

DOI: <http://dx.doi.org/10.18203/2320-1770.ijrcog20185427>

Original Research Article

Association of maternal plasma or serum zinc concentration with the birth weight of the child

Girija C. Bellad, Laxmi K. S.*

Department of Obstetrics and Gynecology, Belagavi Institute of Medical Sciences, Belagavi, Karnataka, India

Received: 23 October 2018

Accepted: 28 November 2018

***Correspondence:**

Dr. Laxmi K. S.,

E-mail: researchguide86@gmail.com

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ABSTRACT

Background: Zinc is a divalent cation first isolated in 1509 and since then its importance has been increasingly recognised in human health and nutrition. Present study has been undertaken to confirm the association between maternal plasma or serum zinc concentration and birth weight.

Methods: Present study was cross-sectional study conducted in tertiary care hospital. Newborns with a birth weight of < 2.5kg and their mothers labelled as study group while newborns with a birth weight of > 2.5kg and their mothers were considered as control group. The analysis for the serum concentration of zinc was done using the Atomic Absorption Spectrophotometric method (AAS), this method analytically the most reliable for routine assessment of serum zinc levels. The results deduced from the analysis were accordingly grouped to the study group / control group. We had a sub-group analysis based on the gestational age, as Preterm and Term.

Results: Maternal serum levels of zinc $67.04 \mu\text{g/dl} \pm 16.66$, in the study group, was less as compared to the maternal serum levels of zinc in the control group with a mean level of $75.39 \mu\text{g/dl} \pm 17.89$. The results show a significant association between zinc levels and birth weight. Mean Maternal serum levels of zinc $67.04 \mu\text{g/dl} \pm 16.66$, in the study group, was less as compared to the maternal serum levels of zinc in the control group with a mean level of $75.39 \mu\text{g/dl} \pm 17.89$. The results show a significant association between zinc levels and birth weight.

Conclusions: Present study showed a positive correlation of maternal zinc levels with birth weight and prematurity. Hence, we recommend routine zinc supplementation could be included with other nutritional supplements during pregnancy.

Keywords: Birth weight, Cross-sectional pregnancy, Zinc

INTRODUCTION

Zinc is a divalent cation first isolated in 1509 and since then its importance has been increasingly recognised in human health and nutrition. Zinc is known as one of the life's essential elements because of its vital role in a wide range of biological activities.

Although severe zinc deficiency is now considered rare, mild to-moderate zinc deficiency may be relatively common throughout the world. Women are at increased risk of zinc deficiency during pregnancy because of high fetal requirements for zinc.¹⁻⁴ Severe maternal zinc

deficiency has been associated with poor fetal growth, spontaneous abortion and congenital malformations, whereas milder forms of zinc deficiency have been associated with low birth weight (LBW), intrauterine growth retardation, and preterm delivery.

Importantly, milder forms of zinc deficiency have also been related to complications of labor and delivery, including prolonged or inefficient first-stage labor and protracted second-stage labor, premature rupture of membranes (PROM), and the need for assisted or operative delivery. These complications in turn impair maternal and perinatal health because they lead to

increased risk of maternal infections, fetal distress, stillbirth, neonatal asphyxia, and neonatal sepsis.^{5,6}

Women are at increased risk of zinc deficiency during pregnancy in part because of high fetal requirements for zinc, and maternal zinc deficiency has been associated with poor fetal growth in both animal and human populations.

However, the research relating maternal zinc status and birth weight has not produced consistent results. Majority of these studies were performed in developed countries.⁷⁻¹⁰

Unlike in developed countries, where preterm is the main cause of low birth weight, in developing countries most low birth weight infants are small for gestational age. Low zinc concentrations in the cord blood of low birth weight newborns have been noted in a number of settings and birth weight has been shown to be highly correlated with cord zinc concentration.¹¹

In India, where there is a high incidence of low birth weight, it will be interesting to know the role of zinc in newborn and their mothers in relation to birth weight and gestation, especially when there have been studies suggesting zinc as one of the significant predictors of low birth weight. This study has been undertaken to confirm the association between maternal plasma or serum zinc concentration and birth weight.

METHODS

We conducted a cross sectional prospective study at the Tertiary hospital, over a period of one year.

Inclusion criteria

- Term newborns.
- Preterm newborns.
- IUGR babies.
- Serum samples of Mothers in good health.

Exclusion criteria

- Mothers on drugs (diuretics, anticonvulsants, anticoagulants)
- Mothers with clinical conditions known to affect mineral metabolism such as severe malnutrition, severe anaemia (haemoglobin <10gm %), diabetes mellitus, parathyroid, bone and gastrointestinal diseases.
- The gestational age in present study was calculated using the maternal dates and the Dubowitz scoring. We included 50 newborns with a birth weight of < 2.5kg (included preterm, term IUGR) and their mothers. All the subjects in this group met our inclusion criteria, we labelled this group as the 'Study group'. Similarly, we included newborns with birth weight >2.5 kg and their mothers, who fulfilled

the inclusion criteria, the subjects of this group were labelled as the 'Control group'.

At the time of admission to the labour ward, 2ml of blood was collected from the peripheral vein of the mother after consent; the samples were collected in a sterile EDTA container and labelled, the samples were immediately sent to the laboratory and centrifuged at 3000rpm for 20min. the supernatant serum was collected in a separate sterile polyethylene container and labelled, the sample was stored at -20°C until analysis.

Similarly, the cord blood was collected immediately after the delivery and was sent to the laboratory in sterile EDTA vacutainer with labelling. The cord blood samples were centrifuged at 3000rpm for 20min and the supernatant serum was collected in a sterile polyethylene container and labelled.

The samples were grouped with the maternal samples. The maternal serum samples and the corresponding cord blood samples were labelled as a set and were taken up for analysis.

The analysis for the serum concentration of zinc was done using the Atomic Absorption Spectrophotometric method (AAS), this method analytically the most reliable for routine assessment of serum zinc levels.

Principle of the method

Nitro-PAPS react with zinc in alkaline solution to form a purple coloured complex, the absorbance of which is measured at 575 nm. (Interference from copper and iron are virtually eliminated by ph and chelating additives). The results deduced from the analysis were accordingly grouped to the study group / control group. We had a sub-group analysis based on the gestational age, as Preterm and Term. The results obtained were correlated as per the objective of present study.

Statistical analysis

Statistical analysis was performed using SPSS 16.0 software. Unpaired t-test was used to analyze continuous data. Categorical data was compared using Chi-square test. P <0.05 was taken as statistically significant. Relative risk was calculated for abnormal UA PI, UA RI, UA S/D, MCA PI and cerebral-umbilical PI ratio. Multivariate regression was used to analyze effect of multiple variables.

RESULTS

A prospective study conducted at the tertiary hospital over a span of one year. We had enrolled 200 newborns and the mothers as per our inclusion criteria. In the present study most of the mothers were belongs to age group of 21-25 years and majority of the mother had normal delivery (Table 1).

Table 1: Maternal characteristics.

Mother details	Number
Age of mother (years)	
18-20	14
21-25	96
26-30	68
More than 30	22
Mode of delivery	
Normal	132
LSCS	68
Total	200

The newborns enrolled were randomized into two equal groups based on the birth weight. Newborns with a birth weight of <2.5kg were categorized as the 'study group'. Among the 100 newborns in the study group we had 40 preterm babies and the rest 60 newborns were term IUGR. 100 Newborns with birth weight of >2.5kg were included in the control group; the babies in the control group were term AGA. In present study we found that the mean Maternal serum levels of zinc $67.04 \mu\text{g/dl} \pm 16.66$, in the study group, was less as compared to the maternal serum levels of zinc in the control group with a mean level of $75.39 \mu\text{g/dl} \pm 17.89$. The 'P' value of 0.031 and the Pearson's correlation coefficient (r) of 0.44 was statistically significant. The results show a significant association between zinc levels and birth weight (Table 2).

Table 2: Zinc levels of maternal serum according to birth weight of baby.

Birth weight	Maternal serum-Zinc (ugm/dl)			'P' value
	Min-max	Mean \pm SD	95%CI	
Study group	26-114	67 ± 16.6	61.45-69.24	0.031
Control group	41-146	82.35 ± 19.45	76.6-88.64	

In present study we compared the zinc levels of the cord blood with birth weight of the baby and we found that zinc levels of the cord blood in the control group (mean zinc levels: 82.35 ± 19.45) were significantly higher than the study group (mean: 75.39 ± 17.89).

Table 3: Zinc levels of cord blood according to birth weight of baby.

Birth weight	Cord blood-Zinc (ugm/dl)			'P' value
	Min-Max	Mean \pm SD	95%CI	
Study group	40-124	75.39 ± 17.89	73.12-84.26	0.001
Control group	49-149	82.35 ± 19.45	91.26-101.23	

These differences in the mean values were statistically significant (Table 3).

DISCUSSION

Zinc is a component of a large number of metalloenzymes and there is a high concentration of zinc in the brain. The consequences of zinc deficiency are several with severe impact on human health.⁵ Severe maternal zinc deficiency has been associated with poor fetal growth, spontaneous abortion and congenital malformations (anencephaly), whereas milder forms of zinc deficiency have been associated with low birth weight (LBW), intrauterine growth retardation, and preterm delivery.¹² Importantly, milder forms of zinc deficiency have also been related to complications of labor and delivery, including prolonged or inefficient first-stage labor and protracted second-stage labor, premature rupture of membranes (PROM).²

In present study we found the mean zinc levels in maternal serum in the 'study group': $67 \pm 16.6 \mu\text{g/dl}$, were less as compared to mean values of the 'control group': $82.35 \pm 19.45 \mu\text{g/dl}$. The difference in mean values was statistically significant. The results were in concordance with other studies done by Neggers et al, Crosby et al, Lalita Bahl et al, Maral et al. The results show, zinc levels have a positive association with birth weight and LBW babies had lower levels of zinc, which might be an independent factor influencing birth weight.

We correlated cord blood levels of zinc with the birth weight of the newborns. The mean cord blood levels of zinc in the study group: $75.39 \pm 17.89 \mu\text{g/dl}$, was comparatively less than the control group: $82.35 \pm 19.45 \mu\text{g/dl}$. The difference in values was statistically significant and had a Pearson's correlation value of 0.42. Our results were in conformity with other similar studies done by Lalita Bahl et al, A.S.M Iqbal et al, Jeswani and Vani et al, Elizabeth et al. The researchers in their study found a similar association between cord blood, levels of zinc and low birth weight.^{7,8}

The results of present study show, Low serum zinc is a significant predictor of low birth weight, if the results are replicable, they will have important implications for both the prediction of low birth weight and possibly the prevention of low birth weight.

CONCLUSION

Authors in present study found the following observations: The maternal serum zinc levels were significantly higher in the control group as compared to the study group. The cord blood levels of zinc were significantly higher in the control group as compared to the study group. Present study showed a positive correlation of maternal zinc levels with birth weight and prematurity. Hence, we recommend routine zinc supplementation could be included with other nutritional

supplements during pregnancy. This might help reduce the incidence of prematurity and low birth weight.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Bellad GC, Laxmi KS. Association of maternal plasma or serum zinc concentration with the birth weight of the child. *Int J Reprod Contracept Obstet Gynecol* 2019;8:219-22.