



A COHORT STUDY OF MAGNETIC RESONANCE IMAGING SPECTRUM OF PAEDIATRIC BRAIN DISORDERS IN SELECTED TERTIARY HEALTHCARE FACILITIES IN SOUTH-SOUTH NIGERIA

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ABSTRACT

BACKGROUND: Globally, about 1.5 billion people suffer from brain disorders, which contribute to the highest number of the world's paediatric disease burden. Nigeria accounts for 7% of the global paediatric population of brain disorder-induced disabilities. Magnetic Resonance Imaging (MRI) is the recommended modality for brain imaging. However, the lack of MRI data relevant to paediatric brain disorders in South-South Nigeria necessitated the present study, which sought to evaluate the MRI spectrum of paediatric brain disorders.

OBJECTIVES: To assess the most prevalent brain disorder in paediatrics, the most susceptible age group and the sex.

MATERIALS AND METHOD: A cohort of 120 paediatrics aged 0 to 18 years in selected three tertiary hospitals were sampled from January 2019 to January 2023. Brain disorders, age, sex, and MRI images were selected from the hospitals' archives. Microsoft Excel version 16.37 was used for data entry, while the Statistical Package for Social Science (SPSS) version 26.0 was used for statistical analysis. The significance level was set at $p < 0.05$.

RESULTS: A total of 73 males and 47 females were recruited in the study. Results showed epilepsy 28 (23.35%) as the highest disorder, others were hydrocephalus 20 (16.7%), meningitis and space-occupying lesions 16 (13.3%), cerebellar tumours, and cerebral infarcts 8 (6.7%). No significant difference in brain pathology between sex ($p = 0.988: > 0.05$) and no statistical association ($p = 0.075: > 0.05$) between the brain disorders and age groups was recorded.

CONCLUSION: The study highlights the importance of MRI in diagnosing a wide range of brain disorders. Epilepsy was recorded to be the most common paediatric brain disorder and there were no differences between brain disorders and sex or age groups.

KEYWORDS: Brain disorder; Magnetic Resonance Imaging; Neurology; Paediatrics.

INTRODUCTION

Globally, about 1.5 billion people suffer from brain disorders. Africa accounts for 20% of this number, making it the most significant cause of disability and the second-highest cause of mortality on the continent (Burton & Allen, 2023; Valery *et al.*, 2020; Moreau *et al.*, 2013; Frank-Briggs & Alikor, 2011).

Nigeria accounts for 7% of the global population of children living with disabilities, and neurological disorders contribute to the highest number of the world's disease burden in children, increasing the risk of premature death and disability (Valery *et al.*, 2020).

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Neurodevelopmental disorders such as epilepsy, schizophrenia, unipolar depression, bipolar disorder, mental retardation, cerebral palsy, and autism can have impact on a person's memory, sensation, motor and cognitive abilities, concentration, speech, personality, and physical appearance, with severe impact on social and psychological well-being (Carbonell *et al.*, 2020; Manton, 1988). Risk factors for these neurological disorders include genetic diseases, neurotoxins, hypoxia, infections and injuries, vascular, traumatic, environmental toxins and exposures, nutritional, immunological, inflammatory, metabolic, endocrine, and oncological (Akodu *et al.*, 2022). These disorders in children can hamper their developmental trajectory and often last into adulthood, necessitating substantial additional support from families, health facilities, and educational systems.

The diagnosis and management of brain disorders in paediatrics pose distinct difficulties and complications because of the dynamic nature of childhood development, age-related variations in symptoms, and the child's inability to express their emotions or the reasons behind their behaviour. Given that over 70% of individuals globally do not currently have access to mental healthcare services, the inability to obtain timely mental healthcare could be a contributing factor (Chand *et al.*, 2023; Wainberg *et al.*, 2017). This challenge is particularly acute in low-to-middle-income countries because of the limited funding set aside expressly for mental health services. Parental worries about the stigma attached to mental illness in Nigeria continue to be a deterrent since it leads to social marginalisation and delays in receiving treatment (Gil-Rivas *et al.*, 2019; Erskine *et al.*, 2015; Adler Nevo *et al.*, 2014).

Electroencephalography, magnetoencephalography, genetic testing, neuropsychological studies, and clinical neurological examinations have been used to diagnose brain disorders. However, magnetic resonance imaging (MRI) plays a unique role in the diagnosis and treatment of brain disorders because it enables a non-invasive assessment of the brain's structure and function. Its high spatial resolution provides the detail required to identify minute lesions. Also, MRI is safer, especially for paediatric imaging, unlike modalities like computed tomography, which uses ionising radiation. Pathology unique to different tissue types including blood vessels particularly normal and or variants/patterns of cerebral arterial circle of Willis that supplies the brain (Paulinus *et al.*, 2023; Paulinus *et al.*, 2021; Igiri *et al.*, 2017; Paulinus *et al.*, 2017), white matter, grey matter, and cerebrospinal fluid, can also be evaluated using the MRI. Furthermore, advanced MRI techniques such as diffusion tensor imaging, diffusion-weighted imaging, spectroscopy, and functional MRI offer a variety of approaches to comprehending neural networks, brain pathways, and the bases of cognitive function.

There are both rural and urban groups among the inhabitants of South-South Nigeria. Therefore, significant variations in the availability of healthcare services in this area may impact the early detection and treatment of neurological illnesses. In the year 2021, the Nigeria Malaria Indicator Survey (Sokunbi *et al.*, 2022) showed an increase in meningitis and malaria cases, which may cause neurological symptoms in children. The confluence of various infectious diseases in this region may give rise to a distinct spectrum of neurological disorders. Previously, the most prevalent neurological problems in children under the age of seven were reported to be migraine, febrile convulsions, epilepsy, peripheral neuropathy, and myelopathy (Longe & Osuntokun, 1989) but recently, epilepsy was the most prevalent neurological condition in Enugu, South-East Nigeria (Ezeala-Adikaibe *et al.*, 2012). However, there is a lack of epidemiological and imaging data relevant to paediatric neurological disorders using modern imaging modalities like the MRI in South-South Nigeria. This paucity gives limited insights to the prevalence of neurological disorders in children. The data obtained from this study will guide treatment options, increase positive outcomes, and inform healthcare resource allocation and planning. Therefore, our study aimed to evaluate the MRI spectrum of paediatric brain disorders in the study location.

MATERIALS AND METHOD

Study design

With the use of Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for retrospective studies, patient data and MRI images of paediatrics who presented with symptoms of brain disorders and were referred for brain MRI at the Ibom Specialist Hospital (ISH) Uyo, Akwa Ibom State, Asi Ukpo Memorial Hospital (AMH) Calabar, Cross River State, and the University of Port Harcourt Teaching Hospital (UPTH) Rivers State, all in the South-South region of Nigeria, were sourced and selected from the image retrieval and archival unit of the aforementioned healthcare facilities.

Ethical approval

Ethical approval was obtained in accordance with institutional guidelines and principles, following permission and clearance (UC/ECRA/22/009). All patients' data were treated with a high level of confidentiality and privacy in line with research ethics.

Study population

A total of 120 paediatric subjects aged 0 to 18 years with queried brain disorders referred for brain MRI scans between January 2019 and January 2023 were included in the study.

In contrast, paediatric subjects with brain haemorrhage, tumour, known contrast allergy, history of brain surgery, and/or radiotherapy of the head and neck, those with queried neurological, psychiatric, or developmental disorders, and those less than 1 year and more than 18 years were excluded from the study.

Data collection

Data obtained included the patient age, sex, MRI images and provisional diagnosis (clinical indications)

from the hospital record. The radiologist's final diagnosis was obtained from the patient's folder.

Data analysis

Microsoft Excel version 16.37 (Microsoft Corporation, Redmond, WA, USA) was used for data entry. Statistical Package for Social Science (SPSS) Inc., Chicago, IL, USA, version 26.0, was used to evaluate the difference in brain disorders between sex and age groups. The level of significance was set at $p < 0.05$.

RESULTS

Table 1: The frequency distribution of brain disorders noted in the study

Pathology	Frequency	Percent (%)
Autism spectral disorder	8	6.7
Cerebellar tumour	8	6.7
Cerebral infarct	8	6.7
Encephalitis	4	3.3
Encephalomalacia	8	6.7
Epilepsy	28	23.3
Hydrocephalus	20	16.7
Meningitis	16	13.3
Space occupying lesions	16	13.3
speech impairment	4	3.3
Total	120	100.0

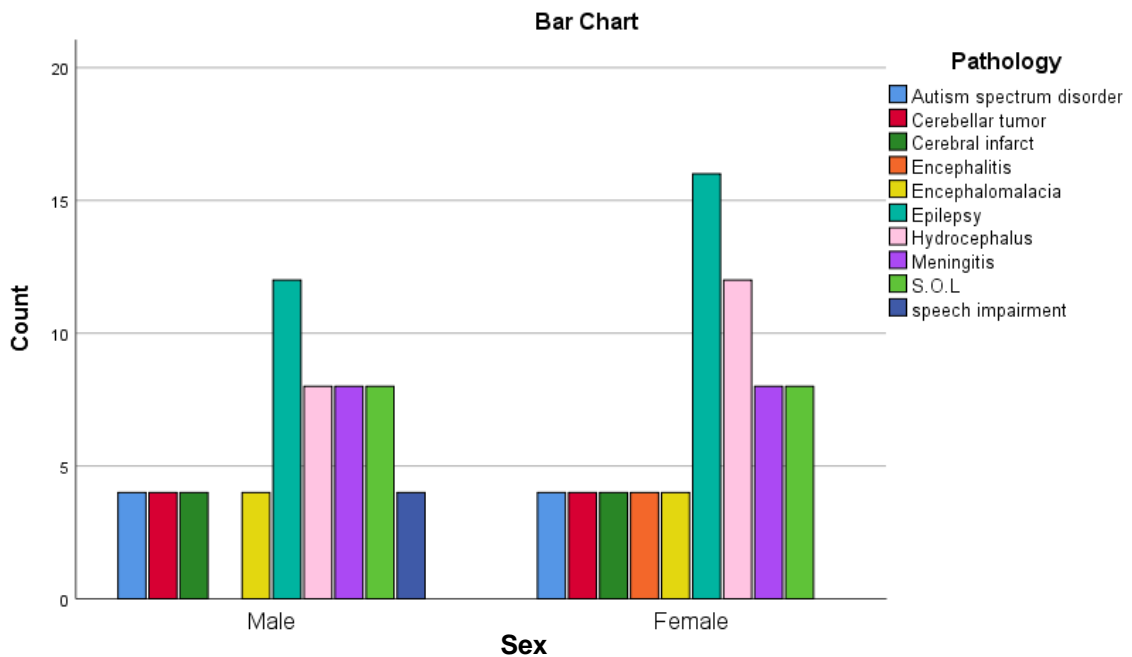


Figure 1: Sex distribution of brain disorders in the study
 Chi-square test: $X^2 = 2.219$, $p = 0.988$

A total of 120 (73 males and 47 females) were included in the study. The demographic characteristics of the cases showed epilepsy 28 (23.35%) as the highest disorder, hydrocephalus 20 (16.7%), meningitis 16 (13.3%), space-occupying lesions 16 (13.3%), cerebellar tumour, cerebral infarct, and encephalitis, all with the same figure of 8 (6.7%). Other presenting pathologies are documented in Table 1. Figure 1 shows the distribution of brain

pathologies between males and females. Epilepsy was also the most common pathology noted in both sex (16 in females and 12 in males). Overall, the result showed comparable associations between males and females with no significant difference in brain pathology between males and females ($X^2 = 2.219$, $p = 0.988$; > 0.05) from the chi-square test of association with clustered bars (Figure 1).

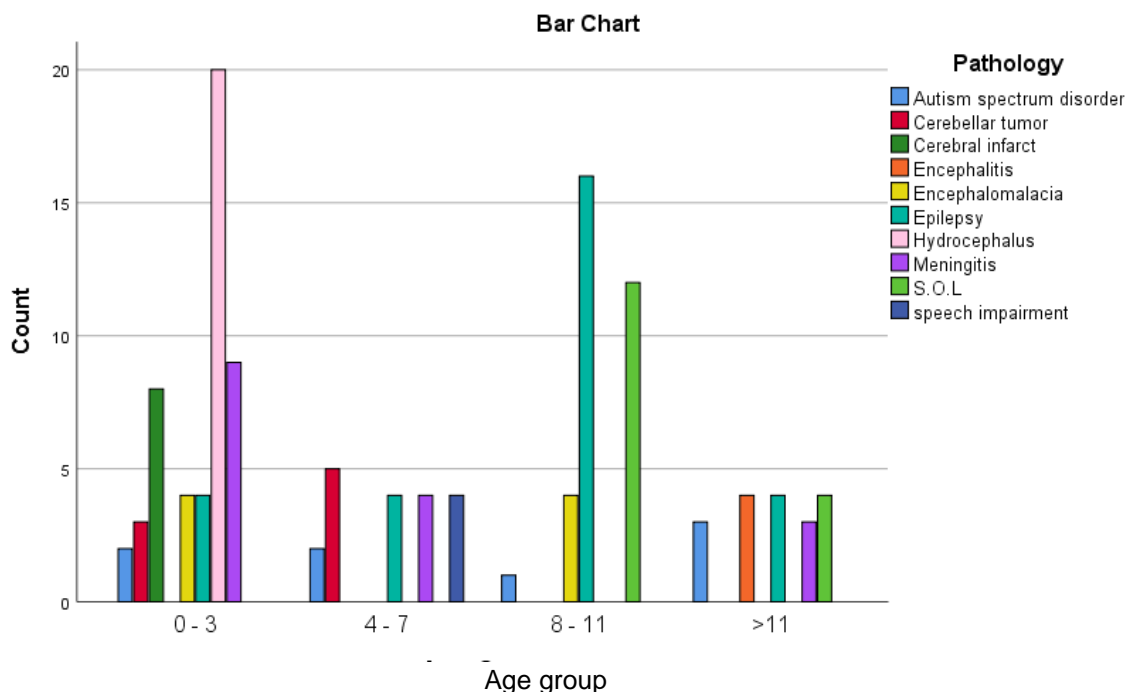


Figure 2: Age group distribution of brain disorder obtained in the study
Chi-square test: $X^2 = 38.190$; $p = 0.075$

Figure 2 shows the distribution of the brain pathology obtained between different age groups. There was no statistical association noted between the pathologies

and the different age groups ($X^2 = 38.190$; $p = 0.075$; > 0.05) from the chi-square association test with clustered bars.

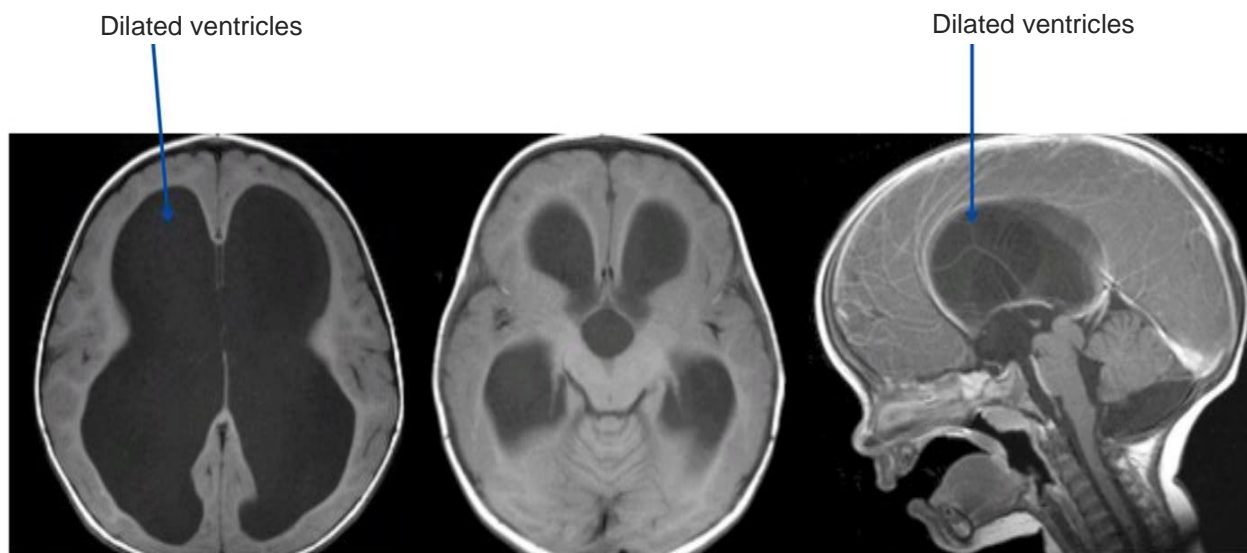


Figure 3: MRI Images of Hydrocephalus in one year old male subject obtained in the present study

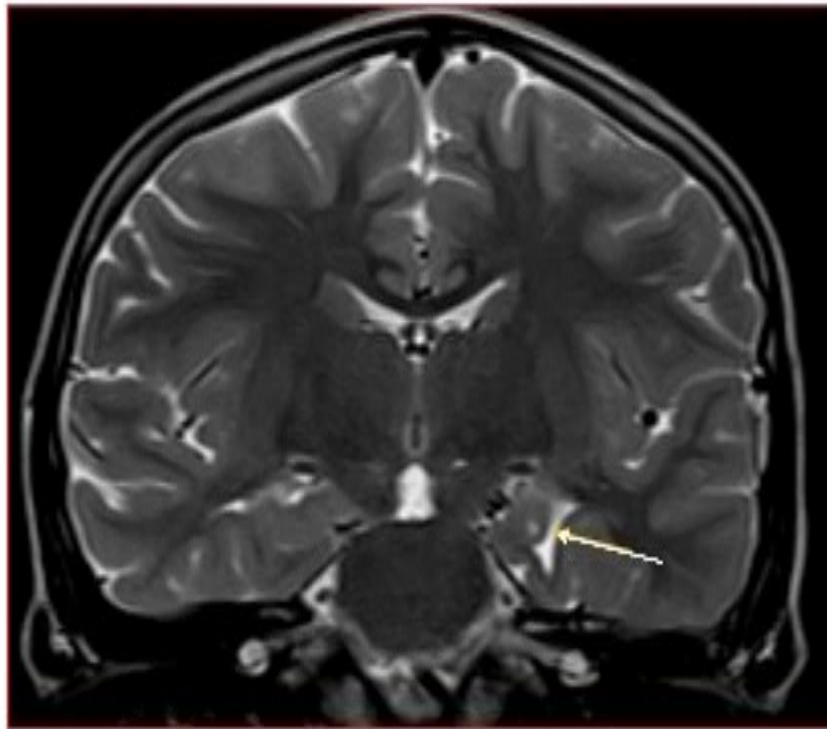


Figure 4: Coronal MRI T2 Image of a four-year-old presenting with focal seizures; arrow shows abnormal shaped left hippocampal head

DISCUSSION

Neurological disorders in paediatrics account for 20% of the global disease burden, which increases the likelihood of premature morbidity, disability, and infant mortality. Africa, where majority of these cases are found, has a higher prevalence of adverse prenatal conditions, regional transitions, and ethnic and regional wars. These variables result in malnutrition and exposure to environmental toxins, thereby increasing the risk of neurological disorders, especially in paediatrics (Valery *et al.*, 2020; Obi & Sykes, 1984). However, the dynamic nature of childhood development, the wide range of risk factors, and age-related variations in symptoms present unique challenges and complexity for diagnosing and treating these brain disorders in paediatric patients.

Therefore, the present study aimed to use MRI to evaluate the scope and prevalence of brain disorders in a cohort of paediatric population within selected tertiary healthcare facilities in south-south Nigeria. The population under investigation revealed a variety of neurological disorders (Table 1), which could be due to genetic diversity in the region, variation in socioeconomic status, disparity in healthcare infrastructure within the populations, and exposure to various environmental toxins. Hepatotoxic and haemotoxic oil spills from crude oil extraction in Nigeria's South-South region may have been linked to

brain tumours and infertility. Moreover, ascorbic acid in vegetables and food protein has been shown to decrease by 36% and 40%, respectively, as a result of oil spills. This results in a 60% annual decline in household food security, which in turn causes a 24% increase in childhood malnutrition which is a risk factor for neurological disorders (Aa *et al.*, 2022; Ordinioha & Brisibe, 2013). The present study reported epilepsy (23.35%) as the most prevalent condition (Table 1). This is consistent with studies that also reported epilepsy as the most prevalent neurological condition in South Africa, Sudan, and Uganda, respectively (Christianson *et al.*, 2000; Mohamed *et al.*, 2016). This incidence may be attributed to the fact that these developing nations have a high rate of endemic infections, including meningitis and malaria, that carry significant risks of neurological consequences that can lead to epilepsy (Sokunbi *et al.*, 2022; Erskine *et al.*, 2015). Genetic factors might also be involved because African Americans have been reported to be more susceptible to epilepsy (Hesdorffer & Begley, 2013). Additionally, the prevalence of epilepsy, which is a more visible condition with periodic seizures compared to others with less visible signs, may be due to the stigma associated with neurological disorders in the study area.

Therefore, rather than seeking medical attention, people may prefer to live with these other conditions and their covert symptoms.

There was no difference in the pattern of brain disorders noted in both sex, with epilepsy presenting as the most common brain condition in both male and female subjects (Figure 1). This suggests that risk factors were equally shared, indicating the need for a gender-neutral approach to the diagnosis, management, and therapy of epilepsy in the paediatric population of the study area. Our findings, however, contradict the conclusion that males were more likely to have epilepsy than females (Apolot *et al.*, 2022; Ba-Diop *et al.*, 2014). This discrepancy may result from social, regional, and genetic factors. In addition, our study revealed no statistical correlation between the study population's age groups and brain disorders (Figure 2). This implies that there is no concentration of these diverse brain disorders in infancy, childhood, or adolescence within the paediatric population, making it more difficult to predict and prevent these disorders in children based on age-related factors and possibly ineffective for age-related interventions. Hence, there is a need for a more comprehensive and holistic research approach to paediatric neurology.

CONCLUSION

The present study highlights the role of MRI in diagnosing a broad spectrum of brain disorders, with epilepsy reported to be the most common neurological disorder affecting the paediatric population. No comparable difference or statistical association was noted in brain disorders between sex and age groups, giving insight into the complexity and diversity of paediatric brain disorders.

CONFLICTS OF INTEREST: No conflicts of interest declared

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