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Original Research Article

Magnetic Resonance Imaging of the Brain in Children: Indications and Findings in a South-West Nigerian Mission Teaching Hospital

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Abstract: The examination of the brain in children is best done using the non-ionizing modality of the magnetic resonance imaging (MRI). The quality and resolution of the examination, which have a direct bearing on the outcome of the examination and patient management are better with a high-field equipment, with at least the 1.5 Tesla magnetic field strength. The aim of this research was to audit the findings in children (0 – 17 years) imaged in our department over a 2-year period (January 2024 – January 2026). The records of the department of radiology, Babcock University teaching Hospital, Ilishan-Remo, South-West Nigeria, which has a General Electric 1.5 Tesla MRI equipment was reviewed retrospectively. The MRI images were reviewed by 2 experienced specialist radiologists. The indications and the MRI findings were recorded on Microsoft Excel and then entered into and analyzed using SPSS version 25. Approval for the research was obtained from the Babcock University's Research Ethics Committee. The commonest indications were seizures (34.9%), headaches (14.2%), meningitis (5.7%) and traumatic brain injury (4.7%). A total of one hundred and six (106) children were examined, out of which thirty-six (34.0%) had normal findings while seventy (66.0%) had abnormalities. The commonest abnormalities in the brain were infarcts (9.4%), general cerebral atrophy (4.7%), gliosis (3.8%), encephalitis (3.8%), meningitis (3.8%), hypoxic ischemic encephalopathy (HIE) (2.8%), subdural empyema (2.8%) and focal cortical dysplasia (2.8%). Our findings are varied widely but comparable with many previous studies in our environment and other parts of the world.

Keywords: Magnetic Resonance Imaging, Indications, Brain Imaging Findings, Children, South-West Nigeria, Seizures, Headaches, Meningitis, Infarct, Cerebral Atrophy.

INTRODUCTION

The paediatric age groups are peculiar in the sense that their body tissues are in the process of growing and multiplying. This makes them very susceptible to small changes in the normal environmental factors such as temperature and pressure (CHQ-NSS-51033, 2024). The rapidly growing and multiplying cells in particular are susceptible to damage by ionizing radiation (Sadetzki S, 2009) that affect their DNA and other vital components of the cells, resulting in cell death or gene mutations. These abnormal cells have enough time to develop into cancerous tissues as the children grow into older ages. This is the reason radiologists prefer to use non-ionizing sources of energy and imaging modalities in the investigation of the growing child.

Magnetic resonance imaging (MRI) is a prime modality in the investigation of children as it is devoid of ionizing radiation (Bhargava *et al.*, 2013). It is also excellent in the details it provides for normal or variant anatomy and soft tissue assessment for injuries and disease (Anwar et al., 2022; Bhargava et al., 2013; Gallo-Bernal et al., 2023). The major setbacks of MRI are: the cost, the long time it takes to acquire images and the need to sedate babies and younger children for the examination period (Anwar et al., 2022; Gallo-Bernal et al., 2023;). Some of the older children that may not

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require sedation, may have issues with staying alone in the large space (claustrophobia) for the long period the examination requires and the noise produced by the equipment. Nonetheless, several hardware (high field strength magnets, multichannel phased-array coils) and software (fast imaging sequences, parallel image processing, e.t.c) strategies abound that reduce scan time and thereby improve image quality in children MRI examinations (Gallo-Bernal *et al*., 2023), and also reduce the need for sedation even in infants and young children (Anwar et al., 2022; Harrington et al., 2022).

Several research workers have reported the benefits of MRI in children and the best ways to adapt the available resources for the maximal use for imaging the different peadiatric conditions (Cherryman, 1994; Harrington et al., 2022). The few previous researchers in Nigeria have documented their findings on MRI in children with seizures (Akinmoladun *et al.,* 2020*;* Suleiman *et al*., 2025), other brain diseases and clinical scenarios (Owojuyigbe *et al.,* 2017, Samson *et al*., 2024). However, the larger number of the equipment used were of low magnetic strength (0.2T, 0.36T). This research was done on children examined with a high magnetic field (1.5T MRI) equipment.

The MRI findings in children in Africa, in their majority, have focused on specific disease conditions such as seizure/epilepsy (Akinmoladun *et al,* 2020*;* Denise *et al*., 2022; Dzefi-Tettey *et al*., 2022; Samia *et al.,* 2021; Suleiman *et al*, 2025;), cerebral malaria (Potchen *et al*., 2012; Yadav *et al.,* 2009), cerebral palsy (Nel *et al*., 2022) and HIE (Lorentz *et al.,* 2023). The various authors have found a wide range of brain lesions on MRI with prevalences up to 74% depending on patient selection procedure and the magnetic field of the equipment used. Akinmoladun *et al.,* (2020) in Ibadan, in a retrospective study of children previously examined using a low field equipment (0.35 Tesla), found MRI abnormalities prevalence of 63.4% among 134 children examined for seizures, most of whom were adolescents and males. The major abnormalities they found in the brain were intracranial tumours, among adolescents and hydrocephalus, among the younger children. On the other hand, Suleiman *et al.,* (2025) in a more recent prospective study in Zaria, Northern Nigeria, found MRI abnormalities in 37.6% of 93 children with seizures, using a 1.5 Tesla equipment. The abnormalities were most common among the 1 – 5 years age group. The commonest abnormal findings were cerebral atrophy and cerebral infarcts. Workers in Ile-Ife, South-West Nigeria (Owojuyigbe *et al.,* 2017), focusing on smaller children who needed sedation for their MRI examination found hydrocephalus as their major abnormality. Another study (Samson *et al.,* 2024) done in some tertiary hospitals in the South-South part of Nigeria, revealed epilepsy to be the commonest indication for MRI in children and a range of abnormalities including hydrocephalus, meningitis, space occupying intracranial lesions, including cerebellar tumours and cerebral infarct were found among others.

In Ghana, West Africa, Dzeffi-Tettey *et al*., (2022) and fellow workers analyzed the Picture Archiving and Communication Systems (PACS) records of one hundred and one (191) children with seizures examined over a period of three years and eight months earlier. They found a prevalence of abnormal MRI features of 46.6%. The major abnormal findings were cerebral atrophy, white matter hyperintensities and temporal lobe atrophy.

Apolot *et al.,* (2022) in Uganda found a prevalence of structural abnormalities of up to 74.15% among 147 children with epilepsy, using high magnetic field (1.5 Tesla) MRI. The commonest findings in their study were hippocampal sclerosis, congenital malformations like heterotopia, lissencephaly and others. They however discovered that prior positive electroencephalography (EEG) was significantly positively correlated with such findings among their participants. The commonest age group with abnormal findings in their cohort was the 1 – 4 years. Samia *et al.,* (2021), and her colleagues in Kenya, reviewed the records of 288 children with epilepsy examined with either 1.5Tesla or 3Tesla MRI over a period of six and a half years and found a prevalence of imaging abnormalities of 33% among them. The commonest abnormalities were encephalomalacia due to chronic infarcts, cerebral atrophy and disorders of neuronal migration such as focal cortical dysplasia, pachygyria, lissencephaly and subcortical heterotopia.

Abnormal MRI findings in children with cerebral malaria were found more commonly in the group of children with malaria retinopathy than in the group without retinopathy (Potchen *et al*., 2012). Such findings included moderate or severe increased cerebral volume associated with loss of sulcal markings, uncal herniation and cisternal effacement. Their other findings included abnormal T2 hyperintensities in the basal ganglia and the thalami, cerebral cortical thickening and T2 hyperintensities that do not follow any particular arterial vascular distribution among a number of other abnormalities.

In children with cerebral palsy, more commonly the spastic type, the most common MRI abnormality found was predominant grey matter injury (Nel *et al*., 2022). However, in another retrospective study of a cohort of 137 children with clinically suspected HIE, but of whom only 128 had their MRI images available for review, abnormal findings were found in 42.2%. The commonest MRI abnormalities discovered were punctate or diffuse periventricular white matter hyperintensities; the punctate pattern being more common among children born preterm, ventriculomegaly, hippocampal volume loss among others (Lorentz *et al.,* 2023).

Interestingly, even in normal children, a number of incidental abnormal findings are possible, as documented by Potchen *et al.*, (2013), who found sinusitis most commonly (in up to about 30% of the kids) with periventricular white matter changes, some mild diffuse brain atrophy, empty sella among others.

MATERIALS AND METHODS

The study was a retrospective, descriptive, cross-sectional study. All available clinical indications and the brain MRI data for the age group 0 – 17 years within the period January 2024 were included while those with incomplete data were excluded.

The images used were acquired using a 1.5 Tesla General Electric machine. The MRI results found in the records of the department of Radiology for all the children included in the study were collected using a Microsoft Excel form designed for the purpose and the data was analyzed using IBM SPSS Statistics version 26. The MRI images for the children in the radiology computer archives (especially those reported as having abnormalities were reviewed by at least 2 specialist radiologists, in line with the standard reporting templates used in our department.

The standard protocols used for the examination of the brain in children includes axial and sagittal T1, axial and sagittal T2, axial T2 Fluid Attenuated Inverse Recovery (FLAIR), axial Diffusion Weighted Imaging (DWI) with the corresponding Apparent Diffusion Coefficient (ADC) maps, Susceptibility Weighted Angiography (SWAN) and axial T1 post-contrast imaging for tumours. When there's seizure disorder or epilepsy, coronal oblique IRFSE, coronal T2 oblique and sagittal CUBE T1 are included.

Approval for this study was obtained from the Babcock University Health Research Ethics Committee (BUHREC 100/26NB/174)

RESULTS AND DISCUSSION

Results

A total of one hundred and six (106) children were examined, comprising fifty-nine (59) males and forty-seven (47) females, giving a male to female ration of 1:1.26. Figure 1 is a pie chart showing the sex distribution of the participants.

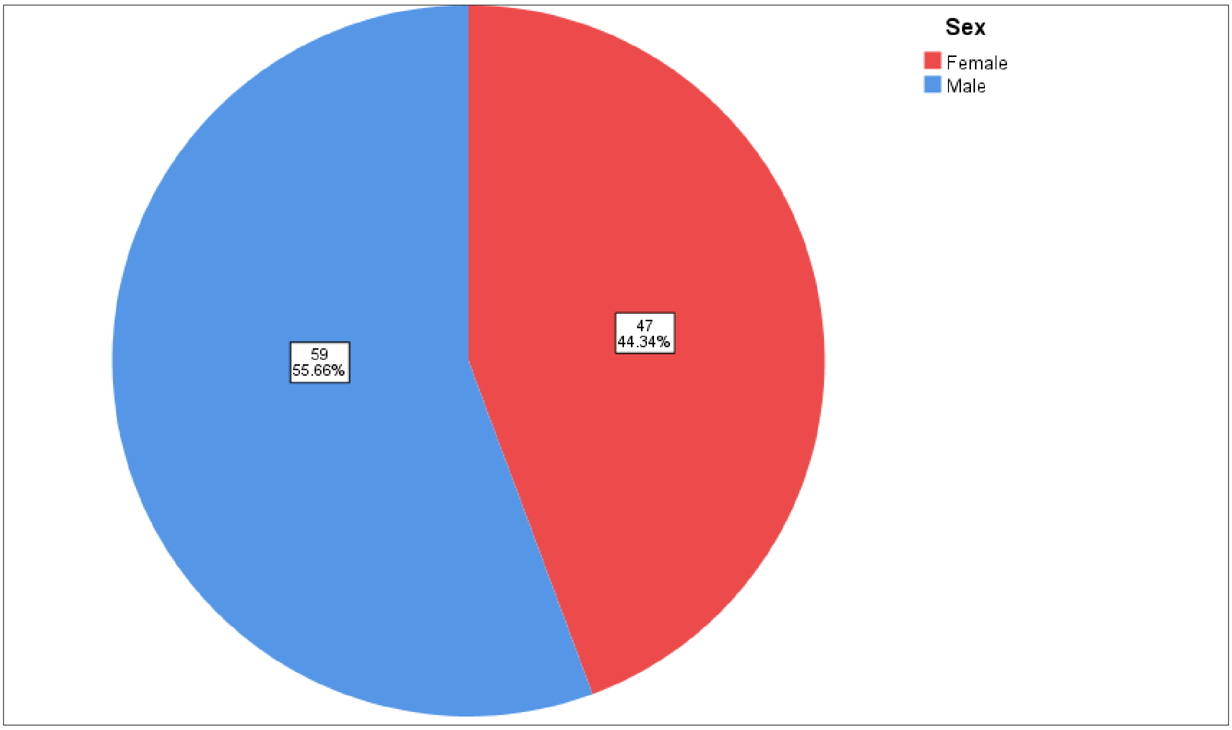

Figure 1: Sex distribution of the children who had brain MRI

The age distribution is displayed on figure 2. The majority of the children were 6 years and above, with the modal age group being 13-17 years, where there were 47 (44.24%) participants.

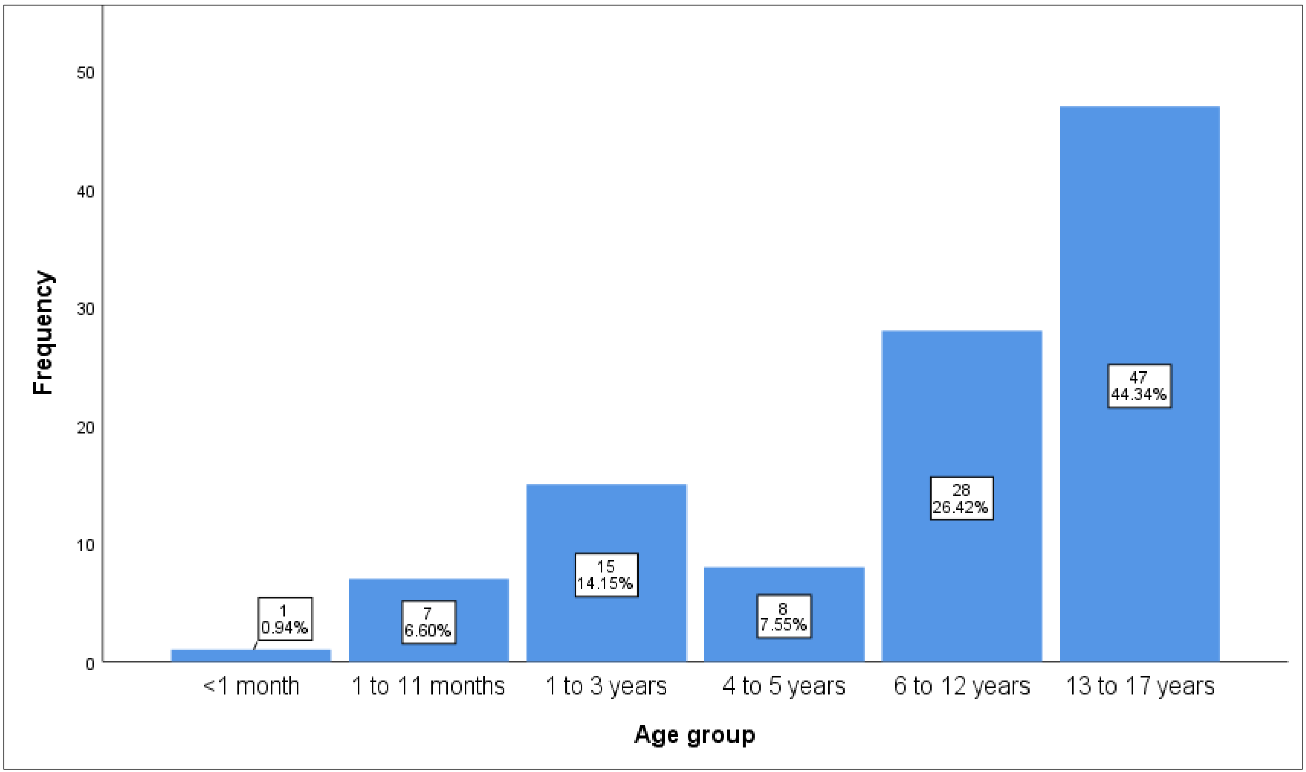

Figure 2: Age distribution of children who had brain MRI

The commonest indications were seizures (34.9%), headaches (13.2%), meningitis (5.7%), traumatic brain injury (3.8%), abnormal jerky movements (3.8%) and hemiparesis (3.8%). Table 1 shows the complete spectrum of the indications.

Table 1: Pattern of indications for Brain MRI in the participants

Indication	Frequency (N = 31)	Percentage
Seizures	37	34.9
Headache	14	13.2
Meningitis	6	5.7
Traumatic Brain Injury	4	3.8
Abnormal jerky movement	4	3.8
Hemiparesis	4	3.8
Cerebral palsy	3	2.8
Hydrocephalus	3	2.8
?Space occupying lesion	2	1.9
Dysarthria	1	0.9
Relapsing multiple sclerosis	1	0.9
Neurofibromatosis 1	1	0.9
Nipple discharge	1	0.9
Asperger syndrome	1	0.9
Spinocerebellar ataxia	1	0.9
Fever	1	0.9
Cough	1	0.9
Quadriplegia	1	0.9
Confusion	1	0.9
Bilirubin induced neurological deficit	1	0.9
Macrocephaly	1	0.9
Dystonia	1	0.9
Intermediate TCD findings	1	0.9
Compressive optic neuropathy	1	0.9
Congenital frontal head swelling	1	0.9
Frontal swelling suggestive of abscess	1	0.9

Indication	Frequency (N = 31)	Percentage
Brain abscess diagnosed on CT	1	0.9
Visual loss	1	0.9
Motor ticks	1	0.9
Sudden LOC	1	0.9
Markedly elevated pituitary hormone	1	0.9
Bilateral optic atrophy	1	0.9
Developmental delay	1	0.9
Deafness	1	0.9
Cavernous sinus thrombosis	1	0.9
Visual blurring	1	0.9
Bilateral lower limb weakness	1	0.9
Sub-occipital encephalocele	1	0.9

N = total number

Among the one hundred and six (106) participants, thirty-six (34.0%) had normal findings while seventy (66.0%) had abnormalities. The commonest abnormalities found in the brain were infarcts (9.4%), general cerebral atrophy (4.7%), gliosis (3.8%), encephalitis (3.8%), meningitis (3.8%), HIE (2.8%), subdural empyema (2.8%) and focal cortical dysplasia (2.8%). These are shown on Table 2.

Table 2: Pattern of major diagnosis in brain MRI among participants

Major Diagnosis (Total number = 106)	Frequency	Percentage
Normal	36	34.0
Infarct	10	9.4
General cerebral atrophy	5	4.7
Gliosis	4	3.8
Encephalitis	4	3.8
Meningitis	4	3.8
Hypoxic ischaemic encephalopathy	3	2.8
Subdural empyema	3	2.8
Focal cortical dysplasia	3	2.8
Polymicrogyria	2	1.9
Aqueductal stenosis	2	1.9
Contusional hermorrhage	2	1.9
Brainstem glioma	2	1.9
Mesial temporal sclerosis	2	1.9
Pituitary microadenoma	2	1.9
Dandy-Walker malformation	1	.9
Macrocephaly	1	.9
Colloid plexus papilloma	1	.9
Hemimegaencephaly	1	.9
Orbital meningioma	1	.9
Metopic craniosynostosis	1	.9
Pilocytic astrocytoma	1	.9
Acute disseminated encephalomyelitis (ADEM)	1	.9
Asymmetric lateral ventricles	1	.9
Choroid plexus xanthogranuloma	1	.9
Tumefactive demyelinating lesion	1	.9
Cystic glioblastoma	1	.9
Dysembryoblastic neuroepithelial tumour	1	.9
Subdural hygroma	1	.9
Arachnoid cyst	1	.9
Corpus callosal dysgenesis	1	.9
Epidermoid cyst	1	.9
Cystic encephalomalacia	1	.9
Cavernous sinus thrombosis	1	.9
Colloid cyst	1	.9
Hypertrophic pachymeningitis	1	.9
Meningocele	1	.9

The abnormalities were found more frequently among the children in the school age (6 – 12 years) and the adolescents (13 – 17 years). These are depicted on Table 3 with a summary shown on Figure 3.

Table 3: Pattern of major diagnosis in brain MRI among participants with respect to age

Major Diagnosis (N = 106)	Age group											
	<1 month		1 to 11 month		1 to 3 years		4 to 5 yrs		6 to 12 yrs		13 to 17 yrs	
	n	%	n	%	n	%	n	%	n	%	n	%
Normal	1	50.00	1	11.11	3	20.00	1	8.33	9	29.03	21	29.87
Infarct	0	0.00	2	22.22	2	13.33	1	8.33	3	9.68	2	2.60
Polymicrogyria	1	50.0	0	0.00	1	6.67	0	0.00	0	0.00	0	0.00
Gliosis	0	0.00	2	22.22	0	0.00	1	8.33	0	0.00	1	1.30
Aqueductal stenosis	0	0.00	1	11.11	0	0.00	1	8.33	0	0.00	0	0.00
Dandy-Walker malformation	0	0.00	0	0.00	1	6.67	0	0.00	0	0.00	0	0.00
Contusional hermorrhage	0	0.00	0	0.00	1	6.67	0	0.00	1	3.23	0	0.00
Encephalitis	0	0.00	0	0.00	3	20.00	0	0.00	0	0.00	1	1.30
Macrocephaly	0	0.00	0	0.00	1	6.6	0	0.00	0	0.00	0	0.00
Hypoxic ischaemic encephalopathy	0	0.00	0	0.00	2	13.33	1	8.33	0	0.00	0	0.00
Colloid plexus papilloma	0	0.00	0	0.00	1	6.67	0	0.00	0	0.00	0	0.00
Meningitis	0	0.00	0	0.00	0	0.00	1	8.33	2	6.45	1	1.30
Hemimegaencephaly	0	0.00	0	0.00	0	0.00	1	8.33	0	0.00	0	0.00
General cerebral atrophy	0	0.00	0	0.00	0	0.00	1	8.33	3	9.68	1	1.30
Brainstem glioma	0	0.00	0	0.00	0	0.00	0	0.00	2	6.45	0	0.00
Orbital meningioma	0	0.00	0	0.00	0	0.00	0	0.00	1	3.23	0	0.00
Metopic craniosynostosis	0	0.00	0	0.00	0	0.00	0	0.00	1	3.23	0	0.00
Subdural empyema	0	0.00	0	0.00	0	0.00	0	0.00	2	6.45	1	1.30
Mesial temporal sclerosis	0	0.00	0	0.00	0	0.0	0	0.00	1	3.23	1	1.30
Pilocytic astrocytoma	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.30
Acute disseminated encephalomyelitis (ADEM)	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.30
Asymmetric lateral ventricles	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.30
Choroid plexus xanthogranuloma	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.30
Pituitary microadenoma	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	2.60
Tumefactive demyelinating lesion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.30
Cystic glioblastoma	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.30
Focal cortical dysplasia	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	3	3.90
Dysembryoblastic neuroepithelial tumour	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.30
Subdural hygroma	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.30
Arachnoid cyst	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.30
Corpus callosal dysgenesis	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.30
Epidermoid cyst	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.30
Cystic encephalomalacia	0	0.00	0	0.00	0	0.00	0	0.00	1	3.23	0	0.00
Cavernous sinus thrombosis	0	0.00	0	0.00	0	0.00	0	0.00	1	3.23	0	0.00
Colloid cyst	0	0.00	0	0.00	0	0.00	0	0.00	1	3.23	0	0.00
Hypertrophic pachymeningitis	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.30
Meningocele	0	0.00	1	11.11	0	0.00	0	0.00	0	0.00	0	0.00

N = total number; n = frequency; % = Percentage

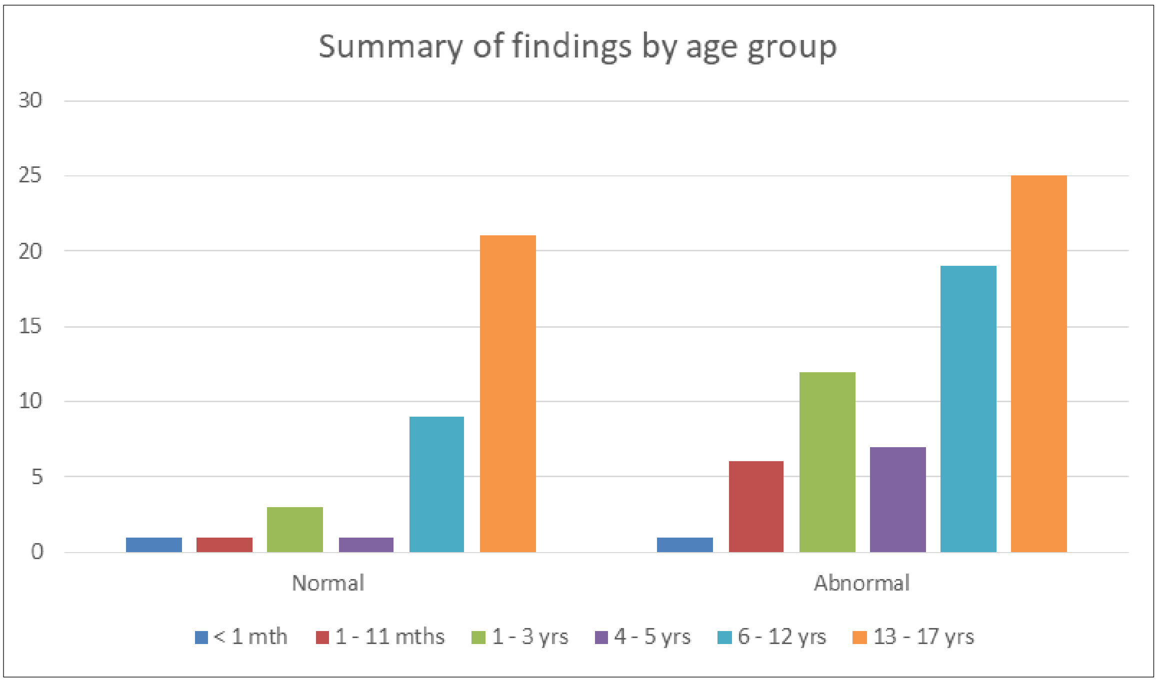

Figure 3: A bar chat showing the summary of the findings according to the age groups

DISCUSSION

The majority of the children in this study were males (59 = 55.56%). This is similar to the finding by Samson *et al.,* (2024) who had 73 (60.83%) males out of 120 children and Akinmoladun *et al.,* (2020) who found 81 (60.40%) among 134 children with seizure disorders. They also reported other workers who studied MRI findings in children with seizures that found more males among their participants (Amirsalari *et al.,* 2012; Anand *et al*., 2017 and Ndubuisi *et al.,* 2016, in Akinmoladun *et al*., 2020), one that found a female preponderance (Kim *et al*., 1992 in Akinmoladun *et al*., 2020) and some others that reported no sex differences (Aaberg *et al*, 2017; Kalnin *et al*., 2008 and Mungdala-odeara *et al*., 2008, in Akinmoladun *et al*., 2020). In their study among children examined with MRI for suspected HIE, Lorentz *et al.,* (2023) reported more males (63%) of the 137 children evaluated, while Nel *et al.,* (2022) found a male majority of 60.7% among the children who had MRI for evaluation of cerebral palsy. There were also more males among the children with cerebral malaria examined by Potschen *et al*., (2012), especially among the larger group with retinopathy. It may be difficult to explain the male preponderance in our study, but the sociocultural considerations in our settings often pay more attention to ensuring the survival male children compared to females.

The larger number of our participants were in the school age (6 – 12 years) and the adolescents age (13 – 17 years). This is similar to the finding by Akinmoladun *et al.,* (2020), Ndubuisi *et al.,* (2016) and Kim et al (1992) among patients with seizures. On the other hand, the major age group findings by others workers tend to be in line with the ages in which the conditions being studied occur more commonly. In line with this pattern, Lorentz *et al.,* (2023) had their participants with a mean age of 15 months (age range of 22 days-12 years) among children with HIE, Nel *et al*., (2022) had more than 50% between 2 and 5 years of age among children examined for cerebral palsy.

The most common indications for MRI examination in children among our participants were seizures (34.9%), headaches (13.2%) and meningitis (5.7%). This is in agreement with Samson *et al.,* (2022) who found epilepsy (23.35%) as the commonest MRI indication in their study cohort in South-South region of Nigeria and Akoda *et al*., (2022) who found seizure disorders in 37.7% of the neurological disorders seen in the peadiatric neurology clinic of their tertiary facility in South-West Nigeria. The same study noted central nervous system infection with complication in 6.2%, similar to our finding of meningitis in 5.7%. Mohammed *et al*., (2016) found a higher percentage (52.8%) of the children attending their neurology clinic in Sudan having epilepsy. The acuteness with the dramatic nature of seizure episodes may explain why such children are likely to be brought to hospital for investigation, even where financial constraints are present. Another explanation could be the increased awareness, through health education in pediatric neurology clinics, among the populace that seizures are not caused by spiritual forces, but are caused by diseases that can be treated with medicines and not just prayers or sacrifices to gods. (Akoda *et al*., 2022).

The spectrum of MRI abnormalities in this study is broad because it is not limited to a particular disease condition, but all patients with diverse complaints that had brain examination were included in the study. The commonest abnormalities found in the brain among our participants were infarcts (10/70 = 9.4%) and general cerebral atrophy (5/70 = 4.7%), This is in alignment with the findings by Suleiman *et al* (2025) in Zaria, Nigeria who found cerebral atrophy and cerebral infarcts as most common among children with non-febrile seizures, and Samia *et al.,* (2021) in Kenya whose commonest findings in children with epilepsy were encephalomalacia from chronic infarcts and cerebral atrophy. Dzeffey-Tettey *et al.,* in their work in Ghana among children with seizures also found cerebral atrophy as the commonest MRI abnormality. In contrast, the commonest findings by Akinmoladun *et al.,* (2020) in Ibadan, and Owojuyigbe *et al.,* in Ile-Ife, both in South Western Nigeria were hydrocephalus and brain tumours, although a good number of their other findings were similar to ours. For example, the group of abnormal findings that are connected to infections like encephalitis, meningitis and subdural empyema together form up to 11/70 (10.4%) of our findings. This is similar to what were reported by Samson *et al.,* (2022) with encephalitis and meningitis forming 16.6% while Akinmoladun *et al.,* (2020) had encephalitis and brain abscess of about 11.8%. Infections remain a health challenge to children in our environment.

The group of abnormal findings that are better demonstrated on higher magnetic field equipment (1.5 Tesla and above) were found in some of our patients: focal cortical dysplasia, mesial temporal sclerosis, polymicrogyria, combined were 7/70 (10.0%) of the total abnormal findings. These findings were either absent or very scanty among the findings by the studies done using low field MRI. This confirms the advantage of the high magnetic field MRI equipment over the low field equipment, as noted by previous authors.

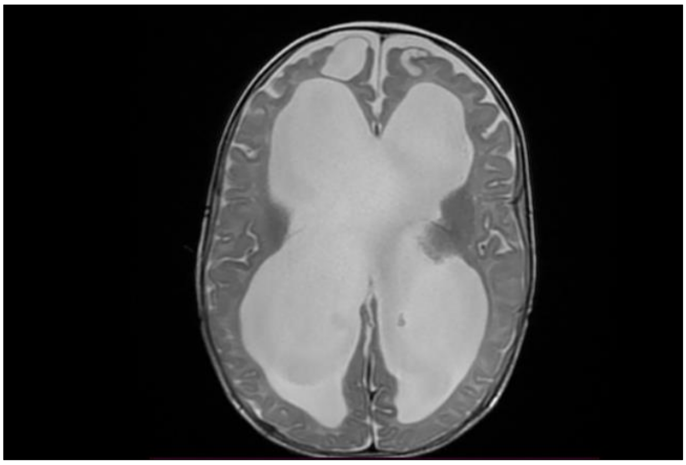

Figure 4a: Four-month-old male. Indication – congenital hydrocephalus. Axial T2 image shows obstructive hydrocephalus

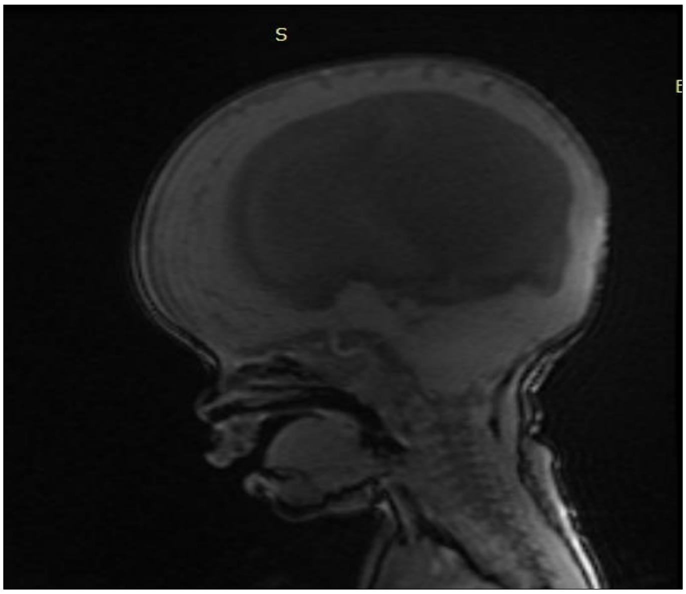

Figure 4b: sagittal image

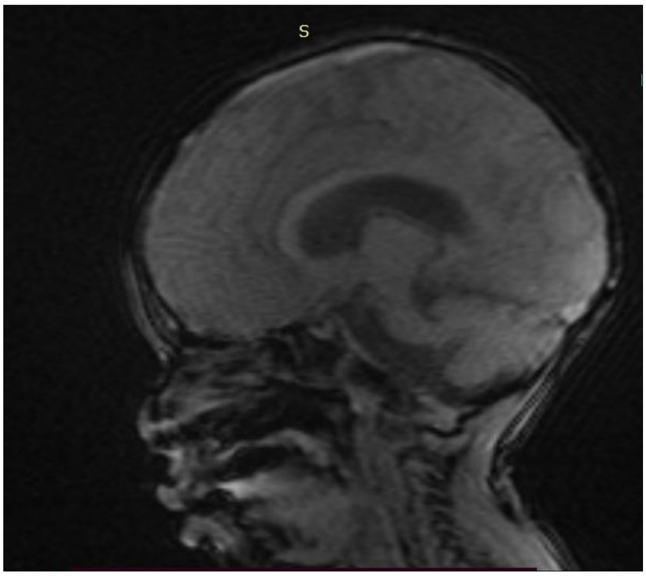

Figure 5a: 3 years. Male. Post-TOF repair seizures. Sagittal T1 – cerebral atrophy

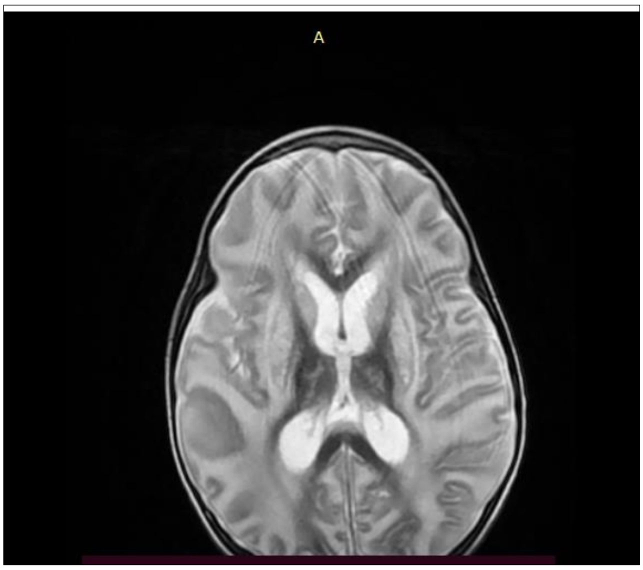

Figure 5b: axial T2 image

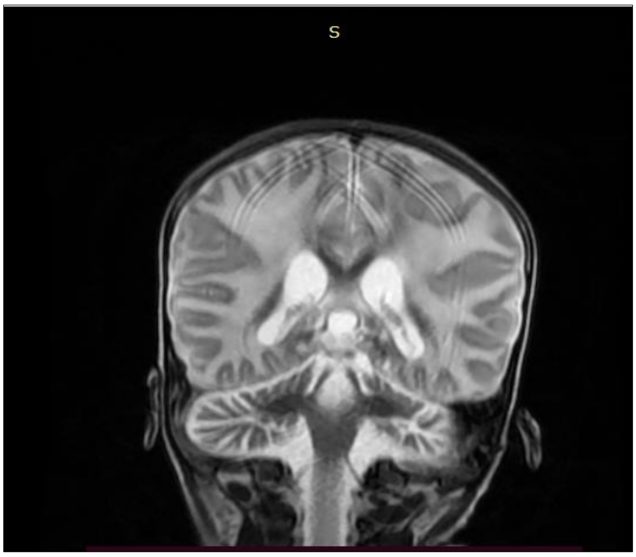

Figure 5c: coronal T2

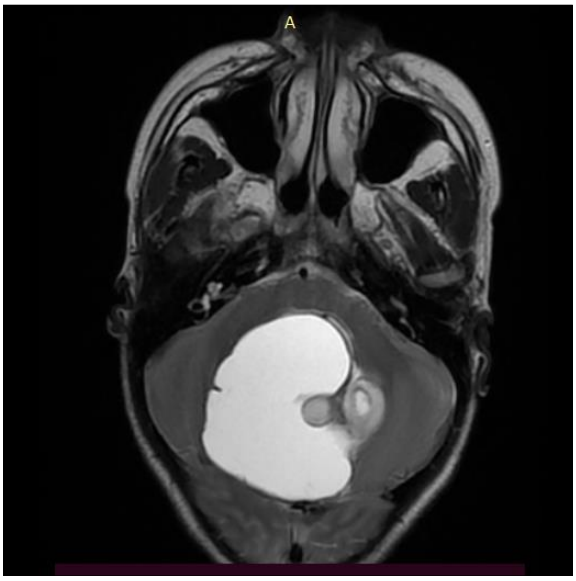

Figure 6a: 13 years. Male. Suspected space-occupying lesion. Axial T2 - Pilocystic astrocytoma

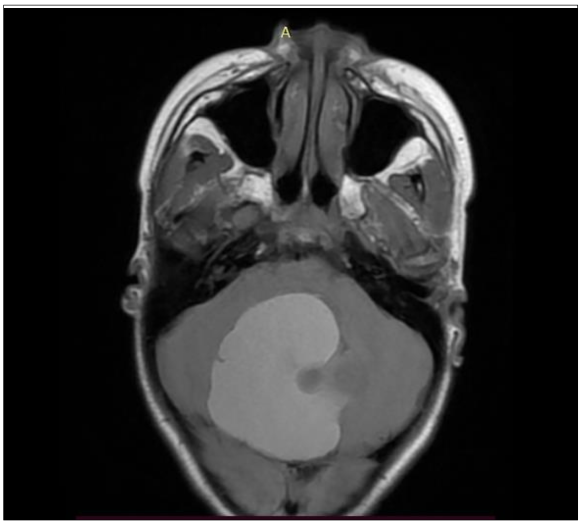

Figure 6b: Axial T1

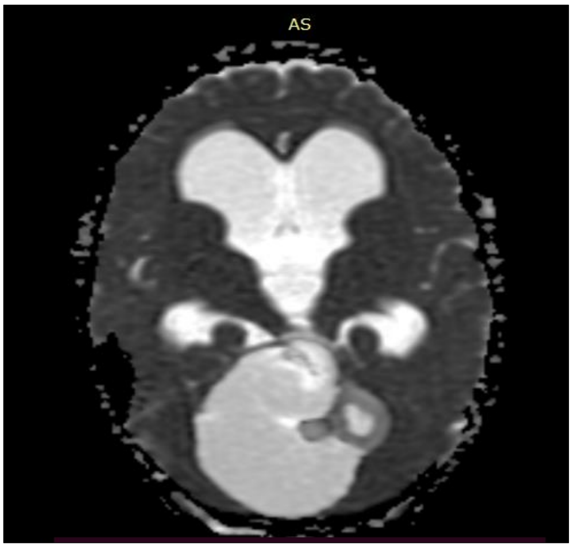

Figure 6c: ADC map

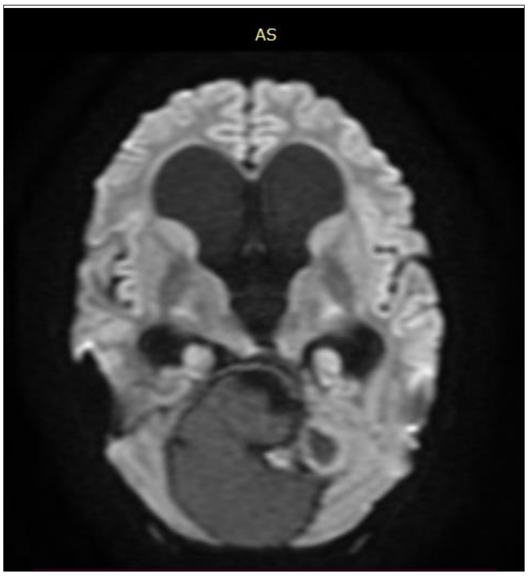

Figure 6d: Axial DWI

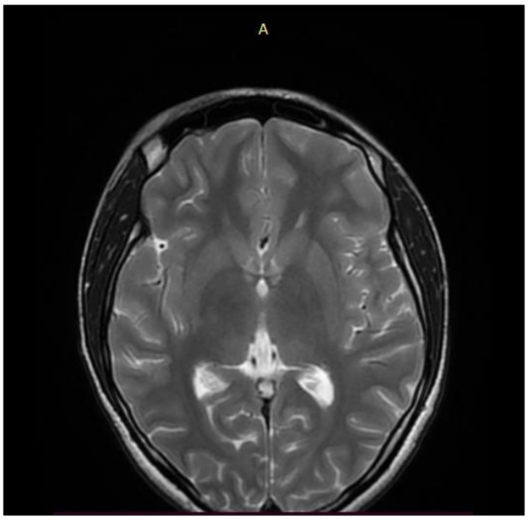

Figure 7a: 17 years old. Female. Indication – recurrent seizures. Axial T2 image – right frontal focal cortical dysplasia

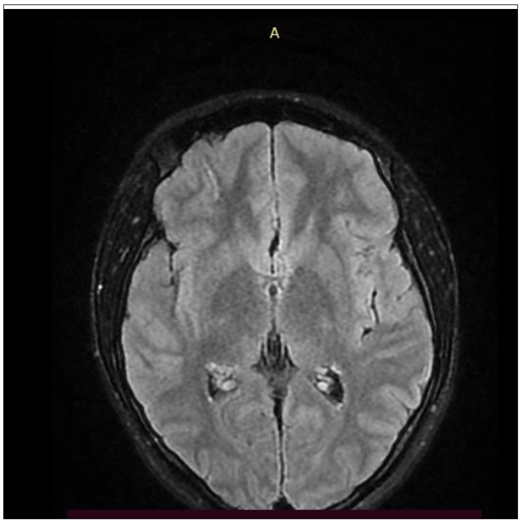

Figure 7b: axial T2 FLAIR image

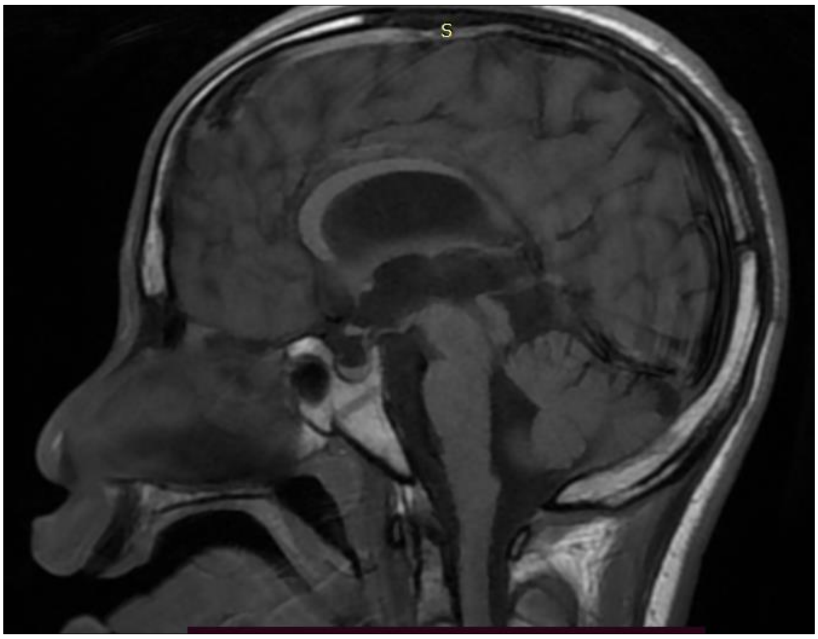

Figure 8: 17 years old. Male. Indication: seizure disorder. Sagittal T1 – corpus callosal dysgenesis

CONCLUSION

The findings in our study confirm the common abnormalities in the paediatric brain when examined with the MR equipment. The high-field MRI is shown to be superior to the low-field MRI in the evaluation of the peadiatric brain for subtle structural abnormalities. We recommend that high-field MRI should be the test of choice in the evaluation of the peadiatric brain.

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