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Etiology of Seizures in Children Aged 6 Months to 10 Years Presenting to Tertiary Care Hospital

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Disclaimers

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ABSTRACT

Background: Seizures are a common cause of pediatric hospitalizations, associated with significant morbidity and mortality. The etiology of seizures in children varies globally, with limited data from resource-limited settings.

Objective: To determine the etiology, clinical types, and outcomes of seizures in children aged 6 months to 10 years admitted to a tertiary care hospital in Quetta, Pakistan.

Methods: A retrospective analysis of 276 children admitted with seizures between August 2021 and February 2022 was conducted. Data included demographics, clinical presentations, laboratory findings, neuroimaging, electroencephalography (EEG), and outcomes. Seizures were classified using the International League Against Epilepsy 1993 guidelines. Logistic regression was applied to assess associations, and results were analyzed using SPSS version 25. Ethical approval was obtained, and the study adhered to the Declaration of Helsinki.

Results: Generalized tonic-clonic seizures were the most common type (69.9%), followed by partial seizures (19.8%). Febrile seizures accounted for 30.5%, while neurocysticercosis represented 12%. Abnormal neuroimaging findings were present in 45.9% of cases, with neurocysticercosis being most prevalent. Mortality was 4.4%, primarily associated with CNS infections and status epilepticus ($p < 0.001$).

Conclusion: Febrile seizures and CNS infections were the predominant causes of pediatric seizures. Improved preventive measures, diagnostics, and management are essential to reduce morbidity and mortality.

INTRODUCTION

Seizures are a prominent neurological condition in the pediatric population, presenting a significant burden on healthcare systems globally due to their high rates of morbidity and mortality. Their occurrence among children is influenced by a wide array of underlying causes, ranging from benign febrile seizures to more complex conditions such as central nervous system (CNS) infections, neurocysticercosis, and epileptic syndromes. These episodes are not only alarming for families but also challenge healthcare providers in terms of timely diagnosis, effective treatment, and long-term management. In pediatric emergency departments, seizures account for approximately 1% of all visits, with epilepsy affecting between 50 to 100 cases per 100,000 person-years in various populations (1, 2). The risk of mortality is particularly heightened among children with symptomatic seizures and those presenting with CNS infections, where timely intervention remains critical (3).

In developing countries, CNS infections such as meningitis, viral encephalitis, and neurocysticercosis are predominant causes of seizures, with geographical variations playing a significant role in their prevalence (4). Febrile seizures are particularly common in younger children under the age of five, often representing the initial presentation of seizure episodes in this age group. These seizures, though often benign, may be a harbinger of underlying pathological conditions, necessitating thorough diagnostic evaluation (5, 6). The prevalence of generalized tonic-clonic seizures is well-documented as the most frequent type of seizure observed in pediatric populations, often exacerbated in the presence of fever. However, partial seizures are also encountered, particularly in regions where neurocysticercosis is endemic, emphasizing the need for neuroimaging in children presenting with unexplained seizures (7).

The evaluation of seizures in children requires a comprehensive diagnostic approach that includes clinical assessment, laboratory investigations, neuroimaging, and electroencephalography (EEG). Despite advancements in diagnostic techniques, there is an ongoing debate regarding the necessity of routine imaging in all cases of pediatric seizures,

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particularly in resource-limited settings. While cranial computed tomography (CT) scans and magnetic resonance imaging (MRI) are valuable in identifying structural abnormalities, such as neurocysticercosis or other CNS pathologies, the cost and accessibility of these modalities often limit their use in developing countries. Additionally, lumbar punctures, though critical for diagnosing CNS infections, are not always performed systematically, highlighting variability in clinical practices (8, 9). Misdiagnosis or delayed diagnosis can lead to prolonged hospital stays, increased healthcare costs, and significant anxiety for families, further compounding the burden of pediatric seizures (10).

Most studies on pediatric seizures have focused on epilepsy and its long-term outcomes, with limited research dedicated to understanding the etiology and clinical spectrum of acute symptomatic seizures. The mortality associated with these episodes varies widely, with febrile seizures and neurocysticercosis generally associated with favorable outcomes, while conditions such as meningitis and encephalitis carry a higher risk of poor prognosis (11). In this context, the present study aims to provide a comprehensive analysis of seizure etiologies, clinical presentations, and outcomes in children aged 6 months to 10 years presenting to a tertiary care hospital in a resource-limited setting. By examining the demographic patterns, clinical types, and underlying causes of seizures in this population, the study seeks to contribute valuable insights into the management and prevention of pediatric seizures in developing regions, where the burden of disease is disproportionately high (12, 13).

MATERIAL AND METHODS

This retrospective study was conducted in the Department of Pediatrics at the Balochistan Institute of Child Health Services, Quetta, focusing on children aged 6 months to 10 years admitted with acute seizure episodes. The study encompassed a six-month period, from August 25, 2021, to February 26, 2022, and included a total of 276 patients meeting the inclusion criteria. Children who experienced seizures after admission and neonates or infants under six months of age were excluded to ensure the homogeneity of the study population, as these age groups often present with distinct etiologies such as metabolic disorders, hypoxic-ischemic encephalopathy, or septicemia (1, 2).

Patient data were collected retrospectively from medical records maintained in the hospital. The data included demographic details such as age, sex, and clinical presentations, along with associated symptoms, including fever, cough, rhinorrhea, vomiting, diarrhea, and headache. Additional details such as family history of seizures or epilepsy, developmental history, laboratory investigations, neuroimaging results, and electroencephalography (EEG) findings were also recorded. Laboratory parameters included complete blood counts, C-reactive protein levels, serum electrolytes, blood sugar levels, and cerebrospinal fluid (CSF) analysis, while neuroimaging assessments comprised cranial computed tomography (CT) and magnetic resonance imaging (MRI). The outcomes of hospitalization were documented and categorized as discharged after recovery, left against medical advice (LAMA), mortality during hospital stay, or referrals to other specialty centers for further management.

Seizure classification was performed using the guidelines established by the Commission on Epidemiology and Prognosis of the International League Against Epilepsy in 1993, which categorized seizures into generalized tonic-clonic, absence, myoclonic, partial, and other types. Febrile seizures were defined in accordance with the same guidelines as those occurring in children older than one month of age, associated with fever without any evidence of CNS infection or other acute neurological insult. Status epilepticus was defined as a single seizure lasting more than 30 minutes or recurrent seizures without recovery of function between episodes, persisting for more than 30 minutes (3, 4).

Ethical approval for this study was obtained from the institutional review board of the Balochistan Institute of Child Health Services, and the study adhered to the principles outlined in the Declaration of Helsinki. Patient confidentiality was maintained throughout, and only anonymized data were used for analysis.

Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS), version 25.0. Descriptive statistics were used to summarize demographic and clinical data. Categorical variables were expressed as frequencies and percentages, while continuous variables were summarized as means with standard deviations or medians with interquartile ranges, as appropriate. The Chi-square test was employed to assess associations between categorical variables, while logistic regression analysis was performed to evaluate the strength of these associations, expressed as odds ratios (OR) with 95% confidence intervals (95% CI). A p-value of less than 0.05 was considered statistically significant (5, 6).

Patients were further categorized based on the presence or absence of fever during the seizure episode and into two distinct age groups: 6 months to

5 years and 6 to 10 years. Comparisons were made between these groups regarding variables such as seizure type, associated symptoms, laboratory findings, imaging results, EEG abnormalities, and final outcomes. This detailed analysis aimed to provide a comprehensive understanding of the clinical and etiological spectrum of seizures in children presenting to a tertiary care hospital in a resource-limited setting.

RESULTS

A total of 276 children aged 6 months to 10 years presented with seizures during the study period. Among these, 169 (61.3%) were males, and 107 (38.7%) were females, resulting in a male-to-female ratio of 1.58:1. Children aged 6 months to 5 years constituted the majority of cases (182/276, 65.9%), with a significant association between age group and seizure occurrence ($p < 0.001$). Fever was present in 148 cases (53.5%) at the time of admission, with febrile seizures being the predominant cause in this subgroup. Generalized tonic-clonic seizures (GTC) were the most common seizure type (193/276, 69.9%), followed by partial seizures (19.8%). Status epilepticus was documented in 7.3% of cases.

Table 1: Demographic and Clinical Characteristics of Patients

Variable	No Fever (n=128)	Fever (n=148)	Total (n=276)	Odds Ratio (95%-CI)	P-Value
Sex					
Male	70 (54.7%)	99 (67.1%)	169 (61.3%)	1.691 (1.119–2.390)	0.003
Female	58 (45.3%)	49 (32.9%)	107 (38.7%)	-	-
Age Group					
6 months to 5 years	68 (33.2%)	114 (78.6%)	182 (57.5%)	11.15 (6.637–18.749)	<0.001
6 to 10 years	60 (30.1%)	34 (13.6%)	94 (21.2%)	2.123 (1.171–3.849)	0.001
Type of Seizure					
Generalized Tonic-Clonic (GTC)	71 (55.5%)	122 (82.4%)	193 (69.9%)	2.896 (1.415–5.927)	0.004
Partial	36 (28.1%)	19 (12.5%)	55 (19.8%)	0.870 (0.394–1.920)	0.730
Absence	7 (5.1%)	1 (0.7%)	8 (2.7%)	0.260 (0.051–1.341)	0.108
Myoclonic	4 (2.7%)	4 (1.3%)	8 (2.7%)	-	-
Other	11 (8.6%)	7 (4.4%)	18 (6.4%)	-	-
Status Epilepticus	11 (52.5%)	20 (47.5%)	20 (7.3%)	1.298 (0.681–2.473)	0.428

Among patients with fever, GTC seizures accounted for 82.4% of cases, showing a strong association with febrile episodes ($p < 0.001$). Status epilepticus was more frequently observed in children aged 6 months to 5 years (60%) compared to those aged 6–10 years.

Table 2: Laboratory and Neuroimaging Findings

Parameter	6 months to 5 years (n=182)	6–10 years (n=94)	Total (n=276)	P-Value
CSF Abnormality	42 (19.4%)	25 (41.7%)	67 (25.9%)	<0.001
Neuroimaging Abnormality	37 (36.3%)	33 (49.3%)	70 (45.9%)	<0.001
EEG Abnormality	72 (46.8%)	57 (61.3%)	129 (54.8%)	<0.001

Abnormal cerebrospinal fluid (CSF) findings were observed in 25.9% of cases, with older children more likely to exhibit abnormalities ($p < 0.001$). Neuroimaging abnormalities, predominantly neurocysticercosis, were detected in 45.9% of patients, significantly more frequent in the older age group ($p < 0.001$). EEG abnormalities were present in 54.8% of cases, with a higher prevalence in children aged 6–10 years. The overall mortality rate was 4.4%, with higher mortality observed in children diagnosed with encephalitis (24.3%) and meningitis (8.3%). Febrile seizures and neurocysticercosis were associated with favorable outcomes, with 97.6% and 98.5% of patients discharged after recovery, respectively.

Table 3: Outcome Analysis

Outcome	Discharged	LAMA	Died	Referred	P-Value
Male	154 (91%)	4 (2.5%)	9 (5%)	3 (1.5%)	NS
Female	94 (87.8%)	6 (6.6%)	3 (3.3%)	3 (2.3%)	NS
Febrile Seizures	81 (97.6%)	2 (1.8%)	1 (0.6%)	0	<0.001
Neurocysticercosis	33 (98.5%)	1 (1.5%)	0	0	<0.001
Status Epilepticus	12 (60%)	3 (12.5%)	5 (25%)	1 (5%)	<0.001

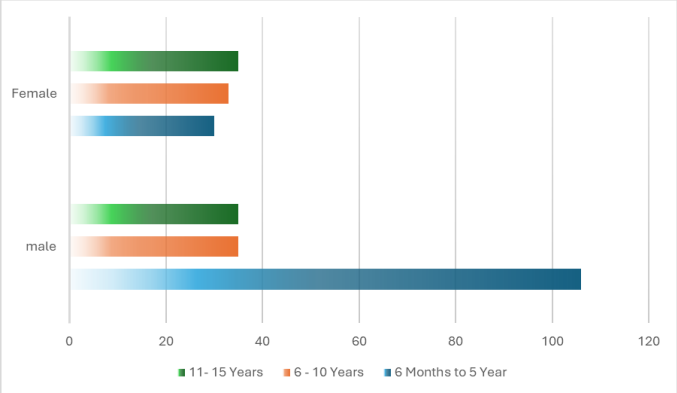

Figure 1 Age and sex distribution of children with seizure

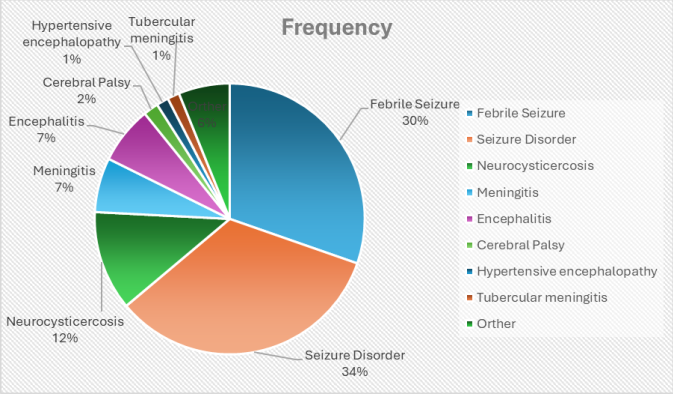

Figure 2 Etiological diagnosis of children with seizures

Younger children, particularly males, were more likely to experience febrile seizures and GTC seizures, while older children showed a higher prevalence of neurocysticercosis and EEG abnormalities. Mortality rates were significantly influenced by the underlying diagnosis, with CNS infections posing the greatest risk. The findings underscore the importance of targeted diagnostic and management strategies for pediatric seizure disorders in resource-limited settings.

DISCUSSION

This study provided a comprehensive analysis of the etiological, clinical, and demographic characteristics of children presenting with seizures in a tertiary care setting. The findings revealed that generalized tonic-clonic seizures were the most frequently encountered seizure type, particularly among children aged 6 months to 5 years, a pattern consistent with previous studies highlighting the predominance of generalized seizures in pediatric populations (1, 2). The higher prevalence of febrile seizures in this age group was also in line with existing literature, which underscores fever as a significant trigger of acute seizure episodes in younger children (3, 4). The male predominance observed across all age groups further corroborated prior research demonstrating a higher incidence of seizures among boys, likely due to genetic, hormonal, and possibly cultural factors that contribute to health-seeking behaviors (5, 6).

The study also highlighted the considerable burden of CNS infections and neurocysticercosis, particularly among older children, as a major cause of seizures in resource-limited settings. Neurocysticercosis accounted for nearly half of the abnormal neuroimaging findings, emphasizing the endemicity of this condition in developing regions, as previously reported (7). These findings reinforced the critical role of neuroimaging, particularly in older children and those with afebrile seizures, to identify structural abnormalities and guide appropriate management (8). However, the routine use of neuroimaging in resource-constrained settings remains challenging due to financial and logistical constraints, a limitation that has been discussed extensively in similar studies from low- and middle-income countries (9, 10).

EEG abnormalities were present in over half of the cases, with a higher prevalence in older children. This finding was consistent with prior research demonstrating the utility of EEG in identifying seizure etiology and predicting outcomes in pediatric patients (11). Although EEG was invaluable in this study, the variability in its interpretation, particularly in resource-limited settings, posed a limitation. Additionally, CSF analysis revealed a higher frequency of abnormalities among older children, reflecting the significant contribution of CNS infections, such as meningitis and encephalitis, to seizure etiology. This aligns with global evidence emphasizing the importance of early diagnosis and management of CNS infections to reduce seizure-related morbidity and mortality (12, 13). The overall mortality rate of 4.4% was comparable to other studies conducted in similar settings, where CNS infections, encephalitis, and status epilepticus were associated with higher mortality rates (14). Children with febrile seizures and neurocysticercosis demonstrated favorable outcomes, with most cases being discharged after recovery. These findings underscore the importance of targeted interventions, including improved sanitation, vaccination programs, and early identification of neurocysticercosis, to reduce the burden of seizures in endemic regions (15, 16). One of the strengths of this study was its comprehensive approach to data collection, encompassing demographic, clinical, laboratory, neuroimaging, and EEG findings, which provided a holistic understanding of seizure etiology in children. Additionally, the study's focus on a resource-limited setting offered valuable insights into the unique challenges faced in managing pediatric seizures in

such contexts. However, certain limitations must be acknowledged. The retrospective design of the study limited the ability to establish causal relationships and relied on the accuracy and completeness of medical records. Furthermore, the study was conducted at a single tertiary care center, potentially limiting the generalizability of the findings to other regions with different sociodemographic and healthcare profiles.

Future studies should aim to address these limitations by adopting prospective designs with multicenter collaboration to capture a broader spectrum of cases and improve generalizability. Efforts should also focus on the standardization of diagnostic protocols, including criteria for neuroimaging and EEG use, to optimize resource utilization in low-resource settings. Moreover, long-term follow-up studies are essential to understand the natural history of seizure disorders in children and the impact of various interventions on their outcomes.

This study highlighted the significant burden of febrile seizures, CNS infections, and neurocysticercosis as leading causes of seizures in children, with variations in etiology across different age groups. The findings emphasized the need for targeted preventive measures, including vaccination, sanitation improvement, and public health education, to address the underlying causes of seizures. Enhanced diagnostic capabilities and standardized management protocols are essential to reduce morbidity and mortality associated with pediatric seizures, particularly in resource-limited settings.

CONCLUSION

This study highlighted the significant burden of pediatric seizures in resource-limited settings, with febrile seizures, CNS infections, and neurocysticercosis emerging as the most common etiologies. The findings underscored the critical need for early diagnosis, targeted preventive measures such as vaccination and improved sanitation, and standardized diagnostic and management protocols to reduce seizure-related morbidity and mortality. Strengthening healthcare systems to enhance access to neuroimaging, EEG, and long-term follow-up care is essential to improve outcomes in affected children, ultimately contributing to better public health and addressing the disparities in pediatric neurological care.

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