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FREQUENCY OF IRON DEFICIENCY ANEMIA IN PATIENTS WITH SIMPLE FEBRILE SEIZURES

Original Research

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ABSTRACT

Background: Febrile seizures are the most frequently encountered type of convulsions in pediatric populations, particularly affecting children between 6 months and 5 years of age. Emerging evidence suggests a potential link between iron deficiency anemia (IDA) and the occurrence of febrile seizures due to iron's role in neurotransmitter metabolism and brain oxygenation. Given the high burden of both conditions in early childhood, evaluating their association is crucial for timely diagnosis and intervention.

Objective: To assess the frequency of iron deficiency anemia in children diagnosed with simple febrile seizures and identify associated demographic factors.

Methods: This cross-sectional study was conducted at the Department of Pediatrics, Mardan Medical Complex, from March to September 2024. A total of 146 children aged between 6 months and 5 years presenting with simple febrile seizures were enrolled through non-probability consecutive sampling. After obtaining informed consent, a 5cc venous blood sample was collected from each participant to evaluate hemoglobin levels. IDA was defined as hemoglobin concentration <11 g/dL, in accordance with WHO criteria. Data were analyzed using SPSS version 26, and associations between IDA and demographic variables were examined using the Chi-square test with a significance threshold of $p<0.05$.

Results: IDA was identified in 64 out of 146 patients (43.8%). A higher frequency of IDA was observed in male children (64.1%) compared to females (35.9%) ($p=0.02$). IDA was significantly associated with low socioeconomic status (39.1% vs. 7.3%, $p=0.0001$) and a positive history of worm infestation (29.7% vs. 2.4%, $p=0.00001$).

Conclusion: Iron deficiency anemia was prevalent in children with simple febrile seizures. Male gender, low socioeconomic background, and history of worm infestation were significantly associated with higher risk, warranting early screening and targeted interventions.

Keywords: Anemia, Child, Febrile seizures, Hemoglobin, Iron deficiency, Parasitic infection, Socioeconomic factors.

INTRODUCTION

Febrile seizures are the most common type of convulsions experienced in childhood, with the majority occurring between 12 and 18 months of age (1–3). These seizures are generally categorized as either simple or complex, based on their duration and characteristics. Simple febrile seizures, which last for 15 minutes or less and do not recur within 24 hours, constitute the predominant form, whereas complex febrile seizures are longer in duration and may recur or have focal features (4). A strong familial component has been observed, with 10% to 33% of affected children having a first-degree relative with a seizure history. Twin studies further support this genetic link, with concordance rates ranging from 35% to 69% in monozygotic twins and from 14% to 20% in dizygotic twins (5–7). In recent years, attention has turned to the possible role of iron deficiency anemia (IDA) as a contributing factor in the development of febrile seizures. This is particularly relevant given that both IDA and febrile seizures commonly affect children under the age of two, suggesting a potential overlap in their pathophysiology (8). Iron plays a critical role in oxygen transport via hemoglobin and is essential for proper brain function. It also influences the metabolism of neurotransmitters, thereby affecting neuronal excitability (9). Several studies have proposed a link between iron levels and seizure threshold, with some evidence suggesting that iron deficiency might, paradoxically, exert a protective effect by increasing the threshold for convulsions. For example, one study reported that anemic children had a lower risk of experiencing febrile seizures compared to non-anemic counterparts (10). This has led to the hypothesis that iron supplementation in children with febrile seizures should be approached with caution, as it may inadvertently lower the seizure threshold (11). Nonetheless, a high prevalence of IDA—up to 58.9%—has been observed in children presenting with simple febrile seizures (12), emphasizing the need to clarify the nature of this relationship. Given the uncertain and sometimes contradictory findings in existing literature, the current study aims to assess the prevalence of iron deficiency anemia in children presenting with simple febrile seizures. This investigation seeks to enhance understanding of the potential hematological factors contributing to seizure susceptibility in early childhood.

METHODS

This cross-sectional study was conducted in the Department of Pediatrics at Mardan Medical Complex, Mardan, from March 1, 2024, to September 1, 2024. A total of 146 children were included through non-probability consecutive sampling. The sample size was calculated using a 95% confidence interval, a 5% margin of error, and a reference prevalence of iron deficiency anemia (IDA) among children with febrile seizures as 58.9% based on previous research (12). Ethical approval was obtained from the institutional review board, and informed written consent was secured from the parents or legal guardians of all participants prior to inclusion in the study. Eligible participants included children aged between 6 months and 5 years, of either sex, presenting with simple febrile seizures. Febrile seizures were defined as seizure episodes accompanied by a body temperature above 100°F, generalized tonic or clonic movements involving both sides of the body, and a duration of 15 minutes or less, with no recurrence within 24 hours. Children with any prior history of afebrile seizures, intracranial infections, metabolic abnormalities, or diagnosed hematologic disorders such as thalassemia were excluded to ensure a homogenous study population and avoid confounding factors.

Demographic and clinical data were collected via structured interviews with caregivers. A 5cc venous blood sample was drawn aseptically from the antecubital fossa by trained nursing staff and sent to the institutional laboratory for hemoglobin analysis. Iron deficiency anemia was identified based on a hemoglobin level of less than 11 g/dL, in accordance with WHO criteria for anemia in children under five years of age. Data were analyzed using SPSS version 26. Descriptive statistics were applied to summarize demographic variables, with categorical data such as gender, residential status, socioeconomic level, parental education, worm infestation history, and the presence of IDA expressed as frequencies and percentages. Continuous variables, including age, weight, height, duration of symptoms, and monthly family income, were presented as means and standard deviations. Stratification of IDA by demographic variables was performed, and associations were assessed using the Chi-square test, considering a p-value of less than 0.05 as statistically significant.

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RESULTS

The study included 146 children with febrile seizures, with a mean age of 2.79 ± 1.33 years. The average duration of symptoms was 2.99 ± 1.44 minutes. The mean height and weight of participants were 0.92 ± 0.12 meters and 13.74 ± 2.74 kilograms, respectively, while the average family monthly income was Rs. 63,528.68 ± 17,438.02. Among the participants, 78 (53.4%) were male and 68 (46.6%) were female. A slightly higher number of patients resided in rural areas (54.1%) compared to urban regions (45.9%). In terms of parental education, 36.3% were uneducated, 30.8% had primary-level education, 15.8% had secondary education, and 17.1% had higher education. Regarding socioeconomic status, 67.1% of families were from middle-income households, 21.2% from low-income, and 11.6% from high-income brackets. A history of worm infestation was reported in 21 (14.4%) of children. Iron deficiency anemia was present in 64 (43.8%) of the patients. Stratification of IDA across demographic characteristics revealed a statistically significant association with gender, as 41 (64.1%) of the affected children were male compared to 23 (35.9%) females ($p = 0.02$). IDA also showed a strong association with socioeconomic status; 25 (39.1%) of anemic children belonged to the low-income group compared to only 6 (7.3%) in the non-IDA group ($p = 0.0001$). A striking association was noted between IDA and worm infestation, as 19 (29.7%) of children with a history of worms had IDA versus just 2 (2.4%) among those without worm infestation ($p = 0.00001$).

No statistically significant associations were found between IDA and place of residence ($p = 0.90$), parental education level ($p = 0.61$), age distribution ($p = 0.46$), height ($p = 0.11$), weight ($p = 0.12$), or duration of symptoms ($p = 0.46$). Similarly, family income brackets also reflected a notable association with IDA prevalence; 39.1% of children from families earning below Rs. 50,000/month had IDA compared to only 7.3% in the non-IDA group ($p = 0.0001$). Subgroup analysis based on seizure duration revealed that children experiencing seizures lasting between 2 to 5 minutes constituted the largest proportion of iron deficiency anemia cases, with 27 out of 63 (42.9%) showing IDA. The prevalence of IDA was relatively lower in children with seizures lasting less than 2 minutes (54.5%) and higher in those exceeding 5 minutes (38.0%). When stratified by recurrence, children with a history of recurrent febrile seizures demonstrated a higher prevalence of iron deficiency anemia at 55.0%, compared to 39.6% in those without recurrence. These findings suggest that longer seizure durations and recurrence may be associated with increased likelihood of underlying iron deficiency, warranting further investigation to explore potential causality.

Table 1: Descriptive statistics

Numerical variables	N	Mean	Std. Deviation
Age (Years)	146	2.79	1.325
Height (Meter)	146	.9223	.12220
Weight (Kg)	146	13.7397	2.74253
Duration of symptoms (Minutes)	146	2.99	1.438
Family monthly income (Rs)	146	63528.68	17438.018

Table 2: Demographics of the patients

Demographics		N	%
Gender	Male	78	53.4%
	Female	68	46.6%
Residence	Urban	67	45.9%
	Rural	79	54.1%
Education of parents	Uneducated	53	36.3%
	Primary	45	30.8%
	Secondary	23	15.8%
	Higher	25	17.1%
Socioeconomic status	Low	31	21.2%
	Middle	98	67.1%
	High	17	11.6%

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Table 3: Frequency of iron deficiency anemia

Iron deficiency anemia	Frequency	Percent
Yes	64	43.8
No	82	56.2
Total	146	100.0

Table 4: Association of iron deficiency anemia with demographics

Demographics		Iron deficiency anemia				P value
		Yes		No		
		N	%	N	%	
Gender	Male	41	64.1%	37	45.1%	0.02
	Female	23	35.9%	45	54.9%	
Residence	Urban	29	45.3%	38	46.3%	0.90
	Rural	35	54.7%	44	53.7%	
Education of parents	Uneducated	22	34.4%	31	37.8%	0.61
	Primary	19	29.7%	26	31.7%	
	Secondary	13	20.3%	10	12.2%	
	Higher	10	15.6%	15	18.3%	
Socioeconomic status	Low	25	39.1%	6	7.3%	0.0001
	Middle	34	53.1%	64	78.0%	
	High	5	7.8%	12	14.6%	
Age distribution (Years)	1 to 3	45	70.3%	53	64.6%	0.46
	4 to 5	19	29.7%	29	35.4%	
History of worms	Yes	19	29.7%	2	2.4%	0.00001
	No	45	70.3%	80	97.6%	
Height (meter)	0.75 to 0.90	35	54.7%	34	41.5%	0.11
	> 0.90	29	45.3%	48	58.5%	
Weight (kg)	9 to 13.5	34	53.1%	33	40.2%	0.12
	> 13.5	30	46.9%	49	59.8%	
Duration of symptoms (Months)	1 to 3	36	56.2%	51	62.2%	0.46
	> 3	28	43.8%	31	37.8%	
Family monthly income (Rs)	< 50K	25	39.1%	6	7.3%	0.0001
	50K to 80K	34	53.1%	64	78.0%	
	> 80K	5	7.8%	12	14.6%	

Table 5: Seizure Characteristics and IDA Association

Seizure Duration Category	**IDA Yes**	**IDA No**	**Total**	**% IDA**
<2 minutes	18	15	33	54.5
2-5 minutes	27	36	63	42.9
>5 minutes	19	31	50	38

Table 6: Seizure Recurrence and IDA Association

Seizure Recurrence	**IDA Yes**	**IDA No**	**Total**	**% IDA**
Yes	22	18	40	55
No	42	64	106	39.6

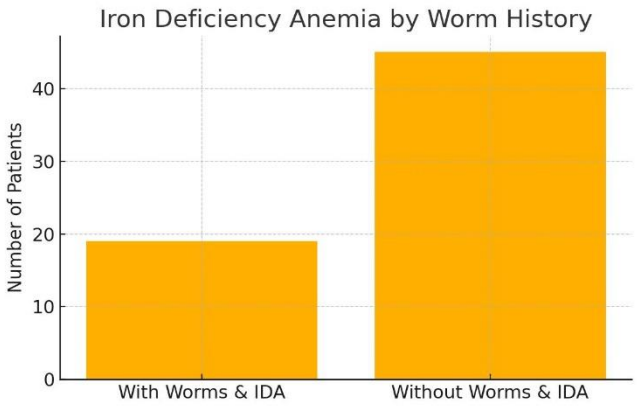

Figure 1 Iron Deficiency Anemia by Worm History

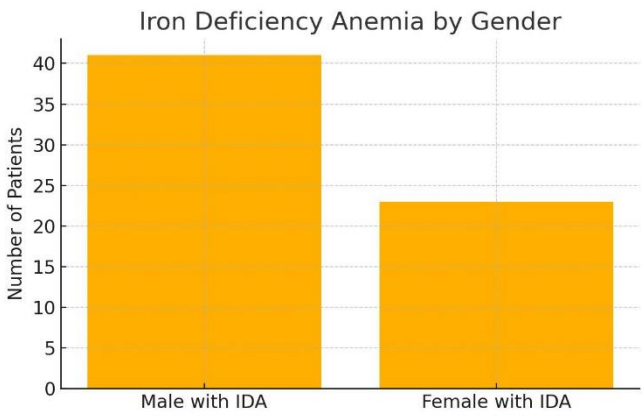

Figure 2 Iron Deficiency Anemia by Gender

DISCUSSION

The present study found that 43.8% of children presenting with simple febrile seizures had iron deficiency anemia (IDA), reinforcing the emerging evidence of a notable association between these two clinical conditions. This finding is in agreement with previously published data, where studies have reported a wide range of IDA prevalence among children with febrile seizures, from approximately 36.7% to as high as 59.5% (13,14). The consistency of these figures suggests a recurrent pattern across different settings, reinforcing the clinical relevance of screening for IDA in children presenting with febrile seizures. Further support for this relationship is demonstrated by research showing that children with IDA had over twice the odds of experiencing febrile seizures compared to those with normal iron levels (15). The study also observed that IDA was more frequent among male children (64.1%) compared to females (35.9%), which is in line with previous research indicating a gender disparity in anemia prevalence among children with febrile seizures (13,14). Although the biological basis for this gender difference remains uncertain, it may be attributed to differences in nutritional access, feeding practices, or physiological iron demands during early development. Socioeconomic status emerged as another critical determinant, with 39.1% of children from low-income families affected by IDA compared to only 7.3% in the non-IDA group. This trend has been echoed in literature where children from rural or economically disadvantaged backgrounds exhibited significantly higher rates of anemia (16,17). These findings highlight the ongoing public health challenge of nutritional deficiencies in low-resource settings and underscore the importance of targeted interventions aimed at early detection and correction of iron deficiency in vulnerable pediatric populations (18).

A significant association was also identified between a history of worm infestation and the presence of IDA, with 29.7% of IDA-positive children reporting past helminthic infections, compared to just 2.4% among non-anemic peers. This aligns with evidence linking intestinal parasitic infections to chronic blood loss and impaired iron absorption, particularly in children living in areas with limited access to deworming programs and sanitation infrastructure (19). This observation strengthens the call for routine deworming and public health education as adjunct strategies in managing pediatric anemia, especially in endemic regions. The mean duration of febrile seizures in this study was 2.99 ± 1.44 minutes, which conforms to established definitions of simple febrile seizures lasting less than fifteen minutes and typically under five minutes (20). However, contrasting studies have reported that prolonged seizure durations may be more frequently associated with IDA, suggesting a possible threshold-modulating effect of iron on neuronal excitability (21). Although this study did not find a statistically significant difference in seizure duration between anemic and non-anemic children, the descriptive findings suggest a need for further exploration into the role of iron in seizure characteristics such as duration and recurrence. Among the strengths of this study are its clear operational definitions, adequate sample size, and comprehensive demographic stratification, allowing for robust subgroup analyses. The inclusion of socioeconomic and parasitic variables adds depth to the understanding of contributing risk factors. However, the study also has notable limitations. Being cross-sectional in nature, it precludes any determination of causality. Furthermore, the use of a single hemoglobin cutoff for diagnosing IDA, without incorporating serum ferritin or other iron indices, may limit diagnostic precision. The absence of follow-up data on seizure recurrence or iron supplementation outcomes further restricts longitudinal interpretation.

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Future studies should consider employing longitudinal designs and integrating broader biochemical parameters to accurately assess iron status. Inclusion of more nuanced seizure classifications—such as focal versus generalized onset, frequency of episodes, and postictal features—would refine the understanding of how IDA influences seizure dynamics. Multicenter collaboration and consideration of dietary assessments could further enhance generalizability and clinical utility. In conclusion, this study contributes valuable evidence supporting the association between iron deficiency anemia and simple febrile seizures in children. It underscores the multifactorial nature of IDA, shaped by biological, environmental, and socioeconomic factors. These insights highlight the need for integrated pediatric care approaches, including nutritional surveillance, deworming protocols, and health education, to effectively mitigate the risk of febrile seizures linked to iron deficiency.

CONCLUSION

This study concluded that iron deficiency anemia is a common comorbidity in children with simple febrile seizures, with a higher likelihood observed among males, those from socioeconomically disadvantaged backgrounds, and children with a history of worm infestation. These findings highlight the importance of incorporating routine anemia screening and addressing modifiable risk factors through nutritional support and preventive public health measures. By identifying vulnerable groups early, pediatric care providers can implement timely interventions that may reduce the burden of iron deficiency and its neurological implications in febrile illness.

AUTHOR CONTRIBUTION

Author	Contribution
Sardar khan*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Mohammad Qasim Khan	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published

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