

# Serum Zinc and Copper Levels in the Maternal Blood and Cord Blood of Neonates

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**Abstract.** Estimation of serum zinc and copper in the maternal blood and cord blood of neonates was carried out to correlate the trace metals in the neonates and their mothers in relation to gestational age and birth weight. Sixty-five healthy neonates, both term and preterm and their mothers were selected. This cross sectional study was done at Azimpur Maternity Centre, Dhaka Medical College Hospital and Chemistry Division, Atomic Energy Centre, Dhaka, Bangladesh from July 1997 to June 1998. The estimation of trace metals was carried out by Atomic Absorption Spectrophotometry (AAS). The mean serum zinc levels in the maternal blood and cord blood were  $0.47 \pm 0.24 \mu\text{g/ml}$  and  $0.85 \pm 0.33 \mu\text{g/ml}$  respectively and the mean copper levels in the maternal blood and cord blood were  $1.37 \pm 0.62 \mu\text{g/ml}$  and  $0.31 \pm 0.32 \mu\text{g/ml}$  respectively. Cord blood zinc level was significantly higher and cord blood copper level was significantly lower than the corresponding maternal blood levels. There was no significant correlation between gestational age and serum zinc levels in the cord or maternal blood. But significant inverse correlation was found between gestational age and serum levels of copper in the maternal and cord blood. [Indian J Pediatr 2001; 68 (6) : 523- 526]

**Key words :** Zinc; Copper; Cord blood; Maternal blood.

Zinc and copper are among the essential trace metals needed for optimal growth and development. Zinc is needed for tissue synthesis both as a component of new tissue and in the form of zinc metalloenzymes essential for the synthesis of nucleic acids, proteins and hormones such as insulin. It is also important for the structure and function of membranes, metabolism of essential fatty acids and immunocompetence. Copper is known to be a component of a number of copper metalloenzymes and is required for cellular respiration, bone formation, proper cardiac function, connective tissue development, myelination of spinal cord, keratinization and tissue pigmentation.

The major part of body zinc and copper stores of fetus is accumulated during the third trimester of pregnancy. Preterm infants have reduced total zinc and copper stores and may develop deficiency at 3-5 months postnatally.<sup>1</sup> Studies of zinc estimation in older children and zinc and copper estimation in breast milk have been reported from Bangladesh.<sup>2,3</sup> But so far, reports are not available from this country on maternal-fetal serum zinc and copper concentration. The present

study was undertaken to study and correlate serum zinc and copper levels in the maternal blood and cord blood of neonates (both preterm and term) according to gestational age and birth weight.

## MATERIALS AND METHODS

This was a cross-sectional study carried out at the Azimpur Maternity Centre, Dhaka Medical College Hospital and Chemistry Division, Atomic Energy Centre, Dhaka, Bangladesh from July 1997 to June 1998. Sixty-five live healthy newborns delivered at Azimpur Maternity Centre and Dhaka Medical College Hospital and their mothers were studied. The neonates comprised 33 term and 32 preterm infants. Gestational age was determined from maternal dates and Dubowitz scores. Birth weight and sex of each baby was also recorded. Only healthy newborn babies, term and preterm and their mothers were included in the study. Mothers with drugs (such as diuretics, anticonvulsant or anticoagulants) and clinical conditions known to affect the mineral metabolism such as severe malnutrition (BMI <17kg/m<sup>2</sup>), severe anemia, diabetes mellitus, parathyroid, bone and gastrointestinal disease<sup>4</sup> were excluded. Mothers with zinc and copper supplementation during antenatal

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period were also excluded from the study. After detailed explanation of the aim of the study consent was obtained from parents of each baby. Blood was collected directly into trace-element free tubes. Cord blood samples were collected from the placental end of the cord and the maternal blood samples from the peripheral vein immediately after delivery. The whole blood was centrifuged at 3000 rpm for 20 minutes, serum was carefully transferred into polyethylene containers and stored at -20°C until required for analysis. The serum zinc and copper analysis was carried out in the Chemistry Division, Atomic Energy Centre, Dhaka. Deproteinization of serum samples was done and the zinc and copper contents were measured by Atomic Absorption Spectrophotometry (AAS), using an air/acetylene flame with Perkins-Elmer model 3110 spectrophotometer. All precautions were taken to avoid contamination. The reagents and chemicals used were of analytical grade. Data, collected on a predesigned data collection sheet were statistically evaluated using a computerized SPSS software. Student's-t test was applied to find out the 'p' value. Correlation coefficients (r) were calculated in order to assess the impact of different variables upon

serum zinc and copper in cord blood as well as maternal blood. The 'p' value <0.05 was taken as significant.

**RESULTS**

The mean gestational age of term (FT) babies was 39.33 ± 0.48 weeks and mean birth weight was 3.01±0.46 kg. The mean gestational age of preterm (PT) babies was 34.78 ± 1.41 weeks and mean birth weight was 1.92 ± 0.52 kg. The mean serum zinc levels in the maternal and cord blood were 0.47 ± 0.24 µg/ml (0.45±0.27 µg/ml and 0.48 ± 0.21µg/ml in mothers of PT and FT babies) and 0.85 ± 0.33 µg/ml (0.89 ± 0.31 µg/ml and 0.82 ± 0.34 µg/ml in PT and FT babies) respectively. The mean copper levels in the maternal and cord blood were 1.37 ± 0.62 µg/ml (1.57 ± 0.65 µg/ml and 1.17 ± 0.54 µg/ml in mothers of PT and FT babies) and 0.31±0.32 µg/ml (0.41 ± 0.42 µg/ml and 0.21±0.10 µg/ml in PT and FT babies) respectively. Table 1 shows the serum zinc and copper levels in the maternal and cord blood according to gestational age of the babies. Because of a small number of babies, the first two groups, 28-30 weeks and 31-33 weeks were merged

**TABLE 1. Serum Zinc and Copper levels in the Maternal and Cord Blood of Neonates According to Gestational Age**

		Gestational age (weeks)				r value (p value)
		28-33 (n = 3)	34-36 (n=29)	37-39 (n = 22)	37-39 (n = 11)	
Serum zinc (µg/ml) (mean+SD)	Maternal blood	0.40 ± 0.08	0.46 ± 0.29	0.52 ± 0.24	0.42 ± 0.15	0.09 (>0.05)
	Cord blood	0.90 ± 0.47	0.88 ± 0.30	0.83 ± 0.39	0.79 ± 0.24	0.12 (>0.05)
	P value	>0.05	<0.001	<0.001	0.001	
Serum copper (µg/ml) (mean ± SD)	Maternal blood	1.98 ± 0.15	1.52 ± 0.62	1.21 ± 0.61	1.11 ± 0.36	-0.35 (<0.01)
	Coard blood	0.34 ± 0.10	0.42 ± 0.44	0.21 ± 0.11	0.21 ± 0.09	-0.25 (<0.05)
	P value	<0.01	<0.001	<0.001	<0.001	

**TABLE 2. Serum Zinc and Copper levels in the Maternal and Cord Blood of Neonates According to Birth Weight**

		Birth weight (gram)					r value (p value)
		1000-1500 (n=11)	1600-2000 (n=16)	2100-2500 (n=10)	2600-3000 (n=18)	3100-4000 (n=10)	
Serum zinc (µg/ml) (mean±SD)	Maternal blood	0.35±0.18	0.50±0.33	0.54±0.22	0.46±0.19	0.53±0.25	0.16 (>0.05)
	Cord blood	1.03±0.37	0.81±0.25	0.79±0.28	0.83±0.43	0.81±0.14	-0.13 (>0.05)
	P value	<0.001	<0.01	<0.05	<0.001	<0.01	
Serum copper (µg/ml) (mean±SD)	Maternal blood	1.47±0.74	1.67±0.68	1.21±0.65	1.19±0.47	1.26±0.54	-0.21 (>0.05)
	Cord blood	0.63±0.63	0.29±0.18	0.20±0.08	0.21±0.12	0.27±0.11	-0.25 (<0.01)
	P value	<0.01	<0.001	<0.001	<0.001	<0.01	

## Serum Zinc and Copper Levels in the Maternal Blood and Cord Blood of Neonates

together. The level of zinc was significantly higher in the cord blood than in the maternal blood irrespective of gestational age. But there was no significant correlation between gestational age and serum zinc levels in the cord or maternal blood. In contrast to zinc levels, the serum copper level was significantly lower in the cord blood than in the maternal blood irrespective of gestational age. There was also significant inverse correlation between gestational age and serum levels of copper in the maternal and cord blood. Table 2 shows the serum zinc and copper levels in the maternal and cord blood according to birth weight of the babies. On account of a small number babies, the last two groups, 3100-3500g and 3600-4000g were merged together. The level of zinc was also significantly higher in the cord blood than in the maternal blood irrespective of birth weight of the babies but there was no significant correlation between birth weight and serum zinc levels in the cord or maternal blood. Here again the level of copper in the cord blood was significantly lower than in the maternal

TABLE 3. Serum Zinc and Copper levels in the Cord Blood of Preterm and Fullterm babies

	Preterm	Fullterm	p value
Serum zinc ( $\mu\text{g/ml}$ ) mean $\pm$ SD)	0.89 $\pm$ 0.31	0.82 $\pm$ 0.34	>0.05
Serum copper ( $\mu\text{g/ml}$ ) (mean $\pm$ SD)	0.41 $\pm$ 0.42	0.21 $\pm$ 0.10	<0.05

blood irrespective of birth weight of the babies. No correlation was found between birth weight and serum copper level in the maternal blood. Whereas there was significant negative correlation between birth weight and serum copper level in the cord blood of neonates. In Table 3, serum zinc and copper levels of term and preterm babies are compared. There was no significant difference of zinc level between term and preterm babies. But copper level was found to be higher in the preterm than the term babies.

### DISCUSSION

In the present study, cord blood zinc level was significantly higher than the corresponding maternal blood level. The same result was obtained by most of the authors.<sup>5,6,7</sup> Zinc is passively transferred from mother to fetus across the placenta.<sup>8</sup> Possible mechanism of higher level of zinc in the cord blood could be to allow efficient transfer of zinc from mother to fetus, there is decreased zinc binding capacity of

maternal blood during pregnancy.<sup>8</sup> This in turn allows the fetus to capture the zinc for its high enzymatic and other functions related to growth. However, other workers<sup>9</sup> attributed this fall of zinc in the maternal blood to physiological adjustment in response to expanded maternal blood volume. In the present study, there was no significant correlation between serum zinc levels in the maternal and cord blood with gestational age or birth weight. Meadows *et al*<sup>10</sup> and Islam *et al*<sup>7</sup> also reported no difference in zinc status of mothers and babies delivering at or before term. But this is in contrast to the studies of Jeswani and Vani<sup>6</sup> and Kapoor *et al*<sup>11</sup> They found a definite positive correlation between gestational age and serum zinc level in the cord blood whereas a negative correlation was noticed in case of their mothers. In the present study, the finding of no correlation of zinc level with gestational age may be explained by the possibility that rapidly transferred zinc is stored in tissue and get utilized by the growing fetus. The findings of no correlation between maternal and cord zinc status with birth weight of the babies was in agreement with the results found by Islam *et al*<sup>7</sup> and Prasad *et al*<sup>12</sup> Islam *et al*,<sup>7</sup> did not find any association between maternal zinc status and birth weight of the babies. But significant positive correlation was found by others.<sup>5,10,11</sup> In contrast to zinc level, serum copper level was significantly lower in the cord blood than in the maternal blood (4 to 5 times). Similar results were found by other authors.<sup>5,7,13</sup> It is believed that copper can not diffuse across the placenta but accumulates in the layers of the placenta from where it is transferred to the fetus by an active process according to the need. The high maternal copper level in normal pregnancy is a reflection of estrogen level.<sup>14</sup> It was also found that both maternal and cord blood copper levels had significant negative correlation with gestational age of the babies. Wasowicz *et al*,<sup>13</sup> found in their study in Poland that copper concentration in preterm infants was significantly higher than in the fullterm infants. The same has been documented in the present study. The lower concentration of copper in fullterm babies might be due to increased blood volume. Copper level in the cord blood had a significantly negative correlation with birth weight of the babies. This is in agreement with the study by Atinmo *et al*.<sup>5</sup>

The serum levels of zinc and copper in both maternal and cord blood seem to be lower in our sample population compared to the levels found by other authors in their studies.<sup>5,6,7</sup> The zinc levels (mean  $\pm$  SD) found by Islam *et al*,<sup>7</sup> (Hyderabad, India) were 0.87  $\pm$  0.08  $\mu\text{g/ml}$  and 0.84  $\pm$  0.04  $\mu\text{g/ml}$  in mothers of preterm (appropriate for gestational age, PTAGA) and fullterm (appropriate for gestational age, FTAGA)

babies respectively and  $1.37 \pm 0.16 \mu\text{g/ml}$  and  $1.18 \pm 0.05 \mu\text{g/ml}$  in cord blood of PTAGA and FTAGA babies respectively. The values for serum zinc level found by Jeswani and Vani<sup>6</sup> (Ahmedabad, India) were  $1.15 \pm 0.15 \mu\text{g/ml}$  and  $0.96 \pm 0.19 \mu\text{g/ml}$  in mothers of PTAGA and FTAGA babies respectively and  $0.94 \pm 0.17 \mu\text{g/ml}$  and  $1.28 \pm 0.14 \mu\text{g/ml}$  in the cord blood of PTAGA and FTAGA babies respectively. Similarly the serum copper levels found by Islam *et al*,<sup>7</sup> (Hyderabad, India) were  $2.45 \pm 0.17 \mu\text{g/ml}$  and  $2.69 \pm 0.19 \mu\text{g/ml}$  in mothers of PT and FTAGA babies respectively and  $0.59 \pm 0.08 \mu\text{g/ml}$  and  $0.58 \pm 0.05 \mu\text{g/ml}$  in cord blood of PT and FTAGA babies respectively. Atinmo *et al*,<sup>5</sup> at Ibadan, Nigeria found the serum zinc levels of  $2.03 \pm 0.36 \mu\text{g/ml}$  and  $2.21 \pm 0.22 \mu\text{g/ml}$  in mothers of normal birth weight (>2500g) and low birth weight (<2500g) babies respectively and  $0.56 \pm 0.17 \mu\text{g/ml}$  and  $0.60 \pm 0.18 \mu\text{g/ml}$  in cord blood of normal and low birth weight babies respectively.

### CONCLUSION

The present study confirms the nearly universal findings – cord blood zinc level is significantly higher and cord blood copper level is significantly lower than the corresponding maternal level. The serum levels of zinc and copper in both maternal and cord blood seem to be lower in our sample population compared to the levels found by other authors in their studies (different regions/countries). Further research with larger number of samples is needed to get the zinc and copper levels in our population.

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