaging access in Africa. *NMR Biomed.* 2023;36(3):e4846.
7. **Kawooya MG**, Kisembo HN, Remedios D, *et al.* An Africa point of view on quality and safety in imaging. *Insights into Imaging.* 2022;13(1):58.