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Is there an association between early childhood caries and serum iron and serum ferritin levels?

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ABSTRACT

Background: Early childhood caries (ECC) is a virulent form of dental caries that can destroy the primary dentition of preschool children. The purpose of this study was to investigate a possible association between ECC with serum iron and serum ferritin levels.

Materials and Methods: Following the ethical approval, 204 children aged 24–71 months were recruited for a double-blind, randomized cross-sectional study. Each child was examined clinically for dental caries using the World Health Organization criteria in Rafsanjan, Iran. Decayed, extracted, and filled primary teeth (deft) index was used to measure the dental caries. To determine serum iron and serum ferritin levels 2 mL blood was collected from each child. Data were then analyzed by Pearson's correlation coefficient and *t*-test using SPSS-16.0 software.

Results: The mean values and their standard deviations of the deft index and levels of serum iron and ferritin were 2.4(± 3.3), 93.8(± 29.0) μg/dL and 63.1(± 32.2) ng/mL, respectively, with the two latter within. There was no significant difference between genders. Pearson's correlation coefficient showed that there was a statistically significant inverse association between ECC and serum iron level (P<0.05); but no association was found with the serum ferritin level.

Conclusion: The deft index decreased significantly with increasing serum iron levels, but there was no association between ECC experience and serum ferritin levels.

Key Words: Deft index, early childhood caries, serum ferritin, serum iron

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INTRODUCTION

Early childhood caries (ECC) is a particularly virulent form of dental caries that is characterized by an overwhelming infectious challenge and is associated with unusual dietary practices.[1] ECC has been defined as the presence of any decayed (cavitated or noncavitated), extracted (due to caries), or filled teeth in any primary tooth in a child aged 71 months or younger.[2] The most important risk factors related to ECC are probably high frequency intake of sugary snacks and drinks, sweetened feeding bottles particularly used during the night, and malnutrition.[3] Additionally, poor oral hygiene, insufficient exposure to fluoride, and general psychosocial stress are common.[1] Nutritional anemia is the most common form of malnutrition and includes a lack of nutrients such as iron, folic acid, copper and vitamins A, B, C, and E.[4] Iron deficiency anemia accounts for 90% of all types of anemia in the world.[5] Although the prevalence of iron deficiency has declined in recent years, it remains an important pediatric public health problem.[6] Iron deficiency can impede physical and mental development in children and also negatively affects cellular immunity.[4,5] Essential nutrients, such as iron, have been associated with dental caries.[7] A child's diet that is high in low-nutrient carbohydrate will likely be deficient in required nutrients.[8] Malnutrition, such as iron deficiency, often impairs salivary gland function causing reduced salivary secretion and low buffering capacity.[4]

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However, iron supplements reduce bacterial colonization and biofilm formation;[7] also an animal study has shown that iron supplements can reverse the carious process, and reduce the incidence of caries, especially on the buccal surfaces, which are bathed readily by saliva.[9]

An earlier study in Iran has reported the prevalence of iron deficiency anemia in children aged 6 months to 5 years to be 19.7%.[10] Another local study reported that 3.2% of 7-year-old children had low intake of iron.[11] Ferritin is an intracellular protein that stores iron and releases it in a controlled fashion. It is a marker of the general iron level and is associated with the inflammatory response.

As the etiology of ECC is multifactorial, and the effect of iron on the development of dental caries and concentration of this metal in noncarious as well as carious teeth remains controversial, the aim of this study is to explore a possible association between ECC and serum levels of iron and ferritin in children aged 24–71 months in Rafsanjan, Iran.

MATERIALS AND METHODS

Ethical approval for this study was received from the Research Ethics Board of the Rafsanjan University of Medical Sciences. Two hundred and four children (117 boys and 87 girls) aged 24–71 months were recruited with convenient sampling method for this double-blind, cross-sectional study. The children were in-patients at the Ali-en-Abetaleb Hospital, Rafsanjan, Iran, hospitalized for uncomplicated medical problems, including mild viral infection and dehydration and simple bone fractures between September 2008 and June 2010. All participants' parents signed a consent form and responded to a structured questionnaire with items regarding as age, gender and general health conditions. The children were selected among children who did not have diseases and conditions and did not take medicines affecting the serum iron level.[12] The inclusion criteria were assessed and eligibility for study participation determined through responses to the questionnaire, interview with children's parents, and discussion with the treating pediatrician.

Blood samples (approximately 2 mL) were collected by an expert nurse in the morning and used to determine serum levels of iron and ferritin levels (Pishtaz Teb Co, Tehran, Iran). Dental examinations were carried out according to the World Health Organization criteria[13] by one of the authors (MS). The examinations were performed at hospital bedside using a disposable plane mouth mirror (Atlas Teb Co, Tehran, Iran) and a penlight. Cotton rolls were used to remove any plaque or debris, where necessary. Teeth with less than two-thirds of the crown erupted were excluded. To assess the caries experience, the decayed, extracted due to caries, and filled primary teeth (deft) index was used. A tooth was diagnosed as decayed ("d" component) if its color was changed and there was any evidence of cavitated or noncavitated dental primary caries or recurrent caries adjacent to already filled teeth. The "e" component included extracted teeth and decayed teeth indicated for extraction due to caries, and the "f" component included restored teeth without caries. White spots were not considered as decayed. It was not practical to take radiographs. The dental examiner was not aware of the serum iron or ferritin levels at the time of clinical examination.

Data analysis included Pearson's correlation coefficient and *t*-test using SPSS-16.0 (SPSS Inc., Chicago, IL, USA). A *P*-value of less than 0.05 was considered statistically significant.

RESULTS

The mean (± SD) age was 40.7 (± 14.7) months with 41.7 (± 14.6) months for boys and 39.3 (± 14.8) for girls. The analyses showed that 73.5% of children had normal serum iron level; only 8.8% had low serum iron and 17.6% had high serum iron. Ninety-eight and a half percent had normal serum ferritin levels while no child tested had low serum ferritin, and 1.5% had high serum ferritin. The mean values of the deft index and levels of serum iron and ferritin were 2.4(± 3.3), 93.8(± 29.0) μg/dL and 63.1(± 32.2) ng/mL, respectively [Table 1]. Normal limits of serum iron and serum ferritin are 50–120 μg/dL and 7–140 ng/mL, respectively. There were no significant differences between the deft index, serum iron, and serum ferritin levels between the genders.

The prevalence of caries-free children was 54.4% (48.7% boys, 62.1% girls) and among those with normal serum iron and serum ferritin levels was 38.2% (38.5% boys, 37.9% girls) and 52.9% (46.2% boys, 62.1% girls), respectively; whereas among children with low serum iron content only 5.9% (5.1% boys, 6.9% girls) were free of caries. Statistical analyses using Pearson's correlation coefficient showed a statistically significant inverse association between caries experience (deft index) and serum iron levels (P=0.001) [Figure 1], while no association was observed with the serum ferritin levels (P=ns) [Figure 2].

DISCUSSION

ECC is the currently accepted term used to describe dental caries occurring in infants and toddlers under the age of 6 years. ECC is a multifactorial, transmissible, and dietobacterial disease,[8] and diet plays a critical role in the development and clinical features of this infection.[1] Nutritional anemia and dental caries are still among the most prevalent diseases in some developing countries.[5,6] In this study, 8.8% of children had serum iron content below the normal limits of 50–120 µg/dL.[14] Anemia can be prevented by fortification of food with iron. Animal studies have demonstrated that iron supplements, such as iron–sucrose that has been used for prevention of anemia, are able to reduce the incidence of caries in rats.[13,15] The concept that two major public health problems could be alleviated by the addition of iron to sucrose is attractive.[15]

Based on our results, there was an inverse significant association between deft index and serum iron levels. A similar study in Iran showed a significant correlation between the DMFT index and low iron intake; the DMFT index of children with iron deficiency was much higher than in those with adequate iron intake.[11] In children, the presence of extensive dental caries will pose challenges for chewing and may negatively impact absorption of nutrients in the gut due to poorly masticated food. It is reasonable to assume that the same dietary factors that cause iron depletion (high consumption of beverages and low meat intake) will predict dental caries.[16] Dietary diversification involves promotion of a diet with a wider variety of naturally iron-containing foods, especially red meat, poultry, and fish.[4] Heme iron from meat is better absorbed by the body than nonheme iron, which is found in dairy products, vegetables, and fruits. There is evidence that children who eat little to no meat or poultry and drink large amounts of juice and milk or snack on cookies or candy are at risk for iron depletion, because their large calorie intake from these other sources prevents them from eating other foods for nutritional needs.[8] It seems children with dental caries, particularly occlusoproximal lesions, avoid consumption of diets containing meat due to meat fibers being entrapped in the cavities and a sense of discomfort. Therefore, ECC may be a risk marker for iron deficiency anemia, so assessment of serum iron levels in ECC patients is appropriate to avoid the harmful health effects of anemia in developing children.[16]

Serum ferritin is an acute-phase protein; its level is an indicator of body-iron stores and may be normal or elevated in infective, inflammatory, or malignant disease. A normal serum ferritin level does not

Table 1: Caries experience and serum levels of iron and ferritin by gender in 24–71 months old children in Rafsanjan, Iran (*N* = 204)

Gender	Mean ± SD		
	Deft Index	Serum iron µg/dL	Serum ferritin ng/mL
Boys	2.7 ± 3.8	94.5 ± 28.4	59.9 ± 33.2
Girls	2.0 ± 2.5	92.8 ± 29.9	67.4 ± 30.4
Total	2.4 ± 3.3	93.8 ± 29.0	63.1 ± 32.2

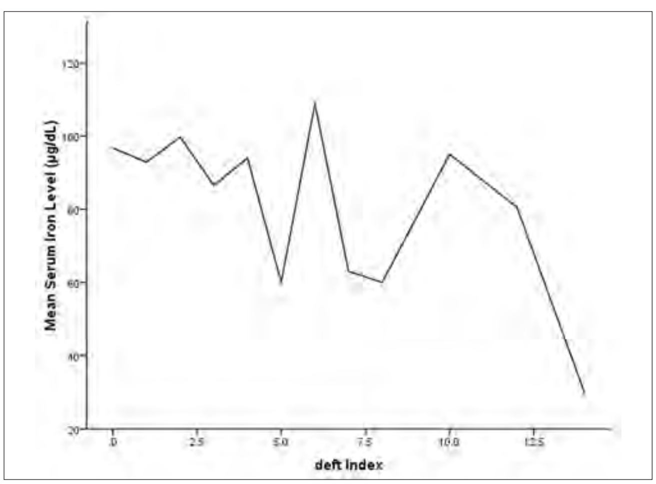

Figure 1: Caries experience by serum iron level in 24–71 month old children (*N* = 204)

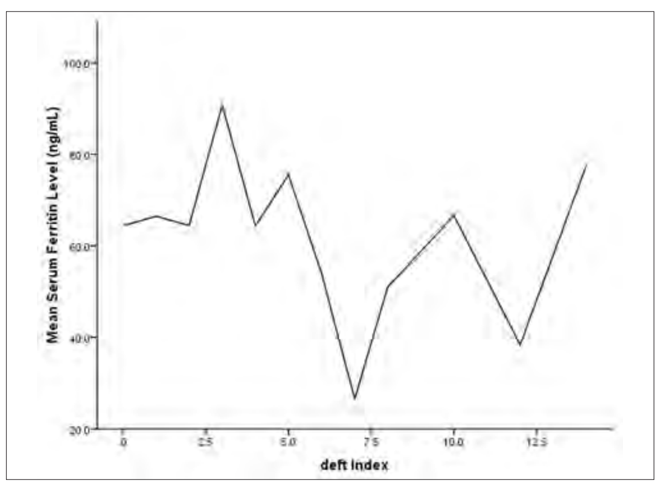

Figure 2: Caries experience by serum ferritin level in 24–71 month old children (*N* = 204)

entirely rule out iron deficiency, which could be present even with a normal concentration of serum ferritin (normal limits; 7–140 ng/mL).[14] Our study has shown that there was no association between serum ferritin levels and deft index, which is similar to the findings of another study that showed no difference in serum ferritin levels between groups classed as having “active dental caries” and “inactive dental caries.”[17]

Iron ions will be precipitated on the enamel surface as thin acid resistant coatings containing gels and crystals of hydrous iron oxides. In addition, by adsorbing salivary calcium and phosphate ions these iron compounds seem to be able to nucleate the formation of apatites, thus mediating a replacement of minerals, which have been dissolved during the acid phases of the caries process.[17] The severity of ECC is directly related to the early establishment of *S. mutans* and iron could have a protecting effect in the human oral cavity from its pathogenicity – in other words iron can be significant inhibitory effect on growth of this microorganism.[2,7]

Clearly, ECC is a complex disease that requires careful and extensive investigation. It is still a serious public health problem. Nevertheless, it is a preventable and infectious disease and its control should be a priority.[1,16] Since iron deficiency has permanent effects on growth and development, pediatric and general dentists should recommend assessment of iron level in ECC patients.[16]

One of the main limitations of this study was that we could not take blood sample from healthy children in the community because of ethical reasons. But we forced ourselves to select hospitalized children who did not have diseases and conditions and did not take medicines affecting the serum iron level.[12]

CONCLUSION

In conclusion, our findings showed that there was an inverse association between the serum iron level and ECC. As our study was cross-sectional, whereas the concentration of serum iron is variable with time in children, further investigation of this association over time, using a longitudinal study design may be appropriate.

An inverse, statistically significant association was demonstrated between serum iron levels and caries experience in a cohort of young children aged 24–71 months. To avoid the harmful sequelae associated with iron deficiency anemia, particularly amongst developing children, testing for iron deficiency anemia should be considered for children affected by ECC.

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