



Original Research Article

COMPARISON OF SERUM ZINC LEVEL IN FEBRILE CHILDREN WITH AND WITHOUT CONVULSIONS

Shilpa S Chalachagudda¹, Chikkanarasa Reddy P S², Anusha Athadkar³, Krishna Kumari Vijay Kumar⁴, K Sree Sarada⁵, Chinmayi Y S⁶

¹Assistant Professor, Department of Pediatrics, St John's Medical College, St John's National Academy of Health Sciences, Bangalore, Karnataka, India.

²Professor and Head, Department of Paediatrics, Bangalore Medical College and Research Institute, Bangalore Karnataka, India

³Senior Resident, Department of Pediatrics, AJ institute of Medical Sciences, Mangalore

⁴Junior Resident, Department of Paediatrics, Bangalore Medical College and Research Institute, Bangalore Karnataka, India.

⁵Junior Consultant, Department of Paediatrics, Ankura Hospitals, Telangana, India.

⁶Fellow in Pediatric critical care, Manipal Hospitals, Old Airport Road, Bangalore, India.

Received : 09/08/2026
Received in revised form : 07/09/2026
Accepted : 10/09/2026

Corresponding Author:

Dr. Shilpa S Chalachagudda,
Assistant Professor, Department of
Pediatrics, St John's Medical College,
St John's National Academy of Health
Sciences, Bangalore, Karnataka, India.
Email: cshilpao9@gmail.com

DOI: 10.70034/ijmedph.2026.3.764

Source of Support: Nil,

Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (3); 4947-4952

ABSTRACT

Background: Febrile seizures are the most common cause of convulsions in children and a frequent cause of emergency hospital admissions. Indian studies suggested that up to 10% of children experience a febrile seizure. Febrile seizures are defined as an event in infancy or childhood usually occurring between 6 months to 6 years of age associated with fever but without evidence of intracranial infection or defined cause, numerous studies have been done to analyse the role of trace elements in febrile convulsions. Low serum zinc level have been linked to febrile convulsions.

Materials and Methods: This study was an observational cross sectional study conducted at tertiary teaching hospital over 18 months. Children aged between 6 months to 6 years admitted in hospitals attached to BMCRI were enrolled in the study. Pre structured format was used for collection of data. After obtaining clearance from institutional ethics committee, cross sectional study was performed on 80 cases, 40 children with febrile seizures and 40 febrile children, these two groups were matched for age and sex, the serum zinc level in both the groups was estimated and relationship between serum zinc level and febrile convulsion was determined by statistical analysis.

Results: Among the 40 cases (children with febrile convulsions) and 40 control (children with fever), majority of children 22 (55%) of cases and 24 (60%) of control belonged to age group of less than 2 years, both study group had majority of male children 23 (57.56%) in cases and 21 (52.56%) in controls, URTI was the most common triggering factor 29 (72.50%) in cases and 23 (65%) in control group respectively, only 4 (10%) of cases and 2 (5%) of controls had significant family history, both study group had almost same average temperature 101.1 F in case and 101.91 F in control, 26 (65%) of children with febrile convulsion belonged to class IV SES and 15 (35%) of children with fever belonged to class IV SES. 26 (65%) of febrile children with convulsion had low serum zinc level as compared to 10 (25%) of children with fever, febrile children with convulsion had a low mean serum zinc level of 61.05 mg/dl as compared to mean of normal serum zinc value of 79.1 mg/dl in children with fever. Mean serum zinc level were significantly low in children with febrile convulsions with p value of 0.001.

Conclusion: Our study revealed that serum zinc level was significantly lower in children with febrile convulsions when compared to children with fever alone without convulsions, thus indicating that zinc deficiency plays significant role in the pathogenesis of febrile convulsions. Children with low serum zinc levels are more prone to get febrile seizures than children with normal serum zinc level. The role of zinc in febrile convulsions should be

investigated by further studies and if the results are in coherence zinc supplementation can be given in febrile convulsions.

Keywords: Febrile convulsion, Low zinc level, Zinc supplementation.

INTRODUCTION

Epilepsy is one of the most common disorders of the brain. During entire lifespan 1 among 10 would have an event of convulsion, however only one third among them would go on to develop epilepsy disorder. Going by the World Health Organization (WHO) survey, epilepsy accounts for 1% of the global burden of disease, which is almost a figure equivalent to breast cancer in women and lung cancer in men.^[1]

Convulsive disorder, seizure disorder, and cerebral seizures are few terminologies that are interchanged with epilepsy in many circumstances: They all refer to recurrent paroxysmal episodes of brain dysfunction manifested by stereotyped alterations in behaviour.^[1]

The most common type of seizures observed in children are the febrile seizures. By definition febrile seizures are defined as an event in infancy or childhood usually occurring between age group of six months to six years, associated with fever but without evidence of intracranial infection or defined cause.^[2]

Children have a time in their development with a low seizure threshold and it is usually around this time that febrile convulsions occur. Convulsions typically occur relatively early in an infectious illness usually during the rise of temperature curve. Upper respiratory tract infection, lower respiratory tract infection, otitis media, acute gastroenteritis, are some of common childhood illness that predispose to febrile convulsions and children respond to these infections with comparably higher temperatures.^[2]

The onset of febrile convulsions generally follows a bell-shaped curve. 94% occur within the first three years of age and 6% of them after three years of age. The peak incidence of febrile convulsions is within 2 years of age, specially between 18-24 months. There must be a strong index of suspicion of serious infections like bacterial meningitis if febrile convulsions occur before 6 months of age.^[2]

Febrile convulsions have been greatly influenced by genetic makeup of the individual. A sibling of febrile convulsion is at 10% percent risk to develop febrile convulsions and increases to 50% for sibling if the parent has febrile seizures as well.^[8] A concordance rate of 56% in monozygotic twins and 14% in dizygotic twins was reported by Tsuboi et al in 1987.^[3] The exact mode of inheritance remains unclear, although there are hints towards genetic basis of febrile seizures.

Audenart et al,^[10] in their study identified chromosome 19p and 8q 13-21 have been mapped as the genes likely to be involved. He also demonstrated a slight male preponderance.^[4]

A febrile seizure becomes complex or complicated when the duration exceeds more than 15 min, when multiple convulsions occur within 24 hours, or when the type of seizure are focal or focal neurological deficits are present during the post ictal period.^[5]

Multiple trace elements are responsible for pathogenesis of convulsions by their virtue of co-enzyme activity or ability to influence ion channels and receptors. Trace elements like iron, zinc, selenium, copper and magnesium play a significant role in febrile convulsions. Glutamic acid decarboxylase, is an enzyme which maintains the production of GABA in central nervous system, zinc is the cofactor the enzyme mentioned above. There are zinc containing neurons which have high concentrations of zinc in the synaptic vesicles. Storage capacity of glutamate is increased by zinc and hence slows the rate of release of glutamate. Zinc also stimulates the activity of pyridoxal kinase, which is involved in the synthesis of pyridoxal phosphate from pyridoxal. Pyridoxal phosphate in turn stimulates the activity of glutamic acid decarboxylase which catalyzes GABA synthesis. Hence decrease in zinc concentration results in lowering of GABA level which can precipitate seizures.^[6]

Recent evidences indicate that deficiency of zinc can play significant role in febrile seizures. To regard the importance of febrile seizure and its possible contributing factors including serum zinc level this study is been conducted to compare the serum zinc levels in febrile children with and without convulsions during 18 months in hospitals attached to Bangalore Medical college and Research institute.

MATERIALS AND METHODS

This Prospective cross sectional study was conducted among Febrile children with and without convulsions admitted in hospitals attached to BMCRI. Duration of study was November 2018-May 2020.

Sample size:

$$\text{Formula n} = \frac{(Z_{\alpha} - Z_{\beta})^2 \times p}{\frac{X \times q \times Z}{Z_{\beta}^2 \times p \times q \times 2}}$$

α^2

$Z_{\alpha} = 1.96$ for α

at 0.05 $Z_{\beta} = 0.675$ for β at 0.25

P=Average prevalence of low serum zinc in febrile children with and without convulsions

$q = 1-p$

P^1 (febrile children with convulsion) =65(reference for the study)

P^2 (febrile children)= 35 % (assumption) $P = \frac{P^1 + P^2}{2} = \frac{65 + 35}{2} = 50\%$

2

2

$$n = \frac{(1.96 + 0.675)^2 \times 50 \times 50 \times 2}{30^2} = 40$$

Inclusion Criteria

1. Febrile children (with fever more than 38°C, per rectal temperature)
2. Children fitting into category of febrile convulsions between 6 months and 6 years of age, associated with a fever more than 38°C (rectal temperature), without neuro developmental delay and without neuro infection (annexure III)
3. Children between 6 months- 6 years

Exclusion Criteria

1. Children on zinc supplementation
2. Children on antiepileptic medication
3. Diarrheal diseases
4. Undernourished children

Methodology: After obtaining clearance from institutional ethics committee, the patients fulfilling inclusion criteria were enrolled for study after obtaining informed consents from parents/guardians. Cross sectional study was performed on 80 number of children aged between 6 months to 6 years, 40 children with febrile seizures and 40 febrile children, two groups were matched for age and sex,

following which the serum zinc level was estimated. 2ml of blood was drawn under strict aseptic precaution in clot-activator tube, Serum Zinc levels were measured by Inductively Coupled Plasma Mass Spectrometry technique. The laboratory reference range was 65-130mcg/dl.

Statistical Analysis: Data entry was done in MS Excel and analyzed by SPSS Software (v20). categorical data is presented in the form of count, percentage. Continuous data is presented in mean (SD). Independent t test and chi square tests of significance were applied across 2 groups for continuous and categorical variables respectively.

RESULTS

In the case group of children with febrile convulsions 55% (22) of children were below 2 years of age, 33%(13) between 2.1 to 3 years, 10% (4) n between 3.1 to 4 years and 3%(1) between 4.1 to 5 years of age. In the control group of children with fever 60% (24) were below 2 years of age, 22.50% (9) were between 2.1 to 3 years, 7.50%(3) were between 3.1 to 4 years of age and 10 % (4) were between 4.1 to 5 years of age.

Table 1: Age distribution of children studied

Age distribution	Children with febrile convulsions		Children with fever		Total	
	n	%	n	%	n	%
2 years and less	22	55%	24	60%	46	58%
2.1 to 3 years	13	33%	9	22.50%	22	27.50%
3.1 to 4 years	4	10%	3	7.50%	7	8.75%
4.1 to 5 years	1	3%	4	10%	5	6%
Total	40	100%	40	100%	80	100%

In the case group of children with febrile convulsions 42.50% (17) were females and 57.50% (23) were males

In the control group of children with fever 47.50% (19) were females and 52.50% (21) were males

Triggering Factors: Upper respiratory tract infection was found to most common triggering

factor in both case group i.e. children with febrile convulsions 72.50% (29) and control group i.e. children with fever (23) 57.50% The other causes in case group were viral fever followed by ASOM followed by dengue fever in that order, while that in control group was ASOM, viral fever followed by dengue in that order.

Table 2: Triggering factors

Triggering Factors	Children with febrile convulsions		Children with fever		Total	
	n	%	n	%	N	%
ASOM	5	12.50%	8	20%	13	16.25%
DENGUE	1	2.50%	4	10%	5	6.25%
URTI	29	72.50%	23	57.50%	52	65%
VIRALFEVER	5	12.50%	5	12.50%	10	12.50%
Total	40	100%	40	100%	80	100%

Family History: Family history of febrile convulsions were positive in (4)10% of children with febrile convulsions and 5%(2) of children with fever.

TEMPERATURE: Average temperature in children with febrile convulsion was 101.19F and in children with fever was 101.93F.

Table 3: Comparison of average temperature

Variable	Children with febrile convulsions (n=40)	Children with fever (n=40)	p value
MEAN TEMP	101.19(±0.99)	101.93(±0.89)	<0.001

Socio Economic Status: In case group of children with febrile convulsion 65% (26) belonged to class IV. In control group of children with fever majority 42.5% (17) of them belonged to class III 10% (4) belonged to kuppaswamy class V, 37.50% (15) belonged to class IV.

Serum Zinc Levels: Among 40 children with febrile convulsions, 26 (65%) had low serum zinc level as compared to 10 (25%) out of 40 in children with fever. Mean serum zinc level were significantly low in children with febrile convulsions with p value of 0.001 (statistically significant).

Table 4: Zinc levels in cases and control groups

Zinc levels	Children with febrile convulsions		Children with fever		Total		p value
	n	%	N	%	n	%	
High	1	2.50%	4	10%	5	6.25%	0.001
Low	26	65%	10	25%	36	45%	
Normal	13	32.50%	26	65%	39	48.75%	
Total	40	100%	40	100%	80	100%	

Normal Reference Value of Zinc: Serum zinc levels: 65-130 µg/dl. Children with febrile convulsions versus children with fever had significant p value of 0.001.

Mean Serum Zinc Level: Children with febrile convulsions had a mean serum zinc value of 61.05 mg/dl (low) as compared to mean of 79.15 mg/dl (normal) in children with fever.

Table 5: Mean serum zinc level studied in both groups

MEAN SERUM ZINC	Children with febrile convulsions (n=40)	Children with fever (n=40)	p value
	61.05(±22.59)	79.15(±36.68)	<0.01

Children with febrile convulsions had a mean fever seizure interval of 10.38 hrs and mean duration of seizure in the group was 38.98 secs.

Table 6: Fever- seizure interval and duration of seizures in febrile children

Children with febrile convulsions	Mean(sd)
FEVER SEIZURE INTERVAL (Hours)	10.38(±5.6)
DURATION OF SEIZURE (seconds)	38.98(±12.84)

DISCUSSION

Febrile seizures are seizures that occur between the ages of 6 and 60 months (peak 12-18 mo) with a temperature of 38°C (100.4°F) or higher, that are not the result of intracranial infection or any metabolic imbalance, and that occur in the absence of a history of prior febrile seizures. Febrile seizure is a result of age-dependent response of the immature brain to fever. This postulation is supported by the fact that (80 -85%) febrile seizures have occurrence in the first half of 6 years that is majorly between 6 months and 3 years of age, with the peak incidence being 18 months. The exact mechanism for increased susceptibility is incompletely understood, animal models suggest that there is increased neuronal excitability during the normal brain maturation. Element zinc has a regulatory effect on excitatory neurotransmitter glutamic acid decarboxylase and the synthesis of GABA. Multiple studies have been made to identify predisposing risk factors like family history, metabolic disturbance (especially serum zinc, magnesium, glucose, calcium) for occurrence of febrile convulsions.

Our study showed that majority of children in both the groups children with febrile convulsion and children with fever alone were below 2 years of age. The mean age of febrile convulsions was 22 months

and 22(55%) of children with febrile convulsion group and 24 (60%) of children with fever were below 2 yrs of age. Waqar Rabbani et al,^[7] reported a mean age of 23.97± 14.45 months in his study. In the study done by Ganesh et al,^[8] reported maximum cases were in the age group less than 24 months and mean age was 23.8 months.

Out of 40 cases of febrile convulsions 23 cases (57.50%) were male and (17) 42.50% were female. Male to female ratio in children with febrile convulsions was 1.35:1. Karthikeyan P et al,^[9] reported 66% male children in febrile convulsion group, male to female ratio was 1.9 : 1, Mojtabaamiri et al,^[10] carried out a study in Iran that reported 60% male children in febrile seizure group, male to female ratio in this study was 1.5 : 1, however in contrast Namakin et al,^[11] reported female preponderance in group of children with febrile convulsion, our study reports male preponderance in line with studies mentioned.

Family history of convulsion has been attributed as one of the risk factors for development of febrile seizures in various study done earlier.

Karthikeyan P et al,^[9] had 22% positive family history in his study. Siddique et al,^[12] reported 30% positive family history in the study group. study. Farwell,^[13] in 1994 reported positive family history in 29% of cases, however our study shows 10% positive family history in children with febrile

convulsion percentage in our study is lesser when compared to other studies.

Triggering factors or illness Associated with febrile convulsion

Viral illness are predominant cause of febrile convulsions. Mahayar et al,^[14] in his study done in Iran in 2007 reoprted URTI as major cause of febrile convulsion, in 53.8% of children with febrile convulsion, Waqar Rabbani et al,^[7] reported major triggering factor as URTI, 24% of children with febrile convulsions were triggered due to viral URTI, in contrast Palliana et al,^[15] in their study showed lower respiratory Tract infection as the major cause to trigger febrile convulsions, 22% of febrile convulsion children had showed lower respiratory Tract infection, our study in accordance with mentioned studies, demonstrates that 72.5% of children with febrile convulsions had trigger factor as URTI.

Serum zinc

Our study showed a low mean serum zinc level of 61.50 ug/dl in children with febrile convulsion. (normal serum zinc level 65-130 µg/dl) and the mean serum zinc value in children with fever was 79.15 ug/dl, Children with febrile convulsions had statistically significant low serum zinc levels when compared to children with fever alone without convulsions.

Children with fever alone did not show decrease in serum zinc level, our findings correlate with findings of multiple studies quoted below. Karthikeyan P et al,^[9] in his study on 50 children with febrile convulsions, reported an average low serum zinc level of 68.4 ug/dl (70-150ug/dl, normal level)

Eshanipour et al,^[16] conducted a study in Iran in study group aged between 6-60 months, study group was divided into 3 groups A, B and C. A group, children with febrile convulsion, group B children with fever alone and group C were non febrile convulsions. The mean serum zinc levels of group A, group B, and group C were 76.8mcg/dl, 90.1mcg/dl and 94.5mcg/dl respectively. It was found in the study that mean serum zinc level in febrile convulsion group was significantly lower in comparison to other two groups

Heydarian farhad et al,^[17] in his case control study in Iran showed that case group had mean lower serum zinc level of 66.3 mcg/dl and the control group had normal serum zinc level of 75.8mcg/dl, the difference was statistically significant.

Ganesh et al,^[8] study showed low mean serum zinc level of 32.17 mcg/dl (60-150 ug/dl) in case group as compared to normal mean serum zinc level of 87.6mg/dl in control group.

Palliana et al,^[15] carried out a study in tertiary hospital in Mumbai, study results concluded ,that cases had low mean serum zinc level of 81.4 mcg/dl as against normal zinc level of 90.38mcg/dl.

Mojtabaamiri et al,^[18] conducted a study in Iran, serum selenium, zinc, and copper cases had low mean serum zinc level of 66.9mcg/dl compared to

normal of 107.8mcg/dl in controls, cases and controls had serum selenium of 44.9mcg/dl and 62.8 mcg/dl respectively, there was no much difference in the level of copper in both the groups.

Serum zinc levels in our study did not show any significant correlation with age of onset, sex, axillary temperature or fever seizure interval in our study. All previous studies have shown similar findings in this aspect.

Limitations

Our study being observational, fails to investigate the reduction in occurrence of febrile convulsions with zinc supplementation on follow up of cases and controls.

CONCLUSION

Our study revealed that serum zinc levels was significantly lower in children with febrile convulsions when compared to children with fever alone without convulsions, thus indicating that zinc deficiency plays significant role in the pathogenesis of febrile convulsions. Children with low serum zinc levels are more prone to get febrile seizures than children with normal serum zinc level The role of zinc in febrile convulsions should be investigated by further studies and if the results are in coherence zinc supplementation can be given in febrile convulsions.

REFERENCES

1. World Health Organization. Atlas: Epilepsy Care in the World. Geneva: World Health Organization; 2005:91.
2. Consensus statement Febrile seizures: long term management of children with fever associated seizures, Pediatrics Dec 1980;(6):1009-12.
3. Tsuboi T, Endo S. Genetic studies of febrile convulsions: analysis of twin and family data. Epilepsy Res Suppl. 1991; 4:119-28
4. Audenart D, Van Broockhoven. Genes and loci involved in febrile seizures and related epilepsy syndromes: Hum Mutat May 2006;27(5):391-401.
5. Mikati M.A., Tchapyjnikov D. In Kliegman R., Geme S, Blum, Shah, Tasker, Wilson. Nelson Textbook of Pediatrics; 21st ed, Philadelphia; Elsevier, 2020; 3092-94
6. M. Ebadi and R.F. Pfeiffer, zinc in Neurological disorders, experimentally induced epileptiform seizures- The Neurobiology of Zinc, vitamin B6 deficiency, Toxicity and pathology, Alan R. Liss Inc 1984 P307-324
7. Waqar Rabbani M, Ali I, Zahid Latif H, Basit A, Rabbani MA. Serum Zinc Level in Children Presenting with Febrile Seizures. Pak J Med Sci. 2013 Jul;29(4):1008-11.
8. R Ganesh, Janakiraman L. Serum zinc levels in children with simple febrile seizures. Clinical Pediatrics, Vol 47, March 2008;164-166
9. Karthikeyan P, Prasanna R, Sathyamoorthy M, Reddy SM, Sekar P. Serum zinc levels in children with simple febrile seizures. Int J Contemp Pediatr 2015; 2:424-7.
10. Amiri M, Farzin L, Moessesi M, Sajadi. Serum trace element levels in febrile convulsions-. Biological Trace Element Research; 2009; Vol 135, No 1-3, Pg 38-44
11. Daoud A D. Iron insufficiency linked to first febrile seizure. Jordan Epilepsia; July 2002 ,Vol 43, Issue 7; Page 740
12. Siddiqui TS. Febrile convulsions in children: relationship of family history to type of convulsions and age at presentation. J Ayub Med Coll Abbottabad. 2002 Oct-Dec;14(4):26-8

13. Farewell JR, Blackwell G, Sulzbacker S, Adelman L. First febrile seizures, Characteristics of the child, the seizure and the illness. *Clinical Paediatric Phila*. 1994;33(5); 263-267
14. Mahya A, Parviz A, Fallahi M, Javadi A. Risk factors of the first febrile seizures in Iranian children. *International Journal of Pediatrics*, Vol 2010, Article ID 862897.
15. Palliana, DK Sinha, Borade A. Zinc deficiency as a risk factor for febrile seizures-. *Pediatric On Call* Cited Dec 1 2010, Art No 77, Vol 7 Issue 12.
16. Ehsanipour F, Talebi-Taher M, Harandi N, Kani k. Serum zinc level in children with febrile convulsion and its comparison with that of control group. *Iranian J Pediatr* 2009; 199:65-8. 8.
17. Heydarian F, Ashrafzadeh F, Kam S. Simple febrile seizure: The role of serum sodium levels in prediction of seizure recurrence during the first 24 hours. *Iran J Child Neurol* 2009; 3(2):31-4. 9
18. Amiri M, Farzin L, Moessesi M, Sajadi. Serum trace element levels in febrile convulsions-. *Biological Trace Element Research*; 2009; Vol 135, No 1-3, Pg 38-44.