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The effect of systemic zinc supplementation on oral health in low socioeconomic level children

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There is limited evidence about the effects of systemic zinc supplementation on oral health in healthy children. The aim of this study is to determine the effect of oral zinc supplementation on oral health in low socioeconomic level primary school children.

In this double-blind randomized study, 68 children were randomly separated into two groups (study and placebo) to receive 15 mg/day elemental zinc or placebo syrup five days a week for 10 weeks. Oral examinations were performed before and after supplementation.

After supplementation, the Gingival Index improved statistically in both groups ($p<0.05$). However, the Plaque Index improved statistically only in the zinc group ($p=0.02$). After supplementation, the Plaque Index scores increased in 13 cases and decreased in 15 in the placebo group ($p=0.70$) and increased in only 6 cases and decreased in 18 in the study group ($p=0.02$).

Oral zinc supplementation may contribute to the prevention of dental caries in low socioeconomic level primary school healthy children.

Key words: *children, dental plaque, oral health, teeth, zinc supplementation.*

Mild to moderate zinc deficiency is common worldwide. Conservative estimates suggest that 25% of the world's population is at risk for zinc deficiency. Most of the affected are poor and rarely consume foods rich in highly bioavailable zinc, while subsisting on foods that are rich in inhibitors of zinc absorption[1]. Zinc supplementation trials have shown beneficial effects on diarrhea, growth retardation, and pneumonia mortality and morbidity in infants and toddlers in underdeveloped countries[2,3]. There is little evidence about zinc supplementation effects on teeth and oral health. Despite the many systemic zinc supplementation studies in children, to our knowledge, none of them investigated the effects on oral health and teeth in low socioeconomic level children.

Dietary factors are important in the structure of oral and gingival mucosa, oral microflora, the integrity and quantity of the teeth, pH and composition of the saliva, and plaque pH. Plaque formation is affected by diet, oral hygiene and composition of saliva. Protein and mineral component and pH of saliva affect plaque formation. Immunologic and non-immunologic molecules like immunoglobulin A, lysozymes, lactoferrin and lactoperoxidase in saliva affect the bacterial microflora of plaque.

Dental caries is among the most common childhood health problems. It is even reported to be more common than asthma and fever[4]. Dental caries is more common in low socioeconomic level and some ethnic groups. Many factors play a role in the etiology of dental decay. Composition of nutrition, eating behaviors, dental care characteristics, composition of saliva, bacterial flora of the mouth, and structure of teeth affect development of dental decay. Dental plaque formation promotes development of dental decay. The effects of nutritional factors on dental decay and plaque formation have been investigated especially for sugar, flour, calcium and phosphate.

Many studies in limited numbers of cases and animals have been published to determine the effect of topical use of mouthrinse or toothpaste with zinc plus other anti-plaque and anti-gingivitis agents on teeth plaque. Waler[5] showed that the plaque-inhibiting effect of chlorhexidine and zinc is slightly better than that of chlorhexidine alone in humans. Luoma[6] reported that chlorhexidine-fluoride applications with zinc and strontium appreciably reduced the extent of plaque in rats. Giertsen[7] confirmed that mouthrinses with chlorhexidine and zinc ions combined with fluoride reduce colony-forming units and glucose metabolism of surviving plaque microorganisms. Schaeken[8] reported that mouthrinses containing zinc and triclosan reduce both plaque and calculus formation. Giertsen[9] later reported that neither triclosan incorporated into a mouthrinse containing sodium lauryl sulphate plus fluoride nor the addition of zinc ions or copolymer affected acid formation by dental plaque in vivo. A meta-analysis of six-month studies of anti-plaque and anti-gingivitis agents reported that there was no evidence of the efficacy of triclosan products containing either soluble pyrophosphate or zinc citrate[10].

In this study, we tried to determine the effect of oral zinc supplementation on oral health and teeth in low socioeconomic level primary school children[11].

Material and Methods

This double-blind randomized controlled intervention trial is a part of a larger study that was planned to determine the behavioral effects of zinc supplementation on primary school children.

The research protocol was approved by Hacettepe University Faculty of Medicine Ethics Committee and the Ministry of Health Central Ethical Committee. Written informed consent was obtained from all the parents before enrolment in the study.

The study was performed on 68 urban third grade students from a low socioeconomic level school in Ankara, Turkey between October 2004 and January 2005. Children in each class were randomized to either the study or placebo group. Children in the study group received 15 mg elemental zinc syrup and those in the placebo group received the syrup without zinc. The zinc and placebo syrups were prepared and labeled by Berko Company (İstanbul, Turkey). The investigators and teachers were blind until the end of the analysis. Zinc and placebo syrups were given by the teachers at school five days/week on school days for 10 weeks.

All parents were given a questionnaire to determine the demographic, dental care and nutritional characteristics and daily dietary zinc intake of children. None of the children had a systemic disease. Blood samples to determine serum zinc levels were obtained from children before and after zinc supplementation.

Oral examination was performed before and after zinc supplementation. The dental assessment included clinical examination of teeth for dental decay and the gingival tissues for oral hygiene. The students were examined by an experienced pediatric dentist (MT) under standard dental lighting with plain mouth mirrors and ball ended periodontal probes. The surfaces of all erupted teeth were assessed using the dmft/DMFT and dmfs/DMFS (decayed, missing or filled teeth or surfaces; lower case letters for primary teeth, upper case for permanent teeth) indices[12]. Oral hygiene was assessed with two standard epidemiological indices -- the Gingival Index (GI) and Plaque Index (PI)[13,14]. Erupting permanent teeth and exfoliating primary teeth were excluded from the evaluation. The GI scores were as follows: 1= normal gingiva, no inflammation, discoloration or bleeding; 2= mild inflammation, slight color change, mild alteration of gingival surface, no bleeding on pressure; 3= moderate inflammation, erythema and swelling, bleeding on pressure; and 4= severe inflammation, erythema and swelling, tendency to spontaneous bleeding, perhaps ulceration. The PI scores were as follows: 0= no plaque; 1= tooth appears clean, but plaque may be removed from its gingival third with a probe; 2= moderate accumulation of plaque deposits visible to the naked eye; 3= heavy accumulation of soft material filling the niche between the gingival margin and tooth surface.

The statistical analyses were performed by SPSS 11.0. The baseline mean values were compared by Student's t-test. As the number of cases in each group was not sufficient for parametric tests, the changes in the values after supplementation were compared by Sign test.

Results

Sixty-eight children were enrolled in the study but only 52 of them completed the second examination. Ten children from the zinc group and 6 from the placebo group were not present on the day of the second examination. The demographic and oral hygiene characteristics of these children were similar to those who presented for the second oral examination.

The mean age of the children was 8.50±0.69 years. There was no difference between the two groups with respect to age, sex, socioeconomic level, nutritional intake, dental care characteristics including dentist visits and teeth brushing, and serum zinc levels. The zinc levels were within normal limits both in the placebo and the study groups before and after supplementation.

The mean DMFT, DMFS, dmft and dmfs scores at baseline are displayed in Table I. There was no difference between the two groups in DMFT, DMFS, dmft and dmfs scores. The mean GI and PI scores at baseline are displayed in Table II. There was no statistically significant difference between the groups.

Table I. DMFT, DMFS, dmft and dmfs Scores at Baseline

	Zinc n=34	Placebo n=34	P*
DMFT	1.05±1.30	0.61±1.04	0.13
DMFS	1.37±1.98	0.67±1.17	0.08
dmft	5.66±2.71	4.97±2.62	0.29
Dmfs	13.74±8.64	11±7.61	0.17

dmft-DMFT/dmfs-DMFS: Decayed, missing or filled teeth or surfaces (lower case letters for primary teeth, upper case for permanent teeth).
*Student t test.

Table II. Gingival Index and Plaque Index Scores at Baseline

	Zinc n=34	Placebo n=34	P*
Gingival Index	0.96±0.40	0.97±0.37	0.87
Plaque Index	0.91±0.45	0.94±0.37	0.77

*Student t test.

The results after supplementation in both groups are displayed in Tables III and IV. After supplementation in both groups, the GI improved statistically (Table III). However, the PI improved statistically only in the zinc group (Table IV).

Table III. Changes in Gingival Index Scores from Baseline after Zinc Supplementation

Group	Gingival Index scores	n	P*
Zinc	Increased	5	0.007
	Decreased	19	
	Total	24	
Placebo	Increased	5	0.001
	Decreased	23	
	Total	28	

*Sign test.

Table IV. Changes in Plaque Index Scores from Baseline after Zinc Supplementation

Group	Plaque Index scores	n	P*
Zinc	Increased	6	0.02
	Decreased	18	
	Total	24	
Placebo	Increased	13	0.70
	Decreased	15	
	Total	28	

*Sign test.

Discussion

In this double-blind randomized controlled study, zinc supplementation improved the PI more than placebo in low socioeconomic level children. However, the GI was improved in both groups. This finding may be due to the limited number of children or the season of viral infections during the first examination when many children had gingival lesions.

Serum zinc levels were found within normal limits in both the placebo and the study group before and after supplementation. However, there is no acceptable single method to demonstrate mild zinc deficiency in humans. Assessment of zinc nutriture is complex, involving a number of chemical and functional measurements that have limitations in sensitivity and specificity[1]. Thus, serum zinc levels are not a clear indicator of inefficiency of supplementation in mild zinc deficiency.

The relationship between trace elements and composition of saliva, dental plaque and dental decay and their interactions have been investigated for many years. The results are controversial. Duggal et al.[15] reported that the concentration of zinc, iron and manganese in saliva did not have any consistent relationship with caries experience. Borella et al.[16] reported that they found evidence that the zinc/copper molar ratios in whole saliva were significantly decreased in subjects with more than three decayed teeth compared with those with no caries in young adults. Zahir[17] reported that zinc concentration of saliva showed highly significant variation between non-caries and multiple caries groups in children. Zinc concentration of teeth in caries disease has been investigated for many years in different geographical areas. Gierat-Kucharzewska et al.[18] reported that zinc concentration is higher in the teeth of children than in adults in caries disease. Niedzielska et al.[19] confirmed that carietic milk teeth contained less magnesium, iron, strontium, nickel, manganese and copper and much more zinc as compared to teeth without caries. Gomershtein[20] reported that the dentin and enamel zinc levels were found increased in caries and they suggested that remineralization effect can be achieved in the initial stages of caries by oral application of zinc preparations. Gierat-Kucharzewska[21] reported that significantly higher concentrations of zinc, iron, copper, nickel, selenium, and strontium were detected in the crowns of healthy primary and permanent teeth. The concentration of chromium, cobalt, lead, and cadmium were significantly higher in primary and permanent teeth with caries than in healthy teeth. They also suggested that lower concentration of zinc in healthy teeth can be one of the risk factors for caries[21].

However, zinc concentration in teeth may sometimes be an indicator of environmental contamination and industrial waste poisoning[22,23].

Ovrutskii et al.[24] studied children living in areas with zinc-deficient soil and compared with areas with zinc-normal soil. They reported that oral health and oral hygiene indices were worse in children in the areas with zinc-deficient soil.

We speculate that oral zinc supplementation may affect the PI by changing the flow rate, pH and composition of saliva. Healthy teeth are essential for nutrition and digestion. Malnutrition affects oral health and oral health affects malnutrition. Oral zinc supplementation may contribute to the prevention of dental caries in low socioeconomic level primary school healthy children. However, there is a need for larger size studies perhaps with longer duration of supplementation and follow-up.

Dental caries is among the important public health problems in children especially those of low socioeconomic level. Understanding the etiology and prevention of dental caries requires a multidisciplinary approach. Pediatricians and dentists should work in collaboration, and prevention of dental caries should be a part of preventive pediatric health services.

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