International Journal of Research in Medical Sciences
Mane SM et al. Int J Res Med Sci. 2019 Jan;7(1):96-100
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20185182

Original Research Article

Effect of nutrition on copper and zinc concentrations in human milk

Sharmila M. Mane, Neelam J. Patil*, Sachin A. Patharkar, Megha G. Bangar

Department of Biochemistry, Topiwala National Medical College and B. Y. L, Nair Ch. Hospital, Mumbai, Maharashtra, India

Received: 02 December 2018
Revised: 14 December 2018
Accepted: 19 December 2018

***Correspondence:**
Dr. Neelam J. Patil,
E-mail: neelamb99@gmail.com

ABSTRACT

Background: The gross composition of human milk is remarkably constant among women of varying nutritional status. Reliable information is now available on the content, and the principal factor affecting it, of most of the trace elements on human milk. However, for some of the trace elements, there is still a wide variation in reported values in the literature, which is due at least in part, to analytical difficulties. Hence this study was taken up to find out if maternal nutritional status influences the copper and zinc concentrations in colostrum of mother.
Methods: Total of 100 mothers were enrolled in the study after obtaining prior informed consent. They were divided into 2 groups - group I had 50 malnourished mothers and group II had 50 well-nourished mothers. Sample digestion was attempted with different quantities of various acids. Analysis of digested colostrum was carried out for copper and zinc.
Results: The mean levels of copper and zinc were slightly more among well-nourished than malnourished women. Values of copper were significantly higher in the colostrum of well-nourished as compared to that of the malnourished mothers.
Conclusions: The parameters of weight, height weight/height ratio and hemoglobin varied significantly between the well-nourished and malnourished mothers. The difference in milk content of malnourished and well-nourished mothers is not significant for zinc. However, copper levels were significantly higher in well-nourished mothers.

Keywords: Flame atomic absorption spectrophotometer, Malnourished, Well-nourished

INTRODUCTION

The question of composition and volume of breast milk produced by mother on different planes of nutrition at different phases of lactation is a major issue in paediatric public health in the world, especially in resource poor countries. Fundamentally, ultimate concerns are the nutritional adequacy of such milk for babies in relation to calories, proteins, vitamins and minerals.[1-3]

Several workers in different parts of the world have extensively studied the chemical composition of breast milk. The variability of the composition of human milk is well known.[4] Not only does the concentration of many nutrients change as lactation progresses but milk composition also varies between women, between the beginning and end of a feed and between reflex drip milk and expressed milk.[5,6] Chronic, severe undernutrition has been associated with reduced breast milk volume and lower concentration of several nutrients in milk including fats and protein.[7,8]

Minerals and trace element content of human milk have been a matter of concern among nutritionist in relation to the availability of the essential elements to the new born.[9] Mineral and trace elements occur in the body in a number of chemical forms, such as inorganic ions and salts, or as constituents of organic molecules, for example proteins, fats, carbohydrates and nucleic acids.[10] They serve a wide variety of essential psychological functions ranging from structural components of body tissue to essential component of many enzymes and other biologically important molecules. The trace elements and minerals found in the milk serve as the only source for development of an infant in initial 6 months of its growth.[11,12] However only a few studies conducted maternal status with milk composition and even fewer studies have addressed the issue of trace element and minerals of these women.[13-15] Such information would be valuable in assessing the effects of maternal nutritional intake, composition of breast milk and in assessing the effect of these on growth and development of new-born. Hence this study was taken up to find out if maternal nutritional status influences the copper and zinc concentrations in colostrum of mother.

METHODS

The study was conducted at the Human Milk Bank and Research Centre, Department of Neonatology at a tertiary care hospital over a period of two years.

The sample processing and analysis was done at human milk bank and research centre of the hospital and at the environmental assessment division, BARC respectively.

100 mothers were enrolled in the study after obtaining prior informed consent. The study protocol was approved by the Institutional Ethical Committee. They were divided into 2 groups.

- Group I had 50 malnourished mothers.
- Group II had 50 well-nourished mothers.

Mothers were considered well or malnourished depending on the following criteria:

- Criteria for malnourished mothers was, W/H ratio less than 0.3 in (group I)
- Criteria for well-nourished mothers was, W/H ratio more than 0.3 in (group II).

Inclusion criteria

- Mothers who have undergone full term normal vaginal delivery of normal neonate
- Mothers with well babies on breast-feed
- No major detectable medical or obstetric illness diagnosed in the mother (other than malnutrition).

Exclusion criteria

- Operative/instrumental delivery
- Medical/ obstetric disease in mother
- Mother on medication.

Detailed maternal and neonatal history was recorded on a printed proforma, following information were noted. Maternal-age, parity, haemoglobin %, weight, height, W/H ratio and nutritional status.

- The weight of the mothers was recorded by weighing scale (Libra).
- The height of the mothers was recorded by the height chart.
- Haemoglobin concentration was determined by Sahli's method.

Analysis from milk samples

Method of milk collection

Samples were collected from 100 mothers (50 malnourished and 50 well-nourished) who were delivered in the hospital. Colostrum was collected on third day after the delivery between 10.00 to 11.00 a.m. The mothers were made to manually express the colostrum into sterile glass test tubes for biochemical estimation and in sterile acid clean test tubes for trace elements. The pre-fed milk sample which was collected was stored at -20℃ until it was processed. It was thawed and analyzed as follows.[16-18]

Precautions

In the present study, all laboratory wares used in sample ashing, analysis and storage were soaked in 10% nitric acid (HNO_3) for several days and then rinsed thoroughly with distilled and double distilled water, respectively before use.

Pre-treatment of colostrum milk samples

For the complete digestion of 2ml milk $2\,^{1}/_{2}$ml nitric acid (HNO_3) and $1\,^{1}/_{2}$ml perchloride acid ($HClO_4$) were required. Acid blank was taken along with each batch of milk sample through the same procedure throughout the analysis.

Determination of copper and zinc in digested colostrum samples were carried out by Flame Atomic Absorption Spectrophotometer (GBC, 904) At Environmental Assessment Division, BARC Hospital.

Statistical analysis

In this study each parameter of both the group mean and standard deviation were calculated by using SPSS software package. To compare the significant difference between two groups "student unpaired t test" was used.

RESULTS

Mothers delivering at the hospital were selected as per inclusion criteria and were classified into two groups of

50 each: group (I) malnourished mothers, and group (II) well-nourished mothers.

Table 1: Maternal demographic profile of well-nourished and malnourished mothers.

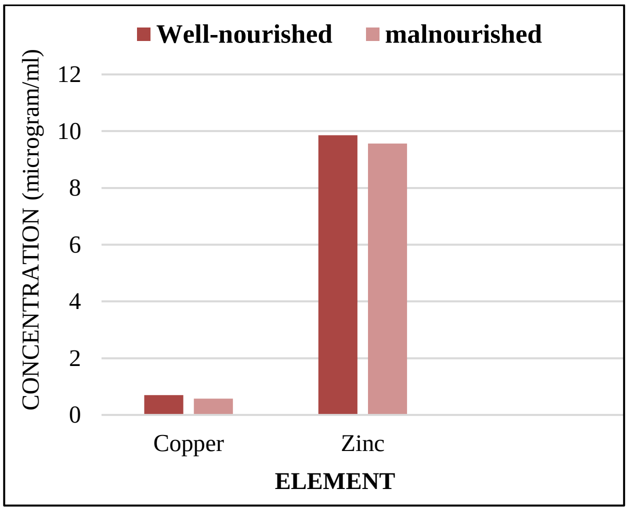
Parameter	Well-nourished (n=50)	Malnourished (n=50)
Age of mothers (years)	@22.8±2.99	22.72±3.43
Weight of mothers (weight)	*50.4±5.91	41.5±3.17
Height of mothers (cm)	*152.34±5.54	149.94±4.17
Weight/height ratio (kg/cm)	*0.33±0.032	0.27±0.018
Haemoglobin (g%)	*10.37±1.03	9.64±0.75

*p <0.05 significant and @p >0.05 not significant.

Table 2: Comparison of copper and zinc of colostrum between well nourished and malnourished mothers.

Parameters	Well-nourished (n=50)	Malnourished (n=50)
	Mean±SD	
Copper (µg/ml)	0.70±0.32	0.58±0.23
Zinc (µg/ml)	9.86±2.85	9.56±2.61

*p <0.05 significant & p >0.05 not significant.



Mean levels of copper were significantly more among well-nourished mothers. Mean levels of zinc were slightly more among well-nourished than malnourished but difference was not significant.

Figure 1: Comparison of copper and zinc concentration of colostrum between well-nourished and malnourished mothers.

The two groups were matched in age. The parameters of weight, height, weight/ height ratio and haemoglobin varied significantly between the well-nourished and malnourished mothers while the change was not significant with respect to the age (Table 1).

Above data reveals that mean levels of copper were significantly more among well-nourished mothers i.e. 0.70 as compared to only 0.58 in malnourished. Mean levels of zinc were significantly more among well-nourished mothers i.e.9.86 as compared to only 9.56 in malnourished which is slightly more among well-nourished than malnourished, but difference was not significant (Table 2).

DISCUSSION

Pregnant women and nursing mothers constitute a vulnerable group because of their special needs. Maternal nutritional status is also known to influence the condition of the offspring. In view of these considerations, the nutritional problems of pregnancy and lactation assume importance.

This perspective study over a period of two years was conducted at postnatal ward and outpatient neonatal centre. It included 50 well-nourished and equal numbers of malnourished women. The milk composition of these two groups was compared for copper and zinc concentrations.

Demographic profile

Table I reveals the demographic profile of the mothers in the two groups for age, weight, height, weight/height ratio and haemoglobin concentration. The (average) age of mothers in the two groups was similar. However, there was statistically significant difference between the weight, height, weight/height ratio and haemoglobin concentration between the well-nourished and malnourished mothers.

The weight (kg)/height (cm) ratio in study group was 0.27±0.018 in malnourished and 0.03±0.032 in well-nourished respectively. The criterion for maternal malnutrition in this study was weight/height ratio less than 0.3.

The mean weight of the mothers in the malnourished group was 4.15±3.17(kg) and the mean of the mothers in well-nourished group was 50.44±5.9 (Table 1).

The mean height of the mothers in malnourished group was 149.94±4.17(cms) and the mean height of the mothers in well-nourished group was 152.34±5.54(cms) (Table 1).

It has been proposed that quantity and quality of breast milk are adversely affected by maternal under nutrition and the growth pattern of infants of these mothers is not satisfactory.[19]

It has been also indicated that maternal nutrition during pregnancy and lactation has little direct impact on birth weight and the infant growth.

Haemoglobin

The haemoglobin levels in malnourished women were 9.64±0.75gm% while those in the well-nourished women RE 10.37±1.03gm%. This difference was found to be statistically significant. However, these levels are below the normal value (11g%) stated for the pregnant women.

Trace elements

Table 2 reveals the trace element and mineral content of well-nourished and mal nourished mother's milk for sodium, potassium, calcium, iron, magnesium and zinc and copper.

The difference in milk content of malnourished and well-nourished mothers was not significant for zinc. However copper levels were significantly higher in well-nourished mothers.

Copper is required for iron utilization and a cofactor for enzyme involved in the metabolism of glucose and the synthesis of haemoglobin, connective tissue and phospholipid.[20-22] Dietary deficiency of copper is uncommon except in conditions of severe malnutrition.[23] There is no significant correlation between dietary copper intake and milk concentration.[24,25]

Zinc is essential for growth and development; sexual maturation and wound healing and it may also be involved in the normal functioning of the immune system and other physiological process.[26] Zinc content in human milk is less than that of cow's milk. No significant correlation has been observed between zinc intake and zinc concentration in human milk. The bioavailability of zinc from human milk is higher than the cow milk. It is likely that the lower concentration of zinc in human milk may be a contributory factor to the higher absorption efficiency from human milk in infancy. Rajlakshmi et al, and Picciano et al, found that copper and zinc concentrations in milk of women from lower income group were significantly lower than that of high income group.[27,28]

Garg M et al, reported that the mean level of micronutrients is less in colostrum of undernourished mothers than in colostrum of well-nourished mothers, but the differences are not statistically significant.[29]

CONCLUSION

The present study has made an effort to find out the influence of maternal malnutrition on some of the important biochemical components and trace elements in the milk and its effect on the growth of newborn.

The parameters of weight, height weight/height ratio and hemoglobin varied significantly between the well-nourished and malnourished mothers.

The study reveals that mean level of zinc were slightly more among well-nourished than malnourished, but difference was not significant. Values of copper were significantly higher in the colostrum of well-nourished as compared to that of the malnourished mothers.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Jelliffe DB, Jelliffe EP. The volume and composition of human milk in poorly nourished communities. A review. Am J Clin Nutr. 1978 Mar 1;31(3):492-515.
2. Bauer J, Gerss J. Longitudinal analysis of macronutrients and minerals in human milk produced by mothers of preterm infants. Clin Nutr. 2011 Apr 1;30(2):215-20.
3. Ballard O, Morrow AL. Human milk composition: nutrients and bioactive factors. Pediatr Clin. 2013 Feb 1;60(1):49-74.
4. Manjrekar C, Vishalakshi MP, Begum NJ, Padma GN. Breast feeding ability of undernourished mothers and physical development of their infants during 0-1 year. Indian Pediatr. 1985 Nov 1;22(11):801-9.
5. Harzer G, Haug M, Dieterich I, Gentner PR. Changing patterns of human milk lipids in the course of the lactation and during the day. The Am J Clini Nutr. 1983 Apr 1;37(4):612-21.
6. Ali JA, Kader HA, Hassan KH, Arshat HA. Changes in human milk vitamin E and total lipids during the first twelve days of lactation. The Am J Clin Nutr. 1986 Jun 1;43(6):925-30.
7. Karmarkar MG, Ramakrishnan CV. Studies on human lactation: Relation between the dietary intake of lactating women and the chemical composition of milk with regard to the principle and certain inorganic constituents Acta Paed Scand. 1969;49:599-604.
8. Chierici R, Saccomandi D, Vigi V. Dietary supplements for the lactating mother: influence on the trace element content of milk. Acta Paediatr. 1999 Sep;88:7-13.
9. Li JZ, Yoshinaga J, Suzuki T, ABE M, Morita M. Mineral and trace element content of human transitory milk indentified with inductively coupled plasma atomic emission spectrometry. J Nutritional Sci Vitaminol. 1990;36(1):65-74.
10. Björklund KL, Vahter M, Palm B, Grandér M, Lignell S, Berglund M. Metals and trace element concentrations in breast milk of first time healthy

mothers: a biological monitoring study. Environment Health. 2012 Dec;11(1):92.
11. Albert Flynn. Minerals and trace elements in human milk. Adv Food Nutri Res. 1992;36:209-52.
12. Bates CJ, Prentice A. Breast milk as a source of vitamins, essential minerals and trace elements. Pharmacol Therapeut. 1994 Jan 1;62(1-2):193-220.
13. Keenan BS, Buzek SW, Garza C, Potts E, Nichols BL. Diurnal and longitudinal variations in human milk sodium and potassium: implication for nutrition and physiology. Am J Clin Nutr. 1982 Mar 1;35(3):527-34.
14. Krebs NF, Hambidge KM, Jacobs MA, Rasbach JO. The effects of a dietary zinc supplement during lactation on longitudinal changes in maternal zinc status and milk zinc concentrations. Am J Clin Nutr. 1985 Mar 1;41(3):560-70.
15. Picciano MF, Guthrie HA. Copper, iron, and zinc contents of mature human milk. Am J Clin Nutr. 1976 Mar 1;29(3):242-54.
16. Tripathi RM, Raghunath R, Sastry VN, Krishnamoorthy TM. Daily intake of heavy metals by infants through milk and milk products. Sci Total Environm. 1999 Mar 9;227(2-3):229-35.
17. Raghunath R, Tripathi RM, Sastry VN, Krishnamoorthy TM. Heavy metals in maternal and cord blood. Sci Total Environment. 2000 Apr 24;250(1-3):135-41.
18. Iyengar GV, Sansoni B. Elemental analysis of biological materials-Current problems and techniques with special reference to trace elements. Technical Report. IAEA, Vienna. 1980:73-101.
19. Rodriguez-Palmero M, Koletzko B, Kunz C, Jensen R. Nutritional and biochemical properties of human milk: II: lipids, micronutrients, and bioactive factors. Clinics Perinatol. 1999 Jun 1;26(2):335-59.
20. Hannan MA, Faraji B, Tanguma J, Longoria N, Rodriguez RC. Maternal milk concentration of zinc, iron, selenium, and iodine and its relationship to dietary intakes. Biological Trace Element Res. 2009 Jan 1;127(1):6-15.
21. Vuori E, Kuitunen P. The concentrations of copper and zinc in human milk: a longitudinal study. Acta Pædiatrica. 1979 Jan;68(1):33-7.
22. Feeley RM, Eitenmiller RR, Jones Jr JB, Barnhart H. Copper, iron, and zinc contents of human milk at early stages of lactation. Am J Clin Nutr. 1983 Mar 1;37(3):443-8.
23. Moser PB, Reynold RD. Dietary zinc intake and zinc concentration of plasma, erythrocytes and breast milk in antepartum and postpartum lactating and non lactating women: A longitudinal study. Am J Clin Nutr. 1983Jul;38(1):101-8.
24. Vaughan LA, Weber CW, Kemberling SR. Longitudinal changes in the mineral content of human milk. Am J Clin Nutr. 1979 Nov 1;32(11):2301-6.
25. Vuori E, Mäkinen SM, Kara R, Kuitunen P. The effects of the dietary intakes of copper, iron, manganese, and zinc on the trace element content of human milk. Am J Clin Nutr. 1980 Feb 1;33(2):227-31.
26. Khaghani S, Ezzatpanah H, Mazhari N, Givianrad MH, Mirmiranpour H, Sadrabadi FS. Zinc and copper concentrations in human milk and infant formulas. Iran J Pediatr. 2010 Mar; 20(1):53-7.
27. Rajalakshmi K, Srikantia SG. Copper, zinc, and magnesium content of breast milk of Indian women. Am J Clin Nutr. 1980 Mar 1;33(3):664-9.
28. Fransson G, Gabre-Medhin M, Hambreans L. The human milk content of iron, copper, zinc, calcium and magnesium in human milk. J.. Paediatr. 1982;101:504.
29. Garg M, Thirupuram S, Saha K. Colostrum composition, maternal diet and nutrition in North India. J Trop Pediatr. 1988 Apr 1;34(2):79-87.

Cite this article as: Mane SM, Patil NJ, Patharkar SA, Bangar MG. Effect of nutrition on copper and zinc concentrations in human milk. Int J Res Med Sci 2019;7:96-100.