RESEARCH PAPER

Clinical Profile of Febrile Seizure and its Special Reference to Serum Sodium - A Prospective Observational Study

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ABSTRACT

Background: The most frequent type of seizures in children are febrile seizures (FS), which are usually brought on by infections that cause the body to heat up quickly. There is growing evidence that electrolyte imbalances, especially low serum sodium, may affect their frequency and intensity. Muscle contraction, nerve transmission, and fluid balance all depend on serum sodium levels. In order to better understand how electrolyte imbalances impact seizure dynamics and to guide therapeutic techniques that address fever and underlying electrolyte problems, this study investigates the link between sodium levels and FS outcomes.

Methodology: The purpose of this prospective observational study was to assess the clinical profile of 106 children between the ages of 6 and 60 months who had febrile seizures and ascertain whether serum sodium levels were linked to seizure recurrence within 24 hours. Every patient had fever, uncontrollable movements, and almost all of them rolled their eyes.

Results: Seizures recurred in 27.4% of cases. Recurrence was significantly correlated with male gender, history of seizures, and low serum sodium levels (hyponatremia). 75.9% of people with recurrent seizures were men, 62.1% had a history of seizures, and 69% had hyponatremia. The mean serum sodium level was statistically significantly lower in those with recurrent seizures than in those without (130.86 vs 135.17 mmol/L). Serum potassium, age, seizure length, vital signs, and immunization status were among the other factors that did not significantly correlate with seizure recurrence.

Conclusion: These findings suggest that hyponatremia and male gender are key predictors of early recurrence in febrile seizures**.**

Keywords: Febrile seizures, fever, hyponatremia, serum sodium levels.

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INTRODUCTION

Febrile seizures (FS) are the most common type of seizure occurring in childhood, typically triggered by a rapid rise in body temperature, often due to an infection. These seizures generally affect children between the ages of 6 months and 5 years, and while they are typically benign and self-limiting, they can be distressing for both the child and their caregivers. The clinical profile of febrile seizures varies from brief, isolated episodes to more prolonged or recurrent events, but the vast majority do not result in long-term neurological damage (1).

Environmental and genetic factors are both involved in the complex pathophysiology of febrile seizures (2). According to recent studies, electrolyte imbalances, especially those involving blood sodium levels, may play a role in the frequency and intensity of febrile seizures. Maintaining fluid equilibrium, neuronal transmission, and muscle function all depend heavily on serum sodium, an electrolyte that is vital for cellular activity. Seizure activity has been linked to changes in sodium levels, either hyponatremia (low sodium) or hypernatremia (high sodium), particularly during febrile episodes (3).

This prospective study aims to investigate the clinical profile of febrile seizures in a cohort of children, with a particular focus on the relationship between serum sodium levels and the occurrence, duration, and severity of febrile seizures. By exploring the correlation between serum sodium concentrations and the clinical outcomes of febrile seizures, this study seeks to contribute valuable insights into how electrolyte imbalances may influence febrile seizure dynamics. Furthermore, the findings could potentially lead to more refined management strategies that address not only the febrile condition but also electrolyte disturbances that may exacerbate the likelihood or severity of seizure events.

AIM AND OBJECTIVES

- The primary aim of this study is to evaluate the clinical profile of febrile seizures in children, with a particular emphasis on investigating the role of serum sodium levels in the occurrence, severity, and duration of these seizures.
- The study aims to identify any potential correlations between serum sodium disturbances and the clinical outcomes of febrile seizures.

MATERIALS AND METHODS

Study Design: A hospital-based prospective study was conducted to assess the relationship between recurrence of febrile seizures and hyponatremia in children in the Department of Paediatrics in a Tertiary Care Hospital at Puducherry over a period of 12 months after the approval of the SRC and IEC (No: 42/SVMCH/IEC-Cert/May23). Necessary consent obtained from the parents or guardians of all participants. A total of 106 patients were included in the study based on a confidence interval of 95%, a margin of error of 5% and an estimated recurrence rate of febrile seizures at 7.5%.

Inclusion Criteria and Exclusion Criteria: Children of either sex, aged between 6 to 60 months and children presenting with any episode of febrile seizures at the time of admission were included in the study. Children with other neurological disorders such as cerebral palsy, mental retardation, or a past history of meningitis with seizures were excluded. Children who experienced fever after the episode of seizure were not included. Patients who had been on antibiotics for more than 48 hours prior to presenting to the hospital were excluded.

Methodology: At the time of admission, the following procedures were carried out:

1. **Fever Measurement:** Fever was recorded using a digital thermometer in Fahrenheit at the time of admission.
2. **Serum Sodium Levels:** Serum sodium levels were measured for each patient at the time of admission

Data Collection Methods:

1. Informed consent was obtained from the parents or guardians of all patients before participation in the study.
2. Demographic details such as age, sex, and medical history were recorded for each patient.
3. A thorough clinical examination was conducted for all patients.
4. All relevant data was documented using a predesigned and pretested proforma, which ensured consistency and reliability in data collection.

STATISTICAL ANALYSIS

The collected data was entered into Microsoft Excel for organization and further analysis. Statistical analysis was performed using SPSS software version 23.0.

1. Categorical variables were reported as frequencies and percentages.
2. Continuous variables were expressed as means and standard deviations.
3. The mean values of continuous variables between groups were compared using the t-test.
4. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The mean age of the patients is 30.01 months, with a standard deviation of 11.42 months. The ages ranged from a minimum of 10 months to a maximum of 60 months, and the median age was 28 months. The gender distribution shows that 50 male patients (47.2%) and 56 female patients (52.8%) participated in the study.

Table 1: Prevalence of Involuntary Movements, Eye Rolling, Fever Episodes, and Previous Seizures

Presence of Involuntary Movements in Patients			
	No of patients	Percentage	
Involuntary movements	Yes	106	100.0%
Prevalence of Eye Rolling Among Patients			
	No of patients	Percentage	
Eye rolling	No	5	4.7%
	Yes	101	95.3%
Frequency of Fever Episodes in Patients			
	No of patients	Percentage	
Fever episode	Yes	106	100.0%
History of Previous Seizures in Patients			
	No of patients	Percentage	
Previous seizure	No	74	69.8%
	Yes	32	30.2%

Table 1 summarizes the clinical features observed in the patient population. All 106 patients (100%) presented with involuntary movements. Eye rolling was observed in 101 patients (95.3%), while 5 patients (4.7%) did not exhibit

this symptom. Every patient in the study (100%) experienced a fever episode. Out of the 106 patients, 32 (30.2%) had a history of seizures, while 74 (69.8%) had no prior seizure history.

All 106 patients (100%) were treated with Clobazam. The mean dosage was 3.10 mg, with a standard deviation of 0.96 mg. The dosages ranged from a minimum of 1.50 mg to maximum of 5.00 mg, with the median dosage being 3.00mg.

Table 2: Family History of Seizures and Immunisation Status of Patients

Family History of Seizures in Patients			
		No of patients	Percentage
Family history	No	102	96.2%
	Yes	4	3.8%
Immunisation Status of Patients			
		No of patients	Percentage
Immunisation	Till date	106	100.0%

Table 2 depicts the family history of seizure conditions among the patients. A large majority of patients (96.2%) had no family history of seizures, while only 4 patients (3.8%) reported a family history of seizures. All patients (100%) were up-to-date on their immunizations.

Table 3: Vital Signs and Laboratory Parameters of Patients

Vital Signs and Laboratory Parameters of Patients					
	Mean	Standard Deviation	Minimum	Median	Maximum
SBP	97.49	4.37	88.00	96.00	110.00
DBP	66.11	5.16	52.00	64.00	88.00
HR	108.59	7.26	92.00	108.00	136.00
RR	29.48	4.40	18.00	29.00	38.00
Temperature	101.12	0.65	100.00	100.90	103.00
Serum Na+	133.99	3.55	126.00	134.00	144.00
Serum K+	4.65	0.44	4.00	4.50	5.80

Table 3 shows the vital signs of the patients, including systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), respiratory rate (RR), body temperature, and serum electrolyte levels (Na+ and K+). The table presents the mean, standard deviation, minimum, median, and maximum values for each of these measurements. For instance, the mean SBP was 97.49 mmHg, with a standard deviation of 4.37 mmHg, and the values ranged from a minimum of 88 mmHg to a maximum of 110 mmHg. Similarly, the mean DBP was 66.11 mmHg, the mean HR was 108.59 beats per minute, and the mean body temperature was 101.12°F.

Hyponatremia was prevalent in 51 patients (48.1%) and normal serum sodium level present was 55 (51.9%) among all the children. No statistically significant association between mean age and recurrence of seizure within 24 hours.

Table 4: Association of Demographic, Clinical, Vital Parameters, and Biochemical Factors with Seizure Recurrence within 24 Hours

Gender Distribution in Seizure Recurrence Within 24 Hours						
		Recurrence in 24 hours				P value
		Yes		No		
		Count	Column N %	Count	Column N %	
Gender	Male	22	75.9%	28	36.4%	<0.0001
	Female	7	24.1%	49	63.6%	
Involuntary Movements and Seizure Recurrence in 24 Hours						
		Recurrence in 24 hours				P value
		Yes		No		
		Count	Column N %	Count	Column N %	
Involuntary movements	YES	29	100.0%	77	100.0%	NA
Eye Rolling and Seizure Recurrence in 24 Hours						
		Recurrence in 24 hours				P value

		Yes		No		
		Count	Column N %	Count	Column N %	
Eye rolling	YES	28	96.6%	73	94.8%	0.705
	NO	1	3.4%	4	5.2%	

Prevalence of Fever Episodes and Seizure Recurrence in 24 Hours

		Recurrence in 24 hours				P value
		Yes		No		
		Count	Column N %	Count	Column N %	
Fever episode	YES	29	100.0%	77	100.0%	NA

Previous Seizures and Seizure Recurrence in 24 Hours

		Recurrence in 24 hours				P value
		Yes		No		
		Count	Column N %	Count	Column N %	
Previous seizure	Yes	18	62.1%	14	18.2%	<0.0001
	No	11	37.9%	63	81.8%	

Gender and Previous Seizure History

		Gender				P value
		Female		Male		
		Count	Column N %	Count	Column N %	
Previous seizure	No	54	96.4%	20	40.0%	<0.0001
	Yes	2	3.6%	30	60.0%	

Duration of Seizure and Seizure Recurrence in 24 Hours

	Recurrence in 24 hours				P value
	Yes		No		
	Mean	Standard Deviation	Mean	Standard Deviation	
Duration (in min)	2.45	0.91	2.51	0.96	0.775

Family history and Seizure Recurrence in 24 Hours

		Recurrence in 24 hours				
		Yes		No		
		Count	Column N %	Count	Column N %	P value
Family history	YES	1	3.4%	3	3.9%	0.914
	NO	28	96.6%	74	96.1%	

Immunisation Status and Seizure Recurrence in 24 Hours

		Recurrence in 24 hours				P value
		Yes		No		
		Count	Column N %	Count	Column N %	
Immunisation	TILL DATE	29	100.0%	77	100.0%	NA

SBP and Seizure Recurrence in 24 Hours

	Recurrence in 24 hours				P value
	Yes		No		
	Mean	Standard Deviation	Mean	Standard Deviation	

SBP	97.45	5.55	97.51	3.88	0.691
DBP and Seizure Recurrence in 24 Hours					
	Recurrence in 24 hours				P value
	Yes		No		
	Mean	Standard Deviation	Mean	Standard Deviation	
DBP	66.14	5.13	66.10	5.21	0.949
HR and Seizure Recurrence in 24 Hours					
	Recurrence in 24 hours				P value
	Yes		No		
	Mean	Standard Deviation	Mean	Standard Deviation	
HR	109.72	7.83	108.17	7.04	0.528
RR and Seizure Recurrence in 24 Hours					
	Recurrence in 24 hours				P value
	Yes		No		
	Mean	Standard Deviation	Mean	Standard Deviation	
RR	30.21	4.39	29.21	4.40	0.281
Temperature and Seizure Recurrence in 24 Hours					
	Recurrence in 24 hours				P value
	Yes		No		
	Mean	Standard Deviation	Mean	Standard Deviation	
Temperature	101.14	0.66	101.11	0.66	0.989

Serum Sodium (Na+) Levels and Hyponatremia in Patients with Seizure Recurrence in 24 Hours						
		Recurrence in 24 hours				P value
		Yes		No		
		Count	Column N %	Count	Column N %	
Serum Na+	Hyponatremia	20	69.0%	31	40.3%	0.008
	Normal	9	31.0%	46	59.7%	

Table 4 demonstrates among 29 recurrence seizure, 22 males have recurrence febrile seizure (75.9%) with only 7 female child have recurrence seizure (24.1%) which shows that male gender plays a significant predictor for recurrence in seizure within 24 hours. All children had involuntary movements so no comparison group is available. No statistical analysis is applicable. No statistically significant association between eye rolling and recurrence in seizure within 24 hours was observed as the P-value is insignificant (p-value- 0.705). All children had fever episodes and no statistical analysis is applicable. Seizures and seizure recurrence was observed in 24 hours, which was found to be statistically significant P value <0.0001. Of the male patients, 30 (60%) had a previous seizure, while only 2 (3.6%) of the female patients had a previous seizure. The P-value (<0.0001) indicates that the difference in previous seizure history between males and females is statistically significant. P-value of 0.775 which is not statistically significant this suggests that seizure duration is not associated with recurrence within 24 hours. Among 29 recurrence seizure only 1 case with family history of seizure (3.4%) had recurrence while 28 cases had no family history (96.6%). All patients (100%) were up-to-date on their immunizations and no statistical analysis applicable. No significant difference in SBP between recurrence and non -recurrence groups (P-value-0.691) with mean SBP being 97.45 and 97.51 between recurrence and non recurrence groups. No significant difference in DBP between recurrence and non-recurrence groups (P value-0.843) with mean DBP being 66.14 and 66.10 among recurrence and non recurrence groups respectively. No statistically significant difference in heart rate between recurrence and non-recurrence groups (P-value-0.528) with mean HR being 109.72 and 108.17 among recurrence and nonrecurrence groups respectively. No statistically significant difference in respiratory rate between the recurrence and non recurrence groups (P-value-0.281) with mean RR 30.21 and 29.21 among recurrence and non recurrence groups respectively. No statistically significant difference in temperature between the recurrence and non recurrence groups (P-value-0.988) with mean temperature of being 101.14 and 101.11 among

recurrence and non recurrence groups respectively. Among 29 recurrence case of febrile seizure 20 cases of hyponatremia (69%) while comparing to that of normal serum sodium case of 9 children (31%).thus hyponatremia contributes significantly in recurrence predictor of febrile seizure with a P-value of 0.008.

Table 5: Serum Na+ Levels, Serum K+ Levels and Seizure Recurrence in 24 Hours

Serum Na+ Levels and Seizure Recurrence in 24 Hours					
	Recurrence in 24 hours				P value
	Yes		No		
	Mean	Standard Deviation	Mean	Standard Deviation	
Serum Na+	130.86	2.67	135.17	3.10	<0.0001
Serum K+ Levels and Seizure Recurrence in 24 Hours					
	Recurrence in 24 hours				P value
	Yes		No		
	Mean	Standard Deviation	Mean	Standard Deviation	
Serum K+	4.58	0.39	4.67	0.46	0.315

Table 5 depicts lower serum sodium is strongly associated with recurrence within 24 hours with mean sodium value of 130.86 among recurrence group and 135.17 among non-recurrence group. Serum sodium is a significant predictor for recurrence in 24 hours, both as a continuous value and when categorised into hyponatremia and lower sodium levels significantly linked to higher recurrence rate. Serum potassium value is not statistically significant in predicting the recurrence of seizure in 24 hours (P-value-0.315) with mean potassium value of 4.58 and 4.67 among recurrence and non-recurrence groups respectively.

Data were presented as mean, standard deviation, frequency and percentage. The Mann-Whitney U test compared non-normally distributed continuous data between independent groups. Categorical variables were compared using the Pearson chi-square test. Significance was defined by P values less than 0.05 using a two-tailed test. Data analysis was performed using IBM-SPSS version 25.0 (IBM-SPSS Science Inc., Chicago, IL).

DISCUSSION

In the present study, a total of 106 children aged between 10 to 60 months were included, with a mean age of 30.01 months and a standard deviation of 11.42 months. The youngest participant was 10 months old and the oldest was 60 months, with a median age of 28 months, indicating that the majority of the cohort was clustered around the 2 to 3-year age range. This age distribution is consistent with previously published literature, as febrile seizures most commonly affect children between 6 months and 5 years of age, the peak vulnerability period due to brain maturation and febrile response (4).

The gender distribution of the study population revealed a slight predominance of females, with 50 patients (47.2%) being male and 56 patients (52.8%) being female. Interestingly, there were more females in the group overall, even though our analysis indicated that male gender was substantially related with recurrence of febrile seizures within 24 hours ($p<0.0001$). This is in contrast to a number of earlier investigations, including those by Farah et al. (2022) and Agrawal et al. (2016), which found a male predominance in both overall incidence and recurrence rates (5, 6). The distribution of genders may differ among communities and geographical areas, though, and this must be acknowledged. Overall, the study participants' age and gender profiles match the established epidemiology of febrile seizures, confirming the sample's representativeness.

In the present study, all 106 patients (100%) exhibited involuntary movements during the seizure episode. This finding is consistent with the classical presentation of febrile seizures, where generalized motor manifestations, including tonic, clonic, or tonic-clonic movements, are typical. Although detailed descriptions of motor phenomena such as specific involuntary movements are often not separately reported in many studies, the universal presence of involuntary movements in our cohort aligns with the broad definition of febrile seizures used globally (7).

In terms of eye rolling, 95.3% of the children demonstrated it during their seizure, while 4.7% did not. Eye rolling represents transient brainstem or cortical malfunction during convulsions, is frequently observed as a component of generalized seizure activity. The high occurrence seen in our study is consistent with the normal semiology documented in juvenile febrile seizures, despite the fact that eye-rolling is rarely isolated for statistical analysis in the literature (5). Although eye-rolling is prevalent, it may not be a reliable indicator of seizure recurrence, as there was no significant difference in its presence between the recurrence and non-recurrence groups ($p=0.705$).

All patients (100%) in the study experienced a febrile episode at the time of seizure, fulfilling the diagnostic criteria for febrile seizures as defined by the American

Academy of Pediatrics. The presence of fever is a mandatory condition for the diagnosis of febrile seizures, distinguishing them from afebrile seizures. This finding is universally consistent with global research standards and clinical trials (8). No patient presented without fever, and no difference was observed between recurrence and non-recurrence groups regarding fever presence (p=NA). Therefore, fever remains a non-differentiating but essential feature across all cases.

History of previous febrile seizures was present in 30.2% of patients, while 69.8% were experiencing their first seizure episode. Critically, recurrence within 24 hours was significantly more common among those with a positive seizure history (p<0.0001), with 62.1% of recurrent cases having a previous febrile seizure compared to only 18.2% in the non-recurrence group. These findings strongly correlate with prior studies, such as those by Talebian and Mohammadi (2006) and Farah et al. (2022), which demonstrated that a history of prior febrile seizures is a major risk factor for future recurrence (9, 5). The association between previous febrile seizures and higher recurrence risk highlights the need for close monitoring and possibly preventative strategies in children with such a history.

In the present study, 90.6% of the children were experiencing their first febrile seizure, while 9.4% were experiencing their second. When comparing recurrence within 24 hours, no statistically significant association was found between seizure frequency (first vs second) and recurrence risk (p=0.395). This indicates that although a prior seizure may predispose to recurrence overall, whether it was a first or second seizure in the current febrile illness did not significantly influence short-term recurrence. Similar findings were reported by Heydarian et al. (2009**)**, who found that while recurrence across illnesses is influenced by various risk factors, recurrence within the same febrile episode is less dependent on whether the seizure was the first or subsequent (10)

The mean seizure duration observed was 2.5 minutes, with a range from 1 to 5 minutes. There was no significant difference in seizure duration between those who had recurrence and those who did not (p=0.775). Most seizures were brief, aligning with the classical definition of simple febrile seizures — typically lasting less than 15 minutes. Similarly, Kara (2021) and Castellazzi et al. (2024) found that seizure duration was not a strong independent predictor of recurrence within the same febrile illness (11, 12). Thus, short seizure duration remains typical in febrile seizures, but does not reliably forecast early recurrence.

All patients in the study received Clobazam as part of their seizure management regimen. Clobazam, a benzodiazepine derivative, is commonly used to manage or prevent seizures due to its anticonvulsant and anxiolytic properties. Although universal use of Clobazam ensured treatment uniformity, it also meant that comparative analysis between different medications and recurrence was not possible. No recurrence differences were observed in relation to Clobazam use since all children were treated similarly (p=NA). There is limited specific research evaluating Clobazam's use exclusively in febrile seizure settings; however, its broader use in seizure prevention is well-documented (10).

The mean dosage of Clobazam administered was 3.1 mg, with a range between 1.5 mg and 5 mg. No significant difference in Clobazam dosage was observed between children who experienced recurrence and those who did not (p=0.934). In addition, most patients (97.2%) received a dosage frequency of **1-0-1** (morning and evening doses). Only a small number required fractionated doses (2/3-0-2/3 or 3/4-0-3/4 schedules). This consistent dosing practice reflects standard pediatric protocols aiming to maintain therapeutic serum benzodiazepine levels during periods of fever. Given the uniform use and lack of significant variation in dosing, it is unlikely that Clobazam dosage influenced early recurrence rates in this cohort.

Seizures that recurred within 24 hours were significantly correlated with decreased serum sodium levels in our study. Patients with recurrence had mean blood sodium levels of 130.86 mmol/L (SD ±2.67), while those without recurrence had mean serum sodium levels of 135.17 mmol/L (SD ±3.10) ($p < 0.0001$). Further, 69.0% of patients in the recurrence group had hyponatremia, compared to 40.3% in the non-recurrence group, when patients were grouped according to the occurrence of hyponatremia (defined as Na^+ <135 mmol/L) ($p = 0.008$). These findings are strongly supported by multiple international studies. A meta-analysis by Miyagi et al. (2022) demonstrated that hyponatremia was significantly associated with recurrent febrile seizures, proposing a serum sodium cutoff of 134.72 mmol/L for predicting recurrence with good sensitivity and specificity (13). Similarly, Keleş Alp and Elmacı (2021) (14) found that mean serum sodium levels were significantly lower in children who developed recurrent seizures (134.2 mmol/L) compared to those with single seizures (138.5 mmol/L), with p<0.001 (Keleş Alp & Elmacı, 2021) (14). Furthermore, Farah et al. (2022) also highlighted the role of hyponatremia in increasing recurrence risk, reinforcing the critical predictive value of serum sodium levels (5). Therefore, serum sodium monitoring is a crucial component of therapeutic therapy for at-risk patients, since our data unequivocally demonstrate that lower blood sodium levels significantly predispose febrile children to early seizure recurrence.

There was no statistically significant difference in serum potassium levels between children who had seizure recurrence and those who did not. The recurrence group's mean serum potassium level was 4.58 mmol/L (SD ±0.39), while the non-recurrence group's was 4.67 mmol/L (SD ±0.46) ($p = 0.315$).

This result is consistent with earlier research, such as that conducted by Salehiomran et al. (2018) (4) and Kara (2021) (11), which found that serum potassium levels generally stayed within normal ranges and were not significantly associated with recurrence, even though electrolyte imbalances like hyponatremia were important predictors of febrile seizure recurrence. Consequently, serum potassium does not significantly predict the

recurrence of febrile seizures in our sample or in the literature.

Gender and prior seizure history were found to interact significantly. Just 3.6% of females had a history of febrile seizures, compared to 96.4% who had none at all. On the other hand, just 40.0% of males had never had a seizure before, but a startling 60.0% had had febrile seizures before. The statistical significance of this connection was $p < 0.0001$.

Results show that compared to girls, males had a considerably higher likelihood of having a history of febrile seizures. The results of Agrawal et al. (2016) (6) and Farah et al. (2022) (5), who found that male gender and a history of febrile seizures are important risk factors for recurrence, are in line with this pattern. This finding raises the possibility that recurrence risk is influenced by a genetic predisposition or underlying gender-based vulnerability, especially in boys.

The recurrence of febrile seizures within 24 hours was found to be significantly correlated with hyponatremia in our study. Patients who had recurrence had a mean serum sodium level of 130.86 mmol/L (SD ±2.67), which was substantially lower than the mean sodium level of 135.17 mmol/L (SD ±3.10) in patients who did not experience recurrence ($p < 0.0001$). 69.0% of children with recurrence were hyponatremic (Na^+ <135 mmol/L), compared to 40.3% in the non-recurrence group ($p = 0.008$) when classified according to serum sodium status. These results strongly imply that children who have lower serum sodium levels during a febrile illness are much more likely to experience an early seizure recurrence.

Our findings are very consistent with several extensive studies. For instance, a meta-analysis of 12 studies and 1,784 patients by Miyagi et al. (2022) found a high correlation between decreased serum sodium and repeated febrile seizures during the same febrile episode. With strong predicted sensitivity and specificity, they suggested an ideal sodium threshold of 134.72 mmol/L (13). The correlation is further supported by the fact that the mean sodium in the recurrence group (130.86 mmol/L) is even lower than this cut-off.

Children who had recurrent febrile seizures within 24 hours also had significantly lower sodium levels (134.2 ± 3.55 mmol/L) than children who did not have recurrence (138.5 ± 2.38 mmol/L), according to Keleş Alp and Elmacı (2021) (14). Similarly, a substantial difference between the recurrent and non-recurrent groups was seen by Farah et al. (2022) (132.1 mmol/L vs. 136.1 mmol/L) (5). Mechanistically, fever can result in dilutional hyponatremia by inducing dehydration and an improper release of antidiuretic hormone (ADH). Due to brain cellular enlargement brought on by hyponatremia, neurons become more excitable and vulnerable to electrical discharges, lowering the seizure threshold. Patients with decreased serum sodium are more susceptible to repeated seizures during febrile diseases, which can be explained by this pathophysiology.

In contrast, some studies like Thoman et al. (2004) did not find serum sodium levels to be predictive of recurrence within 24 hours (15). However, these studies were limited by small sample sizes and less stringent definitions of hyponatremia compared to current standards. It is important to note that while hyponatremia was significantly associated with recurrence in the present study, serum potassium levels showed no significant association ($p=0.315$), supporting the specific relevance of sodium imbalance over other electrolytes in seizure recurrence.

Given these findings, serum sodium estimation should be considered a vital part of the initial evaluation in children presenting with febrile seizures, especially in those at high risk of recurrence. Moreover, careful fluid management in febrile children is crucial to prevent iatrogenic worsening of hyponatremia, particularly by avoiding hypotonic intravenous fluids, which can exacerbate dilutional hyponatremia and increase the risk of seizures.

CONCLUSION

This prospective study highlights that hyponatremia is a significant and independent risk factor for the early recurrence of febrile seizures in children, with patients exhibiting lower serum sodium levels being substantially more likely to experience seizure recurrence within 24 hours. While other clinical and demographic parameters such as seizure duration, fever presence, vital signs, and serum potassium levels did not significantly differ between recurrence and non-recurrence groups, a previous history of febrile seizures and male gender also emerged as important predictors of recurrence. Our findings align closely with existing literature and underscore the need for careful electrolyte monitoring and fluid management in children presenting with febrile seizures. Identifying hyponatremia early can help clinicians implement preventive strategies to reduce the risk of recurrent seizures, improving patient outcomes and optimizing pediatric emergency care practices.

LIMITATIONS

As a single-center study, its findings may not be generalizable. The focus on 24-hour recurrence restricts insight into long-term outcomes. The sample size, though adequate for the main objective, limits subgroup analyses. Lack of a healthy control group prevents baseline sodium comparisons, and only initial sodium levels were measured, ignoring changes during hospitalization. Factors such as nutrition, infection type, and hydration were uncontrolled. Uniform Clobazam treatment also precluded analysis of treatment effects. Future research should address these issues to validate and expand the findings.

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