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A study of serum copper levels and its relation to dietary intake among rural pregnant women in Chengalpattu district, Tamil Nadu

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Abstract

Background: Copper plays a definitive role in normal function and development of the body. Previous studies have shown that suboptimal copper intake during fetal development contributes to occurrence of birth defects in humans. Copper deficiency is more common in pregnancy especially in developing countries like India. Prevalence studies on copper levels in pregnant women in south Indian population are scanty and needs to be evaluated.

Aim: The aim of this study is to assess serum copper levels during pregnancy and its association with dietary intake, socioeconomic status, gestational age and parity.

Materials and methods: This cross sectional study included a total of 54 healthy pregnant women in the rural area of chengalpettu district, Tamil Nadu. A proforma was used to collect a detailed obstetric history and their average daily dietary intake in terms of copper was assessed by using a weekly standardized food frequency questionnaire. Serum Copper level was estimated using colorimetric method.

Results: Serum copper levels were deficient in 3.7% of the study population with mean serum copper levels of 193.93±79.24 µg/dl in study population. The dietary intake of copper was found to be deficient <2 Cu (mg/day) in entire study population. There was statistically significant association between serum copper and maternal age, parity but no significant association between copper levels with respect to demographic characteristics.

Conclusion: Dietary intake of copper needs to be increased by nutrition related counselling given to pregnant women. Larger studies are required to understand the magnitude of copper deficiency among pregnant women in India.

Keywords: Copper deficiency, Pregnancy, Dietary Intake

Introduction

The recent advances in molecular and cellular biology have greatly increased our understanding of the mechanisms regulating normal development yet, the etiology of most of the human developmental defects remains to be elucidated [1]. There is increasing evidence that the origin of a significant number of developmental defects may be because of suboptimal nutrition during embryonic and fetal development. This is important because it suggests that the frequency of birth defects, as well as that of other pregnancy complications, may be reduced significantly through appropriate maternal dietary modifications [1].

Micronutrients needed by our body in very small quantities are very important for normal functioning, growth and development [2]. The inadequate micronutrients resulting in deficiency during pregnancy may give rise to complications in growth and development of foetus [3, 4]. Hence, adequate nutrition during pregnancy plays a vital role for the development of the placenta, for a healthy delivery and successful lactation. Also, females who want to become pregnant, are prone to develop severe deficiencies in micronutrients, with multiple or closely spaced pregnancies [5]. Few observational studies suggest that consumption of micronutrient supplements in pregnancy is associated with higher birth weight and better outcomes [6]. Multiple micronutrient deficiencies are generally found in low socio-economic population [7].

Copper belongs to the transition elements and its excess may promote the intensification of oxidative stress.

Copper (Cu) and zinc (Zn), both are involved in the oxidative balance in division and differentiation of cells, in inflammatory and immune processes and in the activation or inhibition of numerous enzymes.Both are part of the enzyme superoxide dismutase, which is the enzyme for the first line antioxidant defense mechanism [8]. The oxidative stress plays a key role in the development of pregnancy induced hypertension. The involvement of copper and zinc in the oxidative balance suggests their possible association with pregnancy-induced hypertension (PIH) which occurs in 5–10% of pregnant women and increases the morbidity and mortality of mothers and fetuses. This disease includes two main forms: namely gestational hypertension (GH) and preeclampsia (PE) [8].

The clinical risk factors are namely chronic hypertension, multiple pregnancy, primiparity and pre-pregnancy obesity. The disease is characterized by arterial pressure increasing after the 20th week. The abnormal invasion of trophoblasts (in the first half of pregnancy) results in insufficient re-modelling of the spiral arteries, which leads to placental high-resistance circulation and hypoxia. This results in intensification of the production of ROS (reactive oxygen species) and intensification of antioxidant enzymes that protect trophoblast cells against oxidative stress. Hence lower Copper levels may be associated with lower antioxidant activity and higher risk of the disease [8].

Copper is an essential micronutrient required for the formation of enzymes that has important role in pregnancy and other processes within the developing foetus. During pregnancy, many changes occur in serum copper levels and its transport in both mother and the foetus. The serum copper increases in early pregnancy and continues to rise reaching twice the levels found in non-pregnant women at full term. Maternal age does not influence serum copper levels [9].

Although copper deficiency is considered as a major health problem in developing countries like India, there is no precise data available about copper deficiency in rural pregnant women in South India with reference to their dietary intake. This study was done to assess the maternal serum copper levels in rural pregnant women of chengalpettu district and its association with their dietary intake, socioeconomic status, parity and intake of animal food sources.

Materials and Methods

This cross sectional study was conducted on 54 healthy pregnant women attending tertiary care hospital in rural area in Chengalpattu district, Tamil Nadu. Institutional ethical committee approval was obtained. Informed consent was obtained from all the study participants. All the patients were referred to the laboratory after applying inclusion and exclusion criteria in the study.

The Inclusion criteria includes healthy antenatal women attending the OPD of a tertiary care hospital in rural area in chengalpettu district, Tamil Nadu. The exclusion criteria included subjects with severe anaemia (Hb < 7g/dl), Diabetes mellitus, chronic hypertension, seizure disorders, malignancies, infections, infestations, alcohol and drug abuse, twin pregnancies, pre-eclampsia, eclampsia and antenatal bleeding.

Patient's age, obstetric profile, Socioeconomic status along with co-morbidities were collected using a proforma and the average dietary intake per day was calculated using a validated food frequency questionnaire for a week [10].

Serum sample was collected from all the study participants. Serum sample was centrifuged at 3000 rpm for 5 minutes and the serum was analysed for copper by colorimetric method using manufacturer's instructions.

Results

The results are tabulated. Distribution of demographic characteristic among the study participants are tabulated in table1. Association of serum Copper with their demographic characteristic is shown in table 2. Distribution of serum copper levels among the pregnant women is shown in the table 3 (figure 1). Distribution of daily dietary intake of copper nutrient among the pregnant woman is depicted in the table 4. Statistical analysis was performed by using SPSS software. Results were reported as Mean± Standard deviation for quantitative variables. Chi square test was used to evaluate the significance of difference between the two groups. P Value <0.05 was considered as a statistically significant difference.

Mean serum copper levels were 193.93±79.24 µg/dL. Serum copper levels were deficient in 3.7% of the study population. The average daily dietary intake of copper was found to be deficient <2 Cu (mg/day) in the entire study population.

Table 1: Distribution of demographic characteristic among the study participants (N=54)

Sl. No.	Variable	Frequency	Percentage
1	**Age**		
	20-25	28	51.9
	25-30	22	40.7
	30-35	4	7.4
2	**Gestational age**		
	1-12 weeks	4	7.4
	13-26 weeks	23	42.6
	27-37 weeks	25	46.3
	≥ 38 weeks	2	3.7
3	**Parity**		
	0	4	7.4
	1	41	75.9
	2	9	16.7
4	**SES**		
	Low	30	55.6
	Lower middle	19	35.2
	Middle	5	9.3
5	**Type of diet** Veg		
	Non-veg	23 31	42.6 57.4

Table 2: Association of serum Copper with demographic characteristic of the study participants (N=54)

Sl. No.	Variable	(<80 µg/dl) (n= 2)	(80-155µg/dl) (n=13)	(>155µg/dl) (n=39)	p value
1	**Age**				
	20-25	0	7 (53.8)	21 (53.8)	0.001
	25-30	2 (100)	2 (15.4)	18 (46.2)	
	30-35	0	4 (30.8)	0	
2	**Gestational age**				
	1-12 weeks	0	3 (23.1)	1 (2.6)	0.15
	13-26 weeks	2 (100)	5 (38.5)	16 (41)	
	27-37 weeks	0	5 (38.5)	20 (51.3)	
	≥ 38 weeks	0	0	2 (5.1)	
3	**Parity**				
	0	0	3 (23.1)	1 (2.6)	0.05
	1	2 (100)	10 (76.9)	29 (74.4)	
	2	0	0	9 (23.1)	
4	**SES**				
	Low	1 (50)	6 (42.6)	23 (59)	0.82
	Lower middle	1 (50)	6 (42.6)	12 (13.8)	
	Middle	0	1 (7.7)	4 (10.3)	
5	**Type of diet**				
	Veg	2 (100)	8 (61.5)	21 (53.8)	0.51
	Non-veg	0	5 (38.5)	18 (46.2)	

Table 3: Distribution of serum levels of copper among the pregnant women (N=54)

Sl. No.	Analyte	Frequency	Percentage	Mean±SD	Range
1.	Cu (µg/dl)			193.93±79.24	(22,482)
	<80	2	3.7		
	80-155	13	24.1		
	>155	39	72.2		

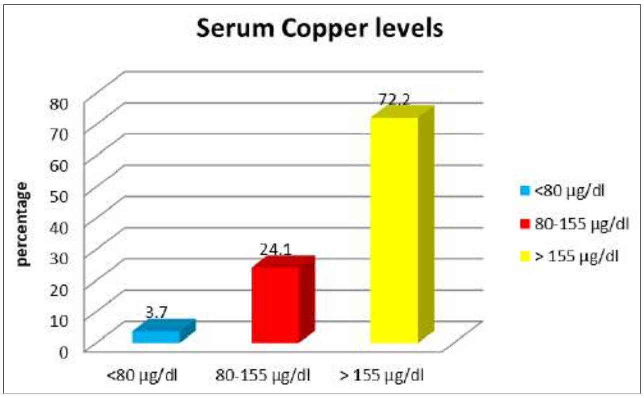

Fig 1: Serum Copper levels among pregnant women (N-54)

Table 4: Distribution of daily dietary intake of copper among the pregnant women (N=54)

Sl. No.	Analyte	Frequency	Percentage	Mean±SD	Range
1.	Cu (mg/day)				
	<2	54	100	.41±0.66	(0-2)
	2-3	0			
	>3	0			

Discussion

The present study was conducted to assess the serum levels of copper and its association with the demographic parameters such as age, gestational age, parity, socioeconomic status and type of dietary intake. Average daily dietary intake of copper was also calculated.

Table 1 shows the demographic characteristics of pregnant women with reference to age, gestational age, parity, socioeconomic status and type of dietary intake. Majority of the women belonged to age group of 20-25 years, gestational age of 27-37 weeks, parity as 1, lower socioeconomic status and non-vegetarian diet. Table 2 shows the association of serum Copper with demographic characteristic of the pregnant women. There is statistically significant association between serum copper levels and maternal age, parity.

Table 3 shows the distribution of serum copper levels (<80, 80-155 & >155 (µg/dl) among the pregnant woman. The serum copper levels in 13 individuals accounting to 24.1% of the study population were in the normal range (80-155 µg/dl). Serum copper levels were found to be deficient (< 80µg/dl) in 2 antenatal women comprising of 3.7% of the total study participants. 39 of the study participants had levels > 155 µg/dl accounting to 72.2% of the study population. Mean levels of serum copper were 193.93±79.24 µg/dl in the study population.

Table 4 show the distribution of daily dietary intake of copper nutrient (<2, 2-3 & >3 Cu mg/day) among the pregnant woman. Lower dietary intake of copper is seen in all patients. There was statistically significant association between serum copper levels with respect to age and parity and no statistical significant association between copper levels with respect to gestational age, socioeconomic status and dietary intake of the pregnant women in the rural area.

Copper found in trace amount in all tissues in the body is an essential nutrient that plays a vital role in the production of hemoglobin, myelin, collagen and melanin. It also helps to make a component of connective tissue by binding with vitamin C. It is an essential co-factor for many enzymes and transported in the blood bound to ceruloplasmin, the rest is bound to albumin, transcuprien and copper amino acid complex [9].

Copper is very important for the normal fetal development. Physiological changes during pregnancy increase serum copper concentration due to increased levels of ceruloplasmin as a result of elevated levels of estrogen and move across the placenta by passive transfer. Deficiency of copper may occur during pregnancy due to low estrogen level, low dietary intake and metabolic defect. Again, low serum copper status in pregnant mother may occur due to severe protein calorie malnutrition, malabsorption states and prolonged diarrhea or gastrointestinal (GIT) disturbance which contributes to the depletion of the hepatic stores of copper. Low serum copper level during pregnancy strongly affects fetal growth as well as length of gestation [9, 11].

The high level of copper found in full term mother is essential for the proper growth of fetus [9, 12]. It has been suggested that high serum Copper concentration during pregnancy might be due to increased binding affinity with ceruloplasmin, increase in ceruloplasmin production, and passive transfer across the placenta [9].

The lower level of hemoglobin in full term mother due to hemodilution suggest the increased synthesis of ceruloplasmin, which has ferroxidase like activity as a compensatory mechanism to counteract anemia. About 90-95% of copper binds with ceruloplasmin and small fraction diffuses through the placenta for maintaining the copper level of neonates [9].

Previous research studies have shown that substantially lower plasma concentrations of copper in pathological conditions diagnosed during the first trimester of pregnancy (spontaneous abortion, threatened abortion, missed abortion and blighted ovum) [13]. No significant differences in maternal plasma copper concentrations have been found in pathological conditions (threatened abortion, preterm delivery and pyelonephritis) diagnosed in the second trimester of pregnancy. Tendencies to higher plasma copper concentrations, however statistically insignificant, can be observed in other pathological conditions during the third trimester (intrauterine growth retardation, preterm labour) [13]. The multi-nutrient supplementation either as food supplements or as pills can significantly reduce the frequency of birth defects and maternal complications. The teratogenic effects of copper deficiency was shown in the previous studies and stated the hypothesis that suboptimal copper nutrition during embryonic or fetal development contributes to the occurrence of some human birth defects.[1]

Conclusion

The study concludes that the average daily dietary intake of copper was found to be deficient in the entire study population but the Serum copper levels were deficient in only 3.7% of the study population. Nutritional counselling on a large scale can be done to all pregnant mothers to raise the awareness of multiple micronutrient supplementation in pregnancy and intake of nutrient dense foods.

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