Concentration of Eight Trace Minerals in Milk and Sera of Mother–Infant Pairs in Northern Nigeria

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Summary

Breastmilk from 15 healthy lactating women (21–31 years of age) from the hot, semi-arid sahel of Africa were analysed for copper, iron, zinc, magnesium, manganese, sodium, potassium, and phosphorus. Relative to published data from other populations worldwide, the milk of the Jos women appeared to contain adequate levels of magnesium, manganese, sodium, potassium, phosphorus and iron, but relatively low concentrations of zinc (1.07 μg/ml) and copper (170 μg/l). The sera of the exclusively breastfed infants nursed by these mothers contained levels of all these minerals that are within the international reference range of values. No statistically significant correlation was observed between the level of a particular mineral in the mothers' milk and the sera of their nursing infants.

Introduction

For exclusively breastfed infants, milk must provide them with adequate amounts of all the essential nutrients, including the trace minerals they need for normal growth and development.[1] Although the concentrations of trace minerals are relatively low in blood and human milk, they play a critical role in many physiological processes.[2,3]

Although numerous studies have reported on the nutrient composition of human milk in various populations around the world, little is known about the levels of trace minerals in the milk of women in northern Nigeria.[4]

While most published studies of human milk have sought to compare the contents of various minerals between different populations worldwide or trace changes in the concentrations of these minerals during the course of lactation, few have investigated the relationship between the trace mineral levels in the sera of the mothers and their exclusively breasted infants.[5]

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The present study is part of an ongoing project aimed at evaluating the nutrient quality of milk in West Africa and comparing the result with that of the women who live in other parts of the world.

Subjects and Method

The 15 mother–infant pairs who participated in this study were recruited from the city of Jos and the surrounding villages that are served by the Jos University Teaching Hospital. The age and parity of each mother and the weight of each infant were recorded.

Breastmilk was collected at 6 months of lactation and stored in cryovials at −20°C for 4–6 weeks until they were transported on dry ice to the US for analysis.

The samples were analysed for trace mineral content by ICP-OES using a Spectro-Analytical EOP (end-on-plasma) spectrometer equipped with an ultrasonic nebulizer.

TABLE 1
Characteristics of the study population

	Mean ± 1 SD	Range
Age of mothers	26.2 ± 3.3	21–31
Parity	3.1 ± 1.6	1.0–6.0
Age of infants (months)	6.12 ± 0.26	6.0–6.5
Weight of infant (kg)	7.78 ± 0.84	6.75–10.0

Male/female ratio of infants, 10:5.

TABLE 2
Comparison of the mineral content of human milk from various populations worldwide

	Nigeria/Hausa[a]	Nigeria/Yoruba[b]	Guatemala[b]	Philippines[b]	Zaire[b]	Sweden[b]
Copper (μg/l)	170 (11.0–2040)	279 (103–440)	261 (140–431)	339 (174–430)	199 (119–715)	186 (80–408)
Iron (μg/l)	1510 (70.0–7330)	487 (273–644)	239 (101–1010)	642 (306–1230)	851 (384–1997)	446 (205–1049)
Potassium (mg/l)	424 (300–869)	509 (234–576)	443 (287–537)	534 (333–600)	548 (404–1040)	(397–711)
Sodium (mg/l)	178 (65.5–435)	87 (48–119)	101 (61–158)	118 (69–170)	120 (85–1220)	88 (37–306)
Magnesium (mg/l)	24.9 (202.2–35.5)	32.2 (15.0–39.3)	37.5 (26.3–55.7)	28 (18.6–38.5)	38.9 (24.3–62.5)	34.2 (19.6–59.7)
Manganese (μg/l)	30 (10.0–60.0)	12.2 (4.13–43.3)	3.5 (1.40–70.3)	29.8 (8.42–65.8)	26.16 (7.52–115)	3.23 (1.51–26.1)
Phosphorus (mg/l)	117 (79.1–217)	161 (146–177)	147 (126–164)	317 (137–357)	164 (86–385)	142 (131–150)
Zinc (mg/l)	1.07 (0.067–4.54)	1.86 (0.74–3.50)	4.93 (1.28–10.6)	1.87 (0.91–3.43)	1.68 (0.63–2.90)	0.7 (0.27–1.99)

The numbers in parentheses indicate the range of values.
[a] Values from this study.
[b] Adapted from the WHO/IAEA study.[6]

Results

Table 1 shows the characteristics of the study population. Table 2 shows the comparison of the median values of the mineral contents of human milk from our study and the various populations worldwide. The median values of our study group for potassium, sodium, magnesium, manganese, and phosphorus fell within the range of values found in the milk of other populations. Our zinc value was within the range of values but was at the lower end of the range, and copper was below the values from the comparing population. But our iron value was significantly higher than that from the other populations.

Table 3 shows the comparison of the mineral content of milk and sera of the mother–infant pairs. The levels of manganese and zinc were approximately the same in maternal serum and milk. Copper, iron and sodium were all less concentrated in milk than in maternal serum, whereas, magnesium, potassium, and phosphorus were all more concentrated in milk than in maternal serum. The sera concentrations of the mothers and infants were nearly the same, irrespective of the maternal milk concentration. However, with the exception of iron (where the maternal level was 9.1 per cent higher), the infant's serum level of a particular mineral was always slightly higher than it was in the mother's serum. For instance, infant's serum levels of copper, magnesium, phosphorus, and zinc were 41, 26, 27 and 21 per cent, respectively, greater than the maternal serum levels. The manganese concentration was the same in both maternal and infant's serum (0.03 μg/ml).

Discussion

Using published data from other populations worldwide as a point of reference, the main finding of the present study is that the milk of women who inhabit the high arid Jos Plateau in northern Nigeria, appears to contain adequate concentrations of a number of nutritionally significant minerals, including iron, potassium, sodium, magnesium, manganese, and phosphorus. However, two trace minerals, zinc and copper, were present at relatively low levels in the milk of these women.

Our study also demonstrated that apart from copper and sodium, the other minerals were efficiently accumulated in the milk of these mothers irrespective of

TABLE 3
Comparison of the mineral content of milk and sera of Nigerian mother–infant pairs

	Mother		
Mineral	Serum	Milk	Baby serum
Copper (μg/ml)	1.38	0.43	1.99
Iron (μg/ml)	5.11	2.39	4.58
Magnesium (μg/ml)	15.2	26.1	18.1
Manganese (μg/l)	0.038	0.030	0.043
Phosphorus)μg/ml)	98.1	121	116
Potassium (μg/ml)	393	449	335
Sodium (μg/ml)	5880	215	5898
Zinc (μg/ml)	1.17	1.52	1.64

Mean values of mineral concentrations.

their low serum levels. For example, the breastmilk levels of magnesium and zinc were considerably higher than their serum levels (26.1 v 15.2 μg/l for magnesium and 1.52 vs. 1.17 μg/l for zinc). Whereas ratios of concentrations of copper and sodium in milk and maternal serum were 0.32 and 0.03, respectively.

Another significant finding in our study was that when we plotted the milk level of each of the eight minerals versus the serum level of the corresponding infant of the mother–infant pair, in no instance was a statistically significant correlation found. Thus, given the range of concentrations for eight minerals we found in the milk of the Nigerian women we studied, regardless of the concentration of a particular mineral in their mother's milk, the exclusively breastfed infants were able to obtain adequate amounts of that mineral.

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