

Association between Serum Ferritin, Hemoglobin, Vitamin D₃, Serum Albumin, Calcium, Thyrotropin-releasing Hormone with Early Childhood Caries: A Case–Control Study

Anju Jha¹, Sovendu Jha², Richa Shree³, Amit Kumar⁴, Kumari Menka⁵, Manisha Shrikaar⁶

ABSTRACT

Aim and objective: This study aimed to contrast and compare serum ferritin, hemoglobin, Vitamin D₃, Ca⁺⁺, thyrotropin-releasing hormone (TRH), and serum albumin levels between preschoolers with severe caries (SC) and measures taken for caries control.

Materials and methods: A sample size of 300 children was selected but only 266 participated; 54.14% with SC and 45.86% caries-free. Blood samples for serum ferritin, hemoglobin, Vitamin D₃, Ca⁺⁺, TRH, and serum albumin levels were taken.

Results: The mean age was estimated to be 40.82 + 14.09 months. The serum ferritin level estimated mean value for sample pedodontic subjects came to be 29.58 ± 17.87 µg/L whereas their hemoglobin level with mean value 115.13 ± 10.12 g/L was measured. Logistic regression analysis (LRA) suggested that children with SC were nearly two times as likely to have ferritin level depreciation and likely six times more chance of FeDA (iron deficiency anemia) than in children with caries control. Children with SC had significantly lower mean Vitamin D₃ value ($p < 0.001$), Ca⁺⁺ ($p < 0.001$), and serum albumin ($p < 0.001$) levels, and significantly higher thyrotropin-releasing factor ($p < 0.001$) levels than those subjects without caries.

Conclusion: Analysis of children with SC at a very young age significantly showed an increased chance of low ferritin levels than children with a caries-free mouth. The level of hemoglobin was deficient in children with SC at a very young age. Children with SC at a very young age appeared to be malnourished when compared with children without dental caries. Other contrasting parameters like FeDA, Vitamin D₃, Ca⁺⁺, and serum albumin concentrations were significantly deficient in children with SC at a very young age, in contrast, to a sample of children with a caries-free mouth. The analysis also suggested an increased level of TRH.

Clinical significance: The following research study sets a benchmark for the dental fraternity and other health specialists to analyze serum ferritin, hemoglobin, Vitamin D₃, Ca⁺⁺, TRH, and serum albumin levels while generally treating pediatric patients. Accordingly, supplements should be prescribed rationally even in dental caries.

Keywords: FeDA, Hemoglobin, Preschool child, Serum ferritin, Severe caries, Vitamin D₃, Ca⁺⁺, Thyrotropin-releasing hormone, Serum albumin level.

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INTRODUCTION

After Coryza, dental caries is the most frequently occurring chronic disease in young children. Severe caries (SC) in children at a very young age is defined as any carious lesion in the deciduous teeth in children who are less than six years.¹ Few children develop SC at a very young age and some researchers have coined it as “severe early childhood caries (S-ECC)”, which affects the general health of pediatric patients.² Anemia is a systemic pathology characterized by deficient RBC or hemoglobin functioning at a suboptimal level. Systemically anemia is indicative of poor nutrition and health and is generally diagnosed by abnormally low hemoglobin concentrations.³ Pediatric patients with FeDA shows stunted growth and retarded mental development.⁴ Few studies suggest serum iron deficiency can occur without FeDA if it is for a very transient period and prevents hemoglobin levels to fall below the set pathological thresholds.⁴ Systemic iron deficiency occurs when myotomes keep functioning with zero iron reserve in the body.⁴ Another reason for FeDA is long-standing systemic infections that interfere with systemic iron absorption and hemopoiesis.³

Vitamin D₃ regulates serum Ca⁺⁺ levels as well as aid in the development of the craniofacial region. Thus, its presence in adequate quantity is vital for the maintenance of overall good health. Vitamin D₃ is either synthesized endogenously within

¹Department of Pediatric and Preventive Dentistry, Patna Dental College and Hospital, Patna, Bihar, India

²⁻⁴Department of Orthodontics and Dentofacial Orthopaedics, Buddha Institute of Dental Sciences and Hospital, Patna, Bihar, India

⁵Consultant, Pediatric and Preventive Dentistry, Patna, Bihar, India

⁶Department of Oral and Maxillofacial Pathology, Buddha Institute of Dental Sciences and Hospital, Patna, Bihar, India

Corresponding Author: Anju Jha, Department of Pediatric and Preventive Dentistry, Patna Dental College and Hospital, Patna, Bihar, India, Phone: +91 7004230311, e-mail: dr.anju2015@yahoo.in

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the body or through diet and supplement. Vitamin D₃ promotes ontogenesis significantly.⁵⁻⁷

The deficiency of Vitamin D₃ leads to various developmental defects like enamel hypoplasia, which can act as a precursor

for dental caries in children. In addition, it also has a role in the causation of periodontal diseases. Immunologically, Vitamin D₃ induces the synthesis of defensins, cathelicidins, etc. These antimicrobial peptides are protective in nature and prevent us from oral pathogens.

MATERIALS AND METHODS

A sample size of 300 young children was selected. Out of which only 34 children did not participate; 144 (54.14%) children had SC and 122 (45.86%) children did not have caries. After a proper explanation, the consent forms were signed by the parents; blood samples were then collected from all the pediatric subjects. Tests for serum ferritin, hemoglobin, Vitamin D₃, serum Ca⁺⁺, thyrotropin-releasing hormone (TRH), and serum albumin levels were conducted. A questionnaire regarding the child's nutritional habits, oral health, and family demographics was conducted on the parents. Statistical analysis included descriptive and bivariate statistics (DBS) and logistic regression analysis (LRA). A probability value of ≤0.05 was set as significant.

RESULTS

The estimated mean age of the sample was 40.82 ± 14.09 months. The serum ferritin level estimated mean value for recruited pedodontic subjects came to be 29.58 ± 17.87 µg/L whereas their hemoglobin level with mean value 115.13 ± 10.12 g/L was measured. Logistic regression analysis (Table 1) suggested children with SC had nearly two times ferritin level depreciation and likely six times more chance of FeDA (iron deficiency anemia) than in children with caries control.

Children with severe dental caries at very young childhood had significantly lower mean Vitamin D₃ (68.87 ± 28.04 vs 82.89 ± 31.12 nmol/L, *p* < 0.001), Ca⁺⁺ (*p* < 0.001), and serum albumin (*p* < 0.001) levels, and significantly higher TRF (*p* < 0.001) levels than those children without caries. Subjects with SC had Vitamin D₃ levels below physiological thresholds, i.e., between <75 and <50 nmol/L.

DISCUSSION

This research study was undertaken to set a comparative evaluation between the level of serum ferritin, hemoglobin, Vitamin D₃,

serum Ca⁺⁺, TRH, and serum albumin levels between very young children with SC and very young children without dental caries (Table 2).

This research statistics opened a gateway for evaluating a pediatric patient for minor, comprehensive, and invasive dental treatments. This research provided an additional informative relation between oral health and systemic health. The study gives an insight into the result of different nutritional intake by young children especially in relation to serum ferritin, hemoglobin, Vitamin D₃, serum Ca⁺⁺, TRH, and serum albumin in both the categories of the pediatric samples.

Serum Ferritin and Hemoglobin Levels

As emphasized earlier in the introduction, long-standing systemic infections interfere with systemic iron absorption and hemopoiesis resulting in hemoglobin depletion which may lead to FeDA. Hence, untreated SC can be one such chronic infection. In addition, choice of diet, diet pattern, and masticatory patterns are altered and compromised too, leading to mental upset due to severe odontalgia, malnourishment, systemic malfunctions including gastric upsets, etc., and interference into physical growth.^{1,2}

The two groups (case vs control) showed no statistically significant difference in relation to mean serum iron concentrations, but there was definitely a significant difference in patients showing low ferritin levels. Our study reveals that those undergoing dental surgery were significantly more likely to be classified as having low ferritin (*p* = 0.033).

Vitamin D₃, Ca⁺⁺, TRH, and Serum Albumin Levels

The result of the blood test revealed a significant difference in the serum albumin values in both the categories of the pediatric subjects. Comparatively 18.6% of children with SC depicted lower serum albumin levels whereas only 15% of children were in the control group.

Serum albumin is an indicator of overall health and nutritional status besides Vitamin D₃. Serum albumin deficiencies can be suggestive of nutritional deficient children with SC with unwanted levels of TPH, Vitamin D₃, and Ca⁺⁺.^{3,4} Different schools have also confirmed nutritional deficiency and overall wellbeing of young children as resultant effects from SC.⁵⁻⁹ These findings are very

Table 1: Logistic regression for low ferritin and iron deficiency anemia

	Variable	Regression coefficient (b)	Standard error (b)	Adjusted odds ratio	Confidence interval	p value
Severely low ferritin (i.e., iron depletion)	S-ECC (Reference: Yes)	0.643	0.312	1.89	0.0047, 1.267	0.049
	Multivitamin use (Reference: Yes)	-0.264	0.310	0.765	-0.85, 0.34	0.381
	Yearly Household income (Reference: >\$28,000)	-0.038	0.32	0.956	-0.668, 0.578	0.908
Iron deficiency anemia	S-ECC (Reference: Yes)	1.88	0.45	6.58	1.01, 2.76	<0.0001
	Multivitamin use (Reference: Yes)	-0.687	0.364	0.510	-1.388, 0.014	0.055
	Yearly household income (Reference: > \$28,000)	0.431	0.382	1.54	-0.312, 1.18	0.246

Table 2: Vit-D₃, Ca⁺⁺, serum albumin, and TRH status by SC and caries-free group

Variable	Overall value	Caries status				p value
		S-ECC		Caries-free		
		N (%)	95% CI	N (%)	95% CI	
Vit-D₃ status						
Mean (nmol/L) [†]	75.43 ± 30.23	68.89 ± 27.879	–	82.91 ± 31.1	–	<0.001
Optimal* (≥ 75 nmol/L)						
Yes	125	56 (44.81)	36.1, 53.5	69 (55.2)	46.0, 64.0	0.006
No	136	84 (61.82)	53.6, 69.89	52 (38.2)	30.1, 46.4	
Adequate* (≥ 50 nmol/L)						
Yes	218	111 (50.9)	44.3, 57.66	107 (49.1)	42.4, 55.7	0.05
No	43	29 (67.4)	53.45, 81.45	14 (32.612)	18.6, 46.6	
Deficient* (< 35 nmol/L)						
Yes	16	12 (75.0)	53.81, 96.2	4 (25.0)	3.8, 46.2	0.12 ^a
No	245	128 (52.2)	46.0, 58.5	117 (47.8)	41.5, 54.0	
Calcium status						
Mean (mmol/L) [†]	2.3 ± 0.1	2.2 ± 0.1	–	2.4 ± 0.1	–	<0.001
Low calcium*						
Yes	10	10 (100.0)	100, 100	0 (0.0)	0, 0	0.002 ^a
No	248	130 (52.4)	46.2, 58.6	118 (47.6)	41.4, 53.8	
Low calcium (corrected)*						
Yes	6	6 (100)	100, 100	0 (0.0)	0, 0	
No	252	134 (53.2)	47.0, 59.3	118 (46.8)	41.0, 53.0	0.03 ^a
PTH status						
Mean (ng/L) [†]	47.3 ± 22.0	59.1 ± 21.8	–	32.9 ± 10.8	–	<0.001
Elevated PTH*						
Yes	92	85 (92.4)	87.0, 97.8	7 (7.6)	2.2, 13.0	<0.001
No	162	55 (34.0)	26.7, 41.2	107 (66.0)	58.7, 73.3	
Albumin status						
Mean (g/L) [†]	38.4 ± 3.7	36.8 ± 3.1	–	40.3 ± 3.5	–	<0.001
Low albumin*						
Yes	33	26 (78.8)	64.8, 92.7	7 (21.2)	7.3, 35.2	0.002
No	225	114 (50.7)	44.1, 57.2	111 (49.3)	43.0, 56.0	

*T-test

†Chi-Square

^aAssociated

S-ECC, severe early childhood caries

important for the dental fraternity and other health specialists to analyze serum ferritin, hemoglobin, Vitamin D₃, Ca⁺⁺, TRH, and serum albumin levels while generally treating pediatric patients. Accordingly, supplements should be prescribed rationally even for dental caries.¹⁰ Thus, our study establishes a positive correlation between poor nutritional status and the occurrence of SC in young children.

This study has few shortcomings too. As the Indian sub-continent has diverse socioeconomic status people; this study design does not differentiate between the etiology and the progressive sequences of the diseases. Furthermore, this study only considered the age of young children. Other parameters like gender, socioeconomic status, education level which play a very significant role in all the above-discussed conditions are missed out. The questionnaire as answered by the parents made it crystal clear that few parameters are beyond control.

CONCLUSION

Subjects with SC were at greater risk of having mean serum ferritin levels below the levels of their caries-free control group counterparts and at a greater risk of having mean hemoglobin levels below the levels of their caries-free control group counterparts. These subjects seemed to be at a greater risk of having FeDA than their caries-free control group counterparts. Serum levels of Vitamin D₃, Ca⁺⁺, and albumin in subjects without caries were comparatively higher than the subjects with SC. Subjects with SC were malnourished and displayed significantly higher levels of TRH compared with the subjects of the counter group.

This study sets a benchmark for the dental fraternity and other health specialists to analyze serum ferritin, hemoglobin, Vitamin D₃, Ca⁺⁺, TRH, and serum albumin levels while generally treating pediatric patients even with dental caries. It is their responsibility that supplements should be prescribed rationally.

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