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Effect of Zinc Supplementation on Anthropometric Parameters of Male School Children

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ABSTRACT

Introduction: Zinc has a key role in reproductive physiology, immune modulation, growth, and development.
To determine the effect of zinc supplements on the anthropometry of healthy 6-year-old children.
Methods: In this double-blind placebo-controlled trial was carried out on 40 children 6-7 years old. The intervention group (n=20) received 20mg of oral zinc sulfate syrup and the control group (n=20) received a placebo daily in the same buttle and same test for 6 months duration of study. Serum zinc levels and anthropometric measurements (weight, height, head circumference, and arm circumference) were measured before and after intervention. Zinc deficiency was defined as serum zinc level < 9.9 µmol/l.
Results: Serum zinc level did not differ between the two groups (P=0.86). Zinc supplementation resulted in a significant increase in height (P= 0.008).
Conclusion: This study showed that zinc supplements have a significant increase in the length of male 6-year-old children.

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Introduction

It is essential that Vitamins as Minerals are important for growth and metabolism. There is deficiency of vitamins and minerals, particularly vitamin A, iodine, iron, and zinc (1) in more than 2 billion people.

As zinc is present in more than two hundred specific enzymes and also a factor for structural ion in transcription there for will be an essential trace elements for humans (2, 3).

The first health concern and major attention for zinc deficiency was recognized in 1961 (4, 5). It is estimated that one-third of the world population lives in countries with a high prevalence of zinc deficiency, which was found to be responsible for 0.4 million child deaths in 2008 (6, 7). It is estimated that 17.3% of the world population, ranging from 7.5% in developed countries to 30% in South Asia, are at risk for inadequate zinc intake (8). The vulnerable populations include infants, young children, and pregnant and lactating women due to high zinc requirements at these critical stages of life (9, 10).

Zinc deficiency is reported to be associated with impairment of growth, testicular functions, appetite, and sense of taste as well as delay in wound healing, immune resistance, and impaired memory (11). Zinc deficiency

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also interferes with the metabolism of thyroid hormones, androgens, and growth hormone (GH) (11). It was shown that the insulin-derived growth Fctor-1 (EGF-1) is decreased in zinc deficiency regardless of the energy intake (12, 13). IGF-1 receptor activation is responsible for changes in cell cycle and proliferation through tyrosine phosphorylation as a result of increased tyrosine kinase activity (12, 13). On the other hand, IGF-1 increases protein and collagen synthesis through increasing cellular thymidine uptake (12, 13). Regardless of the described mechanisms of action of zinc on growth, the findings of human studies are controversial. Some studies reported positive effects of zinc supplementation on growth in various groups of zinc-deficient children (14-16), this effect was not observed in other studies (17, 18). This study aimed to determine the effect of zinc supplementation on the physical growth of six-year-old male children. This difference might, in part, be due to the cut-offs used for detecting zinc deficiency ranging from 9.9 to 10.7 µmol/l for children under the age of 10 years (19, 20). It is hypothesized that zinc supplementation may not have substantial clinical effects in children with normal serum zinc levels. This study aimed to assess the children by testing the effect of providing 6 months of zinc supplementation on their anthropometric validity. The novelty of our study is the same sex and same age in samples.

Materials and Method

Subjects and methods

This study was a double-blind clinical trial conducted on male 6 to 7-year-old (first-grade) primary school students. Subjects were selected based on cluster random sampling, after obtaining approval from the Education organ of Khorasan Razavi province, from primary schools of the region (Region Five). Written informed consent was obtained from the parents or legal guardians of the subjects.

Procedure

All studied children were subjected to medical history and clinical assessment. Healthy male children between 6 and 7 years old were included in this study. Children with a history of preterm birth, chronic systemic disease, bone dysplasia, dysmorphic syndromes, chronic malabsorption, other nutrition deficiencies, and a history of previous use of zinc supplements were excluded. Parents and laboratory staff were blinded to treatment assignment.

A total of 40 subjects were recruited for this study. Subjects were randomly assigned into intervention and control groups each consisting of 20 subjects. A single daily dose of 20 mg zinc sulfate syrup was administered orally to the intervention group for 6 months. The control group received a placebo similar to the zinc sulfate syrup in shape and tested as a case group for 6 months. It was made by a pharmacies as our coworker.

Measurements

Anthropometric characteristics, including weight, height, head, and arm circumference were measured at baseline and after intervention. Height was measured to the nearest 1.0 mm with a Harpenden wall mounted stadiometer and weight to the nearest 0.1 kg on electronic bathroom scales. Head and arm circumferences were manually measured by tape.

All blood samples were taken in the morning in a non-fasting state. Serum zinc levels were measured at baseline and 12 hours after the last dose of zinc sulfate by manual colorimetric method technique (13). Zinc deficiency was defined as a serum zinc level of less than 9.9 µmol/l (21, 22).

This study was approved by the ethical committee of the Mashhad University of Medical Science, Iran. IRCT 138711021162N9

Statistical analysis

Continuous data were presented as mean and standard deviation (SD) while frequency and percentage were used to describe categorical variables. The mean difference between the baseline and the final assessment was assessed using an independent student t-test. The results were analyzed using the statistical package for the social science (SPSS) software version 10.00 (Echosoft Corp; USA, 2005). A p-value of less than 0.05 was considered significant.

Results

The range of weight in children in the case group was 17.1 kg minimum and 24.6 kg maximum and in the control group was 17.2 kg minimum and 27 kg maximum. Two groups were the same with normal distribution in variable weight (p= 0.56), length (p= 0.16), head circumference (p= 0.48), arm circumference (p=0.31), and zinc serum level (p= 0.78). Although there was no significant difference between the two groups in weight (p=0.97), head circumference (p=0.21), and arm circumference(p=0.06) after the intervention, a significant difference was found in liner growth (P= 0.008) (Table 1).

Serum zinc levels were within normal limits and did not differ between the two groups at baseline and after intervention (P=0.86) (Table 2).

Table 1: Anthropometric characters of two groups

Variable		Case group	Control group	p
Weight (kg)	Before	20.37± 2.21	20.92± 1.98	P= 0.97
	After	21.65 ± 3.02	21.90± 1.96	
Height (cm)	Before	116.67± 5.70	117.50± 2.80	P= 0.01*
	After	122.93 ± 5.52	122.97± 3.80	
Head circumference (cm)	Before	49.79± 1.57	50.58± 1.41	P= 0.21
	After	51.26± 1.46	51.68± 1.26	
Arm circumference (cm)	Before	15.91± 1.04	16.09± 0.93	P= 0.06
	After	16.79± 1.27	16.57± 1.16	

* Significant difference

Table 2: Serum zinc levels (µg/dl) before and after zinc supplementation

Time	Case group	Control group	p
Before intervention	90.87±29.20	76.09±36.55	P= 0.86
After intervention	170.04±83.01	117.60±33.48	

Discussion

This study showed no plasma zinc level in cut-off zinc deficiency. The prevalence of zinc deficiency in Iran was reported between 5.9% and 43% (23-26). The first and foremost clinical manifestation of zinc deficiency is the reduction in the velocity of physical growth in neonates and children (27,28). Hamza et al in Egypt (2012), studied short stature and growth retardation in zinc-deficient children (29). They explained this finding by the low intakes of animal products and animal protein due to the low socio-economic status of the population. In addition, zinc intake was not only low, but its bioavailability was poor because of the high phytate, fiber, and tea content of the diet among the Egyptian population (29). The exact mechanism of zinc deficiency and zinc supplementation on growth hormone secretion, serum IGF-1 levels, and growth is not well delineated (12, 14, 30). Das et al (2013) explained that the effect of zinc on growth is due to the synthesis of collagen, osteocalcin, and differentiation of chondrocytes, osteoblasts, and fibroblasts (30). Cesur et al, (2009) found that serum IGF-1 and insulin-like growth factor binding protein-3 (IGFBP-3) were below normal reference ranges in 96.6% and 100% of their short-statured zinc-deficient children (31).

This study showed that zinc supplementation had no influence on weight, head, and arm circumference, but significant differences were found in liner growth in normal 6-year-old children. Although many studies in different countries have shown a positive association between zinc supplementation and physical growth in children the observed effect of zinc supplementation on various indicators of physical growth was inconsistent (26, 27, 32, 33). It has been shown in different studies that zinc supplementation increases height and weight (26, 34, 35). For instance, Brown et al (2002) in a meta-analysis showed a highly significant aggressive effect size of 0.350 (95% CI: 0.189, 0.511) for height, 0.309 (95% CI: 0.178, 0.439) for weight and≈ 0 for weight- for height increments (28). Masoodpoor found that zinc supplementation improved weight and height in underweight stunted children (36). In contrast in a recent systematic review by Pimpin et al. (2016) zinc supplementation was associated only with a 0.69 cm increase in height (95%CI: 0.14, 1.25) and height for age Z score by 0.09 units (95%CI: 0.07, 0.12) (33). But despite our study, Kikafulnda et al in Uganda, no effect of zinc on liner growth was found (37).

In this study administration of zinc supplement for 6 months resulted in a significant increase in linear growth compared to the control group, which was in line with the findings of a previous study by Hakimi et al. (2006) that found a 2.7 ± 2.5 cm increment in linear growth in Iranian children who were supplemented with zinc for a period of 1 to 0 months (26). In contrast to the study by Hakimi et al. (2006), where 10 out of 42 subjects were zinc deficient, in the current study, all subjects had normal zinc levels. Although Hakimi et al. (2006) reported an improvement in weight and height in zinc zinc-deficient group compared to zinc adequate group, they failed to find a significant association between plasma zinc levels at baseline and growth increment (26). Similar to the findings of the aforementioned study, the current study also found an increase in linear growth with zinc supplementation regardless of the plasma zinc level. This observed increase in linear growth regardless of detectable zinc deficiency might be due to the different cut-off values for plasma zinc levels. While the World Health Organization has defined a zinc deficiency cut-off of 9.9 µmol/l for children under 10 years of age, a cut-off of 10.7 μmol/l has been described and used for detecting zinc deficiency in some studies and references (19, 20). On the grounds of these findings it might be hypothesized that although all subjects had plasma zinc levels above the deficiency cut-off, a mild state of zinc deficiency might have been present in the subjects. In other words, the current cut-off for serum zinc levels may only indicate severe zinc deficiency and might not be applicable in identifying children at risk for zinc deficiency. The limitation of the study is that there is an obstacle for the education organization to enter schools for research with more samples and different age groups. On the other hand Lack of complete control of diet despite health and nutritional advice to parents. Uncertainty about the exact intake of zinc supplement or placebo during the 6 months despite repeated reassurances in multiple meetings or phone calls with parents.

Conclusion

This study showed that zinc supplements have a significant increase in the length of male 6-year-old children.

Authors' contributions

AM and EKH participated in the design of the study. Statistical analyses were conducted by MS , AJE and ASF. All authors contributed to the interpretation of the results. NP, AM and AV. contributed to the drafting of the manuscript. All authors also contributed to the critical revision of the manuscript for important intellectual content, approved the final version, and are accountable for the integrity of its content.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Mashhad University of Medical Science .The researchers obtained informed consent from the participating patients. The study was registered in the Iranian Clinical Trial Registration Center (IRCT138711021162N9).

Consent for publication

"Not applicable."

Conflict of interest

The authors declare that no financial or other conflict of interest exists about the content of the paper.

Availability of data and materials

You can request the study's data from the corresponding author.

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