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Predictors of recurrent febrile seizure in children aged from 6 months to 5 years: A cross-sectional study

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ABSTRACT

Objective: To study the clinical profiles of children with febrile seizures, comparing those with single episodes to recurrent cases, and identify predictors of recurrence. In addition, to develop a scoring system to predict recurrence after the first febrile seizure, and identify modifiable risk factors to mitigate recurrence risks.

Methods: This cross-sectional study included children aged 6 months to 5 years with typical febrile seizures, seen as inpatients or outpatients of the Department of Pediatrics at a tertiary care teaching hospital. Data were collected *via* parent interviews, physical exams, and laboratory tests. The questionnaire covered demographics, antenatal, natal, and postnatal events, seizure history, family history, immunization, daycare attendance, and fever management. Clinical evaluations ruled out central nervous system infections and fever causes were diagnosed per ICD-10 at discharge. Laboratory tests assessed anemia, dyselectrolytemia, and hypoglycemia. Data were analyzed in SPSS Version 25 using descriptive statistics, *t*-tests, *Chi*-square tests, and odds ratios with 95% confidence intervals (*CI*), with significance set at $P<0.05$.

Results: 451 children were included in this study. Low birth weight (*OR*=2.60, 95% *CI*=1.12-6.33, *P*=0.026), age at first episode >12 months (*OR*=0.28, 95% *CI*=0.16-0.48, $P<0.001$), family history of febrile seizure (*OR*=5.21, 95% *CI*=2.92-9.28, $P<0.001$), no intermittent prophylaxis (*OR*=15.25, 95% *CI*=7.05-32.90, $P<0.001$), treatment for fever (*OR*=0.26, 95% *CI*=0.13-0.51) and low socioeconomic status (*OR*=5.87, 95% *CI*=3.32-10.38) were significantly associated with recurrent febrile seizures.

Conclusions: Low birth weight, age at first episode ⩽12 months, family history of febrile seizure, no intermittent prophylaxis, inadequate treatment for fever and low socioeconomic status were significant risk factors for having recurrent febrile seizures in children aged from 6 months to 5 years.

KEYWORDS: Febrile seizures; Recurrent; Predictors; Modifiable factors; India

Summary

Question: What factors predict recurrent febrile seizures in children aged 6 months to 5 years, and how can these insights guide preventive strategies?

Findings: Low birth weight, age at first episode ⩽12 months, family history of febrile seizure, no intermittent prophylaxis, inadequate treatment for fever and low socioeconomic status were significant risk factors for having recurrent febrile seizures in children aged from 6 months to 5 years.

Meaning: The study highlighted the need for early identification of at-risk children and targeted interventions, such as enhanced fever care, early prophylactic measures, and addressing socioeconomic barriers. A scoring system based on these predictors can help clinicians forecast recurrence risk, enabling timely parental education and tailored preventive strategies to improve outcomes.

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1. Introduction

Fever is an elevation of body temperature induced by the thermoregulatory center of the hypothalamus in response to certain situations. Normal axillary temperature in children ranges from 36.0℃ in the morning to 37.7℃ in the afternoon, temperatures above this are abnormal[1]. Fever strongly correlates with epileptic seizures, which can present in several forms: febrile seizures, seizures in epileptic patients triggered by fever, acute symptomatic seizures due to non-epileptic conditions (like metabolic changes or infections), and seizures where fever occurs postictally[2].

Febrile seizures occur in children aged 6 months to 5 years with a fever of 38℃ or higher, without central nervous system infection or metabolic imbalance, and no prior afebrile seizures. They are among the most common neurological conditions in childhood, affecting 2%-5% of children under five. Seizures are classified as 'symptomatic' or 'idiopathic', depending on the presence or absence of an identifiable cause. Symptomatic seizures may result from acute central nervous system derangements, structural abnormalities, or trauma. Febrile seizures are a special type of acute symptomatic seizure, often occurring without an underlying cause aside from the fever itself. They are generally benign and rarely lead to epilepsy, though they recur in about 30% of cases after a first episode and 50% after two or more episodes. Predictors of recurrence include early onset, family history of febrile seizures or epilepsy, daycare attendance, sex, and hyponatremia. Despite these recurrences, febrile seizures typically do not cause permanent brain damage or lead to long-term neurological impairment[3,4].

Historically, febrile seizures were viewed pessimistically, but more recent studies indicate a favorable prognosis for most children. Approximately 2%-10% of children with febrile seizures develop epilepsy[5]. While complex features of seizures (prolonged, multiple, or partial) may affect recurrence risk, the overall prognosis remains good. Understanding the natural history and prognosis of febrile seizures is crucial for physicians to provide reassurance and appropriate management, avoiding unnecessary interventions. In developing countries, socioeconomic factors, protein-energy malnutrition, anemia, and parental knowledge significantly impact the incidence and recurrence of febrile seizures.

This study aims to identify predictors of recurrent febrile seizures in a developing society and determine modifiable risk factors to minimize recurrence. Insights from this research could guide preventive strategies and improve outcomes for children at risk of recurrent febrile seizures.

2. Patients and methods

2.1. Study setting

This cross-sectional study was carried out among children aged 6 months to 5 years among the inpatients and outpatients of the Department of Paediatrics who are diagnosed to have typical febrile seizures. Over the past decade, a combination of unforeseen professional and personal commitments, along with shifting research priorities, contributed to the delay in finalizing this study. Furthermore, advancements in the field during this period prompted careful revision of the manuscript to ensure it aligns with the latest scientific understanding, enhancing its relevance and impact. Data analysis was conducted carefully in stages, with a rigorous re-evaluation performed in the past two years using advanced statistical methods, particularly multivariate logistic regression. This approach allowed us to refine the data analysis and validate the study's findings with greater accuracy and reliability, providing insights that are not only current but also more applicable to today's clinical context. Despite the delay, this rigorous, thoroughly analyzed study provides valuable long-term insights into recurrent febrile seizures, offering meaningful contributions to both clinical practice and pediatric research.

2.2. Ethical statement

The ethical clearance was taken from the institutional ethical committee of Jubilee Mission Medical College and Research Institute, Thrissur with clearance number 42/13/IEC/JMMC&RI. The study period was 18 months from approval by the Research and Ethical Committee from November 2013 to April 2015.

2.3. Inclusion and exclusion criteria

Cases included children aged 6 months to 5 years presenting with typical febrile seizures according to American Academy of Paediatrics (AAP) criteria, which includes generalized seizures associated with fever, short duration (<15 minutes), no recurrence within 24 hours, and no prior neurological abnormalities were eligible for inclusion, while children with a history of atypical febrile seizures, afebrile seizures, signs of central nervous system infection, chronic neurodevelopmental problems, severe illness, or those not consenting to the study were excluded (Figure 1).

2.4. Study method

The sample size was calculated using the formula: $n=4pq/d^2$ where,

p=Prevalence (from previous studies)
q=100-p
d=Allowable error (20% of p)

For the calculation of sample size, prevalence was taken as 18.8% for the parameter not immunized for age which had the least prevalence from the available studies from our part of the country. As per calculation, the ideal sample size was 432 cases.

Children were considered as having fever if the axillary temperature recorded at the emergency department, outpatient department, or in the ward was >38℃. A total of 451 children qualified for the study during the stipulated time period. Data were collected through questionnaires, parent interviews, physical examinations, and relevant lab tests, imaging, and electroencephalograms when indicated. The questionnaire covered demographic details, antenatal/natal/postnatal events, recurrence of febrile seizures, family history, immunization, daycare attendance, and fever management. Socioeconomic status was assessed using modified Kuppuswamy's scale [6]. This scale takes into account three major factors: education of the head of the household, occupation of the head of the household, and monthly family income. While the scale includes income categories, specific monetary values reflecting family income were collected *via* interviews with parents or guardians. These were used to calculate the total score. However, for privacy and ethical reasons, individual financial data is not disclosed in the findings. Immunization was verified *via* cards or questionnaires, and PEM status was evaluated using WHO charts. Clinical evaluation identified fever causes and ruled out central nervous system infections. Lab tests assessed anemia, electrolyte imbalances, and hypoglycemia. Specific tests included red blood cell count, haemoglobin, hematocrit, mean corpuscular volume, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration, serum iron, total iron binding capacity, and plasma ferritin, using IMx ferritin assay for low haemoglobin and microcytic hypochromic anemia. Cerebrospinal fluid analysis was conducted if meningitis/encephalitis or prolonged drowsiness was suspected. Neuroimaging was used if lumbar puncture was not feasible or if raised intracranial pressure was evident. Electroencephalograms were performed for frequent recurrences or positive family history of epilepsy.

2.5. Statistical analysis

Descriptive and inferential statistical analyses were conducted using SPSS for Windows, Version 10.0. Continuous data were presented as mean±SD (min-max), and categorical data as numbers (%). Data were coded and entered into Microsoft Excel. Univariate analysis determined factors influencing recurrence, using Student's *t* tests for continuous variables and *Chi*-square or Fisher's exact tests for categorical variables, with significance set at $P<0.05$. Multivariate analysis with multiple logistic regression identified independent associations of significant univariate factors. Relative risks were estimated using odds ratios and 95% confidence intervals (*CI*). A recurrence risk score was calculated for each subject based on the weighted sum of significant risk factors, with presence coded as 1 and absence as 0, and weights derived from the rounded *OR*s.

3. Results

A total of 451 children qualified for the study, with a mean age of (24.8±13.7) months. When stratified by age, the highest number of cases were in the 1-2 year group (*n*=146, 32.4%), followed by the 2-3 year group (*n*=135, 29.9%), with the 5-6 year group comprising the fewest cases (*n*=2, 0.4%).

With regard to age at the first episode, cases with recurrent febrile seizures had a mean age of 11.6 months at the first episode when compared to the single-episode group which had a mean age of 20.9 months. This difference was found to be statistically significant ($P<0.001$). The two groups were further subdivided into two based on age group (≤12 months & >12 months), 62.5% of those who had recurrence had their first episode before 12 months of age while 37.5% were above 12 months when they had their first episode which was statistically significant (Table 1). When compared between males and females in the study population, the incidence of recurrence showed a 65% recurrence in males while 60.5% of females had recurrence. This difference was not statistically significant ($P=0.344$) (Table 1).

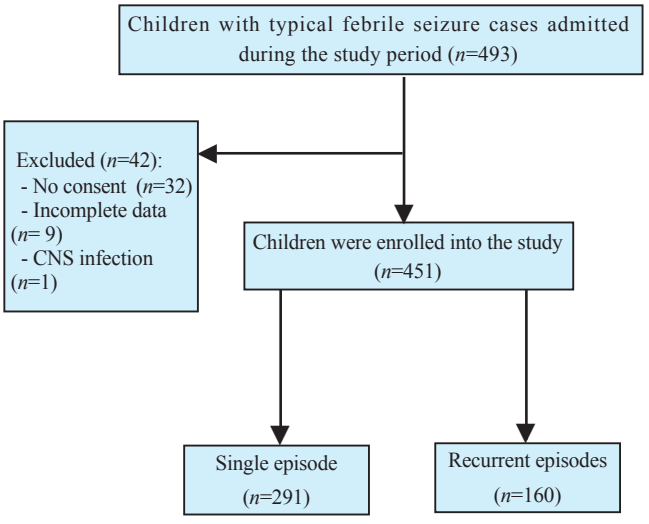

Figure 1. The study flowchart.

Table 1. Patient characteristics.

Variables	Recurrence (%)		*P*
	Yes	No	
Age at 1st episode			
⩽12 months	62.5	32.6	0.001
⩾12 months	37.5	67.4	
Sex			
Female	60.5	39.5	0.344
Male	65.0	35.0	
Socioeconomic status			
Upper middle	15.6	42.3	0.001
Lower middle	32.5	41.9	
Upper lower	46.3	15.5	
Lower	5.6	0.3	
Maternal risk factors			
Preeclampsia/eclampsia	5.2	5.0	0.943
Gestational diabetes	4.1	3.8	0.846
Preterm	6.5	8.1	0.528
IUGR	7.6	6.3	0.604
LBW	5.8	15.6	0.001
Maternal infections	2.1	2.5	0.748
Neonatal	15.1	16.9	0.624
Family history of febrile seizures			
Yes	78.1	40.9	0.000
No	21.9	59.1	
Family history of epilepsy			
Yes	16.3	12.0	0.210
No	83.7	88.0	
Immunized for age			
Yes	82.5	77.0	0.169
No	17.5	23.0	
Exclusive breastfeeding for 6 months			
Yes	20.6	28.2	0.048
No	79.4	71.8	
PEM			
Yes	34.4	25.4	0.044
No	65.6	74.6	
Day care attendance			
Yes	20.0	15.1	0.185
No	80.0	84.9	
Intermittent prophylaxis			
Yes	38.8	5.5	0.000
No	61.2	94.5	
Proper treatment for fever received			
Yes	23.1	13.7	0.011
No	76.9	86.3	
Anemia of any cause			
Yes	41.2	31.6	0.040
No	58.8	68.4	
Iron deficiency anemia			
Yes	33.1	25.1	0.069
No	66.9	74.9	
Hyponatremia			
Yes	62.5	49.5	0.008
No	47.5	50.5	
Hypocalcemia			
Yes	2.5	2.4	1.000
No	97.5	97.6	

IUGR: intrauterine growth restriction; LBW: low birth weight; PEM: protein energy malnutrition.

Table 2. Logistic regression analysis of risks for recurrence.

Variables	Adjusted *OR* (95% *CI*)	*P*
Birth weight (low *vs.* normal)	2.66 (1.12-6.33)	0.026
Age at 1st episode (>12 months *vs.* ≤12 months)	0.28 (0.16-0.48)	<0.001
Family history of febrile seizures (yes *vs.* no)	5.21 (2.92-9.28)	<0.001
HiB vaccine (yes *vs.* no)	0.84 (0.48-1.46)	0.536
Breastfeeding (yes *vs.* no)	1.19 (0.64-2.22)	0.581
PEM (yes *vs.* no)	1.30 (0.70-2.41)	0.403
Intermittent prophylaxis given (yes *vs.* no)	15.25 (7.05-32.97)	<0.001
Fever treatment (yes *vs.* no)	0.26 (0.13-0.51)	<0.001
Anemia (yes *vs.* no)	1.23 (0.46-3.29)	0.686
Serum ferritin (yes *vs.* no)	1.43 (0.50-4.10)	0.503
Sodium (yes *vs.* no)	1.64 (0.95-2.82)	0.076
Socioeconomic status (low *vs.* middle/high)	5.87 (3.32-10.38)	<0.001

Table 3. Risk score & recurrence in the study population.

Risk score	Recurrence, *n* (%)	
	Yes	No
0	78 (98.7)	1 (1.3)
1-14	191 (75.2)	63 (24.8)
≥15	22 (18.6)	96 (81.4)
Total	291 (64.5)	160 (35.5)

The study population was further grouped as middle class and lower class combining the respective groups from the original population and the obtained data was analysed. 51.9% of the lower socioeconomic group had recurrent febrile seizure when compared to 48.1% of middle socioeconomic group and this difference was statistically significant ($P<0.001$) (Table 1).

With regard to the antenatal factors considered in the study, prevalence of low birth weight babies was more common in the recurrence group (5.8% *vs.* 15.6%, $P=0.001$) and the observed difference was statistically significant. The prevalence of hypertensive disorders during pregnancy, gestational diabetes, preterm birth, intrauterine growth retardation, maternal infections and neonatal hyperbilirubinemia was similar between the two groups and not statistically significant (Table 1).

Family history of febrile seizure was present in 78.1% of the cases with recurrent febrile seizure while those with a single episode had a positive family history in 40.9%. This difference was statistically significant ($P=0.000$). The prevalence of family history was 16.3% in the recurrence group while it was 12% in the study group. However, the difference was not statistically significant (Table 1).

The immunization status of the study population showed a prevalence of 17.5% recurrence in the unimmunized group while the immunized group had a recurrence of 82.5%. This difference was not statistically significant. The incidence of recurrent febrile seizure was 0.6% following measles, mumps, rubella vaccination while 2.7% had only a single episode. Meanwhile, diphtheria-pertusis-tetanus vaccination produced a recurrence rate of 4.4% compared to single episode 1.4% and the differences were not statistically significant. When the prevalence of febrile seizure was studied in children with and without HiB vaccination, it was noticed that 59.4% of children who did not receive HiB vaccination had recurrent febrile seizure while only 40.6% of children with haemophilus influenzae B vaccination had recurrent febrile seizure. This difference was statistically significant (Table 1).

The prevalence of recurrent febrile seizure was 20.6% in exclusively breast-fed babies when compared to 79.4% in babies who were initiated on complementary feeds earlier. This difference was statistically significant ($P=0.048$). The prevalence of febrile seizure was 65.6% in children without PEM while it was 34.4% in those with PEM. This difference was statistically significant (Table 1).

The prevalence of recurrent febrile seizure was 20% ($n=32$) in children who had attended daycare when compared to 80% ($n=128$) in children without a history of day care attendance. However, the difference was not statistically significant ($P=0.185$) (Table 1).

The prevalence of recurrent febrile seizure was 38.8% in children who received intermittent prophylaxis when compared with 61.2% in children who were not on regular intermittent prophylaxis. The difference observed was statistically significant ($P=0.000$) (Table 1).

76.9% of children who had recurrent febrile seizures did not receive proper care for their fever when compared to the lower prevalence of recurrence in those who received proper care for fever. This difference was statistically significant too ($P=0.000$). No single etiology of fever identified in current study was associated with increased risk of recurrent febrile seizure (Table 1).

The prevalence of anemia was 41.2% ($n=66$) in those with recurrent febrile seizure when compared to 58.8% ($n=94$) children having

no anemia. This difference was statistically significant (*P*=0.040). Among the laboratory parameters assessed, hyponatremia had a prevalence of 62.5% among recurrent febrile seizure groups while 49.5% had no recurrence in the presence of hyponatremia. This difference was statistically significant (*P*=0.008). Hypomagnesemia was present in 2 cases and both had recurrent febrile seizure but there was no statistical significance (*P*=0.125). Hyperglycemia was seen in 8 cases, of which two had recurrence and there was no statistically significant association (*P*=0.718) (Table 1).

Factors which were found to have association using *Chi*-square test were further analyzed using multivariate analysis (logistic regression) (Table 2). The results obtained showed a positive correlation for low birth weight (*OR*=2.66, 95% *CI*=1.12-6.33, *P*=0.026), age at first episode ⩽12 months (*OR*=0.28, 95% *CI*=0.16-0.48, *P*<0.001), family history of febrile seizures (*OR*=5.21, 95% *CI*=2.92-9.28, *P*<0.001), lack of intermittent prophylaxis (*OR*=15.25 , 95% *CI*=7.05-32.97, *P*<0.001), inadequate treatment for fever (*OR*=0.26, 95% *CI*=0.13-0.51, *P*<0.001), and low socioeconomic status (*OR*=5.87, 95% *CI*=3.32-10.38, *P*<0.001). Conversely, factors such as HiB vaccination (*OR*=0.84, 95% *CI*=0.48-1.46, *P*=0.536), exclusive breastfeeding for 6 months (*OR*=1.19, 95% *CI*=0.64-2.22, *P*=0.581), presence of protein-energy malnutrition (PEM) (*OR*=1.30, 95% *CI*=0.70-2.41, *P*=0.403), iron deficiency anemia (*OR*=1.43, 95% *CI*=0.50-4.10, *P*=0.503), other types of anemia (*OR*=1.23, 95% *CI*=0.46-3.29, *P*=0.686), and hyponatremia (*OR*=1.64, 95% *CI*=0.95-2.82, *P*=0.076) were found to have no correlation with recurrent febrile seizures.

A score for recurrence was calculated as the weighted sum of these risk factors with weights being the rounded odds ratios. The weights used were 3, 4, 5, 15, 4 and 6 respectively for the risk factors listed above. The scores were grouped arbitrarily as 0, 1-14 and ⩾15. There was an increasing trend for recurrence with these risk groups. The prevalence of recurrent febrile seizure in those with no risk factors or the total score obtained was 1.3%. 24.8% of children among the recurrent febrile seizure group had a total risk score in the range of 1-14. Meanwhile, 81.4% in the recurrent seizure group had a total risk score ⩾15. This showed a definite increasing trend of recurrence with increasing risk score. No case had all the six risk factors together. Maximum number of risk factors present in a single case was 5. Number of risk factors among these 5 was compared with recurrence. There was an increasing trend for the chance of recurrence with the number of risk factors. When the number of risk factors was used to predict the recurrence rate, the chance of recurrence was 1.3% when no risk factor was present, 10.4% when any single risk factor alone was present, 45.2% if any 2 risk factors present, 68.9% for 3 risk factors, 94.9% for 4 risk factors and 100% chance of recurrence if any 5 of the 6 factors were together present (Table 3).

4. Discussion

The mean age at first episode was (20.9±12.5) months in those children with no recurrence. A study from the Netherlands published by Offringa *et al*. found that the median age at onset was 18 months[7]. This estimated prevalence in Dutch children may well be compared with prevalence rates found in this study as the health standards of the study area are relatively high. When the age group of the population was stratified year-wise, maximum cases were in the 1-2 year group (*n*=146, 32.4%), which is similar to the study conducted by Hauser where the peak incidence of a first febrile convulsion occurs in the second year of life[8]. This was followed by a 2-3 year group (*n*=135, 29.9%). The 5-6 year group of children was the minimum comprising 0.4% of the study group (*n*=2). This is in agreement with the results of other studies[9].

Meanwhile, the age at first episode was (11.6±4.9) months in those with recurrent febrile seizure. This figure is similar to that found by a study from the United Arab Emirates, which had a figure of 15.1 months[10]. In this study, 62.5% of those who had recurrent episodes had their first episode when they were ⩽12 months of age and 37.5% with recurrent episodes had their first episode >12 months of age. This was statistically significant and the results were comparable to van Stuijvenberg *et al*.'s publicationwhere 230 children were studied to find out predictors for recurrent febrile seizure[11]. It was also similar to the data obtained in the study by Berg *et al.* which was a meta-analytic review[12].

The incidence of recurrence, when compared between male and female groups in the study population, showed a 65% recurrence in males while only 60.5% of females had recurrence. However, the difference was not statistically significant (*P*=0.344). The data obtained in our study were comparable to the study by AL-Zwaini *et al.*, where sex male was not found to be a risk factor for developing recurrent febrile seizure[13].

With regard to the antenatal factors considered in the study, the prevalence of low-birth-weight babies was more common in the recurrence group and was statistically significant. These observations were similar for low-birth-weight babies but other antenatal factors like preterm birth and intrauterine growth retardation were also significantly associated with high risk for recurrent febrile seizure in the study by Sun *et al*.[14].

Family history of febrile seizure was present in 78.1% (*n*=125) of the case with recurrent febrile seizure while those with a single episode had a positive family history in 40.9% (*n*=35) which was statistically significant. Similar observations were found in two

studies by Verity CM and AL-Zwaini[4,15]. Studies by Nick *et al.* found that vaccination with HiB was not associated with an increased risk of febrile seizure recurrence which was on par with our study[16].

The prevalence of recurrent febrile seizure was 20.6% (*n*=33) in exclusively breastfed babies when compared to 79.4% (*n*=127) in babies who were initiated on complimentary feeds earlier. This difference was statistically significant with initial univariate analysis (*P*=0.048) but was not significant with subsequent multivariate analysis using logistic regression. Even though exclusive breastfeeding was not found to have any protective role against recurrent febrile seizures according to Mahyar *et al.*[17].

The prevalence of recurrent febrile seizure was 65.6% (*n*=105) in children without PEM while it was 34.4% (*n*=160) in those with PEM. This difference was statistically significant (*P*=0.044). But during multivariate analysis, no correlation was found between the two. Similar observations were noticed in data published by Kumari *et al.*[18].

The prevalence of recurrent febrile seizure was 20% (*n*=32) in children who had attended daycare when compared to 80% (*n*=128) in children without a history of day care attendance. However, the difference was not statistically significant (*P*=0.185). But data published by Kumari *et al.* show a positive correlation between day care attendance and recurrent febrile seizure day-care attendance[18].

The prevalence of recurrent febrile seizure was 38.8% (*n*=62) in children who received intermittent prophylaxis when compared with 61.2% (*n*=98) in children who were not on regular intermittent prophylaxis. The difference observed was statistically significant (*P*=0.000). In further analysis for correlation with multivariate analysis it was found that those children who received intermittent prophylaxis had a decreased incidence of recurrent febrile seizure (*OR*=15.25, 95% *CI*=7.05-32.9, *P*<0.001). In a prospective randomized study by Knudsen *et al*., children with febrile seizure were classified to 3 groups according to their risk for having febrile seizure with a proposed scoring system and during prophylaxis the recurrence rate was uniformly low (mean 12%) in all risk groups[19].

No single etiology of fever identified in current study was associated with increased risk of recurrent febrile seizure. Lewis *et al.* found that 86% of cases of FSs were due to disseminated viral infection of the upper respiratory tract[20].

33.1% of children (*n*=53) who had recurrent febrile seizure had iron deficiency anemia when compared to 66.9% of children who had recurrent febrile seizure did not have iron deficiency anemia. However this was not statistically significant (*P*=0.069). Similar results were published by Heydarian *et al*.[21]. We found no relationship between iron deficiency anemia and recurrent febrile seizure in our study. This may be due to differences in sample size and age of cases. We suggest that different nutritional conditions may also be considered as other probable causes of such different findings.

Recurrent febrile seizure was seen in 62.5% of cases with hyponatremia when compared to 49.5% having no recurrent febrile seizure in presence of hyponatremia. This difference was statistically significant (*P*=0.008). As there was a significant association, when analyzed by multivariate analysis with logistic regression there was no correlation between the two. Similar data was published by Rutter *et al*. where children were studied retrospectively to see who had had recurrent febrile seizure[22]. A higher proportion of hyponatremic children (5 out of 50) had a further convulsion compared with normonatremic children (2 out of 113), this is significant at the 5% level.

No case of hypoglycaemia was noticed but 1.8% (*n*=8) children had hyperglycemia and the remaining 98.2% (*n*=443) children were normoglycemic in our study. A study by Rutter *et al*. showed that blood glucose levels are often elevated during or soon after a convulsion[23].

The strength of our study included standardized criteria for diagnosing febrile seizures, and iron deficiency, elimination of incidence prevalence bias, concurrent enrollment of controls and cases, and no recall bias regarding exposure. The study does have some limitations. The major limitations of this study which could have influenced the statistical significance of final results may be the lack of proper matching of the two study groups. As it was a hospital-based study the prevalence of exposure and outcome variables may be different from a community setting. Another limitation of this study is the fact that cases were not followed up till the maximum age of 5 years where they can have febrile seizure as per the study definition. That could have picked up more cases with recurrence and the risk factors could have been studied in more detail.

From this study it was noticed that low birth weight, age at first episode ⩽12 months, family history of febrile seizure, intermittent prophylaxis not received, adequate treatment for fever received and low socio-economic status are the risk factors for developing recurrent febrile seizure in children aged from 6 months to 5 year. Among these the modifiable risk factors are low birth weight, administration of intermittent prophylaxis, adequate treatment of fever and low socioeconomic status. The results of this study suggest the interventions that could reduce the incidence of recurrent febrile seizure. Ensuring proper maternal health and good antenatal care can reduce the burden of low birth weight significantly. Early detection and timely correction of maternal malnutrition may be helpful for prevention of recurrent febrile seizures in children. Also, proper education of parents and caretakers of children with

febrile seizure regarding intermittent prophylaxis and adequate and effective control of temperature of the child is also of paramount importance in preventing recurrent febrile seizure. Improving the standards of living can make the parents more aware of the situation and act accordingly. So, the overall improvement of socioeconomic status of the society can reduce the frequency of recurrent febrile seizures in the community.

Conflict of interest statement

The authors report no conflict of interest.

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Data availability statement

The data supporting the findings of this study are available from the corresponding authors upon request.

Authors' contributions

AM, TA, RS, RX and JM all contributed to concept and design development, defined intellectual, conducted literature search and clinical study, acquired and analyzed the data, prepared, edited, and reviewed the manuscript.

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References

[1] Lambertucci JR. Febre. Semiologia médica: As bases do diagnóstico clínico. Rio de Janeiro. *Livraria e Editora Revinter* 2004; **4**: 66-77.

[2] Vasconcellos MC. Febre, tosse e vômito. Pediatria ambulatorial. Belo Horizonte. *COOPMED* 2005; **4**: 221-237.

[3] Aydin A, Ergor A, Ozkan H. Effects of sociodemographic factors on febrile convulsion prevalence. *Pediatr Int* 2008; **50**(2): 216-220.

[4] Li J, Olsen J, Obel C, Christensen J, Precht DH, Vestergaard M. Prenatal stress and risk of febrile seizures in children: A nationwide longitudinal study in Denmark. *J Autism Dev Disord* 2009; **39**(7): 1047-1052.

[5] Annegers JF, Hauser WA, Elveback LR, Kurland LT. The risk of epilepsy following febrile convulsions. *Neurology* 1979; **29**(3): 297-303.

[6] Kumar N, Gupta N, Kishore J. Kuppuswamy's socioeconomic scale: updating income ranges for the year 2012. *Indian J Public Health* 2012; **56**(1): 103-104.

[7] Offringa M, Hazebroek-Kampschreur AA, Derksen-Lubsen G. Prevalence of febrile seizures in Dutch schoolchildren. *Paediatr Perinat Epidemiol* 1991; **5**(2): 181-188.

[8] Hauser WA. The prevalence and incidence of convulsive disorders in children. *Epilepsia* 1994; **35**(Suppl 2): S1-S6.

[9] Annegers JF, Hauser WA, Shirts SB, Kurland LT. Factors prognostic of unprovoked seizures after febrile convulsions. *N Engl J Med* 1987; **316**(9): 493-498.

[10] Berg AT, Shinnar S, Shapiro ED, Salomon ME, Crain EF, Hauser WA. Risk factors for a first febrile seizure: A matched case-control study. *Epilepsia* 1995; **36**(4): 334-341.

[11] van Stuijvenberg M, Steyerberg EW, Derksen-Lubsen G, Moll HA. Temperature, age, and recurrence of febrile seizure. *Arch Pediatr Adolesc Med* 1998; **152**(12): 1170-1175.

[12] Berg AT, Shinnar S, Hauser WA, Leventhal JM. Predictors of recurrent febrile seizures: A meta-analytic review. *J Pediatr* 1990; **116**(3): 329-337.

[13] AL-Zwaini EJ, AL-Ani SS, AL-Khalidi MJ, AL-Taie MF. Risk factors for febrile seizures: A matched case control study. *IPMJ* 2006; **5**(3): 353-358.

[14] Sun Y, Vestergaard M, Pedersen CB, Christensen J, Basso O, Olsen J. Gestational age, birth weight, intrauterine growth, and the risk of epilepsy. *Am J Epidemiol* 2008; **167**(3): 262-270.

[15] Verity CM, Butler NR, Golding J. Febrile convulsions in a national cohort followed up from birth. I--Prevalence and recurrence in the first five years of life. *Br Med J* 1985; **290**(6478): 1307-1310.

[16] Nick A, Stowe J, Wise L, Miller E. Post-licensure comparison of the safety profile of diphtheria/tetanus/whole cell pertussis/Haemophilus influenza type b vaccine and a 5-in-1 diphtheria/tetanus/acellular pertussis/Haemophilus influenza type b/polio vaccine in the United Kingdom. *Vaccine* 2010; **28**(44): 7215-7220.

[17] Mahyar A, Ayazi P, Fallahi M, Javadi A. Risk factors of the first febrile seizures in Iranian children. *Int J Pediatr* 2010; **2010**: 862897.

[18] Kumari PL, Nair MK, Nair SM, Kailas L, Geetha S. Iron deficiency as a risk factor for simple febrile seizures--a case control study. *Indian Pediatr* 2012; **49**(1):17-19.

[19]Knudsen FU. Recurrence risk after first febrile seizure and effect of short-term diazepam prophylaxis. *Arch Dis Child* 1985; **60**(11): 1045-1049.

[20]Lewis HM, Parry JV, Parry RP, Davies HA, Sanderson PJ, Tyrrell DA, et al. Role of viruses in febrile convulsions. *Arch Dis Child* 1979; **54**(11): 869-876.

[21]Heydarian F, Vatankhah H. The role of anemia in first simple febrile seizure in children aged 6 months to 5 years old. *Neurosciences (Riyadh)* 2012; **17**(3): 226-229.

[22]Rutter N, O'Callaghan MJ. Hyponatraemia in children with febrile convulsions. *Arch Dis Child* 1978; **53**(1): 85-87.

[23]Rutter N, Smales OR. Calcium, magnesium, and glucose levels in blood and CSF of children with febrile convulsions. *Arch Dis Child* 1976; **51**(2): 141-143.