Original Research

CLINICAL PROFILE AND FACTORS DETERMINING SEIZURE DISORDER FROM COMPLEX FEBRILE SEIZURE IN CHILDREN AGED 1 MONTH TO 18 YEARS: A RETROSPECTIVE HOSPITAL-BASED ANALYTICAL STUDY

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ABSTRACT

Background: Childhood seizures are a common reason for paediatric admission, and the severity of presentation often guides treatment intensity and prognostic counselling. Hospital profiles from Indian tertiary centres remain limited.

Objective: To describe the clinical profile of paediatric admissions with seizures and to identify antenatal, perinatal, and clinical factors that distinguish children with a seizure disorder from those with a complex febrile seizure.

Materials and Methods: A retrospective hospital-based analytical study was conducted at a tertiary care hospital over 24 months. Children aged 1 month to 18 years admitted with a confirmed seizure episode were included. Seizure was classified into seizure disorder and complex febrile seizure as per ILAE criteria. Fisher's exact and Mann-Whitney U tests were used to compare groups; crude odds ratios with 95% confidence intervals were calculated.

Results: Forty-three children were studied (mean age 5.1 ± 3.1 years; 60.5% male; 48.8% rural). Seizure disorder accounted for 55.8% (n=24) and complex febrile seizure for 44.2% (n=19). Status epilepticus occurred in 23.3%, ICU admission in 34.9%, and 44.2% required two or more antiepileptic drugs. Abnormal electroencephalography was present in 60.5% and abnormal neuroimaging in 34.9%. Pre-seizure developmental delay (crude OR 111, 95% CI 5.83–2112, p<0.001) and a history of birth asphyxia (OR 10.8, 95% CI 1.22–95.2, p=0.026) were strongly associated with seizure disorder rather than complex febrile seizure. Conversely, a febrile presentation (OR 0.08, 95% CI 0.01–0.45, p=0.002) and an age at first seizure under two years (OR 0.03, 95% CI <0.01–0.52, p=0.001) pointed toward complex febrile seizure.

Conclusion. In this hospital cohort, seizure disorder accounted for the majority of admissions. Pre-seizure developmental delay, birth asphyxia, and an afebrile presentation favoured a diagnosis of seizure disorder over complex febrile seizure. Simple bedside features can support early differentiation and direct triage, investigation, and parental counselling.

Keywords: Seizure Disorder, Complex Febrile Seizure, Childhood Seizures, Birth Asphyxia, Developmental Delay, Tertiary Care, India.

INTRODUCTION

Seizure disorders are among the most frequent neurological conditions encountered in paediatric emergency departments and inpatient wards. In population-based cohorts, the annual incidence of childhood epilepsy ranges between 41 and 187 per 100,000 children, with the highest incidence in the first year of life [1]. Worldwide, around 50 million people live with epilepsy, and a quarter of those

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affected are children [2]. The clinical impact extends well beyond the seizure event itself, since recurrence, treatment-related side effects, and developmental concerns weigh on families for years. Febrile seizures most often present between 6 months and 5 years of age. A febrile seizure is termed complex when at least one of the following features is present: focal onset, duration of 15 minutes or more, or recurrence within 24 hours of a febrile illnesss [3,4]. Although a complex febrile seizure carries a slightly higher recurrence risk than a simple febrile seizure, the long-term prognosis remains favourable in the majority of children, and most do not progress to a chronic seizure disorder [5,6]. A seizure disorder, in contrast, denotes a tendency to recurrent unprovoked seizures and frequently presents with prolonged events, focal features with impaired awareness, status epilepticus, clustering of seizures, the need for more than one antiepileptic drug, or background neurodevelopmental compromise. Children with a seizure disorder are more likely to require intensive monitoring, structural and electrophysiological investigation, and long-term antiepileptic therapy. Early identification of a seizure disorder, particularly its distinction from a complex febrile seizure, has direct bedside consequences for triage, investigation, and counselling [3,4,6].

Several factors are thought to push a child's presentation away from a complex febrile seizure and toward a seizure disorder. Antenatal complications have been associated with later seizure problems in some series, although effect sizes vary [6]. Perinatal injury, particularly hypoxic-ischaemic insult, is one of the better-established risk states: children who experienced neonatal seizures or moderate-to-severe hypoxic-ischaemic encephalopathy have a markedly higher risk of subsequent epilepsy [7,8,9]. Underlying structural brain abnormality and pre-existing developmental delay have repeatedly been flagged as markers of a true seizure disorder [5,6]. Most published paediatric seizure profiles from India come from a small number of tertiary centres and typically focus either on acute symptomatic seizures or on chronic epilepsy alone [10,11]. Direct comparisons between children with a complex febrile seizure and those with a seizure disorder, anchored in antenatal and perinatal history, are uncommon. Such a snapshot is useful for clinicians who plan triage pathways and for teams that prepare parent-education material for follow-up clinics. We carried out this study to describe the clinical spectrum of paediatric seizure admissions at our centre and to identify antenatal, perinatal, and clinical factors that distinguish a seizure disorder from a complex febrile seizure in children aged 1 month to 18 years. Because record-based work allows broad capture of admitted children but limited ability to chase missing information, we kept the analysis descriptive and used univariate testing rather than multivariable modelling, given the sample size available within the review window.

MATERIALS AND METHODS

Study Design and Setting

This was a retrospective hospital-based analytical study carried out in the Department of Paediatrics of a tertiary care teaching hospital. The hospital serves both urban and rural populations and acts as a referral centre for the surrounding districts. The review covered admissions over 24 months from January 2023 to December 2024.

Participants

The Study included children aged 1 month to 18 years admitted with a confirmed seizure episode during the study period. Confirmation required documentation of a witnessed seizure by physician's notes. Children whose records were incomplete on key variables (group classification, antenatal history, or perinatal events) were excluded. Children admitted for non-seizure neurological reasons, such as isolated headache or syncope without seizure activity, were not eligible.

Figure 1 summarises the selection flow. Eighty-five paediatric admissions with a recorded seizure event were screened during the 24-month review window. Twenty-five were excluded as non-seizure admissions, isolated syncope, or headache without seizure activity; a further seventeen had incomplete records on group classification, antenatal, or perinatal history. Forty-three children formed the final analytic sample, of whom 24 (55.8%) were classified as having a seizure disorder and 19 (44.2%) as having a complex febrile seizure.

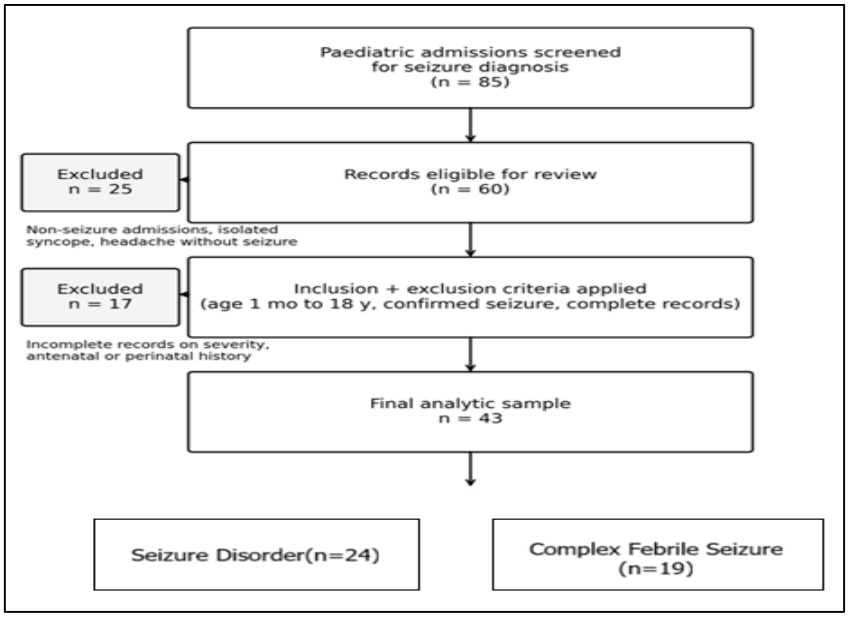

Figure-1: STROBE Flow Diagram of Record Selection

Operational Definitions

A child was classified as having a seizure disorder if the record described at least one of the following in the absence of an alternative febrile aetiology: a seizure lasting 15 minutes or more without fever; focal features with impaired awareness; status epilepticus, defined by an event of 30 minutes or more with continuous activity or no return to baseline between events [12]; clustering of two or more seizures within 24 hours outside a febrile illness; a post-ictal Todd's paresis; recurrent unprovoked events requiring two or more antiepileptic drugs to control; or pre-existing developmental delay with seizure recurrence. A child was classified as having a complex febrile seizure if the index event occurred in the setting of a febrile illness and met at least one of the standard criteria for a complex febrile seizure - focal features, duration of 15 minutes or more, or recurrence within 24 hours - in a child without an established seizure disorder [3,4]. Seizure type was assigned using the ILAE 2017 framework [3]. Birth asphyxia was defined by a recorded 5-minute APGAR score of less than 7 or by a documented need for resuscitation at delivery. Low birth weight (<2500 g), prematurity (<37 weeks), and neonatal seizures followed standard cut-offs.

Variables and Data Extraction

A structured proforma was used to extract age, sex, residence, socioeconomic status, antenatal history, perinatal events, seizure details, examination findings, electroencephalography, neuroimaging, treatment received, and short-term outcome. Antenatal variables included adequacy of antenatal care, pregnancy-induced hypertension, gestational diabetes, maternal infection during pregnancy, maternal anaemia, and antenatal exposure to teratogens. Perinatal variables covered gestational age, birth weight, mode of delivery, birth asphyxia, neonatal intensive care admission for more than 48 hours, neonatal seizures, jaundice requiring phototherapy, and neonatal sepsis. Clinical variables included seizure type, febrile or afebrile presentation, age at first seizure, pre-existing developmental delay, known neurological comorbidity, and, among previously treated children, antiepileptic drug compliance.

Sample Size

The study used a complete enumeration of eligible records during the 24-month window; 43 children met the inclusion criteria after exclusions.

Statistical Analysis

Data were entered into Microsoft Excel and analysed in SPSS version 26. Categorical variables are presented as counts and percentages. Continuous variables are presented as mean with standard deviation, and as median with interquartile range when distributions were skewed. Differences in continuous variables between the seizure disorder and complex febrile seizure groups were tested with the Mann-Whitney U test, since normality could not be assumed at this sample size. Differences in categorical variables were tested with Fisher's exact test, because expected cell counts were often below five. Crude odds ratios with 95% confidence intervals were calculated for each candidate exposure, taking seizure disorder as the outcome of interest relative to complex febrile seizure; a Haldane-Anscombe correction was applied when any cell was zero. A two-sided p-value below 0.05 was considered statistically significant.

Ethical Considerations

The study was approved by the Institutional Ethics Committee (IECHS/IRCHS/NO:947). A waiver of informed consent was granted because the work involved a de-identified retrospective chart review. No patient identifiers were entered into the analytic dataset.

RESULTS

Forty-three children met the inclusion criteria. The mean age was 5.1 ± 3.1 years, and the median was 4.4 years (IQR 2.8 to 7.1). Boys are 60.5% (n=26) of the sample. Children were almost equally distributed between urban (51.2%) and rural (48.8%) areas. Socioeconomic distribution skewed toward lower-middle and upper-lower classes, consistent with the catchment area of the centre. Seizure disorder accounted for most presentations at 55.8% (n=24), while 44.2% (n=19) were classified as complex febrile seizure. Status epilepticus was documented in 23.3% of children. (Table 1). Antenatal complications were variably represented in the cohort. Inadequate antenatal care, pregnancy-induced hypertension, and maternal anaemia were each documented in a sizeable minority of mothers, while maternal infection and gestational diabetes were uncommon. Among perinatal events, preterm birth was noted in 14.0%, low birth weight in 20.9%, and caesarean delivery in just over a third. Birth asphyxia was documented in 23.3% of children overall, with a striking imbalance between groups (37.5% in the seizure disorder group vs 5.3% in the complex febrile seizure group), with a significant p-value. A neonatal intensive care stay of more than 48 hours and neonatal sepsis were each more common in the seizure disorder group, although the differences did not reach statistical significance. Neonatal seizures were rare in this sample, recorded in only 2.3% of children. (Table 2)

The most common seizure type was generalized tonic-clonic, which made up 41.9% (18) of all events. Focal seizures formed the next largest group at 32.6% (14), followed by focal seizures evolving to bilateral tonic-clonic and myoclonic seizures (each 9.3%, 4), absence seizures (4.7%, 2), and atonic seizures (2.3%, 1) (Figure 2). A febrile presentation was recorded in 27.9% of children overall, concentrated in the complex febrile seizure group (52.6%) as expected. Pre-seizure developmental delay was present in 41.9% of all children and was confined entirely to the seizure disorder group (75.0% of the seizure disorder group vs 0% of the complex febrile seizure group). A known neurological comorbidity was present in 20.9% of children. Status epilepticus was documented in 23.3% of children overall and occurred only in the seizure disorder group. ICU admission was needed for 34.9% of children, again concentrated in the seizure disorder group (58.3% vs 5.3%). Two or more antiepileptic drugs were required in 44.2% of children to bring the seizures under control (62.5% in the seizure disorder group vs 21.1% in the complex febrile seizure group). Electroencephalography was abnormal in 60.5% of children (75.0% vs 42.1%), and neuroimaging (computed tomography or magnetic resonance imaging) showed structural or signal abnormalities in 34.9% (54.2% vs 10.5%). (Table 3)

Table 4 shows that the univariate analysis identified several important factors associated with seizure disorder. Birth asphyxia was significantly associated with higher odds of seizure disorder (OR: 10.80; $p = 0.026$). Developmental delay showed higher odds, with nearly 11-fold increased odds of seizure disorder (OR: 11.00; $p < 0.001$). In contrast, febrile presentation (OR: 0.08; $p = 0.002$) and age <2 years at first seizure (OR: 0.03; $p = 0.001$) were associated with significantly lower odds of seizure disorder. Other antenatal, perinatal, and neonatal factors did not show statistically significant associations in the univariate analysis (Table 4).

DISCUSSION

This retrospective hospital-based study compared paediatric admissions with a seizure disorder against those with a complex febrile seizure and identified antenatal, perinatal, and clinical features that distinguish the two presentations. Seizure disorder accounted for the majority of admissions in our centre, which is consistent with the referral pattern of tertiary hospitals that tend to receive a higher proportion of severe and recurrent seizure cases [6,10]. Population-level studies, by contrast, typically document a larger share of complex and simple febrile seizures, because most febrile events are managed at peripheral facilities and few are referred upward [5]. Pre-seizure developmental delay emerged as the single strongest discriminator between seizure disorder and complex febrile seizure. Every child in our cohort with documented developmental delay was in the seizure disorder group, in line with earlier work showing that pre-existing developmental or neurological impairment greatly increases the likelihood of an established seizure disorder rather than an isolated febrile event [5,6]. The underlying mechanism is likely a combination of pre-existing structural or genetic substrate, prior neuronal injury, and altered cortical excitability, none of which are typical of an uncomplicated febrile seizure. Although the observed odds ratio was extremely high, its wide confidence interval reflects the small sample and the absence of any developmentally delayed children in the complex febrile seizure group; the direction of the effect, however, is unambiguous.

Birth asphyxia was the second clear discriminator and was significantly associated with seizure disorder over complex febrile seizure. This is consistent with the work of Tekgul et al., who identified hypoxic-ischaemic encephalopathy as an important cause of neonatal seizures and adverse neurological outcomes [8], and with Pisani et al., who showed that newborns with hypoxic brain injury and neonatal seizures had a substantially higher risk of later epilepsy [9]. Ronen et al. likewise reported poorer neurological outcomes and increased seizure recurrence in children with a history of neonatal hypoxic injury [7]. Hypoxic damage during the perinatal period may produce permanent neuronal injury and epileptogenic foci, providing the substrate for a later seizure disorder rather than for an isolated febrile seizure. A febrile presentation at admission was, predictably, strongly associated with complex febrile seizure and was rare in the seizure disorder group. This finding is consistent with existing literature showing that febrile seizures are usually short-lasting, generalized, and self-limiting with a good prognosis [6,10]. Age at first seizure under two years was strongly associated with complex febrile seizure rather than seizure disorder, mirroring the well-known peak incidence of febrile seizures between six months and three years of age [5,6]. This contrasts with some earlier reports identifying a very young age of onset as a predictor of severe epilepsy [6], but the discrepancy is explained by variability in the inclusion of cases. The difference may be due to referral practices and the limited sample size in the current study.

Several factors, including preterm birth, low birth weight, maternal anaemia, neonatal seizures, neurological comorbidity, and poor antiepileptic drug compliance, did not reach significance in the present study. The findings of this study have practical relevance in clinical settings. Simple clinical information, such as developmental status, history of birth asphyxia, and type of seizure presentation, may help clinicians identify children who are at greater risk of complex seizures and who may benefit from closer monitoring and early neurological evaluation. However, the results should be interpreted considering certain limitations, including the retrospective design, small sample size, and single-centre setting. Since multivariable analysis was not performed, the observed associations may also be influenced by confounding factors. Further prospective multicenter studies with larger sample sizes are required to confirm these findings.

CONCLUSION

In the present study, seizure disorder accounted for the majority of seizure admissions, while complex febrile seizures formed a substantial minority. Pre-seizure developmental delay, a history of birth asphyxia, and an afebrile presentation were strongly associated with a seizure disorder rather than with a complex febrile seizure. These simple clinical features can be identified during the initial assessment and may support early differentiation between the two presentations, guiding triage, investigation, and parental counselling. Further large-scale prospective multicentre studies are needed to validate these findings and to support multivariable risk modelling.

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Conflict of interest: Nil

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Table-1: Baseline Demographic and Clinical Characteristics, by Seizure Severity (N=43)

Variable	Total N (%)	Seizure Disorder N (%) (N=24)	Complex Febrile Seizure N (%) (N=19)	P-Value
Age (years), mean ± SD	5.1 ± 3.1	6.1 ± 3.0	3.7 ± 2.8	0.003*
Age at first seizure (years), mean ± SD	5.0 ± 3.2	7.0 ± 2.8	2.5 ± 1.4	<0.001*
Sex: Male	26 (60.5%)	15 (62.5%)	11 (57.9%)	1.000
Sex: Female	17 (39.5%)	9 (37.5%)	8 (42.1%)	1.000
Residence: Urban	22 (51.2%)	10 (41.7%)	12 (63.2%)	0.223
Residence: Rural	21 (48.8%)	14 (58.3%)	7 (36.8%)	0.223
SES: Upper-middle	1 (2.3%)	1 (4.2%)	0 (0.0%)	1.000
SES: Lower-middle	17 (39.5%)	11 (45.8%)	6 (31.6%)	0.369
SES: Lower	12 (27.9%)	4 (16.7%)	8 (42.1%)	0.091

(Values are mean ± SD for continuous variables and n (%) for categorical variables. p-values from Mann-Whitney U test (continuous) or Fisher's exact test (categorical). SES, socioeconomic status. *p<0.05)

Table 2. Antenatal and Perinatal Factors among Seizure Disorders Relative to the Complex Febrile Seizure Group (N=43)

Factor	Total N (%)	Seizure Disorder N (%) (N=24)	Complex Febrile Seizure N (%) (N=19)	P-Value
Inadequate antenatal care (<4 visits)	10 (23.3%)	4 (16.7%)	6 (31.6%)	0.295
Pregnancy-induced hypertension	10 (23.3%)	7 (29.2%)	3 (15.8%)	0.470
Gestational diabetes	2 (4.7%)	1 (4.2%)	1 (5.3%)	1.000
Maternal infection in pregnancy	2 (4.7%)	1 (4.2%)	1 (5.3%)	1.000
Maternal anaemia	9 (20.9%)	5 (20.8%)	4 (21.1%)	1.000
Preterm birth (<37 weeks)	6 (14.0%)	3 (12.5%)	3 (15.8%)	1.000

Low birth weight (<2500 g)	9 (20.9%)	4 (16.7%)	5 (26.3%)	0.477
Caesarean delivery	15 (34.9%)	6 (25.0%)	9 (47.4%)	0.198
Birth asphyxia	10 (23.3%)	9 (37.5%)	1 (5.3%)	0.026*
NICU stay >48 h	10 (23.3%)	7 (29.2%)	3 (15.8%)	0.470
Neonatal seizures	1 (2.3%)	1 (4.2%)	0 (0.0%)	1.000
Neonatal jaundice	5 (11.6%)	3 (12.5%)	2 (10.5%)	1.000
Neonatal sepsis	6 (14.0%)	5 (20.8%)	1 (5.3%)	0.205

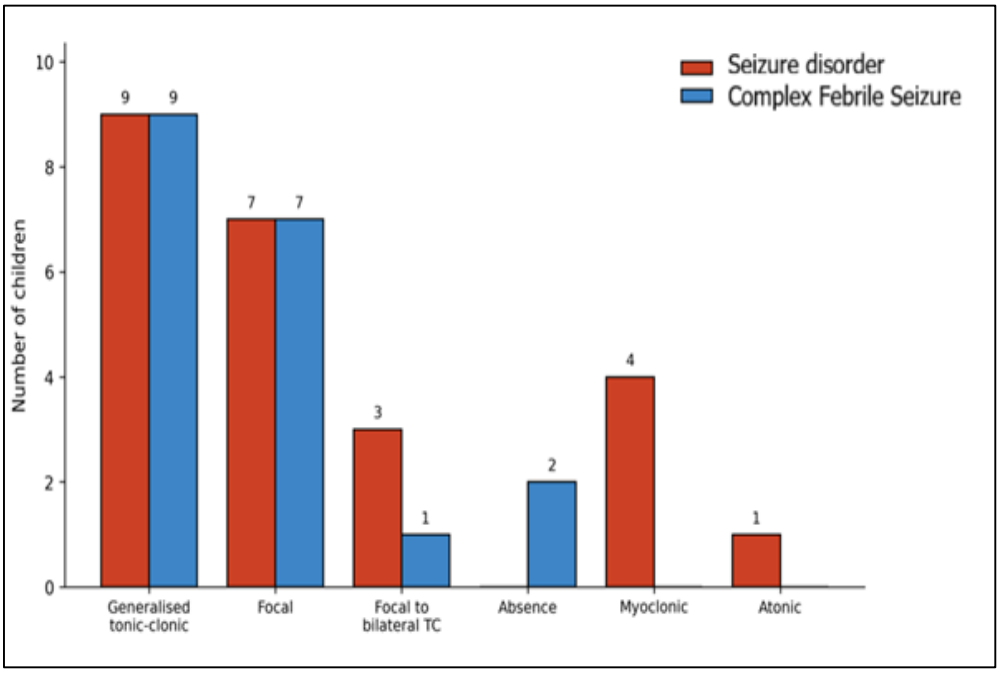

Figure-2: Distribution of Seizure Types by Group (Seizure Disorder Vs Complex Febrile Seizure)

Table-3: Seizure Characteristics, Presentation Features, Investigations, and Etiological Mix, by Group (N=43)

Characteristic	Total N (%)	Seizure Disorder N (%) (N=24)	Complex Febrile Seizure N (%) (N=19)
Febrile presentation	12 (27.9%)	2 (8.3%)	10 (52.6%)
Developmental delay (pre-seizure)	18 (41.9%)	18 (75.0%)	0 (0.0%)
Family / neurological comorbidity	9 (20.9%)	6 (25.0%)	3 (15.8%)
Status epilepticus	10 (23.3%)	10 (41.7%)	0 (0.0%)
ICU admission	15 (34.9%)	14 (58.3%)	1 (5.3%)
Required ≥2 AEDs	19 (44.2%)	15 (62.5%)	4 (21.1%)
Abnormal EEG	26 (60.5%)	18 (75.0%)	8 (42.1%)
Abnormal neuroimaging	15 (34.9%)	13 (54.2%)	2 (10.5%)

(EEG, electroencephalography. AED, antiepileptic drug. ICU, intensive care unit.)

Table-4: Univariate Associations: Crude Odds Ratios for Seizure Disorder (Vs Complex Febrile Seizure) Across all Candidate Exposures (N=43)

Exposure	Crude OR	95% CI	P-Value
Inadequate antenatal care	0.43	0.10-1.84	0.295
Pregnancy-induced hypertension	2.20	0.48-9.99	0.470
Gestational diabetes	0.78	0.05-13.39	1.000
Maternal infection	0.78	0.05-13.39	1.000
Maternal anaemia	0.99	0.22-4.33	1.000
Preterm birth	0.76	0.14-4.29	1.000

Low birth weight	0.56	0.13-2.46	0.477
Caesarean delivery	0.37	0.10-1.35	0.198
Birth asphyxia	10.80	1.22-95.22	0.026*
NICU stay > 48 h	2.20	0.48-9.99	0.470
Neonatal seizures	2.49	0.10-64.62	1.000
Neonatal jaundice	1.21	0.18-8.12	1.000
Neonatal sepsis	4.74	0.50-44.57	0.205
Febrile presentation	0.08	0.01-0.45	0.002*
Developmental delay	11.00	5.83-21.28	<0.001*
Neurological comorbidity	1.78	0.38-8.30	0.708
Poor AED compliance	1.22	0.36-4.21	1.000
Age <2 y at first seizure	0.03	0.00-0.52	0.001*
Perinatal HIE etiology	0.56	0.13-2.46	0.477

(Crude odds ratio (OR) with 95% confidence interval (CI). p-values from Fisher's exact test. Haldane-Anscombe correction applied where any cell was zero. *p<0.05.)