Original Article

Serum Zinc Level and Eating Behaviors in Children Receiving Zinc Supplements without Physician Prescription

Abstract

Background: The aim of the study was to compare the serum zinc level and eating behaviors in 2–8-year-old children with and without arbitrarily zinc supplementation. **Materials and Methods:** This case–control study was conducted from December 2015 to December 2017 in Isfahan, Iran. The case group consisted of seventy children, aged 2–8 years, who have received zinc supplement without physician prescription; the controls were an equal number of age-matched children who did not receive any supplement. The serum zinc level was measured, and eating behaviors were identified using Children's Eating Behavior Questionnaire (CEBQ). **Results:** There was no significant difference in serum zinc level between two groups ($P = 0.18$). Some differences in CEBQ subscales were identified between the groups studied. In the control group, the subscale of enjoyment of food was higher than the case group ($P < 0.001$). In the case group, the subscales of food fussiness and satiety responsiveness were higher than controls ($P < 0.001$). **Conclusion:** In this study, serum zinc levels were not significantly different between the two groups, and arbitrarily zinc supplementation does not play an important role in improving anorexia subscales.

Keywords: *Anorexia, children, supplementation, zinc*

Mohammad Ali Pourmirzaiee, Samaneh Chehrazi, Motahar Heidari-Beni[1], Roya Kelishadi

From the Departments of Pediatrics and [1]Nutrition, Child Growth and Development Research Center, Research Institute for Primordial Prevention of Non-communicable Disease, Isfahan University of Medical Sciences, Isfahan, Iran

Address for correspondence:
Dr. Roya Kelishadi, Department of Pediatrics, Child Growth and Development Research Center, Research Institute for Primordial Prevention of Non-communicable Disease, Isfahan University of Medical Sciences, Hezar Jerib Avenue, Postal Code: 81676-36954, Isfahan, Iran.
E-mail: roya.kelishadi@gmail.com

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Introduction

Zinc is an important trace element or motivating cofactor for about seventy vital enzyme systems. It has an energetic role in many body functions including vision, cognition, taste perception, cell replication, growth,[1] immune response, wound healing, and production of testicular hormone; it has an antioxidant role and protects cell membrane's stability.[2-6]

Zinc insufficiency can be able to long-standing consequences including impairment of brain development, short stature, osteoporosis, and delayed puberty.[1] Zinc deficiency is associated with other consequences such as anorexia and diminished taste perception. Zinc supplementation might reduce the risk of acute respiratory and gastrointestinal infections in children.[2] This supplementation develops specific cognitive skills in children.[6]

Similar to some other countries, the general population in Iran has limited information about zinc supplementation and they obtain these data by the media and internet. They are interested to give supplements for health promotion of their children, even when they are well grown. Many people recognize zinc as an appetite stimulant, and many families start zinc supplementation for their children arbitrarily and without physician prescription. There is no history of valuable and specific study for this unlicensed zinc supplementation in Iran and other countries in the region. This study was conducted to clarify this misconception and to assess eating problems and their relation with zinc deficiency in our community; this study aims to evaluate the serum zinc level and eating behaviors in children who had received arbitrarily zinc supplement and to compare them with controls. This study was performed only with an observational process without any therapeutic intervention.

Materials and Methods

We conducted this case–control study from December 2015 to December 2017 in the Pediatric Clinic of Amin hospital, affiliated to Isfahan University of Medical Sciences in Isfahan, Iran. We recruited

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seventy children, aged 2–8 years, who received arbitrarily zinc supplementation and an equal number of age-matched controls without arbitrarily zinc supplementation. As after zinc supplementation in individuals with zinc deficiency, the serum zinc level becomes normal at least 3 months after the replacement therapy,[7,8] and a short period of zinc supplementation cannot correct this deficiency; we included children who had received zinc supplement during 15 days before the study. We stopped zinc supplementation and requested parents to take their children at the clinic after 3 months of zinc discontinuation to begin the study. Without any compulsion, eligible children were recruited sequentially. Signed informed consent was obtained from parents. This study was approved by the Research and Ethics Committee of Isfahan University of Medical Sciences (Project code; Ir.mui.rec. 1395.3.714).

The inclusion criteria were as follows: age between 2 and 8 years, body mass index (BMI) between −2 and +2 Z-score of the growth charts of the World Health Organization (WHO), and history of arbitrary zinc supplementation for a maximum of 15 days. We excluded children with growth problems according to the WHO definition, any underlying disorder, anemia, hypoalbuminemia,[9] and associated parasitic infection.

A pediatrician conducted the physical examination for all children. Weight was measured by Seca weighing scale; barefoot height was measured by Seca stadiometer. BMI was calculated as weight (kg) divided by height squared (m^2), taken wearing light clothing and using standardized equipment.

Due to the geographical location of Amin Hospital, most of the children referred to the clinic had the same socioeconomic status. In addition, to eliminate the impact of economic conditions and eating intake in the study results, we tried to unify the two groups (case and control) by filling out the social, personal, and food frequency questionnaires (FFQs). For assessment of dietary intake of children, we used a 125-item FFQ, which was validated for Iranian children.[10] We asked mothers to complete the questionnaire regarding the frequency of eating and portion size of foods consumed by their children over the previous 3 months.

For assessment of eating behaviors, we used the Children's Eating Behavior Questionnaire (CEBQ).[11] It is a 35-item questionnaire that evaluates the children's food approach with four subscales of (1) food responsiveness, (2) emotional overeating, (3) enjoyment of food, and (4) desire to drink. It also determines the food avoidant behaviors with four subscales of (1) satiety responsiveness, (2) slowness in eating, (3) emotional undereating, and (4) Food fussiness. Our questions' scoring was identified by a 5-point scale and five matters reversed score. The mean scores were calculated according to the responses to every subscale and credible scores ranging from 1 to 5 (with good internal validity and reliability). Greater scores indicated a higher prevalence of that exact eating behavior. CEBQ is a 5-point scale questionnaire ranging from "never" to "always." It was translated to Persian and validated for Iranian children.[12] The mothers were interviewed to fill in the questionnaires, and it was completed for all enrolled children in the case and control groups.

After achieving the inclusion criteria, fasting venous sample was obtained from children for assessment of zinc, ferritin, albumin, and hemoglobin. Three samples of stool were also tested for parasitic contamination. Briefly, to measure the zinc levels, we used the Abcam's zinc assay kit (ab102507); an atomic absorption spectroscopy (AAS), which has been the method of choice for the elemental analysis of zinc and other metals because of its utility, sensitivity, and reliability. This method is well characterized and widely used and can rapidly determine metals in trace amounts in many types of biological fluids such as serum, cerebrospinal fluid, or urine. AAS is based on absorption by ground state atoms of an element present in the sample which is atomized in the flame. Depending on the absorption of selected wavelength of the element, the concentration is estimated.[13] The technique provides valuable information on the concentration of zinc element present in the sample with detection sensitivity of 0.2 μg/ml. Serum zinc levels ≥65 μg/dL were normal.[14] To measure the ferritin, albumin, and hemoglobin, we also used ideal ferritin ELISA kit, Tehran and pars Azmoon albumin ELISA kit, Tehran and XP300 Automated cell counting, respectively. All tests were conducted in the same laboratory.

Statistical analysis

We used SPSS software version 20 (IBM Inc., Armonk, NY, USA) for statistical operations. We employed Chi-square and Student's *t*-tests, where appropriate, to compare the variables between the two groups studied. *P* values were calculated as two sided and values <0.05 were considered statistically significant.

Results

Overall, 135 of 140 recruited children contributors completed the study, 135 kids finished the trial (68 in the case and 67 in the control group). They consisted of 87 (64.4%) male and 52 (35.6%) female, without a significant difference in gender ratio between the case and control groups. The average (± standard deviation) age was 4.15 ± (1.52) years. Table 1 demonstrates the characteristics of the case and control groups. It shows that there was no significant difference in anthropometric measures and the serum zinc level of the groups studied.

As presented in Table 2, the daily calorie, protein, and carbohydrate intake were not significantly different between the case and control groups. According to the reference values of the kit used for zinc measurement, five

children (7.1%) in the case group and six children (8.5%) in the control group had zinc deficiency (i.e., levels below 65 μg/dL).

Findings of the CEBQ showed that the mean score of the subscale of enjoyment of food was significantly lower in the case than in the control group ($P < 0.001$), but the mean scores of satiety responsiveness and food fussiness were significantly higher in the case than the control group ($P < 0.001$). There was no significant difference between the mean of other items between the two groups [Table 3].

Discussion

The child's appetite is an important issue related to children's health and a big concern for their parents. There are several factors that may influence a child's appetite, for example, emotional variability, exhaustion, mood fluctuation, and level of activity.[15] The growth velocity of children begins to reduce at about the age of two, which explains the relative decline in their appetite at this age. Every kid grows at a disparate speed, and this pattern would affect his/her eating behavior. The appetite varies from day to day and from one meal to other one. If child's growth is normal, there is no reason for parents to be worried. Fluctuation on appetite is not often permanent and will not have adverse effects for an otherwise healthy child.

Many Iranian parents always try to increase their children's appetite even if they have a normal growth pattern. Therefore, food refusal by children is one of the most common complaints of Iranian parents. They receive some information from media and various websites about the impact of zinc on increasing appetite. Zinc intake might have some effects in reducing the stress and anxiety,[13,15] and this can be one of the mechanisms for the influence of zinc on appetite. In a study on US toddlers, no difference was found in dietary energy intake by zinc supplementation.[16] Up to now, there is no strong consensus that zinc supplementation can increase appetite and different results exist from several regions of the world.[17-19] However, many Iranian parents begin zinc supplementation for their children arbitrarily and without a physician prescription.

Although zinc insufficiency in humans is reported for the first time from Iran (1961),[3] a recent study showed that the prevalence of zinc deficiency is no more prevalent. The current study showed that the prevalence of zinc deficiency is about 7%–8% in children in Isfahan. In another study in the same city in 2014, about 4% of children had serum zinc concentration under the normal level.[12] The estimated prevalence in the present study was not high in comparison with some developing countries, for example, 44% in Ethiopia and 25% in Mexican children,[20] but it was relatively high compared with the previous study in our city.[12] It should be noted that we used also the serum zinc level as an indicator of zinc status,[20] which is affected by several factors such as growth velocity, stress, and inflammation, and therefore its diagnostic value might be limited.

In the current study, there was no significant difference in serum zinc level between the groups with and without zinc supplement and therefore no direct relation between appetite and serum zinc concentration. It seems that the poor appetite in many young children has various behavioral and interactive etiologies;[21,22] however, organic diseases and exposure to environmental pollutants[23] should be considered as well.

In our study, some differences existed between some subclasses of CEBQ scores in two groups. We found that, in the control group, some subscales, for example, my child loves food was lower in the case than in the control group, whereas some other subscales were higher in the case group, for example, my child leaves food on his/her plate at the end of a meal, and my child is difficult to please with meals. It seems that some differences between eating habits and subscales of two groups are more related to communicative problems, not to zinc supplementation.

Table 1: Characteristics of children in the case and control groups

Parameters	Case group (*n*=68)	Control group (*n*=67)	*P*
Age (years)	3.9 (SD)	4.2 (SD)	0.06
Weight (kg)	15.4 (SD)	16.3 (SD)	0.13
Height (cm)	102.1 (SD)	104.6 (SD)	0.19
BMI (kg/m^2)	14.8 (SD)	14.7 (SD)	0.73
Zinc (μg/dL)	79 (16)	84 (23)	0.18

Data are presented as mean (SD). BMI: Body mass index, SD: Standard deviation

Table 2: Food intake of children in the case and control groups

Variables	Case group	Control group	*P*
Energy (Kcal)	1820 (220)	1608 (280)	0.39
Protein (g/day)	64.3 (20.7)	65 (20.7)	0.85
Carbohydrate (g/day)	307 (83)	318 (82)	0.43

Data are presented as mean (SD). SD: Standard deviation

Table 3: The subscales of the Child Eating Behavior Questionnaire in the case and control groups

CEBQ	Case group	Control group	*P*
EF	2.50 (0.82)	4.06 (0.90)	<0.001
EOE	2.26 (0.77)	2.25 (0.88)	0.94
SE	3.85 (0.92)	3.94 (0.87)	0.57
EUE	4.24 (0.63)	4.34 (0.64)	0.32
SR	3.78 (1.06)	2.79 (1.08)	<0.001
FF	4.26 (0.68)	2.03 (1.21)	<0.001

CEBQ: Child Eating Behavior Questionnaire, EF: Enjoyment of food, EOE: Emotional overeating, SE: Slowness in eating, EUE: Emotional under eating, SR: Satiety responsiveness, FF: Food fussiness

Although zinc can increase taste perception and appetite of young children by affecting several CEBQ subscales,[24] and in our study, there were some differences between two group's subscales; we did not find any relation between CEBQ subscales and serum zinc level. Actually, the disinterest of some young children to eat seems to be related to their steady growth rate and communicative problems. For instance, many parents encourage their kids to eat more and this embolden makes the children alert to the importance of eating for their parents, so they would refuse foods to reach a favorite gain. Whatever the cause of food refusal, arbitrary zinc supplementation is not an appropriate and scientific method to manage it.

Study limitations and strengths

One of the limitations is the relatively small sample size of our study. The other limitation is using questionnaire-based data, which are subject to different biases. The main strength of our study is its novelty and evaluating the subscales of anorexia through a validated questionnaire. The other strength is considering detailed physical examination and laboratory tests for excluding some major organic causes of anorexia in the children studied.

Conclusion

The current study revealed that arbitrary zinc supplementation has no beneficial effect on the appetite of young children. Public awareness should be increased in this regard.

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Conflicts of interest

There are no conflicts of interest.

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