SERUM IRON, COPPER AND ZINC STATUS IN MATERNAL AND CORD BLOOD

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ABSTRACT

Pregnancy is associated with increased demand of all the nutrients like Iron, Copper, Zinc etc. and deficiency of any of these could affect pregnancy, delivery and out come of pregnancy. With this consideration, the study was conducted on 80 mothers and newborns and 20 age matched control women. Out of 80 mothers, 34 had Iron deficiency anemia and their Hb levels were below 9.0 gm/dl. Pregnant women had significantly lower Iron and Zinc levels while Copper and Total Iron Binding Capacity (TIBC) were significantly higher ($P < 0.001$). Newborns had significantly elevated Iron and Zinc levels and low levels of Copper and TIBC as compared to their mothers irrespective of Iron deficiency anemia. Micronutrient status of newborn was found to be dependent on their mother's micronutrient status. Besides, results also suggest micronutrient interactions, which are reflected in Iron/Zinc, Iron/Copper and Zinc/Copper ratios. In view of this, there is need for proper, adequate and balanced micronutrient supplementation during pregnancy to affect a healthy outcome.

KEY WORDS

Iron, Copper, Zinc, Pregnancy, Newborn, Iron Deficiency Anemia.

INTRODUCTION

Vitamins and Minerals collectively referred to as micronutrients, have important influence on the health of pregnant women and the growing fetus (1). Pregnancy is associated with increased demand of all the nutrients like iron, copper, zinc, vitamin B₁₂, folic acid and ascorbic acid (2) and deficiency of any of these could affect pregnancy, delivery and out come of pregnancy. Iron deficiency results in anemia, which may increase the risk of death from hemorrhage during delivery, however its effects on fetal development and birth outcomes still needs further elucidation (3). It is a common experience that anemia of pregnancy is sometimes not corrected despite Iron supplementation (4), which may be due to underlying deficiency of other micronutrients, which affects pregnancy, childbirth or fetal development (5). Recently Kolesteren *et al.* (6) suggested supplementation of Zinc along with Iron improves hemoglobin level and is beneficial in iron deficiency anemia. RBC zinc proto porphyrin for its strong positive correlation with ferritin, is now considered useful in screening for

Iron depletion and potential risk of anemia (6). Majority of Indian women practice vegetarianism on dictates or compulsion of religion or poverty and consume cereal based diet rich in phytates, oxalates, phosphates, fibers etc. which affect the absorptions of micronutrients like Iron (8) and Zinc (9). In Rajasthan, where this study was conducted, one can expect micronutrient deficiencies due to semi-arid conditions with prevalent vegetarian dietary habits and the situation could be worse in pregnancy, which is vulnerable period for both mother and newborn. In this context present study was conducted to examine serum Iron, Copper and Zinc status in maternal and cord blood.

MATERIAL AND METHOD

The study is based on 80 pregnant women ranging in age from 25 to 39 years (mean 29.8 ± 4.48) and their newborns as well as 20 age matched non-pregnant healthy controls. The subjects selected were among those admitted in maternity wards of Obstetric and Gynecology Department of SMS Medical College & Hospital, Jaipur and controls were volunteers among the staff members of the hospital. The selected subjects were all nonsmoker, lacto-vegetarian, normotensive, within ± 15 percent of ideal bodyweight and not taking any drug for preceding one month except iron and folic acid, which is a part of antenatal care. Patients with any obstetrical abnormalities or diseases

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complicating pregnancy were excluded. Blood samples were collected from antecubital vein of mother at the time of delivery. For the newborn, cord blood was taken from maternal end of umbilical cord to coincide precisely with the newborn's venous blood level. Samples were analyzed for Hemoglobin (10) and Micronutrients. Peripheral Blood Film (PBF) was prepared and stained with Leishmann's stain (11). Iron and TIBC were estimated using kit supplied by Raichem (Raichem, Inc. San Diego, CA) on Merck Selectra auto analyzer. Copper and zinc were measured by atomic absorption spectrophotometry.

Data were statistically analyzed by using student 't' test.

RESULT

Pregnant women had significantly lower ($P < 0.001$) hemoglobin, serum Iron and Zinc levels as compared to non-pregnant women, while serum copper and TIBC were found to be significantly elevated ($P < 0.001$). Hb, serum Iron and Zinc levels estimated in cord blood were found to be significantly elevated as compared to their mothers. But at the same time copper levels were significantly low ($P < 0.001$) in cord blood (Table 1). Out of 80 mothers, 34 were found to have Hb level less than 9.0 gm/dl and their blood film showed hypochromic, microcytic picture with few anisocytes and poikilocytes suggesting iron deficiency anemia of pregnancy. As shown in Table 2 iron deficiency anemia adversely affected maternal zinc and iron levels and interestingly their newborn also had significantly lower levels of zinc and iron as compared to those of non-anemic mothers. While anemic mothers and their newborns had significantly higher levels of copper as compared to non-anemic mothers and their newborns. Results further indicate a strong positive correlation between mother and cord blood levels of iron, copper and zinc (Table 3).

DISCUSSION

Micronutrient interactions are particularly important during pregnancy, when the developing fetus is very vulnerable to inappropriate micronutrient status (12). Further, in developing countries over enthusiastic and uncontrolled supplementation of micronutrients especially Iron during pregnancy could unfavorably affect other micronutrients because of competitive interaction among trace elements (13). In the recent years, there is a tendency to add minerals along with vitamin preparations, which may further exacerbate imbalances. To assess this aspect the study was conducted on 80 pregnant women and their newborns and their blood samples were

Table 1. Serum Iron, Copper and Zinc status of non-pregnant and pregnant women

(Values are Mean $\pm$ SD)

	Non-Pregnant n = 20	Pregnant n = 80	New born n = 80
Hemoglobin (gm/dl)	12.2 $\pm$ 1.9	9.8 $\pm$ 2.7**	14.2 $\pm$ 2.1**
Iron (μ g/dl)	106.9 $\pm$ 20.5	72.7 $\pm$ 7.3**	94.9 $\pm$ 7.2**
TIBC (μ g/dl)	291.3 $\pm$ 38.6	369.8 $\pm$ 32.7*	298.7 $\pm$ 40.2*
% Saturation	36.7 $\pm$ 6.2	19.6 $\pm$ 3.7**	31.2 $\pm$ 6.9**
Zinc (μ g/dl)	100.9 $\pm$ 9.5	70.5 $\pm$ 11.2**	88.7 $\pm$ 9.8*
Copper (μ g/dl)	127.7 $\pm$ 11.1	187.3 $\pm$ 19.9**	101.6 $\pm$ 11.9**
Fe/Zn ratio	1.05 $\pm$ 0.06	1.03 $\pm$ 0.05	1.06 $\pm$ 0.05
Fe/Cu ratio	0.84 $\pm$ 0.04	0.39 $\pm$ 0.04**	0.93 $\pm$ 0.08**
Zn/Cu ratio	0.79 $\pm$ 0.08	0.40 $\pm$ 0.06**	0.87 $\pm$ 0.09**
Statistical Comparison was done between Non-pregnant and pregnant women; Pregnant and newborn; * $P < 0.01$; ** $P < 0.001$.			

analyzed to assess iron, copper and zinc status of pregnant women and their effects on the newborn. The result of the present study indicates that despite routine supplementation of Iron and Folic Acid, pregnant women had significantly low Hb and Iron levels as compared to age matched controls which was either due to reluctant intake or simultaneous intake of food inhibiting iron absorption or increased metabolic demands (Table 1). Decrease in Iron has adversely affected percent saturation of TIBC in pregnant women, which was reduced to 50 percent as compared to non-pregnant women, the values being 20 percent in pregnant women and 37 percent in non-pregnant women. This is perhaps the reflection of metabolic demands created by the fetus for erythropoiesis and fetus draws its full requirement from mother making mother Iron deficient (4). This is also evident from the significantly elevated Hb and Iron levels of

Table 2. Serum Iron, Copper and Zinc status of non-anemic and anemic mothers and their newborns

(Values are Mean $\pm$ SD)

	Non Anemic Group		Anemic Group	
	Mother Hb >9.0gm/dl n=46	Newborn n=46	Mother Hb<9.0gm/dl n=34	Newborn n=34
Hemoglobin (gm/dl)	11.2 $\pm$ 1.6	14.9 $\pm$ 1.9**	7.5 $\pm$ 1.6**	13.1 $\pm$ 1.9**
Iron (μ g/dl)	89.9 $\pm$ 8.3	108.0 $\pm$ 8.9**	37.7 $\pm$ 7.1**	76.7 $\pm$ 8.2**
TIBC (μ g/dl)	327.6 $\pm$ 29.6	288.9 $\pm$ 32.4*	433.6 $\pm$ 61.7**	332.8 $\pm$ 39.3**
% Saturation	27.5 $\pm$ 3.9	38.0 $\pm$ 5.7**	8.7 $\pm$ 2.1**	23.1 $\pm$ 3.4**
Zinc (μ g/dl)	87.6 $\pm$ 8.2	98.6 $\pm$ 9.8*	55.2 $\pm$ 8.8**	61.8 $\pm$ 5.7*
Copper (μ g/dl)	209.8 $\pm$ 17.2	91.8 $\pm$ 11.2**	243.5 $\pm$ 21.2*	122.9 $\pm$ 10.7**
Fe/Zn ratio	1.03 $\pm$ 0.07	1.09 $\pm$ 0.18	0.68 $\pm$ 0.06**	1.24 $\pm$ 0.12**
Fe/Cu ratio	0.42 $\pm$ 0.04	1.17 $\pm$ 0.13**	0.15 $\pm$ 0.02**	0.62 $\pm$ 0.07**
Zn/Cu ratio	0.42 $\pm$ 0.05	1.10 $\pm$ 0.09**	0.23 $\pm$ 0.02*	0.50 $\pm$ 0.04**
Statistical Comparison was done between Non-anemic and anemic mothers; Mother and newborn; * P< 0.01; ** P < 0.001				

Table 3. Correlation between micronutrients of maternal and cord blood

Correlation between Mother - Newborn	Coefficient of correlation (r)	Significance
Iron	+ 0.827	P < 0.001
Zinc	+ 0.612	P < 0.001
Copper	+ 0.706	P < 0.001

newborns as compared to mothers and the levels were all the more higher than non pregnant women. Hb levels estimated in pregnant women varied from 6.0 to 12.5 gm/dl. Examination of Hemoglobin and blood film showed that 34 women (42%) were suffering from Iron deficiency anemia (Hb <9.0 gm/dl) had still lower levels of Iron as compared to those having Hb level above 9.0 gm/dl (Table 2). Despite Iron deficiency in mothers, newborns remained unaffected and their Hb and Iron levels were significantly higher, which indicate selective uptake of Iron by the fetus (14), however levels were low as compared to newborns of non-anemic mothers. The coefficient of correlation (r) between the Iron of mother and newborn was +0.827 (P< 0.001), suggesting that the maternal Iron status

influences the Iron level of newborn and therefore mother with adequate Iron status tend to produce newborns with correspondingly adequate Iron levels.

Interestingly serum zinc levels followed similar trend as Iron and levels were significantly (P<0.001) reduced during pregnancy. However newborns had significantly higher levels of zinc as compared to their mothers irrespective of iron deficiency anemia and found to be controlled by zinc status of mother (r = +0.612; P< 0.001). Similar were the observations of other workers (15, 16). Besides various inhibiting factors in vegetarian diet, over supplementation of Iron during pregnancy could also adversely affect absorption of zinc (17, 18). Zinc is passively transferred from mother to fetus across the placenta (19) and there is also decreased zinc binding capacity of maternal blood during pregnancy which facilitates efficient transfer of zinc from mother to fetus resulting in an increase level of zinc in cord blood. Zinc is essential for proper growth of fetus and the fall in zinc during pregnancy could also be a physiological response to expanded maternal blood volume (20, 21, 22).

Pregnant women had serum copper levels significantly higher as compared to non-pregnant women and also more than their newborns (Table 1) and the levels had further increased in pregnant women with iron deficiency anemia having serum iron level as low as 37.7 μ g/dl (Table 2). Serum

copper level of neonate of anemic mother was also significantly higher than non-anemic mother. The increase of copper in anemic mother could be a compensatory mechanism to counteract anemia and this is accompanied by increased synthesis of ceruloplasmin, which has ferroxidase like activity (8). About 90-95 percent of circulating copper remains as ceruloplasmin and a small fraction is diffusible, which maintains copper level of neonates. Amongst various factors affecting copper level, elevated level of oestrogen during pregnancy also increase the synthesis of ceruloplasmin by making copper available through mobilization from maternal tissues especially liver (19).

In this study the ratio of Fe to Zn levels of mother and newborn indicates that there is a positive correlation between these two micronutrients and their levels are parallel keeping the ratio unaltered. On the contrary the ratio of Fe to Cu and Zn to Cu suggests an inverse correlation between these micronutrients as reported by other workers (23, 24). Fe/Cu and Zn/Cu ratio of mother was found to be almost half of the newborn and non-pregnant women as well (Table 1). However ratio of Fe/Zn was doubled in newborn of anemic mothers (Table 2). There appears to be an intriguing interrelation between copper, zinc and Iron in absorption and utilization. On one-hand supplementation of Iron has been reported to affect bio-availability of zinc and copper in iron deficiency anemia by inter element competition in the bowel, while on the other hand bio-availability of copper and iron is affected by zinc supplementation and the impact is reflected in their blood levels (18, 25, 26). In view of this it becomes important that the judicious supplementation of micronutrients during pregnancy especially in iron deficiency anemia is essential to maintain their optimum blood levels required for the proper growth of the fetus.

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