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Relationship Between Early Childhood Caries And Iron Levels In Children: A Systematic Review

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Abstract
Background: *Early childhood caries (ECC) is one of the most common diseases in early years of life. It is considered a serious public health problem. Though preventable, globally over 530 million children have decay in their primary teeth, and the condition is highly prevalent in both developed and developing countries. It has also been reported to have a close relationship with other systemic deficiencies.*
Materials and Methods: *A systematic review on ECC and iron deficiency was done based on published articles in PubMed and Google scholar databases. The search profiles included ECC/risk factor, ECC/anemia, ECC/ferritin, and ECC/iron. Inclusion criteria comprised of all studies that focused on ECC and iron.*
Results: *A significant relationship was observed between iron deficiency (ID) and occurrence of ECC. Several theories have been laid down in this regard. Our listed studies states that children with ECC appear to be at greater odds of having low iron and haemoglobin levels depicting iron deficiency anemia as compared to the control groups.*
Conclusions: *Based on our findings, it is concluded that the incidence of ECC in young children appears to be associated with iron deficiency even in its mildest form. It is one of the risk factors for ID in children. More research needs to be done to examine lifestyle and socioeconomic risk factors that are associated with malnourishment.*
Keywords: *Early childhood caries (ECC), serum iron (Fe), iron deficiency (ID), Iron deficiency anemia (IDA).*

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I. Introduction

Dental caries is one of the most prevalent complication affecting the society and also, one of the commonest unmet health needs of children. Early childhood caries (ECC) is a form of dental caries that influences the primary teeth in children under 6 years[1,2]. ECC diagnosis includes one or more cavities, one or more missing teeth as a result of caries or one or more filled surfaces in primary maxillary teeth, etc. Dental caries can cause oral pain, interfering with eating and sleeping and making a child underweight [3] and stunted[4]. It is believed that infants with severe dental caries are anemic, scrawny, ill-fed and undergo changes in physical growth patterns, thereby suffering from nutritional deficiency anemia, especially iron deficiency, and poor oral health-related quality of life[5].

Recently, clinical and epidemiological surveys have found that children with iron deficiency were associated with dental caries in childhood[6,7]. Some studies have also shown that children with caries have lower serum ferritin, hemoglobin (HGB), and mean corpuscular volume (MCV) levels than caries-free children[8-9]. There are many reasons for ECC prevalence such as genetic and high consumption of carbohydrates, improper bottle- or breast-feeding practices, inflammatory processes and environmental factors. One of the important

consequences induced by ECC is malnutrition, followed by anemia, hence, the association between ECC & ID is bidirectional[10]. Therefore, we performed a systematic review to investigate the potential relationship between ID and ECC and implement preventive policies for the same.

II. Materials And Methods

This systematic review was performed according to the guidelines of preferred reporting items for systematic reviews and meta-analysis (PRISMA statement). All relevant studies were searched in PubMed and Google Scholar in the last 10 years. The key terms were selected based on the medical subject headings (MeSH) and non-MeSH terms in simple terms or combinations. Majorly the search terms consisted of: dental caries, early childhood caries, risk factors, serum iron, serum ferritin, anemia, iron deficiency. The language of search was English.

Inclusion criteria: All the studies that focus on ECC and iron deficiency or serum ferritin levels and their relationship, particularly involving child population <6 years of age.

Exclusion criteria: Articles in (1) adult group (2) duplication of previous publications (3) no direct comparison between ECC and non ECC free age groups (4) no mention of relationship between ECC and iron deficiency (ID) were excluded.

The lists of reviews and retrieved studies were manually searched. All suitable studies were selected and their results were extracted.

III. Results

A total of 492 articles/newsletter [143 on ProQuest, eight on Web of Science, 212 on Scopus, and 137 on MEDLINE (PubMed)] were obtained (online & hand searched). Excluding the duplicate and irrelevant articles, the abstracts of 32 articles were shortlisted and studied. All the articles were summarised & put up together for re analysis. Finally, 21 articles were subjected to full-text analysis, out of which 10 studies met our criteria fully. Table 1 illustrates the details of the studies along with the study results.

Table 1

Sr No.	Title	Year	Study Type	Result
1	The association of childhood iron deficiency anaemia with severe dental caries	2012	Case - Control	Significant association between iron deficiency anaemia and severe dental caries
2	Association between iron status, iron deficiency anaemia, and severe early childhood caries: a case-control study	2013	Case- Control	lower ferritin and hemoglobin levels and higher iron deficiency anemia in children with SECC
3	Iron deficiency in young children: a risk marker for early childhood caries.	2013	Case- Control	Iron deficiency is observed definitely in children having ECC
4	The relation between early dental caries and iron-deficiency anaemia in children.	2014	Case- Control	Early dental caries had an effect on the state of iron in preschool children leading to IDA
5	Association of severe early childhood caries with iron deficiency anemia.	2016	Case- Control	strong association between SECC and anemia due to iron deficiency
6	The association between growth factors and blood factors with early childhood caries.	2017	Case- Control	No significant correlation between ECC and blood indices. Growth factors showed were correlated
7	Estimation of ferritin levels in children with and without early childhood caries - A case-control	2017	Case- Control	Lower ferritin levels in children with ECC. Consideration of SECC as a risk marker of anemia
8	Association between DMFT Score and Iron Studies in Children up to 12 years	2017	Case- Control	This study suggested the need for public health campaigns regarding oral hygiene and the prevention and treatment of anaemia
9	Iron deficiency anaemia and early childhood caries: a cross-sectional study	2021	Cross- Sectional	Negative correlation of haemoglobin and dental caries while IDA and ECC are significantly related
10	Iron defciency anemia associated factors and early childhood caries in Qingdao	2022	Cross- Sectional	IDA significantly associated with ECC in 2 year old and above

All the reviewed articles were studies that assessed the blood factors associated with IDA. Of the ten articles included in the systematic review, all studies evaluated either blood ferritin levels, mean corpuscular

volume or haemoglobin levels. In all studies included in the systematic review, the studied children were under six years.

IV. Discussion

Early childhood caries is a severe tooth decay that influences infants and young children. These children undergo iron deficiency, growth retardation, and weight loss due to malnutrition, poor chewing ability, and pain [11]. Disturbed sleep quality causes inadequate growth in these children due to decreased production of glucosteroids. On the other hand, anemia can occur as a result of factors such as genetic (congenital) factors, inflammatory processes, nutritional factors, and environmental factors like dental caries and low socioeconomic status[12,13]. Nutrition-induced anemia is the most common form of malnutrition and includes nutritional deficiencies such as iron, folic acid, copper, and vitamins A, B, C, and E. Iron deficiency anemia is generally recognized by biochemical indices: hemoglobin, hematocrit, as well as MCV, and ferritin[13].

According to WHO, if at least 2 parameters of 3 parameters (Hb, MCV, and serum ferritin) are lower than normal, iron deficiency anemia is confirmed[14]. Serum ferritin is an acute phase protein and its level is an indicator of body iron storage. However, ferritin may increase as an inflammatory phase protein during inflammatory, infectious and malignant infections, but this is not interpreted as a very high level of iron in the body[15]. The iron status has a significant impact on the health of the baby. For example, a child who suffers from iron deficiency may not only show nerve symptoms such as reduced learning and memory deficits, reduced motor skills and increased anxiety, but also weakness, poor physical growth, and weakened immune systems that lead to injury. They also show infections[16-18]. Several theories have indicated a relationship between ECC and IDA in children with dental caries. Inflammation in ECC can induce cytokine production, which can hinder erythropoiesis and decrease hemoglobin and iron levels[19]. A probable effect of severe caries on children is that chronic dental abscesses and pulpitis influence their growth by causing chronic inflammation, which influences metabolic pathways where cytokines affect erythropoiesis. For example, interleukin-1 (IL-1), which has a wide range of activities against inflammation, can inhibit erythropoiesis. This hemoglobin inhibition can induce anemia due to decreased erythrocyte production in the bone marrow[15].

Untreated caries leads to acute and chronic inflammation such as pulpitis, periapical aphasia, and fistula, which release various inflammatory mediators, mainly interleukin I and cytokines[20]. Second, nightly pulpal pain causes sleep disorder that results in decreased glycosteroids production. This reduction leads to suppress of the synthesis of hemoglobin in blood and anemia caused by chronic inflammation by suppressing erythropoiesis[8,21]. On the other hand, iron deficiency can destroy the functions of the salivary gland in children and decrease the buffering capacity and dental caries[22]. Moreover, ECC induced malnutrition and chewing inability cause iron deficiency and anemia. A nutritional and health survey showed a prevalence rate of 0.2% - 6.2% for iron deficiency in children aged 4 - 6 years.

Anemia may not be directly caused by ECC but may be induced by elevated milk consumption in early childhood. Long-term consumption of milk and milk bottles for more than two years can expose children to ECC and malnutrition because they do not take enough iron and other nutrients. Hence, ECC, iron deficiency, and other nutritional complications are more likely to occur in this group of children[23,24]. Multiple dental caries make it difficult for children to chew foods, which reduces the absorption of nutrients in the intestine. As a result, children tend to consume sugary drinks to create a feeling of satiety to avoid chewy food containing iron[21,25].

It is reasonable to assume that diet factors that cause iron deficiency (high intake of beverages and low intake of meat) can also predict dental caries[26]. Dietary diversity includes promoting a diet with a range of foods that naturally contain iron, in particular, red meat, chicken, and fish[27]. Iron in meat is found better than non-alcoholic iron found in dairy products, fruits, and vegetables, and it is absorbed into the body. Evidence showed that children who eat less meat and poultry and drink plenty of juice and milk, snacks, or candy are at high risk for iron deficiency because of high calories of these sources, the eating of other foods and Preventing nutritional needs[28]. therefore, children with ECC should be evaluated for nutritional habits and iron levels[26].

According to some animal studies, iron also affects the flow of saliva, in which iron deficiency has been associated with reduced salivation and reduced buffering ability, increasing the risk of caries[29]. Considering the microbial risk factors responsible for ECC, two important bacterial strains in ECC are streptococcus mutans and streptococcus sobrinus. Lactobacilli have key role in the caries progression. This infection can be transmitted by vertical and horizontal transmission. Vertical transmission is carried between mother or father and child[30,31]. Several studies confirmed that when S streptococcus mutans M bacteria have been acquired at an early age, it will mostly lead to ECC, where other important factors, such as economic and financial situation, the use of fluoride and other related factors, can contribute to the development or prevention of ECC. Children with a background marked by dental caries, whose parents and siblings have serious dental caries, are viewed as being at high risk of having dental caries in their future. Additionally, kids' involvement in financial burden influences grownup dental well-being[32,33].Shaoul et al.[8] showed a significant relationship

between ECC and low serum levels of ferritin. However, the mechanism of the relationship between iron deficiency and dental caries is unknown.

Schroth et al.[11], investigated the relationship between S-ECC and nutritional iron status. This group compared the ferritin and hemoglobin levels between children undergoing rehabilitative dental surgery for S-ECC and cavity-free children recruited from the community. The results of this group showed that there is significant difference in the number of children exhibiting low ferritin levels. This study showed that children with S-ECC had lower ferritin level than cavity-free children. Schroth et al.[11], also indicated that children with S-ECC had significantly lower hemoglobin levels than the caries free controls. According to these studies, Children with S-ECC had low ferritin status and low hemoglobin levels compared with caries-free children. Iron deficiency and iron deficiency anemia had more frequency in children with S-ECC in comparison with cavity-free children. Bansal et al.[6], Pushpa Iranna et al.[10], and Tang et al.[34], showed that S-ECC strongly increased anemia due to iron deficiency. So, ECC is considered as one important reason for anemia and iron deficiency.

Schroth et al. reported that children with ECC have altered dietary habits that can predispose them to nutritional deficiencies such as iron deficiency[4]. Fretham[35] hypothesized that iron deficiency in children leads to a decrease in mental capacities, a decrease in motor skills and an increase in anxiety levels. Early diagnosis of such deficiency, for example by detecting ECC in children, might result in the early initiation of treatment[36, 37].

In the end, whether caries causes ID or ID results in caries in children remain unclear, indicating the need for further cohort studies with larger sample sizes among various communities[38]. Despite the limitations of this study, our results added the association investigation between ECC and blood parameters and developmental indices to the literature and provided additional evidence for the complexity of this relationship

V. Conclusion

Severe early childhood caries is a virulent form of dental caries that can destroy the primary dentition of preschool children. This review identifies that early childhood caries as a risk marker for iron deficiency, as well as the poor nutritional status as determined by low weight in children. Based on this literature review, ECC must be considered as a risk factor for iron deficiency. More studies are needed to examine lifestyle and socioeconomic risk factors that may be associated with the malnourished status of these children. Dentists should also know that children with dental caries are at risk of developing nutritional deficiencies that may influence their long-term health. Preventive strategies of ECC should be developed to reduce the risk of iron deficiency and its related anemia. So, it is important that dentists and other specialists be aware about the relationship between ECC and its related. The findings of this review can help researchers to design future research.

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