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Association between Iron Deficiency and Severe Early Childhood Caries among Preschool Children in Zawia City, Libya: A Cross-Sectional Study

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Abstract

Background: Early childhood caries is a multifactorial infectious disease and a significant public health issue, the sever form of early childhood caries has distinct clinical features, and negatively affects children's quality of life. This study aims to investigated relation between iron deficiency and early childhood caries in children aged 3–6 years in Zawia City, Libya.

Material and methods: A cross-sectional study was conducted involving 100 children aged 3–6 years. Dental examinations assessed caries experience using the deft index (Decay-Extracted-Filled Tooth Index). Blood investigations through phlebotomy for assessment of serum iron and serum ferritin levels. Parental questionnaires were used to collect data on dietary habits, oral hygiene practices. Statistical analysis was performed to identify the effect of serum iron and ferritin on early childhood caries, iron status, and relevant factors.

Result: The prevalence of early childhood caries was 75%, while 24% of participants had severe early childhood caries. Age was significantly positive correlated with early childhood caries. 26% of children had low iron status according to serum ferritin levels. No significant relationship was observed between serum iron or ferritin and early childhood caries, but a significant inverse association was found between sever early childhood caries and low serum ferritin.

Conclusion: Early childhood caries prevalence is directly related to age, while no significant association was observed between early childhood caries and iron deficiency. On the other hand, a significant inverse relationship was noted between iron deficiency (low serum ferritin) and severe early childhood caries, suggesting a potential link between iron deficiency and caries progression.

Keywords: Early childhood caries; Sever Early Childhood Caries; iron; ferritin; iron deficiency.

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INTRODUCTION

A healthy oral environment during early childhood is essential for lifelong oral and general health [1]. Early childhood caries (ECC) is one of the most common diseases in the early years of life and is considered a serious public health problem worldwide [2]. According to the American Academy of Pediatric Dentistry (AAPD), ECC is defined as the presence of one or more decayed (non-cavitated or cavitated lesions), missing (due to caries), or filled tooth Surfaces in any primary tooth in a child aged 71 months or younger [3]. Severe early childhood caries (S-ECC) is characterized by the presence of smooth-surface caries in children aged 3–5 years or by a decayed, missing, or filled tooth surface score of ≥4 at age 3, ≥5 at age 4, or ≥6 at age 5 [4,5]. A foundational understanding of the characteristics, correlations, epidemiological burden, and risk distribution of ECC is essential for effective prevention and management strategies [6].

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Severe early childhood caries (S-ECC) can contribute to nutritional deficiencies through multiple pathways. Feeding aversion resulting from dental pain and discomfort may limit food intake, while frequent consumption of an imbalanced, high-sucrose diet can displace essential nutrients. In addition, the chronic inflammatory state associated with S-ECC, characterized by the release of inflammatory cytokines from pulpal and periapical tissues, may suppress erythropoiesis and reduce hemoglobin synthesis [7].

These mechanisms suggest that the relationship between S-ECC and iron deficiency may be bidirectional. Iron deficiency remains the most prevalent nutritional deficiency worldwide, particularly affecting infants, young children, and women of reproductive age [8,9].

Previous studies have explored the association between iron status and dental caries. In 2023, Yoshita Atri reported a negative correlation between S-ECC and serum iron and ferritin levels in young children[8], suggesting a potential link between cariogenic burden and iron metabolism. Similarly, reduced ferritin levels have been stated among children with S-ECC in other populations [10, 11]. In light of these findings, the present study aims to investigate the potential association between serum iron, serum ferritin, and early childhood caries in children aged 3–6 years in Zawia City, Libya.

MATERIALS AND METHODS

A cross-sectional study was conducted to assess the relationship between serum iron and ferritin levels and early childhood caries (ECC). The investigation was conducted across seven kindergartens in Zawia city, Libya. Eligible participants included children aged 3–6 years who were cooperative and had no history of iron deficiency, supplementation, or chronic illness. A stratified random sampling technique yielded a convenience sample of 100 children, selected based on school accessibility and parental collaboration. Ethical approval was obtained from the Libyan Medical Research Center's biosafety and bioethics committee under reference number; NBC: 018.H.24.2, and written informed consent was secured from all parents prior to participation. Data collection involved a structured, self-administered Arabic version questionnaire to gather socio-demographic, oral care, and dietary information from parents. The questionnaire was distributed to the parents of participated children and collected in the next few days. A standardized clinical oral examination was performed by a single dentist using a knee-to-knee position and disposable diagnostic kits. Caries experience was assessed using the deft index for primary dentition, excluding non-cavitated white spots and teeth extracted for reasons other than caries. All examinations were conducted in a uniform sequence, and the examiner was blinded to the participants' serum biomarker levels to minimize bias.

Following the clinical assessment, venous blood samples (1-2 ml) were collected from each child under sanitary conditions. Serum was analyzed for iron and ferritin concentrations using a fully automated analyzer at a private laboratory. Each code, and all clinical, questionnaire, and participant was assigned a unique laboratory data were managed in a Microsoft Excel spreadsheet. Statistical analysis was performed using SPSS version 27. Descriptive statistics, frequency tables, the chi-square test for association, and Pearson correlation were employed to evaluate the relationships between caries experience (deft score) and serum iron and ferritin levels.

RESULTS

The mean age of the sample was 5.038 (SD = 0.876), 52% were female, and 48% were males. The largest proportion of participants were aged 5 years (41%), followed by 6 years (34%), 4 years (19%), and 3 years (6%). The mean deft score was 3.14 ± 2.87. Overall, 25% of children were caries-free, 51% had moderate caries experience (deft 1–5), and 24% exhibited high caries experience (deft >5). Based on severity, participants were categorized into low-caries (deft 0–5; n = 76) and high-caries (deft >5; n = 24) groups. Additionally, 25% of the children fulfilled the AAPD criteria for severe early childhood caries (fig 1).

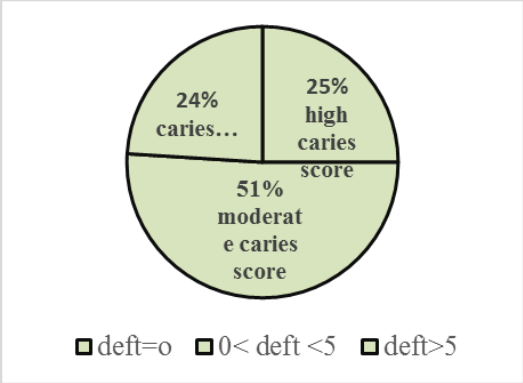

Figure 1. Caries distribution of study sample.

Statistical Analysis

Statistical analysis demonstrated a significant positive correlation between age and deft scores (r = 0.198, p = 0.048), indicating an increase in caries severity with advancing age.

Evaluation of iron status showed that 51% of children had serum ferritin levels ≥30 ng/mL, whereas 49% had ferritin levels below 30 ng/mL, including 26% with ferritin ≤15 ng/mL (fig 2), consistent with iron deficiency according to WHO criteria. Pearson correlation analyses revealed weak, inverse, and statistically non-significant correlations between ECC severity and both serum iron (r = −0.008, p = 0.937) and serum ferritin (r = −0.009, p = 0.928).

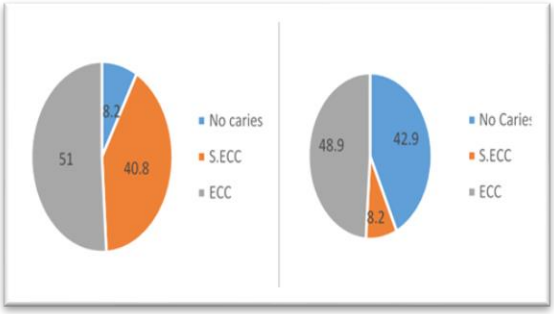

Figure 2. Caries severity in children whose serum ferritin <30 vs. >=30.

In contrast, categorical analysis demonstrated a highly significant association between serum ferritin levels and S-ECC (χ^2 = 22.216, p < 0.001). Children with low serum ferritin levels (<30 ng/mL) showed a markedly higher prevalence of S-ECC (40.8%), whereas only 8.2% were caries-free. Conversely, among children with normal or high ferritin levels (≥30 ng/mL), 42.9% were caries-free and only 8.2% presented with S-ECC. These findings indicate that reduced iron stores are strongly associated with increased severity of early childhood caries.

This study also explored the relationship between ECC, iron status, and dietary patterns. Children with lower ferritin levels reported higher consumption of milk and eggs and lower intake of meat and fish, as shown in Table 1. Beverage consumption patterns also indicated that milk and juice intake were common among children, as presented in Table 2 and Table 3. However, no statistically significant associations were observed between ECC and dietary factors, including milk or juice consumption.

Table 1. Frequency of milk drinking per day.

Cup of Milk	Count	%
0	20	20.0
1	46	46.0
2	16	16.0
3	18	18.0
Total	100	100.0

Table 2. Frequency of juice drinking per day

Cup of Juice	Count	%
0	9	9.0
1	45	45.0
2	28	28.0
3	17	17.0
4	1	1.0
Total	100	100.0

DISCUSSION

Early childhood caries (ECC) is more complex than dental caries at older ages due to its strong multifactorial etiology, including dietary habits and feeding practices. Diet plays a crucial role in the initiation, development, and clinical presentation of ECC [12]. The present study aimed to investigate the relationship between serum iron and ferritin levels and the prevalence of ECC in young children. The high prevalence of severe early childhood caries (S-ECC) observed in this study is consistent with global literature, where socioeconomic factors, limited access to dental care, and inadequate oral

hygiene practices contribute to early onset and disease progression [13]. This substantial burden highlights the need for early preventive strategies, including timely dental visits, fluoride exposure, and oral health education, to reduce the risks associated with S-ECC and improve oral health outcomes [6].

The findings demonstrated a statistically significant association between S-ECC and serum ferritin levels (p = 0.001), supporting the hypothesis that iron status may play an important role in the development of dental caries. Children with serum ferritin levels below 30 ng/ml exhibited a markedly higher prevalence of S-ECC compared to those with ferritin levels ≥30 ng/ml. This observation supports the concept that iron deficiency may contribute to oral health deterioration through its effects on immune function, tissue integrity, and oral microbial balance [7]. Similar findings have been reported by Atri, Schroth, and Mohamed, identified significantly lower serum ferritin levels in children with S-ECC [8, 10, 11].

The consistency of these findings inforce the evidence for an inverse relationship between serum ferritin and severe caries and suggests that ferritin may serve as a potential biomarker for identifying children at increased risk of S-ECC.

This study also explored the relationship between ECC, iron status, and dietary patterns. Children with lower ferritin levels reported higher consumption of milk and eggs and lower intake of meat and fish, which may contribute to iron deficiency due to the lower bioavailability of non-heme iron. However, no statistically significant associations were observed between ECC and dietary factors, including milk or juice consumption, findings that contrast with previous reports linking excessive juice intake to ECC [14,15]. These differences may be attributed to parental reporting bias or variations in overall diet composition.

CONCLUSION

In conclusion, our findings showed that there was a significant categorical association between serum ferritin levels and severe early childhood caries, whereby children with low ferritin levels exhibited a markedly higher prevalence of S-ECC, suggesting a potential link between iron deficiency and caries progression. Preventive strategies in early childhood should meet nutritional and oral health interventions to concurrently reduce iron deficiency and severe dental caries, optimizing overall pediatric health.

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