EFFECTS OF DIETARY ZINC SUPPLEMENT DURING LACTATION ON LONGITUDINAL CHANGES IN PLASMA AND MILK ZINC CONCENTRATIONS

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SUMMARY : Effects of dietary zinc supplement during lactation on maternal plasma zinc and milk zinc concentrations through 5 months of lactation were examined. One hundred and thirty eight healthy lactating mothers received a weekly 100 mg elemental zinc supplement (ZG, n = 67) or placebo (PG, n = 71) starting one week postpartum in a double blind, randomized design. Milk and plasma zinc concentrations were determined by atomic absorption spectrophotometer.

During the course of study, there was not a significant difference between ZG and PG groups in dietary zinc and energy intake. The mean plasma zinc concentration during the 1st week and 5th month were 134±49.1 and 115.6±23µg/dl (p=0.005) for PG group, respectively: that of the ZG group these figures were 124.9±52.8 and 121±27.1µg/dl (p=0.38), respectively. The mean serum alkaline phosphatase concentration of the 1st week and 5th month were 94.8±37 and 92.6±29.9 iu/l for PG group, respectively: that of the ZG group these figures were 90.5±36 and 90±29 iu/l (p=0.21), respectively. Milk zinc concentration declined significantly over the course of study for two groups, with the sharpest decline occurring during the first 2 months. The mean monthly zinc concentration of ZG group declined from 310±138 during the 1st week to 118±64µg/dl at 5th month (declined by 52%). Corresponding means for PG group were 322±161 and 109±70µg/dl (declined by 60%), respectively. Milk zinc concentration was significantly different between two groups for 3 and 4 months. A similar study, however, with different zinc dose and administration manner, in zinc marginal deficient lactating mothers is needed to assess the impact of zinc supplementation on milk zinc concentrations.

Key Words: Zinc, Marginal zinc deficiency, Plasma zinc, Milk zinc, Zinc supplementation, Dietary zinc intake.

INTRODUCTION

Mother's milk has long been regarded as the ideal food for infants, against which all other types of feedings are compared. As such, it is important to have accurate data on the composition of human milk. Several reports concluded that zinc concentration of the milk was not influenced by maternal dietary intake (1-4). Many reports, however, showed a significantly slower rate of decline in the zinc concentrations of milk over 9 months of lactation in a group of women who received a supplement of zinc compared with non-supplemented control subjects (5).

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Table 1: Daily intakes of zinc (mg) by two groups during the study period.

Time of lactation	Zinc supplemented group			Placebo group			
	N	$\overline{X} \pm SD$	95% CI**	N	$\overline{X} \pm SD$	95% CI	P*
1st week	65	10.27 ± 1.9	9.7-10.7	70	10.48 ± 2.5	9.8-11.1	0.59
1st month	56	11.25 ± 2.5	10.5-11.9	65	10.7 ± 2.4	10.1-11.3	0.23
2nd month	97	10.33 ± 1.5	9.8-10.7	58	9.9 ± 1.9	9.4-10.4	0.25
3rd month	46	10.16 ± 1.9	9.5-10.7	55	9.8 ± 1.9	9.3-10.2	0.31
4th month	42	11.34 ± 3.4	10.2-12.4	55	10.8 ± 2.5	10.1-11.5	0.47
5th month	42	11.33 ± 3.4	10.2-12.3	53	10.3 ± 2.0	9.7-10.8	0.07

* Student t-test

** 95% confidence interval

The clinical entity of zinc deficiency in human was first described in young males in Iran and Egypt (6) and in recent years, many studies have showed zinc deficiency in many areas of Iran (7-10). Hence, Iran can be one of the countries where marginal zinc deficiency is frequently observed. Over the last 20 years various studies have been performed on the zinc supplementation effect zinc status of breast milk, however, as yet the relation of zinc supplementation to breast milk zinc concentrations, especially in marginal zinc deficiency cases is not sufficiently elucidated.

The objective of the present study was to determine the effect of maternal zinc supplement on zinc concentration of plasma and milk in the healthy lactating women during the first 5 months of lactation.

MATERIALS AND METHODS

The study was designed as a double blind randomized clinical trial conducted in Yazd-Iran from 2002 to 2004. One hundred and thirty eight healthy lactating mothers, first week after delivery, were randomly assigned into two groups (zinc supplemented group (ZG, n=67) and placebo group (PG, n=71). The ZG group received 2 zinc sulphate capsules weekly each containing 50 mg elemental zinc. The PG group received 2 of the same capsules containing starch which were indistinguishable from the zinc sulphate capsules. The lactating mothers were instructed to take the capsules 0.5 hour before or 3 hours after the evening meal. Compliance monitored by counting the remaining capsules each month, averaged 92.9 ± 2.1%. All mothers were healthy, had unremarkable obstetric histories, delivered at term, had healthy infants, and which were nursed exclusively with breast feeding during the study. Mothers did not smoke, used no alcohole nor contraceptive pills. All women informed consent to participate in the study. The ages (mean ± SD) of the ZG and PG groups were 25.4 ± 5.8 and 24.7 ± 6.2, respectively. Mean parities were 4 ± 1.4 and 3.9 ± 1.5 for the ZG and PG groups, respectively. For determination of plasma zinc and serum alkaline phosphatase, a 5 ml blood sample was collected by peripheral venipuncture using disposable plastic syringes and stainless steel needles during the first week and until the 5th month of lactation. The samples were collected between 9.00 AM and 12.00 noon while they were not fasting. 2.5 ml of each sample of blood was transferred to plastic tubes containing 500 units of heparin. The syringes, heparin, and tubes were free of detectable zinc. After centrifuging, plasma was separated using glass capillary pipettes that had been washed in HCL and deionized water and was stored at -20°C in plastic tubes. The remaining 2.5 ml of the blood sample was transferred to plastic tubes and the serum was separated. Alkaline phosphatase concentration was determined by calorimetry with Zist Shimi kit. For determination of milk zinc concentrations, milk samples of 5-10 ml were hand expressed after mothers cleaned the areola with deionized water at the first week and then once in a month. Zinc free vials were provided to subjects, who were given instructions for avoiding zinc contamination of the mothers milk. Samples were then frozen and stored at -20°C until the day of analysis. Milk and plasma zinc concentrations were determined on each sample by atomic absorption spectrophotometer in the laboratory of the health faculty of Shaheed Sadoughi Medical Sciences and Health Services University of Yazd.

24 hours dietary recall was recorded in each visit and was reviewed for accuracy and completeness by the nutritionist at the time of sample collection. Nutrient intakes were computer calculated using NIII software.

Table 2: Daily intakes of energy (kcal) by two groups during the study period.

Time of lactation	Zinc supplemented group			Placebo group			
	N	$\overline{X} \pm SD$	95% CI	N	$\overline{X} \pm SD$	95% CI	P
1st week	65	2344 ± 606	2173-2474	70	2361 ± 543	2231-2490	0.7
1st month	56	2371 ± 617	2206-2537	65	2453 ± 819	2250-2656	0.5
2nd month	47	2460 ± 537	2303-2618	57	2547 ± 676	2367-2727	0.4
3rd month	46	2502 ± 552	2338-2665	55	2585 ± 762	2379-2791	0.5
4th month	42	2502 ± 684	2289-2716	55	2543 ± 574	2387-2698	0.7
5th month	42	2482 ± 566	2305-2659	53	2460 ± 561	230-2615	0.8

Data was processed by SPSS win software. The differences between plasma zinc concentration before and after were compared by paired t-test. Milk zinc concentrations were compared by student t-test. Data are presented as mean ± SD and 0.95% confidence interval. A value of $p \leq 0.05$ was considered statistically significant.

RESULTS

Mean calculated dietary zinc and energy intake at each visit are shown in Tables 1 and 2. Over the course of the study, there was no significant difference between ZG and PG groups in dietary zinc and energy intake.

Figure 1: Trend of milk zinc concentrations by lactation progress.

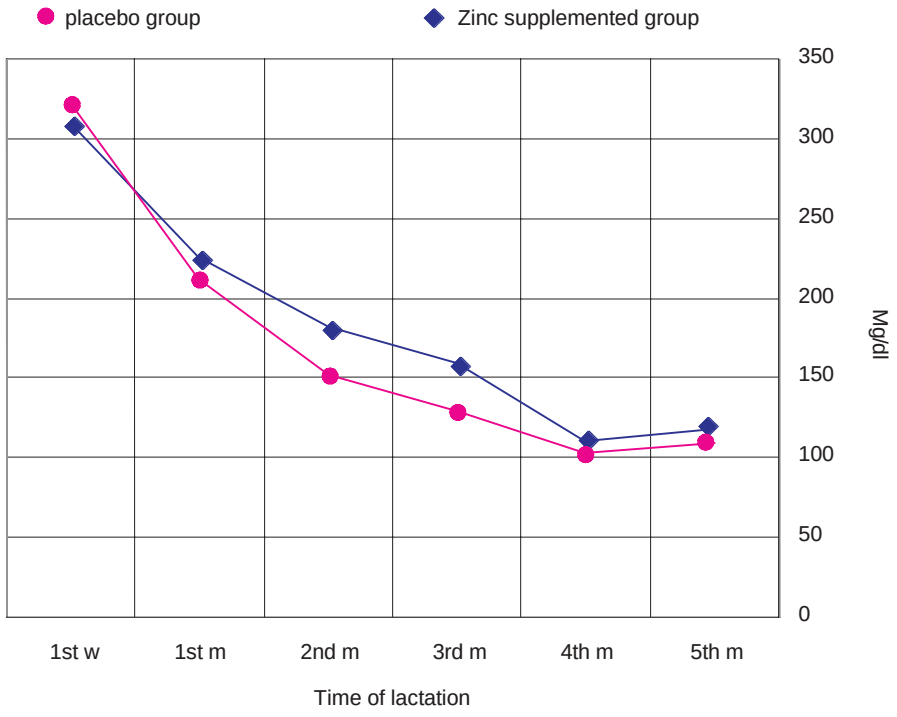

Table 3: The milk zinc concentration (μg/dl) by two groups during the study period.

Time of lactation	Zinc supplemented group			Placebo group			
	N	$\overline{X} \pm SD$	95% CI	N	$\overline{X} \pm SD$	95% CI	P
1st week	68	310 ± 138	277-344	71	322 ± 161	284-360	0.32
1st month	56	226 ± 84	203-249	64	212 ± 90	189-234	0.17
2nd month	49	182 ± 79	159-205	59	152 ± 69	134-170	0.02
3rd month	48	159 ± 73	138-181	58	129 ± 57	113-144	0.005
4th month	45	111 ± 54	94-127	56	103 ± 66	85-121	0.26
5th month	43	118 ± 64	98-137	56	109 ± 70	90-128	0.26

The mean plasma zinc concentration at 1st week and 5th month were 134 ± 49.1 and 115.6 ± 23 μg/dl (p=0.005) for placebo group, and of the zinc supplemented group these figures were 124.9 ± 52.8 and 121± 27.1 μg/dl (p=0.38), respectively.

The mean serum alkaline phosphatase concentration at 1st week and 5th month were 94.8 ± 37 and 92.6 ± 29.9 iu/l for placebo group, respectively: that of the zinc supplemented group these figures were 90.5 ± 36 and 90 ± 29 iu/l (p=0.21), respectively.

Milk zinc concentration declined significantly over the course of study for two groups, with the sharpest decline occurring during the first 2 months (Figure 1, Table 3). The mean monthly zinc concentration of ZG group declined from 310 ± 138 at 1st week to 118 ± 64 μg/dl at 5th month (declined by 52%). Corresponding means for PG group were 322 ± 161 and 109 ± 70 μg/dl (declined by 60%), respectively. As shown Table 3, milk zinc concentration was significantly different between two groups for 3 and 4 months.

DISCUSSION

According to the results, the overall calculated mean of daily dietary zinc, energy and other nutrients intake in two groups were similar and were higher than 75% of related RDA. These results were approximately in agreement with the other studies (1, 4, 5, 11, 12). Also, other confounded variables (education level, parity, weight variation, age, and body mass index) were not statistically different in two groups throughout the study. Hence, the results indicated appropriate randomization and could not be as confounded variables on plasma and milk zinc concentration results.

The overall means of plasma zinc during the 1st week and 5th month of lactation were 128 ± 50 and 117.9 ± 24.6 μg/dl, respectively. Also, plasma zinc differences during 1st week and 5th month of lactation for ZG and PG were 3 and 19 (p=0.005) μg/dl, respectively. This decline may be due to physiological factors in early postpartum and lactation. Elevation of plasma zinc concentration in the early postpartum period can be attributed to physiological changes associated with delivery, including restoration of normal non-pregnant blood volume, hormonal changes, and an increase in serum albumin. In contrast to pregnancy, there were no recognized physiological factors operating during lactation that may depress plasma zinc concentrations. Thus, the slow decline of rate of plasma zinc level may be due to the effects of zinc supplementation.

The plasma zinc level in lactating women has been reported higher than present study (14). While in many studies it has been less than those of the present study (1,4,5,12,13). These differences may be attributable to the significant variation in dietary zinc intake, type of supplementation (daily or weekly) dose of zinc administration, technique of zinc determination and so on.

Concentration of zinc decreased as lactation progressed in both groups. The mean for the PG group declined 52%

between the first week and the subsequent 2 months. The corresponding figure for ZG was 41%. Comparable figures from other studies ranged from 40-60% (5, 12, 16). The similarities between different studies at comparable stages of lactation suggest that these figures may to a large extent be accepted as part of a normal physiological pattern of decline in zinc concentrations of human milk as lactation progresses. However, in contrast with a recent study (4) there was a significant difference in the rate of decline in milk zinc concentrations throughout lactation (especially the first 2-3 months) between the zinc supplemented and placebo groups.

In summary, the present study showed relatively slow decline of milk zinc between supplemented and non-supplemented lactating mothers. Hence, for further clarification, of the process we believe other randomized control studies with different zinc doses should be conducted on marginal zinc deficient lactating mothers.

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