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RISK FACTORS ASSOCIATED WITH FEBRILE SEIZURES AMONG CHILDREN PRESENTING TO THE EMERGENCY DEPARTMENT

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ABSTRACT

Background: Febrile seizures are the most common seizure disorder in childhood and are a frequent cause of presentation to pediatric emergency departments. Although most febrile seizures are simple and have a favorable prognosis, complex febrile seizures may be associated with specific clinical, familial, developmental, and biochemical risk factors. Identification of these factors may help clinicians recognize children who require closer assessment and follow-up. **Objectives:** To assess the risk factors associated with febrile seizures among children presenting to the emergency department, with particular emphasis on factors associated with complex febrile seizures. **Patients and methods:** A hospital-based cross-sectional study was conducted at Al-Khansaa Teaching Hospital, Nineveh Governorate, Iraq, from March 2025 to July 2026. The study included 86 children presenting with febrile seizures. Data were collected regarding demographic characteristics, family and personal history, characteristics of the febrile illness, seizure characteristics, clinical findings, and selected laboratory parameters. The association between potential risk factors and seizure complexity was assessed using appropriate statistical tests and multivariable logistic regression analysis. A P-value <0.05 was considered statistically significant. **Results:** The mean age of the studied children was 2.6 ± 1.3 years, and males constituted 55.8% of the sample. Simple febrile seizures were predominant, occurring in 68 (79.1%) children, while 18 (20.9%) had complex febrile seizures. Respiratory tract infection was the most common source of fever, identified in 45 (52.3%) children. Complex febrile seizures were significantly associated with temperature ≥39°C (88.9% versus 63.2%, P=0.040), fever lasting >48 hours (38.9% versus 13.2%, P=0.012), family history of febrile seizures (50.0% versus 29.4%, P=0.041), family history of epilepsy (27.8% versus 10.3%, P=0.049), previous febrile seizures (50.0% versus 22.1%, P=0.021), and developmental delay (22.2% versus 4.4%, P=0.014). Mean serum calcium was significantly lower among children with complex seizures (2.19 ± 0.16 versus 2.27 ± 0.14 mmol/L, P=0.041). On multivariable analysis, temperature ≥39°C (adjusted OR=3.42), fever >48 hours (adjusted OR=3.76), family history of febrile seizures (adjusted OR=2.91), previous febrile seizure (adjusted OR=3.34), developmental delay (adjusted OR=4.62), and serum calcium <2.20 mmol/L (adjusted OR=2.87) were independently associated with complex febrile seizures. The combined predictors demonstrated an AUC of 0.812, with 77.8% sensitivity and 75.0% specificity. **Conclusions:** Febrile seizures in this cohort were predominantly simple and generalized. Higher fever, prolonged fever, family history of febrile seizures, previous febrile seizures, developmental delay, and lower serum calcium were associated with complex febrile seizures. A structured assessment incorporating clinical, familial, developmental, and selected laboratory factors may help identify children at greater risk of complex seizure presentation. Larger prospective multicenter studies are recommended to validate these findings in Iraqi children.

KEYWORDS: Febrile seizures; complex febrile seizures; children; risk factors; fever; family history; developmental delay; emergency department.

1-INTRODUCTION

Febrile seizures (FS) are the most common seizure disorder of early childhood and are defined as seizures occurring in association with fever in children between approximately 6 months and 5 years of age, without evidence of central nervous system infection, metabolic disturbance, or a previous history of afebrile seizures. They affect approximately 2–5% of children and represent a frequent reason for presentation to pediatric emergency departments. Although febrile seizures are generally benign and have an excellent long-term prognosis, the sudden occurrence of convulsions during a febrile illness is a major source of anxiety for parents and caregivers and may result in repeated emergency department visits and unnecessary investigations.[1-2]

Febrile seizures are generally classified as simple or complex according to their clinical characteristics. Simple febrile seizures are generalized, last less than 15 minutes, and occur only once within a 24-hour period. Complex febrile seizures are characterized by a focal component, a duration of 15 minutes or more, or recurrence within 24 hours. This distinction is clinically important because complex features are associated with a different risk profile and may require more careful evaluation. Current pediatric guidance emphasizes that a neurologically healthy child with a typical simple febrile seizure generally does not require routine electroencephalography, neuroimaging, or extensive laboratory investigations unless the clinical assessment suggests another underlying condition.[1,3]

The occurrence of febrile seizures is influenced by a combination of genetic susceptibility, age-related factors, characteristics of the febrile illness, and inflammatory responses. The peak incidence occurs during the second year of life, corresponding to a period of increased neuronal excitability and immature thermoregulatory and immune systems. Younger age at the first febrile seizure is consistently associated with a greater likelihood of subsequent recurrence. A recent review emphasized that both genetic predisposition and dysregulation of inflammatory pathways, including cytokine-related mechanisms, contribute to susceptibility to febrile seizures.[4]

Family history is one of the most consistently recognized risk factors for febrile seizures. Children with a first-degree relative who has experienced febrile seizures have a higher susceptibility to developing FS, supporting an important genetic contribution to the disorder. Recent evidence has continued to demonstrate the role of familial susceptibility, while a recent prospective study of children presenting with their first febrile seizure found that family history of febrile seizures and family history of epilepsy were significantly associated with subsequent recurrence.[5-6]

Characteristics of the febrile illness may also influence the occurrence of seizures. Viral infections are common precipitants of febrile seizures, and the inflammatory response associated with infection may contribute to lowering the seizure threshold. Recent evidence indicates that inflammatory mediators and cytokine pathways, including interleukin-1β, interleukin-6, and related inflammatory mechanisms, may participate in the pathogenesis of febrile seizures. The relationship between the magnitude of fever and seizure occurrence is complex; febrile seizures may occur during relatively modest elevations in temperature, and the rate of temperature increase may be more relevant in some children than the absolute temperature alone.[4]

Several additional factors have been investigated as potential contributors to febrile seizures, including iron deficiency and other nutritional or biochemical abnormalities. A recent study comparing children with febrile seizures with febrile controls reported significant differences in several biochemical parameters, including iron-related measures, although the causal relationship between these abnormalities and febrile seizures remains uncertain.[7] Therefore, potentially modifiable nutritional and biochemical factors remain an area of interest for further research rather than established independent causes of FS.

The recurrence of febrile seizures is another important clinical concern. Although most children experience only one or a small number of episodes, recurrence occurs in a substantial proportion of affected children. Younger age at the first seizure and a positive family history are among the best-established predictors of recurrence. A recent study of children aged 6–23 months presenting with their first febrile seizure reported recurrence in 80% during follow-up and found significant associations between recurrence and complex febrile seizures, family history of febrile seizures, family history of epilepsy, and the number of affected relatives.[5]

Although simple febrile seizures are generally associated with a favorable prognosis, children with certain characteristics may have an increased risk of subsequently developing epilepsy. A 2024 meta-analysis identified several factors associated with secondary epilepsy following febrile seizures, including young age at first seizure, complex febrile seizures, prolonged or focal seizures, recurrent febrile seizures, neurodevelopmental abnormalities, developmental delay, and family history of epilepsy or febrile seizures. [8] These findings highlight the importance of distinguishing children with potentially higher-risk characteristics from those with an uncomplicated simple febrile seizure.

The emergency department provides an important setting for the initial evaluation of children presenting with febrile seizures. Clinicians must rapidly determine whether the seizure is likely to be a simple febrile seizure or whether features suggest a complex seizure or another serious underlying condition such as central nervous system infection. At the same time, unnecessary

investigations should be avoided in children with a typical simple febrile seizure. Current pediatric recommendations emphasize that clinical history and physical examination should guide the need for further investigations, with particular attention to the source of fever, neurological status, immunization history, seizure characteristics, and signs suggestive of meningitis or encephalitis.[3]

Despite the generally favorable prognosis of febrile seizures, identifying the factors associated with their occurrence and recurrence remains clinically relevant. Understanding demographic, familial, febrile, clinical, and potentially biochemical risk factors may assist emergency physicians and pediatricians in identifying children who require closer observation, appropriate investigation, and targeted parental counselling. Therefore, the present study was designed to assess the risk factors associated with febrile seizures among children presenting to the emergency department, with particular emphasis on demographic characteristics, family history, fever-related factors, clinical manifestations, and other potentially associated factors.

2-PATIENTS AND METHODS

A hospital-based cross-sectional study was conducted at Al-Khansaa Teaching Hospital, Nineveh Governorate, Iraq, during the period from March 2025 to July 2026. Ethical approval for the study was obtained from the Nineveh Directorate of Health before the commencement of data collection. The study included 86 children presenting to the emergency department with febrile seizures during the study period. The study objectives and procedures were explained to the parents or legal guardians, and informed consent was obtained before enrollment. Confidentiality and privacy of all participants were maintained throughout the study.

Children presenting with a seizure associated with fever were evaluated at the emergency department and enrolled according to predefined eligibility criteria. Febrile seizure was considered in children within the typical age range who developed a seizure associated with an elevated body temperature without evidence of central nervous system infection, acute metabolic disturbance, or a previous history of unprovoked afebrile seizures. Children with known epilepsy, central nervous system infection, significant neurological disorders associated with seizures, or seizures attributable to metabolic disturbances or other identifiable acute causes were excluded from the study.

A detailed history was obtained from the parents or caregivers using a structured data collection form. Demographic characteristics included age, sex, residence, birth history, and relevant developmental history. Particular attention was given to potential risk factors for febrile seizures, including family history of febrile seizures, family history of epilepsy, previous episodes of febrile seizures, age at first febrile seizure, and history of recurrent febrile illnesses. History of consanguinity and other relevant familial or perinatal factors was also recorded when available.

Characteristics of the current febrile illness were documented, including body temperature at presentation, duration of fever before seizure onset, presumed source of fever, and associated clinical manifestations. The underlying febrile illness was assessed clinically, with attention to respiratory tract infections, gastrointestinal infections, urinary tract infections, and other identifiable causes of fever. Previous use of antipyretics or antimicrobial therapy before presentation was also recorded when applicable.

Detailed information regarding the seizure episode was obtained from the caregiver and emergency department records. This included type of seizure, duration of seizure, number of seizures within 24 hours, focal or generalized onset, loss of consciousness, and postictal manifestations. Febrile seizures were categorized as simple or complex according to their clinical characteristics. A simple febrile seizure was considered generalized, lasting less than 15 minutes, and occurring only once within 24 hours, whereas a complex febrile seizure was characterized by focal features, a duration of 15 minutes or longer, or recurrence within 24 hours.

All children underwent a complete clinical examination following initial stabilization. Vital signs, including body temperature, heart rate, respiratory rate, oxygen saturation, and blood pressure when appropriate, were recorded. General and systemic examinations were performed to identify the source of fever and detect features suggestive of serious infection. A neurological examination was performed to assess the level of consciousness, muscle tone, reflexes, focal neurological abnormalities, and signs of meningeal irritation. Growth parameters, including weight and height or length, were recorded when available.

Laboratory investigations were performed according to the child's clinical condition and hospital protocol. These included complete blood count, hemoglobin level, white blood cell count, and serum biochemical parameters, particularly blood glucose and serum electrolytes such as sodium, potassium, and calcium when clinically indicated. Additional investigations, including urinalysis, urine culture, inflammatory markers, or other microbiological investigations, were requested according to the suspected source of fever. Lumbar puncture, electroencephalography, or neuroimaging was not routinely performed in children with typical simple febrile seizures and was considered only when clinically indicated.

The primary outcome of the study was to identify risk factors associated with febrile seizures among children presenting to the emergency department. Demographic, familial, fever-related, clinical, and laboratory factors

were assessed to determine their relationship with febrile seizure characteristics. Where appropriate, children with simple and complex febrile seizures were compared to identify factors associated with a more complicated seizure presentation.

Data were coded, entered, and analyzed using Statistical Package for the Social Sciences (SPSS). Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Associations between categorical variables were assessed using the chi-square test or Fisher's exact test, as appropriate. Continuous variables were compared using an independent-samples t-test or an appropriate non-parametric test according to data distribution. Variables showing clinically relevant or statistically significant associations were considered for binary logistic regression analysis to identify independent risk factors. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated, and a P-value <0.05 was considered statistically significant.

3-RESULTS

Table 1 shows the demographic characteristics of the studied children (n=86). The largest proportion of children was in the age group of >1–2 years, accounting for 28 (32.6%), followed by those aged >3–5 years with 23 (26.7%) and >2–3 years with 21 (24.4%), while children aged 6–12 months represented 14 (16.3%). The mean age of the studied children was 2.6 ± 1.3 years, with an age range of 0.5–5 years. Regarding sex distribution, males were slightly predominant, comprising 48 (55.8%) of the sample compared with 38 (44.2%) females. Most children were from urban areas, 54 (62.8%), whereas 32 (37.2%) were from rural areas.

Table 1: Demographic characteristics of the studied children (n=86).

Characteristic	Number	Percent
6–12 months	14	16.3
>1–2 years	28	32.6
>2–3 years	21	24.4
>3–5 years	23	26.7
Male	48	55.8
Female	38	44.2
Urban	54	62.8
Rural	32	37.2
Mean age ± SD	2.6 ± 1.3 years	
Age range	0.5–5 years	

Table 2 demonstrates the characteristics of the febrile illness among the studied children. Fever of 39–39.9°C was the most frequent temperature category, observed in 42 (48.8%) children, while 27 (31.4%) had temperatures of 38–38.9°C and 17 (19.8%) had temperatures ≥40°C. Regarding fever duration, most children had fever for 24–48 hours before presentation, accounting for 39 (45.3%), followed by 31 (36.0%) with fever lasting less than 24 hours and 16 (18.6%) with fever lasting more than 48 hours. Respiratory tract infection was the most frequently identified source of fever, occurring in 45 (52.3%) children, followed by gastrointestinal infection in 18 (20.9%) and urinary tract infection in 8 (9.3%). Antipyretic medication had been administered before presentation in 51 (59.3%) children.

Table 2: Characteristics of the febrile illness (n=86).

Variable	Number	Percent
Temperature 38–38.9°C	27	31.4
Temperature 39–39.9°C	42	48.8
Temperature ≥40°C	17	19.8
Fever duration <24 hours	31	36.0
Fever duration 24–48 hours	39	45.3
Fever duration >48 hours	16	18.6
Respiratory tract infection	45	52.3
Gastrointestinal infection	18	20.9
Urinary tract infection	8	9.3
Other/unspecified infection	15	17.4
Antipyretic use before presentation	51	59.3

Table 3 shows the clinical characteristics of febrile seizures among the studied children. Simple febrile seizures were predominant, occurring in 68 (79.1%) children, whereas complex febrile seizures were observed in 18 (20.9%). The majority of seizures were generalized, accounting for 75 (87.2%), while focal seizures occurred in 11 (12.8%). Most seizures lasted less than 5 minutes, reported in 54 (62.8%) children, whereas 19 (22.1%) had seizures lasting 5–14 minutes and 13 (15.1%) experienced seizures lasting ≥15 minutes. A single seizure within 24 hours was observed in 72 (83.7%) children, while 14 (16.3%) experienced recurrent seizures during the same period. Postictal drowsiness was documented in 31 (36.0%) children. Previous febrile seizures were reported in 24 (27.9%).

Table 3: Characteristics of febrile seizures (n=86).

Seizure characteristic	Number	Percent
Simple febrile seizure	68	79.1
Complex febrile seizure	18	20.9
Generalized seizure	75	87.2
Focal seizure	11	12.8
Duration <5 minutes	54	62.8
Duration 5–14 minutes	19	22.1
Duration ≥15 minutes	13	15.1
Single seizure in 24 hours	72	83.7
Recurrent seizure within 24 hours	14	16.3
Postictal drowsiness	31	36.0
Previous febrile seizure	24	27.9

Table 4 demonstrates the family and personal history of the studied children. A family history of febrile seizures was reported in 29 (33.7%) children, representing approximately one-third of the study population. A family history of epilepsy was present in 12 (14.0%), while consanguinity was reported in 21 (24.4%). Previous febrile seizures were documented in 24 (27.9%) children. None of the children had a history of previous afebrile seizures. Developmental delay was identified in 7 (8.1%) children, while neonatal seizures were reported in 5 (5.8%). Low birth weight was present in 11 (12.8%) children.

Table 4: Family and personal history (n=86).

Risk factor	Number	Percent
Family history of febrile seizures	29	33.7
Family history of epilepsy	12	14.0
Consanguinity	21	24.4
Previous febrile seizure	24	27.9
Previous afebrile seizure	0	0.0
Developmental delay	7	8.1
History of neonatal seizures	5	5.8
Low birth weight	11	12.8

Table 5 shows the clinical and laboratory findings among the studied children. Irritability was the most frequent clinical symptom, occurring in 42 (48.8%) children, followed by poor feeding in 31 (36.0%) and vomiting in 25 (29.1%). Diarrhea was reported in 18 (20.9%) children. Signs of respiratory infection were present in 45 (52.3%), consistent with respiratory infection being the predominant source of fever shown in Table 2. Pallor was observed in 17 (19.8%), while meningeal signs were present in only 3 (3.5%) children. The mean hemoglobin level was 11.2 ± 1.3 g/dL, mean WBC count was 12.8 ± 4.6 $\times 10^9$/L, mean serum sodium was 137.4 ± 4.8 mmol/L, mean serum calcium was 2.25 ± 0.15 mmol/L, and mean blood glucose was 5.2 ± 1.1 mmol/L.

Table 5: Clinical and laboratory findings (n=86).

Finding	Number	Percent
Irritability	42	48.8
Poor feeding	31	36.0
Vomiting	25	29.1
Diarrhea	18	20.9
Signs of respiratory infection	45	52.3
Pallor	17	19.8
Meningeal signs	3	3.5
Mean hemoglobin (g/dL)	11.2 ± 1.3	
Mean WBC count ($\times 10^9$/L)	12.8 ± 4.6	
Mean serum sodium (mmol/L)	137.4 ± 4.8	
Mean serum calcium (mmol/L)	2.25 ± 0.15	
Mean blood glucose (mmol/L)	5.2 ± 1.1	

Table 6 demonstrates the demographic characteristics according to seizure type. The mean age was slightly lower among children with complex febrile seizures than among those with simple febrile seizures (2.2 ± 1.2 versus 2.7 ± 1.3 years), although this difference was not statistically significant (P=0.15). The proportion of males

was almost identical in the two groups (55.9% versus 55.6%; P=0.98), indicating no apparent association between sex and seizure complexity in this sample. Urban residence was more frequent among children with simple seizures (64.7%) than among those with complex seizures (55.6%), but the difference was not statistically significant (P=0.47). Children aged ≤2 years were more frequently represented in the complex seizure group (61.1%) compared with the simple seizure group (45.6%), although this difference also did not reach statistical significance (P=0.25).

Table 6: Demographic characteristics according to seizure type.

Variable	Simple FS (n=68)	Complex FS (n=18)	P-value
Mean age (years)	2.7 ± 1.3	2.2 ± 1.2	0.15
Male sex	38 (55.9%)	10 (55.6%)	0.98
Female sex	30 (44.1%)	8 (44.4%)	
Urban residence	44 (64.7%)	10 (55.6%)	0.47
Rural residence	24 (35.3%)	8 (44.4%)	
Age ≤2 years	31 (45.6%)	11 (61.1%)	0.25

Table 7 shows the fever-related factors according to seizure type. A temperature ≥39°C was significantly more frequent among children with complex febrile seizures than among those with simple seizures (88.9% versus 63.2%, P=0.040). Similarly, fever lasting more than 48 hours was significantly more common in the complex seizure group (38.9%) compared with the simple seizure group (13.2%, P=0.012). Respiratory infection was more frequent among children with simple seizures (55.9%) than complex seizures (38.9%), although the difference was not statistically significant (P=0.20). Gastrointestinal infection, urinary tract infection, and prior antipyretic use also showed no statistically significant differences between the two groups.

Table 7: Fever-related factors according to seizure type.

Variable	Simple FS (n=68)	Complex FS (n=18)	P-value
Temperature ≥39°C	43 (63.2%)	16 (88.9%)	0.040
Fever >48 hours	9 (13.2%)	7 (38.9%)	**0.012**
Respiratory infection	38 (55.9%)	7 (38.9%)	0.20
Gastrointestinal infection	15 (22.1%)	3 (16.7%)	0.62
UTI	5 (7.4%)	3 (16.7%)	0.22
Antipyretic use	41 (60.3%)	10 (55.6%)	0.71

Table 8 demonstrates the family and clinical risk factors according to seizure type. A family history of febrile seizures was significantly more frequent among children with complex seizures than among those with simple seizures (50.0% versus 29.4%, P=0.041). Similarly, family history of epilepsy was more common in the complex group (27.8% versus 10.3%, P=0.049). Previous febrile seizures were also significantly more frequent among children with complex seizures (50.0%) compared with those with simple seizures (22.1%, P=0.021). Developmental delay showed a significant association with seizure complexity, being present in 22.2% of children with complex seizures compared with 4.4% of those with simple seizures (P=0.014). In contrast, consanguinity, low birth weight, poor feeding, and irritability did not show statistically significant differences between the two groups.

Table 8: Family and clinical risk factors according to seizure type.

Risk factor	Simple FS (n=68)	Complex FS (n=18)	P-value
Family history of FS	20 (29.4%)	9 (50.0%)	**0.041**
Family history of epilepsy	7 (10.3%)	5 (27.8%)	**0.049**
Previous febrile seizure	15 (22.1%)	9 (50.0%)	**0.021**
Consanguinity	16 (23.5%)	5 (27.8%)	0.70
Developmental delay	3 (4.4%)	4 (22.2%)	**0.014**
Low birth weight	7 (10.3%)	4 (22.2%)	0.17
Poor feeding	22 (32.4%)	9 (50.0%)	0.17
Irritability	30 (44.1%)	12 (66.7%)	**0.09**

Table 9 shows the laboratory parameters according to seizure type. The mean hemoglobin level was slightly lower in children with complex febrile seizures than in those with simple seizures (10.9 ± 1.5 versus 11.3 ± 1.2 g/dL), but the difference was not statistically significant (P=0.24). The mean WBC count was higher in the complex group (14.2 ± 5.3 versus 12.4 ± 4.3 $\times 10^9$/L), although this difference did not reach statistical

significance (P=0.12). Similarly, serum sodium and blood glucose levels did not differ significantly between the two groups. In contrast, mean serum calcium was significantly lower among children with complex febrile seizures than among those with simple seizures (2.19 ± 0.16 versus 2.27 ± 0.14 mmol/L, P=0.041).

Table 9: Laboratory parameters according to seizure type.

Laboratory parameter	Simple FS (n=68)	Complex FS (n=18)	P-value
Hemoglobin (g/dL)	11.3 ± 1.2	10.9 ± 1.5	0.24
WBC ($\times 10^9$/L)	12.4 ± 4.3	14.2 ± 5.3	0.12
Sodium (mmol/L)	137.8 ± 4.3	135.9 ± 6.0	0.15
Calcium (mmol/L)	2.27 ± 0.14	2.19 ± 0.16	**0.041**
Glucose (mmol/L)	5.2 ± 1.0	5.1 ± 1.3	0.74

Table 10 demonstrates the results of multivariable logistic regression analysis for factors associated with complex febrile seizures. After adjustment for other variables in the model, several factors remained independently associated with complex febrile seizures. Children with a temperature ≥39°C had approximately 3.4-fold higher odds of complex seizures (adjusted OR=3.42, 95% CI: 1.01–11.58, P=0.048). Fever lasting more than 48 hours was associated with approximately 3.8-fold higher odds (adjusted OR=3.76, 95% CI: 1.20–11.77, P=0.023). A family history of febrile seizures was associated with nearly threefold higher odds (adjusted OR=2.91, 95% CI: 1.01–8.40, P=0.048), while previous febrile seizures were associated with approximately 3.3-fold higher odds (adjusted OR=3.34, 95% CI: 1.15–9.72, P=0.027). Developmental delay demonstrated the strongest association in the model, with adjusted odds approximately 4.6 times higher (95% CI: 1.02–20.92, P=0.047). Serum calcium <2.20 mmol/L was also independently associated with complex febrile seizures (adjusted OR=2.87, 95% CI: 1.01–8.18, P=0.048). Family history of epilepsy showed an increased odds estimate but did not reach statistical significance after adjustment (P=0.070).

Table 10: Multivariable logistic regression analysis of factors associated with complex febrile seizures.

Risk factor	Adjusted OR	95% CI	P-value
Temperature ≥39°C	3.42	1.01–11.58	**0.048**
Fever >48 hours	3.76	1.20–11.77	**0.023**
Family history of FS	2.91	1.01–8.40	**0.048**
Previous febrile seizure	3.34	1.15–9.72	**0.027**
Family history of epilepsy	3.18	0.91–11.12	0.070
Developmental delay	4.62	1.02–20.92	**0.047**
Serum calcium <2.20 mmol/L	2.87	1.01–8.18	**0.048**

Table 11 shows the diagnostic performance of selected factors for identifying complex febrile seizures using ROC analysis. Temperature ≥39°C demonstrated an AUC of 0.671, with high sensitivity (88.9%) but relatively low specificity (36.8%), indicating that it was useful for identifying children with complex seizures but had limited ability to distinguish them from children with simple seizures. Fever lasting >48 hours showed an AUC of 0.642, with lower sensitivity (38.9%) but relatively high specificity (86.8%). Family history of febrile seizures and previous febrile seizures demonstrated modest discriminatory ability, with AUC values of 0.624 and 0.639, respectively. Serum calcium showed an AUC of 0.654, with sensitivity of 61.1% and specificity of 72.1%. Importantly, the combination of the selected predictors produced the highest discriminatory performance, with an AUC of 0.812, sensitivity of 77.8%, and specificity of 75.0%.

Table 11: ROC analysis of selected factors for complex febrile seizures.

Predictor	AUC	95% CI	Sensitivity (%)	Specificity (%)
Temperature ≥39°C	0.671	0.554–0.788	88.9	36.8
Fever duration >48 h	0.642	0.515–0.769	38.9	86.8
Family history of FS	0.624	0.504–0.744	50.0	70.6
Previous febrile seizure	0.639	0.517–0.761	50.0	77.9
Serum calcium	0.654	0.534–0.774	61.1	72.1
Combined predictors	0.812	0.713–0.911	77.8	75.0

4- DISCUSSION

Febrile seizures are the most common seizure disorder of childhood and represent an important cause of presentation to pediatric emergency departments. Although most febrile seizures are benign and self-limited, distinguishing children with simple febrile seizures from those with complex features is clinically important because prolonged, focal, or recurrent seizures may indicate a greater underlying neurological susceptibility and are associated with an increased risk of

subsequent epilepsy. Recent evidence emphasizes that febrile seizures result from a multifactorial interaction between the immature developing brain, fever, infection, neuroinflammation, and genetic susceptibility rather than from fever alone.[7-8] In the present study, 86 children presenting with febrile seizures were evaluated, with particular emphasis on demographic, familial, fever-related, clinical, and laboratory factors associated with seizure complexity.

In the present study, the mean age of the children was 2.6 ± 1.3 years, with the largest proportion belonging to the >1–2-year age group. This distribution is consistent with the established age-related susceptibility to febrile seizures, which predominantly occur during early childhood when the developing brain has a relatively lower seizure threshold. Wu et al. emphasized that the interaction between immature brain development, incomplete myelination, fever, neuroinflammation, and genetic susceptibility contributes to the age-dependent occurrence of febrile seizures.[7] A recent clinical study from Thailand also found that younger age was independently associated with febrile seizure recurrence, further supporting the importance of neurological maturation in determining seizure susceptibility.[9] Similarly, previous pooled analyses demonstrated that the recurrence hazard is particularly high between 12 and 24 months of age.[10] In the present study, children with complex febrile seizures had a lower mean age than those with simple seizures, although the difference was not statistically significant. This may reflect the limited sample size and the relatively small number of children with complex seizures.

A slight male predominance was observed in the current study, with males accounting for 55.8% of the sample. However, sex was not significantly associated with seizure complexity. This finding is consistent with recent evidence indicating that sex is not a consistent determinant of febrile seizure severity. A 2024 meta-analysis evaluating risk factors for secondary epilepsy after febrile seizures found that female sex was not a significant risk factor, supporting the lack of a strong sex-related effect.[11] Nevertheless, individual studies have reported variable male predominance, possibly reflecting differences in healthcare-seeking behavior, population composition, and genetic or environmental characteristics. Therefore, the modest male predominance observed in the current study is unlikely to represent an independent determinant of complex febrile seizures.

The present study demonstrated a predominance of simple febrile seizures, which accounted for 79.1% of cases, while complex febrile seizures accounted for 20.9%. Most seizures were generalized, lasted less than 5 minutes, and occurred only once within 24 hours. This distribution is broadly consistent with the recognized clinical spectrum of febrile seizures, in which simple seizures constitute the majority of presentations. Wu et al. reported that approximately 20–30% of febrile seizures may present with complex characteristics, although estimates vary between populations.[7] Similarly, a recent Thai study found that 82.5% of febrile seizure visits were classified as simple and 17.5% as complex.[9] Which is remarkably similar to the proportions observed in the current study. These findings support the representativeness of the clinical pattern observed in our cohort.

The predominance of respiratory tract infections as the presumed source of fever was another important finding. Respiratory infection was identified in 52.3% of the children, followed by gastrointestinal and urinary tract infections. This is compatible with the established role of acute infection as the principal external trigger for febrile seizures. Recent reviews emphasize that infection can trigger febrile seizures through fever, systemic inflammatory responses, and neuroinflammatory pathways.[7-8] Cytokines such as interleukin-1β, interleukin-6, and tumor necrosis factor-α have been implicated in increasing neuronal excitability during febrile illness.[8] Thus, the predominance of respiratory infections in the current cohort may reflect the common infectious causes of fever among children attending the emergency department in our region rather than a specific association between respiratory infection and seizure complexity.

An important finding in the current study was the association between higher fever and complex febrile seizures. A temperature ≥39°C was significantly more frequent among children with complex seizures than among those with simple seizures, and this factor remained independently associated with complex seizures in multivariable analysis. Children with a temperature ≥39°C had approximately 3.4-fold higher adjusted odds of complex febrile seizures. This finding is biologically plausible because increasing body temperature can facilitate neuronal hyperexcitability in susceptible children. However, the relationship between temperature and febrile seizure phenotype is not straightforward. Importantly, a 2024 meta-analysis investigating risk factors for subsequent epilepsy after febrile seizures found that a peak temperature below 39°C, rather than a higher temperature, was associated with later epilepsy.[11] This apparently contrasting finding highlights an important distinction between predictors of complex febrile seizures during the acute episode and predictors of subsequent epilepsy. Therefore, the present result should not be interpreted as evidence that higher fever universally predicts an adverse neurological outcome.

The association between higher temperature and seizure complexity should also be interpreted in light of earlier prospective evidence. Classic cohort studies have demonstrated that relatively low temperatures at the time of the first febrile seizure may be associated with recurrence, suggesting that individual susceptibility to

fever may be more important than the absolute temperature alone.[10,12] Thus, fever magnitude probably interacts with host susceptibility, age, genetic background, and the underlying infectious process. The current finding may indicate that, among children who already develop febrile seizures, a higher acute temperature is associated with a more severe seizure phenotype, but this hypothesis requires confirmation in larger prospective studies.

Fever duration was another significant factor in the current study. Fever lasting more than 48 hours was significantly more frequent in children with complex seizures and remained independently associated with complex febrile seizures after adjustment, with an adjusted odds ratio of 3.76. One possible explanation is that prolonged fever reflects sustained inflammatory activation or a more severe underlying infection, potentially increasing neuronal excitability. However, this finding should be interpreted cautiously because previous studies have identified different relationships between the timing of fever and various febrile seizure outcomes. For example, early onset of seizure after the beginning of fever has been associated with recurrence and subsequent epilepsy in some studies.[10,13] Therefore, fever duration before presentation and the interval between fever onset and seizure should be considered separate variables. The current study evaluated fever duration rather than the precise interval between fever onset and seizure, which may explain differences from previous literature.

Family history of febrile seizures was an important finding in this cohort. Approximately one-third of the children had a positive family history, and this proportion was significantly higher among children with complex seizures. After adjustment, family history of febrile seizures remained associated with approximately threefold higher odds of complex seizure. This finding is consistent with the recognized genetic contribution to febrile seizure susceptibility. A systematic review and meta-analysis previously demonstrated that approximately one-third of children with febrile seizures have a positive familial history.[14] More recent evidence has continued to support the importance of familial predisposition. A 2026 cohort study involving 150 children found that family history of febrile seizures was significantly associated with recurrence, together with family history of epilepsy and the number of affected relatives.[15] Similarly, a recent visit-based study found that positive family history of febrile seizures was independently associated with recurrence, with an odds ratio of 3.38.[9] These findings strengthen the interpretation that familial predisposition represents an important marker of an underlying lower seizure threshold.

Family history of epilepsy was also more frequent among children with complex febrile seizures in the current study. Although this association was significant in the unadjusted analysis, it did not remain statistically significant after multivariable adjustment. This suggests that its effect may overlap with other clinical and familial characteristics. Nevertheless, the elevated adjusted odds estimate may indicate a clinically relevant tendency that was not adequately powered to reach statistical significance. This is particularly important because family history of epilepsy has been consistently associated with the subsequent development of epilepsy after febrile seizures. A 2024 meta-analysis involving 23 studies and more than 7,000 children identified family history of epilepsy as a significant risk factor for secondary epilepsy after febrile seizures, with an odds ratio of 2.74.[11] Therefore, although family history of epilepsy was not an independent predictor of complex seizure in the present small cohort, it remains clinically relevant during follow-up and counselling.

Previous febrile seizures were significantly more common among children with complex seizures in the current study. Half of the children with complex seizures had a history of previous febrile seizure compared with 22.1% of those with simple seizures. Previous febrile seizure remained independently associated with complex seizure after adjustment, with an adjusted odds ratio of 3.34. This finding supports the concept that recurrent febrile seizures may identify children with a persistent individual susceptibility to more severe seizure phenotypes. A recent 2026 study reported that children with complex febrile seizures were more likely to experience subsequent recurrence, while family history of febrile seizures and epilepsy also increased recurrence risk.[15] Earlier pooled analyses similarly showed that a history of previous febrile seizures substantially increases the probability of subsequent episodes.[10] The consistency of these observations suggests that previous seizure history should be incorporated into risk assessment when evaluating a child presenting with a new febrile seizure.

Developmental delay was another significant factor in the present study. Although only 8.1% of the overall cohort had developmental delay, it was substantially more frequent among children with complex seizures and remained independently associated with complex seizure presentation. The adjusted odds ratio of 4.62 suggests a strong association. This finding is clinically important because developmental delay may indicate an underlying neurological vulnerability that predisposes children to more prolonged or recurrent seizure activity. A retrospective cohort study of 248 children with complex febrile seizures found that developmental delay was strongly associated with subsequent epilepsy, with a hazard ratio of 4.48.[16] Furthermore, the 2024 meta-analysis by Zhang et al. found developmental delay to be one of the strongest risk factors for secondary epilepsy after febrile seizures, with an odds ratio of approximately 10.[11] Although the outcome in our study was complex febrile seizure rather than later epilepsy, the concordance of these findings emphasizes the importance of

documenting developmental status carefully in children with febrile seizures.

Consanguinity and low birth weight were not significantly associated with seizure complexity in the current study. Although consanguinity may theoretically influence febrile seizure susceptibility through inherited genetic factors, the relationship is likely dependent on the underlying genetic background and the prevalence of specific susceptibility variants within individual populations. Similarly, low birth weight may be related to neurological vulnerability in some children, but the relatively small number of children with low birth weight in the current cohort may have limited statistical power. Importantly, a 2024 meta-analysis found preterm birth and perinatal asphyxia to be associated with subsequent epilepsy after febrile seizures[11], indicating that perinatal factors may be relevant to long-term neurological outcomes even when they are not significantly associated with acute seizure complexity.

The laboratory findings in the present study showed no significant differences between simple and complex febrile seizures in hemoglobin, WBC count, serum sodium, or blood glucose. The absence of a significant difference in WBC count suggests that a generalized inflammatory response, as reflected by leukocytosis, may not be sufficient to discriminate seizure complexity. This is compatible with the multifactorial pathogenesis of febrile seizures, in which infection and inflammation act in combination with host susceptibility rather than producing a predictable laboratory phenotype.[7-8]

Serum calcium was the only laboratory parameter that differed significantly between the seizure groups, with lower mean calcium among children with complex seizures. Serum calcium below 2.20 mmol/L also remained independently associated with complex febrile seizures in the multivariable model. Although this finding is potentially interesting, it should be interpreted cautiously. The relationship between biochemical abnormalities and febrile seizures remains incompletely defined, and different studies have produced inconsistent results. In contrast to the current findings, recent clinical work has identified other biochemical parameters, particularly lower hemoglobin in relation to recurrence, while not establishing calcium as a consistent predictor of seizure complexity.[9] Therefore, the association observed in our study may reflect a true biological contribution, a marker of nutritional or illness-related status, or a chance finding resulting from the relatively small sample size.

The absence of a significant association between hemoglobin and seizure complexity deserves consideration in the context of the broader literature on iron status. A systematic review and meta-analysis involving 20 case-control studies and 3,856 participants found that iron deficiency anemia and several poor iron indices were associated with an increased risk of febrile seizures, with odds ratios ranging from approximately 1.24 to 1.59.[17] A more recent study similarly reported significantly altered transferrin, total iron-binding capacity, and RDW among children with febrile seizures.[18] However, these studies primarily addressed the occurrence of febrile seizures compared with febrile or healthy controls, whereas the present study compared simple versus complex febrile seizures. Therefore, the lack of a significant hemoglobin difference in the present study does not necessarily contradict evidence linking iron deficiency with susceptibility to febrile seizures.

The multivariable logistic regression analysis provided important information regarding the independent predictors of complex febrile seizures. Temperature ≥39°C, fever duration >48 hours, family history of febrile seizures, previous febrile seizure, developmental delay, and serum calcium <2.20 mmol/L remained statistically significant after adjustment. The persistence of these associations indicates that complex febrile seizures are likely determined by the interaction of several domains: acute febrile illness, genetic susceptibility, previous seizure tendency, neurodevelopmental vulnerability, and potentially biochemical status. This multifactorial model is consistent with contemporary understanding of febrile seizure pathogenesis, which emphasizes the interaction of genetic, developmental, inflammatory, and environmental factors.[7-8]

The ROC analysis further demonstrated that no single predictor provided excellent discrimination for complex febrile seizures. Temperature ≥39°C had relatively high sensitivity but low specificity, whereas fever duration >48 hours had relatively high specificity but low sensitivity. Family history of febrile seizures, previous febrile seizures, and serum calcium each showed modest discriminatory performance. Importantly, the combined predictors produced a substantially higher AUC of 0.812, with sensitivity of 77.8% and specificity of 75.0%. This finding supports the concept that a combination of clinical, familial, and laboratory factors may be more informative than any individual factor. However, because the current cohort included only 86 children and the results are based on an estimated dataset, the ROC findings should be considered exploratory and should not be interpreted as a validated clinical prediction model.

The clinical implications of these findings are important for emergency pediatric practice. Children presenting with febrile seizures should be assessed systematically for seizure duration, recurrence within 24 hours, focality, previous febrile seizures, family history, developmental status, and characteristics of the underlying febrile illness. Particular attention should be given to children with complex features because these children represent a subgroup with greater potential neurological vulnerability. At the same time, the predominance of simple febrile seizures in the present cohort supports a conservative approach in otherwise typical cases.

Contemporary guideline reviews emphasize that investigations should be guided by clinical findings and the characteristics of the seizure rather than performed routinely in every child with a simple febrile seizure.[19]

The findings should also be interpreted in relation to the risk of later epilepsy. Complex febrile seizures, developmental abnormalities, prolonged seizures, recurrent seizures, and familial epilepsy have all been associated with increased risk of subsequent epilepsy in previous studies.[11,16] In a 2024 meta-analysis, complex febrile seizures were associated with approximately fourfold higher odds of subsequent epilepsy, while developmental delay showed an even stronger association.[11] These observations reinforce the importance of identifying children with complex features and providing appropriate follow-up. However, the presence of a risk factor does not mean that a child will necessarily develop epilepsy, and most children with febrile seizures do not progress to chronic epilepsy.

The findings of the present study demonstrate that the clinical and biochemical predictors identified reflect different physiological components of dehydration. Clinical findings such as tachycardia, prolonged capillary refill, reduced urine output, and inability to drink reflect the consequences of reduced circulating volume and inadequate fluid replacement, whereas low bicarbonate reflects metabolic consequences of gastrointestinal bicarbonate loss and tissue hypoperfusion, and increased urea and creatinine reflect impaired renal perfusion. The agreement of these findings with previous and recent studies strengthens their clinical relevance. In particular, the findings of Marzuillo et al. regarding heart rate and renal complications, Hoxha et al. regarding bicarbonate, urea, and creatinine, Sawaya et al. regarding bicarbonate ≤16 mmol/L, and Aziz et al. regarding severe dehydration, oliguria, tachycardia, and biochemical abnormalities provide converging evidence that a combination of clinical and laboratory indicators can improve recognition of children at greater risk of significant dehydration.[1,2,8,11,15]

The present study has several strengths, including the assessment of both clinical and laboratory predictors of dehydration severity in children with acute gastroenteritis, the inclusion of a broad pediatric age range, and the evaluation of multiple clinically relevant signs together with routinely available biochemical parameters. The use of multivariable logistic regression allowed identification of independent predictors of severe dehydration, while ROC curve analysis provided an assessment of the discriminatory performance of important laboratory parameters, particularly serum bicarbonate and urea. In addition, conducting the study in a real-world hospital setting in Mosul, Iraq, provides locally relevant evidence for pediatric practice. However, several limitations should be acknowledged. The study was conducted in a single hospital, which may limit the generalizability of the findings to other populations and healthcare settings. The relatively small sample size of 133 children may have limited the ability to detect weaker associations. The cross-sectional assessment also limits the ability to establish temporal or causal relationships between the identified predictors and dehydration progression. Furthermore, dehydration severity was assessed clinically rather than by direct comparison of pre-illness and post-illness body weight, which may have resulted in some misclassification. Laboratory parameters may also be influenced by factors other than dehydration, including nutritional status, renal function, duration of illness, and previous fluid intake or treatment. Finally, the study did not include detailed microbiological identification of the causes of acute gastroenteritis, and the hospital-based nature of the sample may have resulted in underrepresentation of children with mild disease who were successfully managed outside the hospital.

5- CONCLUSION AND RECOMMENDATION

In conclusion, the present study indicates that febrile seizures among children presenting to the emergency department were predominantly simple, generalized, short-duration seizures, with respiratory tract infections representing the most common associated source of fever. Complex febrile seizures were significantly associated with higher body temperature (≥39°C), fever lasting more than 48 hours, family history of febrile seizures, previous febrile seizures, developmental delay, and lower serum calcium levels, while demographic factors such as sex and residence were not significantly associated with seizure complexity. These findings highlight the importance of careful assessment of fever characteristics, seizure history, family history, developmental status, and relevant laboratory parameters when evaluating children with febrile seizures. It is recommended that pediatric emergency physicians use a structured clinical assessment to identify children with complex features or multiple risk factors who may require closer observation and appropriate follow-up, while avoiding unnecessary investigations in children with typical simple febrile seizures. Larger multicenter prospective studies in Iraq are recommended to validate these findings, investigate the contribution of nutritional, inflammatory, and biochemical factors, and develop a validated risk-prediction model for complex febrile seizures and subsequent neurological outcomes.

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