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Utility of advanced brain MRI techniques for clinical and research purposes in a low-resource setting: A multicentre survey

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ABSTRACT

Rationale and objective: The purpose of this study was to investigate the utility of advanced brain MRI techniques for clinical and research purposes in a low-resource setting.

Materials and methods: A national survey was conducted across healthcare facilities nationwide in Ghana. The survey included questions relating to facility demographic information, MRI scanner work functions, and utility of MRI for clinical and research purposes.

Results: Most MRI scanners were private-owned, with General Electric being the dominating scanner brand, and a high prevalence of 1.5 T MRI scanners. Most facilities have 1 – 4 radiologists and radiographers, and brain MRI prices were higher in private facilities compared to the public facilities. Most (84.6 %) facilities indicated the availability of PACS; however, none indicated the integration of artificial intelligence into their clinical workflow. Average weekly availability of MRI services was 7 days in most facilities (53.8 %). Most (69.2 %) facilities provide a 24-hour window to offer brain MRI services. A total of 1 – 4 brain MRI cases were performed daily. Only 4 (30.8 %) facilities indicated the availability of brain MRI protocol for research purposes. For clinical purposes, most facilities indicated their acquisition of 3D-T1-weighted (11 facilities), diffusion tensor imaging (DTI) (7 facilities), and perfusion imaging (7 facilities). Conversely, fMRI (3 facilities), 1H-MRS (2 facilities), and DTI (1 facility) were in use for research purposes. Approximately 85 % of respondents indicated that they 'rarely' or 'never' utilize the scanners for research purposes.

Conclusion: The wide variation in the utility of MRI for clinical and research purposes highlights some opportunities for enhanced accessibility and potential recruitment of study participants, including challenges related to standardization in a potential multicentre brain MRI research.

1. Introduction

Advanced brain MRI techniques can provide quantitative structural, functional, and perfusion status of various neurological disorders which are not only important for establishing more accurate diagnoses but initiating and implementing effective therapeutic interventions. In addition, they have become ubiquitous tools in neuroscience research, particularly in Western countries. However, comparatively, developing countries, especially Africa still lag in the clinical and research application of these tools, and even the uptake of neuroscience research. Several problems plague neuroscience research in Africa including limited access to scientific training, poor funding, heavy teaching loads on scientists, lack of reliable energy sources, research facilities [1], and lack of technical expertise which limits the adoption and optimization of advanced medical technologies for clinical or research purposes. Multicentre neuroimaging research studies appear to be scarce or non-existent on the African continent, as such an endeavour come with heavy financial burden and complex to plan, execute, monitor, and control. Variations in MRI scanners, protocols, and parameters (e.g., field strength, gradient system, manufacturer, coil sensitivity, post-processing software, and pulse sequences) can also limit the ability for inter- and intra-institutional comparison of images and reports or the combination of multicentre neuroimaging data.

In this study, we conducted a multicentre survey to determine the

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characteristics of MRI suites, availability of dedicated brain MRI protocol for research, utility of advanced brain MRI techniques for either clinical or research purposes, and the frequency of use of MRI scanners for brain MRI research in Ghana. We anticipate that by gaining a first-hand information on these important issues, our findings can inform our future strategic planning for multicentre brain MRI imaging research in resource-limited environments.

2. Materials & methods

This survey encompassed healthcare facilities, including clinics, hospitals, and stand-alone diagnostic centres, operating MRI scanners across the country. From March 2024 to October 2024, through ethical clearance granted by the Ghana Society of Radiographers (GSR/RS/PS/FTA/003/2024), we wrote a letter to facility directors wherein we sought permission and approval to invite MRI clinical leads to participate in the survey. We also indicated in the letter that the result of the study would only be used for the purpose of the study and that their participation in the study was voluntary, anonymous, and confidential. We identified a total of 16 MRI facilities nationwide through the assistance of radiographers and radiologists (Fig. 1). This number represented the total number of MRI scanners in Ghana. However, 3 MRI scanners were out of service in public facilities in 3 regions (Northern, Central, and Volta). The MRI clinical leads were actively responsible for the day-to-day management of the MRI suite in their facility. Follow-ups were done via WhatsApp and phone calls to remind the contacts of the need to complete the questionnaire monthly [2]. A 3-page survey questionnaire was piloted by the authors to identify potential questions that required further clarity, relevance, or comprehension. Adjustments were made upon receiving feedback.

The survey focused on several topics, divided into three sections: Section 1 –basic demographic information about each respondent's facility (Facility ownership and affiliations, Classification of facility, MRI Equipment brand in use, Magnetic field strength in use, and Number of radiology personnel); Section 2 –MRI Scanner Work Functions (Pricing of brain MRI examinations, Availability of Picture Archiving and Communication System (PACS), Use of Artificial Intelligence (AI) in clinical workflow, Average weekly availability of MRI services, Patient waiting time to undergo brain MRI, and Average number of brain MRI cases done per day; and Section 3 – utility of MRI for clinical and research purposes (Availability of dedicated brain MRI protocols, Utility of advanced brain MRI techniques i.e., 3-dimensional T1-weighted [3D T1], diffusion tensor imaging [DTI], proton magnetic resonance spectroscopy [1H-MRS], susceptibility weighted imaging [SWI], perfusion imaging, and magnetization transfer imaging [MTI]), and Frequency of use of MRI scanner for research purposes). We gave participants the option to leave questions they could not answer confidently blank. Written informed consent was obtained from the participants. The anonymity and confidentiality of the respondents and their facilities were ensured and maintained.

We performed statistical analyses of the survey data using Google Forms and 2023 Microsoft Excel (version 16.76).

3. Results

Table 1 shows the demographics of MRI Suites and Table 2 shows the MRI scanner work functions. Fig. 1 shows the geographical distribution of MRI scanners in Ghana. Fig. 2 shows summary of the availability of brain MRI protocol for research purposes, Fig. 3 shows summary of the utility of advanced brain MRI techniques, and Fig. 4 shows the frequency of use of MRI scanner for research purposes.

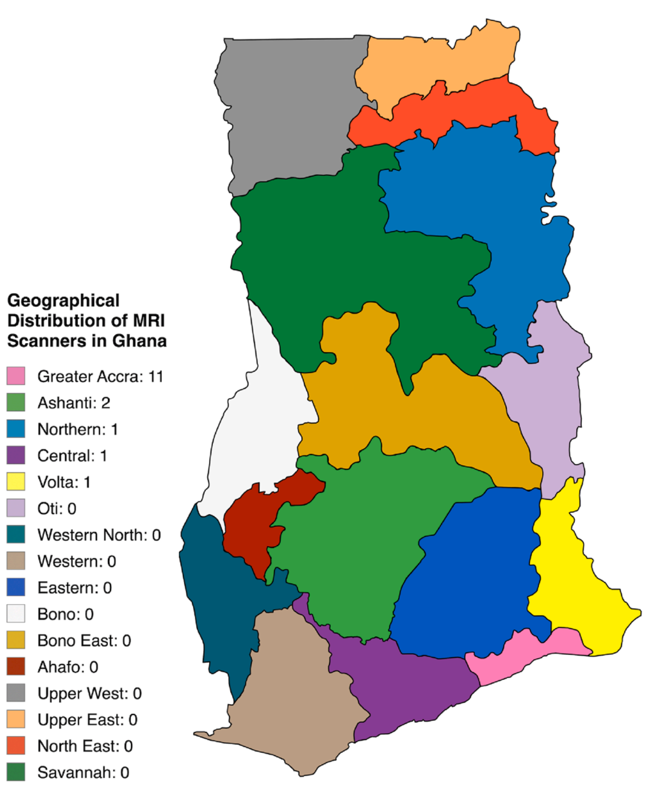

Fig. 1. Geographical Distribution of MRI Scanners in Ghana. Most MRI scanners located in the Greater Accra region.

Table 1
Demographics of MRI Suites. The majority of MRI scanners were located in privately owned facilities, proportionally distributed across tertiary referral centres and private hospitals, with a significant concentration in the Greater Accra region. General Electric (GE) was the most commonly reported scanner brand among respondents. Most facilities utilised 1.5 Tesla (T) MRI systems. In terms of human resources, the majority of facilities reported having 1 to 4 radiologists and a similar number of radiographers.

Item	Response
Facility ownership and affiliations	
Private	7
Public	4
Quasi-government	2
Classification of facility	
Tertiary referral centre	5 (38.5 %)
Private hospital	5 (38.5 %)
Regional hospital	0 (0 %)
Stand-alone diagnostic centre	3 (23.1 %)
Regional Location of MRI Scanner	
Greater Accra	10
Ashanti	2
Northern	1
MRI Equipment brand in use	
Philips	2 (15.4 %)
Toshiba	3 (23.1 %)
General Electric	5 (38.5 %)
Siemens	3 (23.1 %)
Magnetic field strength in use	
$<$ 1.5 T	0 (0 %)
1.5 T	12 (92.3 %)
3.0 T	1 (7.7 %)
Number of radiology personnel	
Radiologists	
1 – 4	9
5 – 10	3
$>$ 10	1
Radiographers	
1 – 4	10
5 – 10	3

Table 2
MRI Scanner Work Functions. Both contrast-enhanced and non-contrast adult brain MRI examinations were reported to be more frequently performed in private facilities compared to public institutions. Approximately 85 % of respondents indicated the availability of Picture Archiving and Communication Systems (PACS). However, none of the facilities reported integrating artificial intelligence (AI) into their clinical workflow. Slightly more than half of the facilities provide MRI services seven days a week, with the majority offering 24-hour access to brain MRI examinations. Notably, most respondents indicated that patient waiting time for brain MRI is typically within 24 h. Additionally, facilities reported performing between one and four brain MRI examinations per day.

Item	Response
Pricing of brain MRI examinations	
Adult with contrast	*GH₵*1806.00 ± 314.40
Adult without contrast	*GH₵*1156.23 ± 214.43
Availability of Picture Archiving and Communication System (PACS)	
Yes	11 (84.6 %)
No	2 (15.4 %)
Use of Artificial Intelligence in clinical workflow	
Yes	0 (0 %)
No	13 (100 %)
Average weekly availability of MRI services	
7 days	7 (53.8 %)
6 days	3 (23.1 %)
5 days	3 (23.1 %)
Patient waiting time to undergo brain MRI	
Within 24 h	9 (69.2 %)
2 – 3 days	4 (30.8)
Average number of brain MRI cases done per day	
5 facilities	4
3 facilities	3
5 facilities	1

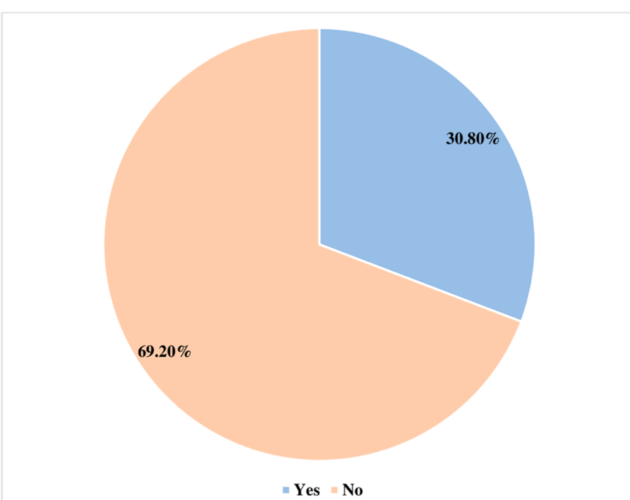

Fig. 2. Availability of brain MRI protocol for research purposes. Only 4 (30.8 %) facilities indicated they have brain MRI protocols.

4. Discussion

4.1. Demographics of MRI suites

The distribution of MRI suites across private, public, and quasi-governmental health facilities reflects the heterogeneous nature of healthcare ownership structures in Ghana (Table 1). Notably, private ownership dominates, suggesting the increasing influence of market-driven forces and entrepreneurial initiatives in the establishment and provision of MRI services. However, the geographic concentration of

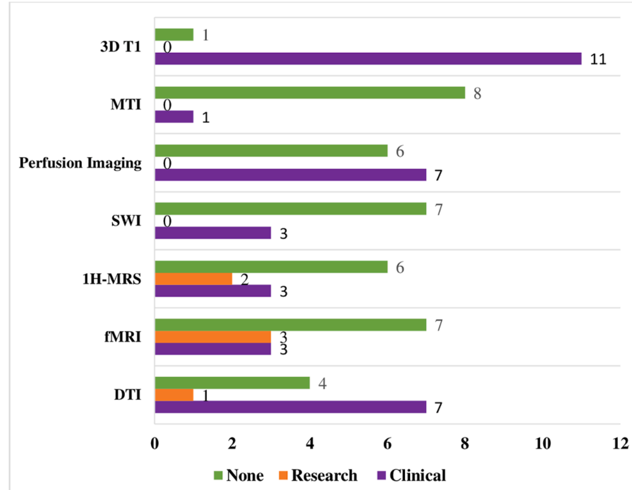

Fig. 3. Utility of advanced brain MRI techniques. 3D T1-weighted imaging emerged as the most commonly available and utilised modality for clinical purposes, followed by perfusion imaging and diffusion tensor imaging (DTI). In contrast, the application of more specialised techniques—such as susceptibility-weighted imaging (SWI), proton magnetic resonance spectroscopy (1H-MRS), functional MRI (fMRI), and magnetisation transfer imaging (MTI)—was notably limited in routine clinical settings. For research purposes, although only a small number of facilities reported engaging in MRI-based research, those that did primarily employed fMRI, 1H-MRS, and DTI.

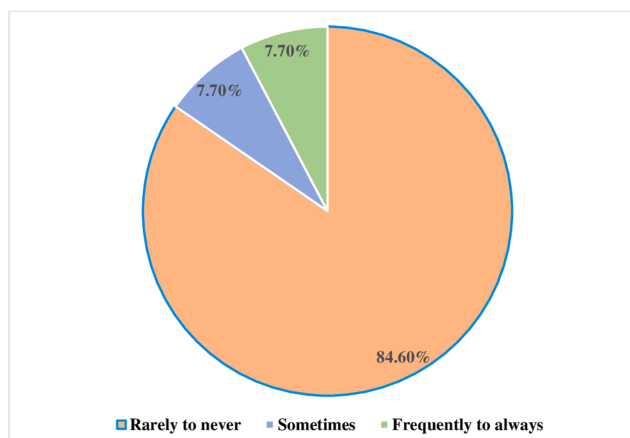

Fig. 4. Frequency of use of MRI scanner for research purposes. Approximately 85 % of respondents indicating that they 'rarely' or 'never' utilize the scanners for research purposes.

MRI scanners in the Greater Accra Region—Ghana's capital and primary commercial hub—underscores a pattern of urban centralisation. This observation aligns with findings from previous studies, which report a higher density of MRI scanners in urban areas compared to rural communities [3,4].

Globally, the regional distribution of MRI scanners is markedly uneven. Africa exhibits the lowest availability at 0.0004 scanners per 100,000 population, in stark contrast to the Western Pacific region, which has the highest density at 0.35 per 100,000. Japan, in particular, possesses the largest number of MRI units globally [5]. The disparity is even more pronounced when comparing low- and middle-income countries (LMICs) with high-income countries (HICs): LMICs report an average of 1.12 MRI units per million population (pmp), whereas HICs boast an average of 26.53 MRI units pmp [6,7].

The findings from our study not only reflect global and regional inequities in MRI access but also highlight potential barriers to equitable participation in multicentre neuroimaging research. The underrepresentation of rural and less-resourced regions could undermine efforts to promote diversity, equity, and inclusion in global health research initiatives. Several factors contribute to these disparities. Establishing and maintaining MRI services is capital-intensive, requiring substantial investment in acquisition, infrastructure, cryogenic materials such as helium, uninterrupted power supply, and skilled personnel for operation and maintenance. In public healthcare facilities, these challenges are particularly acute with MRI systems in often experiencing prolonged downtimes due to inadequate technical support and resource constraints, leading to service interruptions and considerable financial losses [8].

Our findings further reveal considerable diversity in the choice of MRI scanner brands across the surveyed facilities. General Electric systems were the most prevalent, followed by Toshiba, Siemens, and Philips. The selection of these brands is likely influenced by a combination of factors, including existing vendor relationships, procurement costs, software capabilities, and operational efficiency. While brand diversity may reflect a strategic approach to meeting varied imaging demands, it also introduces potential challenges related to interoperability and protocol standardization, particularly in the context of multicentre research. Variability in equipment can affect image quality, data harmonization, and personnel training, thereby complicating efforts to ensure consistency and comparability of imaging outputs.

Additionally, our study identified a predominance of 1.5 Tesla (T) MRI scanners, with only a single facility operating a 3.0 T unit. This distribution aligns with global trends linking scanner field strength to national income levels, with high-income countries (HICs) typically possessing a higher proportion of high-field MRI systems ($\geq$ 3.0 T) compared to low- and middle-income countries (LMICs) [9,10]. The 1.5 T scanners, while less powerful than their 3.0 T counterparts, remain cost-effective and versatile, offering sufficient image resolution for a broad range of clinical applications. Their adaptability and lower operational demands make them particularly suitable for resource-limited settings.

From a research perspective, conducting multicentre studies using scanners with similar magnetic field strengths, particularly 1.5 T systems, offers key advantages. It helps mitigate acquisition-related variability—especially in image quality—while preserving sensitivity to disease-related differences [11]. This approach also supports increased statistical power and larger sample sizes. Notably, it is generally inadvisable to interchange radiomic features derived from 1.5 T and 3.0 T brain MRI scans when evaluating texture features due to inherent differences in magnetic field strength, matrix size, field of view, and spatial resolution [12]. In brain imaging studies, such inconsistencies can be significant and may rival the magnitude of true biological differences between cases and controls [13]. These findings underscore the importance of developing and adhering to standardized acquisition protocols to improve the reproducibility and reliability of radiomic biomarkers across diverse settings.

Despite the clear benefits of protocol harmonization, challenges persist—particularly concerning acquisition parameter variability across different scanner platforms. When such variability is unavoidable, appropriate adjustments must be made during study design to account for these confounding factors [12]. The demographic and technical characteristics observed in our study provide essential context for interpreting respondents' reported distribution and operational functions of MRI suites across the country, which are examined in the subsequent section.

4.2. MRI scanner work functions

Our study revealed that the majority of facilities employed between one and four radiologists and radiographers, highlighting the variability in the distribution of imaging personnel across institutions (Table 1). This distribution may reflect a reliance on a lean workforce, particularly in smaller or privately owned facilities. In contrast, a few institutions reported relatively larger teams, which could be advantageous in delivering broader population coverage and managing patient throughput more efficiently. However, limited staffing can place considerable strain on radiology services, especially in high-demand settings, potentially resulting in extended turnaround times, increased staff workload, and reduced operational capacity.

We also observed that both contrast-enhanced and non-contrast adult brain MRI examinations were more frequently performed in private facilities than in public institutions. However, the listed prices for these services predominantly applied to standard MRI protocols, with limited routine use of advanced pulse sequences (Table 2). The integration of advanced sequences likely demands additional resources, including the acquisition of specialized software packages, which may contribute to increased procedural costs and limit their routine use.

Interestingly, most facilities reported the availability of PACS. The presence of PACS is particularly valuable for multicentre neuroimaging research, as it enables the seamless aggregation and integration of imaging data from various scanners and sites. This capability supports the construction of large, collaborative datasets without geographic limitations, while also facilitating efficient storage, access, and sharing of neuroimaging data across research institutions.

Notably, none of the surveyed facilities reported integrating AI into their clinical workflows. While AI adoption in clinical radiology remains in its early stages across many low-resource settings, its potential benefits for multicentre brain MRI research are substantial. AI-driven tools can support the automation of key imaging tasks—such as segmentation, quantification, and feature extraction—thereby reducing manual workloads and accelerating data analysis. Furthermore, AI applications can contribute to the standardization of imaging protocols, enhance pattern recognition, enable image classification, and support predictive modelling, all of which are critical for improving data quality and consistency across multicentre studies.

Our findings also show that slightly more than half of the facilities provide MRI services seven days a week, with most offering 24-hour access to brain MRI examinations. On average, most respondents indicated patients waiting time to undergo brain MRI is within 24 h. Further, respondents indicated their facility performs between one and four brain MRI cases per day. These patterns suggest a relatively high level of scanner availability, which could support efficient patient recruitment for multicentre research studies. Increased availability may enhance participant enrolment, reduce delays in achieving sample size targets, and ultimately improve the statistical power and generalizability of multicentre trials.

Understanding the scope of MRI-related personnel, service availability, and institutional workflows offers important context for interpreting how advanced MRI techniques are perceived and applied. These considerations are further explored in the subsequent section.

4.3. Availability of brain MRI protocols for research purposes

Our findings indicate that only 4 facilities (30.8 %) reported having brain MRI protocols specifically established for research purposes (Fig. 2), highlighting a potential gap in the integration of neuroimaging research within routine radiological practice. The availability of dedicated research protocols is critical to conducting methodologically rigorous and standardised neuroimaging studies. Such protocols ensure data consistency, enable the pooling of datasets across institutions, and enhance the reproducibility of findings—key elements in advancing collaborative, multicentre research.

The implementation of standardised acquisition parameters, imaging techniques, and post-processing methods contributes significantly to the reliability and comparability of brain MRI results. This standardisation facilitates meaningful comparisons across diverse clinical and research settings, thereby strengthening the scientific rigour and generalisability of neuroimaging studies.

Globally, expert groups have developed and validated numerous brain MRI protocols tailored for both structural and functional imaging modalities. These include protocols for structural MRI [14,15], diffusion tensor imaging (DTI) [16], and proton magnetic resonance spectroscopy (1H-MRS) [17,18], as well as condition-specific protocols for neurological disorders such as Alzheimer's disease [19,20], brain tumours [21], brain metastases [22], epilepsy [23], and multiple sclerosis [24].

Although the limited availability of research-focused MRI protocols among surveyed facilities was not entirely unexpected, it likely reflects a broader tendency to prioritise clinical service delivery over research. This may also suggest a limited pool of personnel with a dedicated interest in MRI-based or neuroimaging research within the local context. Nonetheless, the presence of such protocols, albeit in a minority of centres, underscores a foundational capacity and institutional willingness to support advanced imaging research.

Understanding not only the infrastructural availability but also the actual utilisation of these protocols in both clinical and research contexts is essential. This aspect is explored in greater detail in the following section.

4.4. Utility of advanced MRI techniques for clinical and research purposes

We were also interested to know the purposes for which the available advanced brain MRI techniques were used for. Here, we focused on facilities that used any of the advanced MRI techniques for either clinical or research purposes. We found variations in the use of the listed advanced brain MRI techniques for clinical and research purposes, reflecting the dynamic neuroimaging practices, with some advanced MRI techniques being commonly used in clinical settings, while a few others are being applied in both clinical and research settings. More specifically, we found that most facilities used 3D-T1-weighted (11 facilities; Fig. 3), a pulse sequence that has remained a key component of brain MRI tailored for probing neuroanatomical structure. Its advantage includes its ability to acquire volumetric images with high spatial resolution and excellent anatomical detail, its ability to be reformatted into any of the orthogonal planes, and its ability to allow for quantitative brain volume measurement (i.e., whole-brain, gray matter, white matter, regional or voxel-based). 3D-T1-weighted sequence has also become an integral technique necessary for the acquisition of advanced imaging techniques such as diffusion-weighted imaging, DTI, fMRI, and 1H-MRS, thus its advantage extends beyond structural anatomical visualization but complements the probing of functional and physiological details across a wide range of neurological and other medical conditions. Next is the application of DTI clinically (7 facilities), suggesting its awareness and high uptake for interrogating white matter structures in a wide range of neurological disorders. DTI scalars can be correlated with clinical information to reveal white matter abnormalities associated with neurological diseases [25]. The high uptake may be due to its technological advancements, particularly with the MRI software and hardware, including the sophisticated post-processing imaging software techniques, which may have significantly improved its reliability, sensitivity and spatial resolution. Interestingly, our findings showed a very low clinical adoption of BOLD-fMRI, 1H-MRS, SWI, and MTI. In a comparable study, the authors reported that only 64.3 % and 42.6 % of the surveyed facilities indicated their clinical application of BOLD-fMRI and 1H-MRS, respectively [26]. However, these advanced techniques are fraught with technical complexities [27]. Notably, in some jurisdictions, there have been reports of clinical application of fMRI for pre-surgical mapping of the neural networks, cerebral cortex, and others [28,29]. Similarly, 1H-MRS of the brain has also gained increased acceptance in clinical settings with its application gaining much momentum for the study of brain tumour, epilepsy, multiple sclerosis, senile dementia, neuropsychiatric disorders, among several others [30, 31]. SWI offers valuable information about tissues that demonstrate a different susceptibility compared to its surrounding anatomical structures [31]. MTI can be used to probe tissue integrity, providing indirect measure of the degree of myelin integrity in the brain and spinal cords which may or may not be visible with conventional MRI techniques in several neurological conditions [32,33].

We also found that 7 facilities (53.8 %) indicated their clinical use of perfusion imaging, suggesting that referring clinicians and radiologists may have found that the technique is highly valuable for interrogating a wide range of neurological disorders. Though we did not seek to find out the rationale behind the high adoption of this technique, post-treatment evaluation and primary evaluation of intra-axial brain tumours and stroke are common conditions for which it is applied [2,34]. Our findings are comparable to reports by Manfraini et al. [26] who indicated that 67.3 % and 43.4 % applied dynamic susceptibility contrast-enhanced and dynamic contrast enhanced MRI for perfusion imaging.

Surprisingly, we also found that of all the advanced brain MRI techniques, only three techniques were in use for research purposes which were fMRI (3 facilities), 1H-MRS (2 facilities), and DTI (1 facility). Further, we found that none of the respondents indicated their use of SWI, perfusion imaging, MTI, and 3D T1-weighted imaging for research purposes even though their use has been widely established in the literature, particularly in multicentre studies. This finding may be attributed to the reported frequency of MRI scanner use for research purposes, with approximately 85 % of respondents indicating that they 'rarely' or 'never' utilize the scanners for such activities (Fig. 4). As a reference, multicentre studies of perfusion imaging [35,36], MTI [37, 38], SWI [39,40] and several studies that employed 3D T1-weighted either alone or combined with other advanced MRI techniques have been widely reported. Advanced brain MRI techniques require the generation of large volumes of imaging data that require training for their protocol setup, acquisition, and the application of sophisticated computational methods for post-processing, analysis, and interpretation. Technical expertise, computational infrastructure, and software tools may be lacking in these facilities to support research activities required to post-process and analyze the complex MRI data, this may serve as a barrier to converting raw imaging data into scientifically meaningful data. Additionally, given the clinical reason for the establishment of MRI facilities in the country, certainly there would be the prioritization of clinical work which would override research pursuits. In addition, there is less MRI research uptake in low-resource settings due to cost and there are logistical challenges associated with the provision of continuous training for imaging personnel. Our study highlights the variations in the use of advanced brain MRI techniques in clinical and research settings, reflecting the dynamic and evolving nature of neuroimaging practices in LMICs.

5. Limitations

This study has some limitations beginning with the lack of response from some personnel from the facilities. Although several attempts were made to gather the response from each representative from each facility to no avail, only a few did not respond; nevertheless, the resulting data can be considered representative of the local setting given the high number that responded to the survey. Furthermore, we could not reach out to some facilities because they have had their MRI scanners broken down for years, especially in public health facilities, limiting their representation in the study. Nonetheless, we do not think that a higher response rate would alter the final results. We were also not sure if the respondents indeed provided realistic responses considering the overlapping utility of the advanced MRI techniques for either clinical or research purposes. Therefore, they may have mixed up a clinical implementation with research implementation performed in a clinical setting [26]. Compared to other studies that addressed several areas for some advanced MRI techniques [26,34], we did not address many of such areas as we were concerned about not boring our respondents with too many questions and decreasing their response time. Consequently, this may limit the granularity with which we can interpret the distinct clinical versus research uses of these modalities. As such, while our findings offer a valuable overview of utility patterns, they may under-represent more specialized or infrequent applications. Future studies with more comprehensive instruments may be required to explore these subtleties in greater detail. Future studies could also adopt a mixed-methods approach, incorporating follow-up qualitative interviews or focus groups with key stakeholders such as radiologists, researchers, and technologists. This would allow for deeper exploration of context-specific practices, clarify overlaps between research and clinical applications, and enrich understanding of institutional and infrastructural influences. It is also not out of place that some questions may have been overly generalized, although we tried posing our questions with the notion that all the respondents were well abreast with the technicalities surrounding MRI clinical and research workflow. Nonetheless, to the best of our knowledge, our study provides insight into the clinical and research utility of advanced brain MRI techniques in a low-resource setting.

6. Conclusion

We observed some variations in facility ownership, location, equipment brands, type of contrast usage, pricing of brain examinations, work settings, and staffing levels across the surveyed facilities, which reflects the heterogeneous nature of MRI services in this region. Nevertheless, the availability of MRI scanners and the presence of advanced MRI techniques, though predominantly in the capital suggest that it is feasible to undertake multicentre MRI studies. But then the lack of MRI scanners or their complete breakdown in some regions may hamper the diversity, equity, and inclusion of those from resource-poor communities. Our study further revealed diverse patterns in neuroimaging practices for clinical and research purposes in a low-resource setting. Overall, AI integration into clinical and research workflows can enhance multicentre brain MRI research which can facilitate not only scientific progress but also clinical impact of collaborative neuroimaging research efforts. Furthermore, the wide variation in MRI service availability signifies opportunities for increased accessibility and facilitation of potential recruitment of study participants. There is high clinical adoption of 3D T1-weighted MRI sequence, DTI, and perfusion imaging. However, other advanced brain MRI techniques are underutilized for clinical research purposes partly attributable to the absence of dedicated post-processing software, which remains unaffordable for many facilities. Our survey highlights an unmet need to promote individual or multicentre utility of advanced brain MRI techniques demonstrating their clinical and research benefits. That is, facilities may consider the establishment of collaborative research groups, applying and securing external research funding for strategic investments in imaging infrastructure, and effecting training programs to enhance staff skills and expertise. If there is a plan for multicentre studies, there would be the need to standardize and optimize MRI techniques to ensure accuracy (closeness to the truth, or lack of systematic error), and precision (reproducibility, or lack of random error) with the use of either phantoms or human [41]. By integrating advanced MRI techniques into research protocols, a better scientific understanding of diverse neurological disorders can be achieved, consequently leading to the development of novel therapeutic methods.

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CRediT authorship contribution statement

Albert Dayor Piersson: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **George Nunoo:** Writing – review & editing, Writing – original draft. **Klenam Dzefi-Tettey:** Writing – review & editing. **Nicholas Otumi:** Writing – review & editing.

Declaration of competing interest

This research was not supported by any Funding Organization. The authors declare no other competing interests.

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