The Effect of Zinc Supplementation on Improving Cognitive and Nutrition Status among Preschool Children Coming to Family Medicine Center Clinic in Nikla Village at Giza

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Abstract

Objectives:

- Prevalence of zinc deficiency among preschool children in the study.
- Impact of zinc supplementation on cognitive function and the nutritional status among preschool children.
- Health education for healthy food and their requirement from the food regard the age and sex.

Study design:

This is a pre-post intervention study included 50 preschool child.

Method: The children randomly assigned to receive zinc supplementation daily for 6 months according to the level of plasma zinc. They were A self- administered questionnaire was used included (socio-demographic data, food frequency questionnaire and 24 hr. recall), anthropometric and cognition were assessed at the beginning and the end of the supplementation period. In addition to health education about healthy food throughout the follow up 6 months.

Results:-The study included males (46%) and females (54%);

-There was a significant difference in weight for age and height for age between the group before and after zinc supplementation.

- A significant difference in cognitive function, which the full-scale IQ, verbal IQ and nonverbal IQ between the group before and after zinc supplementation

-The health education effect positively on increasing the consumption of healthy food as protein, CHO, fruits, and vegetables to the normal proportions also effect on decrease consumption of unhealthy food as manufactured potatoes, fizzy drinks, and sweats.

Conclusions: zinc supplementation has an effect on cognitive and nutrition status on preschool age.- Health education about healthy food have good feedback on the study.

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Introduction

Zinc is an important vital micronutrient for humans, and zinc deficiency among children is deleterious to growth and development, and cognitive function.[1]

The main sources of zinc are beef, pork, poultry, fish and shellfish. Vegetables represent a good plant source of zinc. [2]

Adequate nutrition is a cornerstone of health and essential in early childhood to ensure healthy growth, proper organ formation and function, a strong immune system, and neurological and cognitive development**.** [3]

Method

Study design and settings:

This is a pre-post intervention study carried out on pre-school age children attending the Family Medicine center clinic of Nikla village at Giza.

Inclusion criteria:

Apparent healthy children randomly chosen aged 2-5 years who came to the clinic starting from January 2018.

Exclusion criteria:

Any child had a chronic disease**,** any child with congenital anomalies**,** any child with chronic diarrhea and IQ test below 80

Sample size& sampling

A total sample size of (45). Based on the previous data, the expected difference in IQ results over time is 6.4±13. [4] Using power 85% and 5% significance level. 39 children needed to be studied to be able to reject the null hypothesis that this response difference is zero. This number increased to 60 children to compensate for possible losses during follow up. The sample size was calculated by the PS program.

Data collection by different tools:

1) A structured interviewing questionnaire:

· Socio-demographic Characteristics adopted from Gelani questionnaire.

· Food frequency questionnaire and 24-hour recall for full dietary assessment. The FFQ was derived from a validated FFQ and was adjusted specifically for the National Institute of Nutrition in Egypt (NIN).

2) General examination:

Anthropometric assessments done to every child while wearing light clothing and barefoot. The anthropometric measures recorded according to the WHO Child Growth Standards charts for boys and girls (from birth to 5 years / Z-scores).

3) Laboratory investigation: to assess the level of zinc in plasma.

4) Cognitive function: assessed by (SB-5) Stanford Binet intelligence scale fifth edition.

5) Written models of healthy food, the amount of food calculated for each child regard to child sex, age, and writing models for unhealthy food to avoid.

Zinc dose supplementation plan:

According to zinc level, in normal children, they supplied according to RDA of zinc for age 2-5 years (3-5 mg zinc sulfate oral / day), but deficient children received therapeutic dose (0.5- 1 mg zinc sulfate oral / kg/day)divided 2 times/day in the form of zinc sulfate. Then calculated the dose of zinc to each child in the form of syrup.

Study time

The study carried out from 1st January 2017 to the end of March 2019.

Statistical Design:

The collected data were computerized and statistically analyzed using the Statistical Package for Social Science (SPSS) program version 17. Using descriptive and analytical statistics

Results

- Table (1) the study group included 50 children distributed 54% females and 46% male also shows that zinc deficiency in females and males represented (24% and 22%) respectively so prevalence of zinc deficiency 46 % of the studied group.

- Noticed that increase in weight, height, and serum zinc measure and showing highly significant differences before and after zinc supplementation in table (2).

- As regards the anthropometric measures improved after intervention regarding growth curves in table (3).

- This table illustrated improving of all factors of IQ scores and their subtypes according to age by months and shows statistical significant differences intervention with p-value (0.000) in all illustrated in table (4)

- The table (5) shows high significant differences in mean values of total energy for all food components after health educations for 6 months.

- Notice in table (6) that enhancement increase of daily food-frequency of egg, milk products, potatoes, fruits and vegetables and also weekly food-frequency of, milk, rice, and pasta but decrease consumption of junk food.

Table (1) Distribution of children group according to the zinc level and its relation to sociodemographic characteristics:

sociodemographic	Normal zinc		Zinc deficiency		Total		P-value
	No	%	No	%	No(50)	%	
1- Sex:							
- Male	12	24	11	22	23	46	
- Female	15	30	12	24	27	54	0.811
- Total	27	54	23	46	50	100	
2- Socioeconomic status:							
- Low	16	32	7	14	23	46	
- Moderate	11	22	12	24	23	46	0.05
- High	0	0	4	8	4	8	
3- Mother education:							
- Low	6	12	5	10	11	22	
- Moderate	17	34	13	26	30	60	0.388
- High	4	8	5	10	9	18	

** Pearson chi-square*

Table (2)Anthropometric measures before and after zinc supplementation

Anthropometric measure	Before		After		P-value
	Mean± SD	Median (min-max)	Mean± SD	Median (min-max)	
1- Weight (by Kg)	15 ± 2	15(11-21)	17 ± 2	17(12-23)	0.000
2- Height (by cm)	98 ± 6	99(86-113)	103 ± 6	103(91-118)	0.000
3- Serum zinc measure (109- 167 mg/dl)	109 ± 24	111(55-153)	140 ± 14	144(115-160)	0.000

**P-value is considered significant if < 0.05*

Table (3): Comparing anthropometric measure using the standard WHO Z-Score curves before and after zinc supplementation

Anthropometric measure	Before zinc supplementation		After zinc supplementation		P-value
	No (50)	%	No (50)	%	
1- Wt/age :					
· -3 to -2	1	2	0	0	
· -2 to 0	32	64	27	54	0.000
· 0 to + 2	15	30	21	42	
· +2 to +3	2	4	2	4	
2- Ht/ age :					
· -3 to -2	12	24	3	6	
· -2 to 0	32	64	30	60	0.000
· 0 to +2	5	110	15	30	
· +2 to +3	1	2	2	4	
3- Wt/ ht:					
· -2 to -1	1	2	0	0	
· -1 to 0	12	24	9	18	0.000
· 0 to +1	22	44	26	52	
· +1 to +2	14	28	13	26	
· +2 to +3	1	2	2	4	

*P value is considered significant if < 0.05

** Test used chi-square

Table (4): Comparing cognitive function before and after zinc supplementation

IQ score	Before		After		P-value
	Mean ± SD	Median (min-max)	Mean ± SD	Median (min-max)	
1- Full-scale IQ	99 ± 10	99 (81-120)	109 ± 8	110 (94-126)	
2- Factors index score	96 ± 13	91(74-129)	105 ± 12	105(87-147)	
- FR	106 ±10	106 (84-126)	111 ± 16	113 (91-137)	
- KN	96 ± 11	96 (69-113)	103 ± 10	107 (81-120)	0.000
- QR	99 ± 8	100(78-124)	107 ± 6	107 (90-124)	
- VS	95 ± 12	97(58-119)	104 ± 6	104 (91-127)	
- WM					
3- Verbal IQ	98 ± 14	99(66-124)	110 ± 11	111(87-134)	
4- Verbal subtypes	9±4	7 (4-19)	12±3	12 (6-18)	
- FR	13±3	14 (6-17)	15±3	15 (7-21)	
- KN	8±3	8 (2-14)	10±3	11 (2-16)	0.000
- QR	10±2	10 (2-15)	12±2	11 (7-17)	
- VS	10±3	10 (2-14)	12±2	12 (6-18)	
- WM					

Cont... **Table (4): Comparing cognitive function before and after zinc supplementation**

5-	Non- verbal IQ	97 ± 7	97 (83-112)	104 ± 6	105 (91-122)	
6-	NV subtypes	9±2	9 (6-12)	10±2	10 (6-19)	
-	FR	10±2	10 (7-14)	12±2	11 (8-21)	
-	KN	10±2	11 (3-14)	11±2	12(7-14)	0.000
-	QR	10±2	10 (5-15)	12±2	12(6-16)	
-	VS	10±3	9 (3-17)	11±2	11(7-21)	
-	WM					

**P-value is considered significant if < 0.05*

Table (5): Comparing approximately contents of food components before and after zinc supplementation

Food components	**Before**		**After**		**P-value**
	Mean ± SD	**Median (min-max)**	**Mean ± SD**	**Median (min-max)**	
Total energy	1210 ± 284	1158 (643-2016)	1523±265	1489(1094-2357)	0.000
CHO (by gm)	178± 47	173 (67-297)	218±38	216(160-339)	0.000
Protein (by gm)	41±13	39 (20-83)	53±15	57(30-88)	0.000
Fat (by gm)	35±15	32 (14-87)	45±16	43(21-83)	0.002
Zinc (by mg)	5.5±1.9	6.5 (2-11)	7.7±3	9 (3-15)	0.015
Ca (by mg)	418±234	366(105-1084)	510±225	500 (59-1302)	0.017
Iron (by mg)	7.76±2.4	8.5 (2-15)	11.5±4.6	15 (5-24)	0.000

*P-value is considered significant if < 0.05 Test used Wilcoxon Signed Ranks

Table (6): comparing food category by FFQ before and after follow up 6 months among the studied group:

food category	Before				After				P-value
	daily	weekly		monthly	daily	weekly		monthly	
		< 3 times	> 3 times			< 3 times	> 3 times		
meat	2	40	4	4	2	38	5	5	0.000
egg	8	23	7	12	11	20	9	10	0.000
bean	18	12	4	16	17	11	5	17	0.000
milk	14	18	14	4	13	16	15	6	0.000
milk product	28	13	9	0	31	9	0	0	0.000
rice	9	27	14	0	4	30	16	0	0.000
pasta	3	32	12	3	1	33	13	3	0.000
potatoes	8	25	15	2	21	18	11	0	0.000
fruits	34	11	4	1	37	8	4	1	0.000
vegetables	24	23	3	0	32	13	5	0	0.000
processed potatoes	31	9	8	2	25	10	10	5	0.000
fizzy drinks	6	27	10	7	5	21	11	13	0.000
sweets	13	21	7	9	6	16	7	21	0.000

Discussion

The prevalence of zinc deficiency in the current study represent 46%. Male to female represent (22%, 24%) respectively. Regarding World Bank Nutrition-Related Activities in Egypt, Vitamin and Mineral Deficiencies Cause Hidden Hunger although they may not be visible to the naked eye and 9% of the population at risk for insufficient zinc intake[5]. But Rabeh 2010 showed that the prevalence of zinc deficiency in their study about 70%, male to female represent (38%, 32%) respectively. [6] This variation finding due to the variation of community and habits.

Concerning the mean weight and height of this study group before and after zinc supplementation showed a highly significant difference as the mean of weight before and after represented (15 ± 2 and 17 ± 2 kg) respectively and the mean of height represented (98 ± 6 and 103 ± 6 cm) respectively. While Garemo in NOPLAS project in United Arab Emirates (UAE) founded the mean of weight and height in children 2-3 years (13.9 ± 2 kg and 92.6 ±4.8 cm) and the children more than 3 years (15.5± 2 kg and 99.7± 6 cm). [7]Although our observations show that zinc supplementation stimulated growth, the mechanisms for this effect are unknown. The effect of zinc may result from increased appetite and improved ingestion of protein.

Results of the current work illustrated that weight gain and linear growth improved more after zinc supplementation, as before zinc supplementation the underweight and wasting represented (2%) and the stunting represented (24%), whereas after zinc supplementations only (6%) represented the stunting. This agrees with Islam et al., done in India, El-Farghali et al., done in Ain shams university and Bhutta and Das**,** who prove that preventive zinc supplementation in populations at risk of zinc deficiency increases linear growth and weight gain among infants and young children. [8,9, 10] In contrast, a meta-analysis by Ramakrishnan**,** based on 43 studies found no significant effect of zinc supplementation on linear growth in

children < 5 years of age. [11] this is against another meta-analysis done by Liu et al., based on 78 trials included 54 in infancy/childhood (target age of our study) which found improved specific growth outcomes including height, weight, and WAZ. They also identified evidence for potentially stronger effects on height and HAZ by child age, with greater effects when supplements were given to children aged ≥2 years, rather than infants. [12]

We found that zinc supplementation significantly increased FSIQ, NVIQ, VIQ, and also subtypes which indicated that preschool children increased their abilities in reasoning, solving problems, and adapting to the cognitive demands of the environment. more recently studied as de Moura et al., which founded that children supplemented with zinc alone presented better particularly in reasoning, orientation– engagement and hand and eye coordination. [5]

The results of the present study showed highly significant differences after health education regarding the contribution of approximately total energy and energy intake from dietary carbohydrate, protein, and fat in daily diets. This study agreement with the recommended RDA of total energy and macronutrients by FAO[13,14].

The current results approximately illustrating improve in the frequency of food rich in protein (meat, liver, poultry, egg, fish, bean, legumes, milk and milk products), vegetables, fruits, CHO (rice, pasta, and potatoes) and fat among studied group by FFQ and showed highest significant difference between before and after 6 months follow up to nearly meeting their needs recommended by FAO and WHO and UNICEF. [13,14] This improvement is due to teaching the mother about the balanced diet to meet the needs of children should be distributed, regarding energy/ caloric intake, according to the rules of healthy nutrition, i.e. the diet should be varied and include foods which provide the necessary nutrients in terms of proportion and quantity.

Ethical Clearance: The study protocol was discussed by selected staff members of the Family Medicine Department, Faculty of Medicine, Cairo University, and was approved by its council held in Juan 2017. and taken from center direct for Research and Health Development from Ministry Of Health and Population (Com.No/Dec. No:1-2018/7). An informed consent was obtained from every child-parent before filling the questionnaires.

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Conflict of Interest: Authors declare there is no conflict of interest regarding the publication of this paper.

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