ONLINE ISSN :3007-309X
PRINT ISSN :3007-3081

Journal of Medical & Health Sciences Review

INCIDENCE AND RISK FACTORS OF FEBRILE SEIZURES AT PEDIATRIC DEPARTMENT OF BOLAN MEDICAL COMPLEX HOSPITAL, QUETTA

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ARTICLE INFO:

Keywords: Febrile Seizures, Pediatric Neurology, Risk Factors, Hypozincemia, Cesarean Delivery

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Article History:
Published on 13 July 2025

ABSTRACT

Febrile seizures (FS) are common neurological events in children aged 6 months to 5 years, triggered by fever without intracranial infection or metabolic disturbance. This descriptive cross-sectional study assessed the incidence and risk factors of FS among 1120 pediatric patients presenting with seizures at Bolan Medical Complex Hospital, Quetta, Pakistan. The incidence of FS was 6.25%, predominantly affecting males aged 6–36 months. Simple FS accounted for 77.1%, while 22.9% were complex. A significant association was found between cesarean delivery and complex FS (p=0.007). Positive family history of FS or epilepsy was common, although complex FS was more frequent in children without such history. Developmental delays and low Apgar scores were prevalent but not statistically significant risk factors. Hypozincemia and incomplete immunization were also common. These findings highlight the multifactorial etiology of FS and suggest the influence of perinatal and environmental factors, particularly in resource-limited settings. Further multicenter studies are needed to elucidate causality and improve preventive strategies.

INTRODUCTION

Febrile seizures are among the most common neurologic disorders in early childhood, typically occurring in children aged 6 months to 5 years and characterized by convulsions accompanied by fever in the absence of intracranial infection or defined metabolic disturbances(Tarhani, Nezami, Heidari, & Dalvand, 2022). The prevalence of FS is 3–5% worldwide (F. Heydarian & Vatankhah, 2012; Nasehi, Sakhaei, Moosazadeh, & Aliramzany, 2015). Approximately 2% to 5% of children in Europe and North America are expected to experience at least one episode of febrile seizure requiring pediatric emergency care before reaching the age of five(Verity, Butler, & Golding, 1985). In comparison, reported incidence rates in various Asian countries are notably higher, ranging from 8% to 10%(Hackett, Hackett, & Bhakta, 1997). The clinical manifestations vary depending on the affected brain regions and may include a range of motor, sensory, or sensorimotor disturbances, as well as alterations in the level of consciousness(Jisha, Jayaprabha, Gnanawel, Kumar, & Kogila, 2020). It typically involves impaired consciousness with involuntary, bilateral limb movements and often occurs within the first 24 hours of fever onset(Jisha et al., 2020).

To better understand and manage this condition, febrile seizures have conventionally been classified as either simple or complex, based on their duration, the occurrence of recurrence, and the presence of focal neurological features(Patel et al., 2015). **Simple febrile seizures are defined as generalized convulsions lasting less than 15 minutes and occurring only once in 24 hours**, whereas complex febrile seizures involve **any of the following: focal onset, duration of 15 minutes or more, or recurrence within the same** day("Neurodiagnostic evaluation of the child with a simple febrile seizure," 2011). While febrile seizures are often safe for children, they can be alarming for caregivers, so it's critical to handle parental worry in the most compassionate way possible(Ahmed et al., 2022). The precise underlying mechanisms of febrile seizures remain unclear(Zhang et al., 2024). A minority of children with febrile seizures are at risk of developing subsequent epilepsy, along with potential complications such as cerebral dysfunction, neurocognitive impairment, and intellectual, disabilities(Verity & Golding, 1991). Another study described FS as generally benign and self-limiting, though it highlighted variability in risk factors, prognosis, and progression to epilepsy(Civan, Ekici, Havali, Kiliç, & Bostanci, 2022).

An increased risk of febrile seizures has been observed in children with a positive family history of febrile seizures or epilepsy, with such a history reported in 25–40% of cases(Millichap & Millichap, 2006). Febrile seizures are more commonly observed in children with pre-existing neurological impairments, including cerebral palsy and neurodevelopmental delays (Leung, Hon, & Leung, 2018; Smith, Sadler, & Benedum, 2019). Established risk factors for the development of epilepsy include a family history of epilepsy, delayed neuromotor development, and complex febrile convulsions(Vestergaard, Pedersen, Sidenius, Olsen, & Christensen, 2007). The occurrence of febrile seizures is believed to result from a combination of genetic predisposition and environmental factors, such as the presence of fever and its underlying cause(Sawires, Buttery, & Fahey, 2021). The majority of febrile seizures are triggered by febrile illnesses linked to specific viral infections, including human herpesvirus-6 (HHV-6), rotavirus-associated gastroenteritis, and respiratory infections caused by influenza A(Chiu, Tse, Lau, & Peiris, 2001; Laina et al., 2010; Lloyd, Lloyd, Gesteland, & Bale, 2010). Trace elements play multiple roles in the

functioning of the central nervous system (F. Heydarian, Nakhaei, Majd, & Bakhtiari, 2020). Low serum levels of zinc and iron have been linked to a heightened risk of febrile seizures (Ganesh & Janakiraman, 2008; Hartfield et al., 2009). Smith et al. listed discharge from the neonatal unit at or beyond
28 days of age as a potential risk factor, although the study did not elaborate on this association(Smith et al., 2019).

Given that limited healthcare infrastructure, inadequate access to medical services, and insufficient understanding of neurological conditions have been associated with a higher burden of epilepsy in rural African settings, it is plausible that similar challenges may also contribute to the burden of febrile seizures in underserved regions of Pakistan such as Balochistan(Mung'ala-Odera et al., 2008). Therefore, this study aimed to assess the incidence and identify risk factors of febrile seizures among children admitted to the Pediatric Department of Bolan Medical Complex Hospital, a tertiary care teaching facility in Balochistan.

Methodology:

The study was descriptive cross-sectional design. The study was carried out at the Pediatric Department of Bolan Medical Complex Hospital (BMCH), a tertiary care teaching facility located in Quetta, the capital city of Balochistan province. The hospital serves a diverse population from all over the province. The study was carried out over a period of six months, from Dec 2024 to May 2025. The study focused on pediatric patients aged 6 to 60 months who presented with seizures at Bolan Medical Complex Hospital in Quetta, during the defined study period. A total of 1120 eligible cases were identified and included using total population sampling, ensuring that all qualifying patients were analyzed without selection bias. • Children aged 6–60 months • Seizures accompanied by fever (≥38°C) • All out and in patients of Pediatric Medicine Department during the study period • History of afebrile seizures • Diagnosed central nervous system infections (e.g., meningitis, encephalitis) • Documented metabolic disturbances (e.g., hypoglycemia, electrolyte imbalance) • Incomplete or missing medical records

A total population sampling approach was utilized, whereby all eligible individuals were systemically included. This method allowed for the comprehensive inclusion of cases meeting the defined criteria, thereby ensuring robust and unbiased representation in the analysis. A purpose developed, standardized data collection Performa was used to collect the patient‘s data. The data collection form consisted of the demographics, clinical characteristics, immunization history, family history, and Socio-economic status and laboratory findings variables. Informed verbal consents were taken from patients' attendants before data collection. Keeping in view the patients' privacy, the data will be kept confidential and used only for the research purpose. Laboratory values of authentic laboratories were taken and Performa's were filled asking child's attendant. Delivery specific questions were noted from child's discharge card of labour room. Clinical related Medical records were reviewed, and information was extracted by trained medical officer. Data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS) version 25. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were calculated. The point estimate at a 95% confidence interval was computed for the prevalence of febrile seizures. Ethical approval was obtained from the Institutional Review Board of Bolan Medical Complex Hospital. Study was conducted after the approval of CPSP's concerned ethical review committee and the data was collected from the inpatients. Confidentiality of patient information was maintained throughout the study.

RESULTS

Incidence of Febrile Seizures

During the study period, a total of 1120 pediatric patients aged 6 to 60 months presented with seizures at Bolan Medical Complex Hospital. Of these, 70 were diagnosed with febrile seizures, reflecting an incidence rate of 6.25% among seizure presentations. Accordingly, all subsequent analyses and evaluations of clinical profiles and risk factors were performed specifically on this subgroup of 70 febrile seizure cases. Majority of cases (84.3%) occurred in children aged 6–36 months, while 15.7% were between 37–60 months. Males constituted 58.6% of the cohort and females 41.4% as depicted in table 1.

Table 1: Demographic and Clinical Characteristics of Febrile Seizure Patients (n=70)

Variable	Frequency (%)
Age 6–36 months	59 (84.3%)
Male Gender	41 (58.6%)
Female Gender	29 (41.4%)
NICU Stay >30 Days	46 (65.7%)
Home Delivery	40 (57.1%)
Cesarean Delivery	32 (45.7%)
Early/Post-term Births	57 (81.4%)
Developmental Delay	41 (58.6%)
Low APGAR / Resuscitation	44 (62.9%)

Perinatal and Clinical Characteristics

Most children (65.7%) had a history of neonatal intensive care unit (NICU) admission for more than 30 days. A larger proportion of patients (57.1%) were delivered at home compared to 42.9% in hospital settings. Regarding mode of delivery, 54.3% were born via spontaneous vaginal delivery (SVD) and 45.7% through cesarean section. Early-term (41.4%) and post-term (40.0%) deliveries were more prevalent than full-term births (18.6%).

Maternal age at the time of delivery was categorized as less than 30 years in 18.6% of cases, 30–35 years in 35.7%, and more than 30 years in 45.7%.

Seizure Classification and Associated Factors

Among the 70 children diagnosed with febrile seizures, 54 (77.1%) experienced simple febrile seizures, while 16 (22.9%) had complex febrile seizures. A statistically significant association was observed between cesarean delivery and the occurrence of complex febrile seizures ($\chi^2 = 7.168$, $p = 0.007$), suggesting increased odds of complex seizure patterns among cesarean-born children as depicted in Table 1.

Identified Risk Factors

A positive family history of febrile seizures was reported in 65.7% of diagnosed febrile seizures cases, and a family history of epilepsy was present in 68.6%. Complex seizures were significantly more frequent among children with history of cesarean delivery ($p = 0.007$). Additionally complex seizures were found more frequent among children with no family history of febrile seizures highlighting its potential protective association.

Developmental delays were noted in 58.6% of patients, while 62.9% had a history of low APGAR scores or required resuscitation at birth. Feeding practices

revealed that 62.9% of children were formula-fed, and 37.1% were breastfed exclusively.

Table 2: Risk Factors for Febrile Seizures		
Risk Factor	Frequency (%)	Statistical Significance (p-value)
Delayed Developmental Milestones	41 (58.6%)	Not significant
Low APGAR Score / Resuscitation	44 (62.9%)	Not significant
Formula Feeding	44 (62.9%)	Not significant
Positive Family History of FS	46 (65.7%)	Not significant
Family History of Epilepsy	48 (68.6%)	p = 0.063
Cesarean Delivery	32 (45.7%)	p = 0.007
No Family History of FS (Complex FS Association)	24 (34.3%)	p = 0.007

Parental Educational Status

Regarding parental education, 47.1% of mothers and 52.9% of fathers were illiterate. Only 4.3% of mothers and fathers, respectively, had achieved graduate-level education, suggesting a generally low educational background among caregivers.

Immunization Coverage

Suboptimal vaccination coverage was observed among the study population. A total of 62.9% of children had not received measles or Haemophilus influenzae immunization. Additionally, 35.7% had not received pneumococcal vaccination, and 40% were unvaccinated for meningococcal disease.

Table 3 Immunization Status				
Immunization Type	Yes (n)	Yes (%)	No (n)	No (%)
Measles	26	37.1	44	62.9
H. Influenza	26	37.1	44	62.9
Pneumococcal	45	64.3	25	35.7
Meningococcal	42	60.0	28	40.0

Biochemical and Laboratory Findings

Low serum zinc levels (hypozincemia) were present in 41.4% of cases, while 55.7% had normal zinc levels. The mean zinc level was 1.61 (SD = 0.546), within the normozincemic range. Hyponatremia was observed in 21.4% of cases, while 74.3% had normal serum sodium levels. Other biochemical values—including serum calcium, white blood cell count (WBC), and cerebrospinal fluid (CSF) markers—were predominantly within normal reference ranges across the sample as shown in table 4.

Table 4 Laboratory Findings			
Lab Parameter	Hypo (n/%)	Normo (n/%)	Hyper (n/%)
Serum Sodium	15/21.4%	52/74.3%	3/4.3%
Serum Potassium	3/4.3%	66/94.3%	1/1.4%

Serum Chloride	1/1.4%	67/95.7%	2/2.9%
Serum Zinc	29/41.4%	39/55.7%	2/2.9%
Serum Zinc	29/41.4%	39/55.7%	2/2.9%
Serum Calcium	1/1.4%	65/92.9%	4/5.7%
Serum Phosphorus	2/2.9%	67/95.7%	1/1.4%
Serum WBC	3/4.3%	66/94.3%	1/1.4%
Serum Neutrophils	1/1.4%	69/98.6%	0
Serum Lymphocytes	1/1.4%	67/95.7%	2/2.9%
CSF WBC	1/1.4%	69/98.6%	0
CSF Neutrophils	1/1.4%	67/95.7%	2/2.9%
CSF Lymphocytes	2/2.9%	67/95.7%	1/1.4%
CSF RBC	7/10%	63/90%	0
CSF protein	1/1.4%	68/97.1%	1/1.4%
CSF PH	2/2.9%	67/95.7%	1/1.4%
CSF Sugar	1/1.4%	67/95.7%	2/2.9%

Discussion:

The incidence of febrile seizures was found to be 6.25%, aligning with reports from regional studies conducted in India and Nepal, where rates ranged from approximately 4% in hospitalized children (Pokhrel, Bhurtel, Malla, & Shah, 2021) to 10% lifetime prevalence in community samples(Hackett et al., 1997). This reinforces the prevalence of febrile seizures as a significant pediatric neurological concern in South Asia.

In our study, most cases (84.3%) occurred in children aged 6–36 months, which aligns with the age range widely recognized for peak febrile seizure susceptibility (Millichap & Millichap, 2006; "Neurodiagnostic evaluation of the child with a simple febrile seizure," 2011). A higher proportion of febrile seizure cases were observed in males (58.6%), consistent with findings from previous studies reporting male predominance (MZ et al., 2025; Tarhani et al., 2022). However, some literature also notes a more balanced gender distribution across different populations.

A notable finding of this study is the statistically significant association between cesarean delivery and the occurrence of complex febrile seizures ($p = 0.007$). This observation is consistent with emerging evidence suggesting that perinatal stress factors may influence seizure susceptibility and early neurodevelopmental outcomes. For instance, Gholipoor et al. demonstrated that prenatal stress significantly increased the risk, duration, and severity of febrile seizures in children under two years of age, alongside elevated cortisol levels(Gholipoor et al., 2017). These findings underscore the potential role of early-life stressors in seizure pathophysiology. While Gholipoor et al. did not assess delivery mode specifically, the observed impact of prenatal stress supports the plausibility that cesarean-associated perinatal stress—such as altered neurohormonal transitions, maternal-infant separation, and delayed initiation of breastfeeding—may contribute to increased vulnerability to complex febrile seizures in cesarean-born children.

Although the exact mechanism linking cesarean delivery to seizure complexity remains speculative, existing literature suggests that cesarean-born infants experience delayed colonization of beneficial microbiota and altered immune system maturation. Amjad et al, while not focused on seizure outcomes, identified that higher cesarean section rates in Pakistan are associated with

factors such as urban residence, maternal socioeconomic status, and private healthcare utilization—suggesting a trend toward cesarean deliveries that may not always be medically justified (Amjad et al., 2018). It can therefore be inferred that such non-essential surgical births could expose neonates to avoidable perinatal stress, which may, in turn, contribute to the increased risk of complex febrile seizures observed in our study.

Dominguez-Bello et al. (2010) found that cesarean-delivered infants acquire microbial communities resembling maternal skin flora, in contrast to vaginally delivered infants who acquire microbiota similar to their mother's vaginal microbiota. Dominguez-Bello et al.(Dominguez-Bello et al., 2010) and Neu and Rushing(Neu & Rushing, 2011) further discussed how such alterations in early microbial colonization can impact immune system development, potentially increasing the risk of allergic and autoimmune conditions. While a direct link between these microbial changes and seizure susceptibility has not been conclusively established, the influence of the gut microbiome on the gut-brain axis suggests a plausible connection warranting further investigation.

Although a positive family history of febrile seizures was observed in 65.7% of cases, complex febrile seizures were significantly more frequent among children without such a history ($p = 0.007$). Verity and Golding(Verity & Golding, 1991) identified familial predisposition as a contributing factor to the risk of developing epilepsy after febrile seizures, particularly among children with a history of complex or multiple seizures. However, our findings suggest that in the absence of family history, complex febrile seizures may arise from alternative etiologies—possibly involving neurodevelopmental or structural abnormalities—highlighting an area that warrants further investigation. The study also found a high prevalence of developmental delays (58.6%) and low Apgar scores or resuscitation history (62.9%) among febrile seizure patients. These findings suggest that perinatal factors may contribute to seizure susceptibility, aligning with previous research indicating that perinatal hypoxia and developmental impairments can increase the risk of seizures in children(Glass et al., 2009). In terms of nutritional factors, 41.4% of patients in our study had low serum zinc levels. This finding reinforces earlier research linking hypozincemia to an increased risk of febrile seizures(Farhad Heydarian, Ashrafzadeh, & Ghasemian, 2010). However, no statistically significant association was found in this sample ($p > 0.05$).

Immunization coverage was suboptimal in this cohort, with over 60% of children unvaccinated for measles and Haemophilus influenzae type b (Hib). This finding raises concerns given the well-documented role of vaccine-preventable viral and bacterial infections as potential triggers for febrile illnesses, which in turn may precipitate febrile seizures. While limited research exists specifically linking measles or Hib vaccination status to febrile seizures, related studies on other viral pathogens offer indirect support for this concern. For example, a nationwide study in Japan by Takahashi et al(Takahashi et al., 2020) demonstrated that rotavirus vaccination significantly reduced hospitalizations due to seizures, including febrile seizures, suggesting that immunization against certain pathogens can mitigate seizure risk by preventing the underlying infection. However, no solid, large-scale studies to date have established a direct link between under-vaccination for measles or Hib and increased febrile seizure incidence. This highlights the need for further research to clarify whether improving coverage for these vaccines could reduce the risk of febrile seizures in susceptible pediatric populations.

Overall, while most risk factors did not reach statistical significance, the associations

observed—especially with cesarean delivery and absence of family history—highlight important areas for clinical awareness and further research. This study underscores the multifactorial nature of febrile seizures and the need for comprehensive neonatal, nutritional, and immunization-based interventions in at-risk populations.

Conclusion

This study provides valuable insights into febrile seizures from a tertiary care setting in Pakistan. It confirms their higher prevalence in males under three years of age and reveals a significant association between cesarean delivery and complex febrile seizures, pointing to possible perinatal stress-related mechanisms. The increased occurrence of complex seizures in children without a family history suggests other contributory factors. Although developmental delay, low APGAR scores, hypozincemia, and incomplete immunization were frequently observed, they were not statistically significant in this cohort, though still clinically relevant. Overall, these findings highlight the multifactorial nature of febrile seizures and the need for broader risk assessment. Further multicenter research is essential to explore causal pathways and guide preventive strategies, particularly in resource-limited settings.

Limitations

This descriptive cross-sectional study limits causal inference; observed associations, such as between cesarean delivery and febrile seizures, cannot confirm causality. With only 70 confirmed cases from a single institution, statistical power and generalizability are limited. The absence of control groups restricts comparative analysis. Future research should use multicenter, longitudinal designs with control groups to improve causal understanding and generalizability.

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