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The role of maternal and fetal serum zinc level in low birth weight

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Abstract

Background: there are many micronutrients deficiencies in the developing countries, one of the most common is a Zinc deficiency.

Aims: To assess the effect of low serum zinc level on mother and newborn

Patients and Methods: A cross-sectional study that was conducted in the labor ward of AL Yarmouk Teaching hospital in Baghdad, Iraq for a period of 12 months from September 2014 to the September 2015. The data and blood samples were collected from the mother and their babies within the first day of delivery; Serum zinc is low if the level is less than 50 (μg/dL) as the cutoff point, and the level of 50–77 (μg/dL) is categorized as normal.

Results: it was found that each of preterm and term (low birth weight) neonates has lower serum zinc level as compared to term and preterm neonates with (normal birth weight) of more than 2.5 Kg.

Conclusion: Serum Zinc is significantly lower among low birth weight neonates in comparison to normal weight newborn. In addition, the maternal serum zinc level of LBW newborns is significantly lower than that of normal weight newborns mothers and a decrease in maternal serum zinc level is associated with the low birth weight.

Keywords: zinc, growth, lower birth weight

INTRODUCTION

Regardless of the gestational age, any liveborn infant of a body weight less than 2.5 kg is defined as low birth weight. Low birth weight (LBW), causes an increased rate of death and complications in later years of life. Low birth weight (LBW) is considered a crucial and substantial factor contributing to infant mortality. Infants with LBW are at increased risks for long-term disability and various physical morbidities (1). The genetic growth potential and the growing support will both affect the fetal growth. Healthy mothers during pregnancy, who do not have any nutritional deficiencies or chronic diseases in their early years of life will have normal body weight and healthy infants as compared to mothers with such problems(2). Zinc is one of the essential trace elements whose importance to human health is increasingly being recognized. It is crucial for the activity of metalloenzymes involved in the synthesis of (RNA polymerase), deoxyribonucleic acid (DNA polymerase) and protein (thymidine kinase) (3). In addition to poor dietary supplements which is the usual cause of Zinc deficiency, many factors can lead to that problem such as chronic diseases such as diabetes, malabsorption liver disease, sickle cell disease and malignancy. Growth suppression, anemia and anorexia are also associated with zinc deficiency, (4). Zinc deficiency leads to growth failure through its negative effect on the endocrine system. The association between low serum zinc and low birth weight newborns was found in many studies of both human and animal groups (5). Once it occurs during pregnancy, zinc deficiency will affect the immune system leading to growth retardation in infants. Zinc was found to affect the activity of IGF-I in the formation of osteoblasts so that it is essential for the regulation of bone growth. Postnatal growth requires many enzymes and growth hormones such as placental alkaline phosphatase which enhances the synthesis of DNA and cell proliferation in pregnancy, all of these factors require zinc during pregnancy (6). Zinc one of the elements which has an essential role in the living system. Since its discovery as an important micronutrient, it was found to affect many processes. such as the nucleic acid metabolism, enzyme function, apoptosis and cell signaling. Lipid metabolism, growth and development of immune and brain function all require Zinc as an important element .(7)

PATIENTS AND METHODS

Study design

The study was a cross-sectional design, conducted in the labor ward of AL-Yarmouk Teaching hospital in Baghdad, Iraq. the study duration was from September 2014 to September 2015. The study was approved by the Ethics Committee of Medical college, Al-mustansyria University, Iraq.

Population and sample

The study population includes the parturient mothers attending hospital for delivery. The samples were taken randomly from the mothers who agreed to sign the informed consent. 150 women and their babies participated in the study. The criteria for inclusion were the mothers not in high-risk conditions such as diabetes mellitus, hypertension, eclampsia, and carrying singleton viable fetus at any maternal age, cervical dilatation more than 3 cm with effacement.

Data collection

The data was collected from mother including name, age, parity, employment, smoking, family history of low birth weight, the first day of last menstruation, history of vitamin and zinc intake and blood zinc, and from newborn is gender, weight, and physical examination. The Gestational age was determined from the first day of last menstruation, prenatal ultrasonography. Low birth weight means the baby with a birth weight of 2500 gram or less, and preterm denotes the gestational age of completed 37 weeks.

Zinc measurement

for the purpose of the zinc level measurement in mother, the blood specimen was taken from mothers' peripheral vein on the time prior to delivery in the hospital. Peripheral venous samples (2 ml) were taken from their newborn soon after delivery; each sample was put in a sterile container and labeled. Centrifugation at 3000 rpm for 20 min was done to each sample and the supernatant serum was collected in a separate sterile polyethylene container and was stored at -20°C until analysis. An atomic absorption spectrometer was used to measure the serum zinc (8). Serum zinc is low if the level is less than 50 (μg/dL) as the cutoff point, and the level of and above 50–77 is categorized as normal or adequate level.

Statistical analysis

The data was analyzed using the available statistical package of SPSS-22 (Statistical Packages for Social Sciences- version 22). Data were presented in simple measures of frequency, percentage, mean, standard deviation, and range (minimum-maximum values). The significance of the difference between different means (quantitative data) was tested using Students-t-test for the difference between two independent means or ANOVA test for difference among more than two independent means. Pearson correlation was calculated for the correlation between two quantitative variables with its t-test for testing the significance of correlation. The correlation coefficient value (r) either positive (direct correlation) or negative (inverse correlation) with value <0.3 represent no correlation, 0.3-<0.5 represent weak correlation, 0.5-<0.7 moderate strength, >0.7 strong correlation. In addition to correlation the r^2 was calculated (The coefficient of determination), i.e. when the value of r=0.58, then r^2=0.34, this means that 34% of the variation in the values of y may be accounted for by knowing values of x or vice versa. Statistical significance was determined according to the P value whether equal to or less than 0.05.

RESULTS

150 pregnant ladies of at least 28 weeks of gestation were included in the study. All of them were diagnosed to have active labor, the data taking from them shown in the table (1) which including the mode of delivery was (54 %) by CS and (46%) by NVD. The mean birth weight of baby (2.67±0.73) (Kg) and the range were between (1.5-3.9 Kg). While the mean parity was (2.8±1.0) and the range was (1-4) & the mean gestational age was (37.9±2.8) weeks and the range was (32-42). The mean maternal zinc level in patients was (75.32±18.28). The mean Neonatal Zinc level was (67.24±19.21). The percentage of patient with a history of vitamin intake was 39.3% and the percentage of patient with a history of zinc supplementation was 27.3% as seen below (table 1). A significant indirect correlation between maternal and neonatal zinc level and parity, gestational age, birth weight. We found significant positive (direct) correlation between neonatal zinc level and maternal zinc level with significant p-value as seen in table 2.

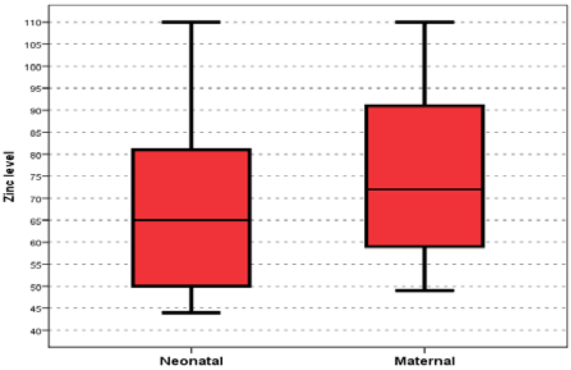

Figure 1: The distribution of zinc level in maternal and neonatal serum

The range of neonatal zinc level between (44-110) and the maternal zinc level between (49-110) as shown in figure no.1. No significant difference was seen in each of the modes of delivery, the gender of the baby, vitamin intake regarding the neonatal and maternal serum zinc level. While regarding parity, gestational age, birth weight and zinc supplement, there was a significant difference between the neonatal and maternal zinc level since the p values <0.05. As seen below (table 3). The study also revealed that for each of term low birth weight term and preterm neonate the maternal and neonatal serum zinc level is lower in comparison to term neonates whose birth weight is more than 2.5 Kg. as shown in table 4

Table 1. The characteristics of the study groups in relation to different parameters

		Mean±SD (Range) -No (%)
Parity		2.8±1.0 (1-4)
Mode of delivery	CS	81 (54.0%)
	NVD	69 (46.0%)
Gestational age (weeks)	32-37	61 (40.7%)
	>37	89 (59.3%)
Mean GA±SD (Range)		37.9±2.8 (32-42)
Gender	Male	77 (51.3%)
	Female	73 (48.7%)
Birth weight (Kg)	<2.0	29 (19.3%)
	2.0---<2.5	41 (27.3%)
	=>2.5	80 (53.3%)
Mean±SD (Range)		2.667±0.732 (1.500-3.900)
Neonatal Zinc level(μg/dL)		67.24±19.21 (44-110)
Maternal Zinc level(μg/dL)		75.32±18.28 (49-110)
Vitamin intake		59 (39.3%)
Zinc supplementation		41 (27.3%)

		Mean±SD (Range) -No (%)
Parity		2.8±1.0 (1-4)
Mode of delivery	CS	81 (54.0%)
	NVD	69 (46.0%)
Gestational age (weeks)	32-37	61 (40.7%)
	>37	89 (59.3%)
Mean GA±SD (Range)		37.9±2.8 (32-42)
Gender	Male	77 (51.3%)
	Female	73 (48.7%)
Birth weight (Kg)	<2.0	29 (19.3%)
	2.0---<2.5	41 (27.3%)
	=>2.5	80 (53.3%)
Mean±SD (Range)		2.667±0.732 (1.500-3.900)
Neonatal Zinc level(μg/dL)		67.24±19.21 (44-110)
Maternal Zinc level(μg/dL)		75.32±18.28 (49-110)
Vitamin intake		59 (39.3%)
Zinc supplementation		41 (27.3%)

Table 2 -The correlation of Neonatal and Maternal Zinc level to another factor

		Neonatal Zinc level	Maternal Zinc level
Parity	*r*	-0.167*	-0.221**
	P	0.041	0.007
Gestational age (weeks)	*r*	0.485**	0.497**
	P	0.0001	0.0001
Birth weight (Kg)	*r*	0.651**	0.756**
	P	0.0001	0.0001
Neonatal Zinc level	*r*		0.668**
	P		0.0001

**Correlation is significant at the 0.05 level **Correlation is significant at the 0.01 level*

Table 3 -The distribution of maternal and neonatal zinc level according to statistical characteristics

		Neonatal Zinc level		Maternal Zinc level	
		No	Mean±SD (Range)	No	Mean±SD (Range)
Parity	P1	19	65.79±15.13 (45-100)	19	80.37±19.64 (52-107)
	P2	39	73.79±19.63 (44-110)	39	78.13±15.11 (52-109)
	P3	46	68.52±20.16 (44-108)	46	77.65±19.32 (49-110)
	P4 & more	46	61.00±17.84 (44-101)	46	68.52±17.78 (49-109)
	P value		0.020*		0.022*
Mode of delivery	CS	81	65.35±19.38 (44-110)	81	73.81±18.18 (49-110)
	NVD	69	69.46±18.90 (44-108)	69	77.09±18.38 (49-109)
	P value		0.192		0.276
Gestational age (weeks)	32-37	61	57.25±16.37 (44-108)	61	65.87±16.81 (49-109)
	>37	89	74.09±18.03 (45-110)	89	81.80±16.40 (49-110)
	P value		0.0001*		0.0001*
Gender	Male	77	66.65±20.39 (44-109)	77	74.47±17.93 (49-110)
	Female	73	67.86±18.00 (44-110)	73	76.22±18.73 (49-109)
	P value		0.700		0.559
Birth weight (Kg)	<2.0	29	49.76±7.14 (44-73)	29	58.66±5.23 (49-69)
	2.0---<2.5	41	52.83±9.05 (44-82)	41	58.78±6.10 (49-70)
	=>2.5	80	80.96±15.02 (60-110)	80	89.84±12.03 (57-110)
	P value		0.0001*		0.0001*
Vitamin intake	Yes	59	64.98±19.31 (44-110)	59	72.27±18.28 (49-109)
	No	91	68.70±19.10 (44-105)	91	77.30±18.11 (50-110)
	P value		0.248		0.100
Zinc supplementation	Yes	41	61.54±17.05 (44-108)	41	69.39±16.90 (49-109)
	No	109	69.39±19.60 (44-110)	109	77.55±18.36 (49-110)
	P value		0.025*		0.014*

*Significant difference using Student-t-test for two independent means or ANOVA for more than two independent means at 0.05 level

Table 4: The relationship between birth weight and gestation age according to neonatal and maternal serum zinc

		Neonatal Zinc level		Maternal Zinc level	
		Low (<60)-No (%)	Normal (=>60)-No (%)	Low (<60)	Normal (=>60)
Birth weight (Kg)	LBW(70)	53(88.4)	17 (18.9)	42 (97.7)	28 (26.2)
	=>2.5(80)	7(11.6)	73 (81.1)	1(2.3)	79 (73.8)
P value		0.001*		0.001*	
Weeks of gestation	32-37(61)	44 (73.3)	17 (18.9)	31 (72.1)	30 (28.0)
	>37(89)	16 (26.7)	73 (81.1)	12(27.9)	77 (72.0)
P value		0.0001*		0.0001*	
Preterm(61)	LBW	44(91.7)	5(38.5)	31(91.2)	18(66.7)
	>2.5	4(8.3)	8(61.5)	3(8.8)	9(33.3)
P value		0.001*		0.001*	
Term (89)	LBW	16(66.7)	5(7.7)	11(84.6)	10(13.2)
	>2.5	8(33.3)	60(92.3)	2(15.4)	66(86.8)
P value		0.001*		0.001*	

DISCUSSION

This study demonstrated that the serum zinc concentration (µg/l) of mothers who delivered infants with a low birth weight significantly lower than mothers with normal birth weight and even there is an association of this deficiency of serum zinc in their neonate (p<0.0001). This is also found by Jyotsna et al [6], Ashraf et al [9] and Elizabeth et al [10]. The results of the current study confirm the findings of many researchers around the world who found a positive correlation between maternal serum zinc and birth weight Rwebembera et al [11], Danesh A et al [12], Naher K et al [13] and Nazari M et al ([14]

All of them found that the maternal serum zinc level of LBW neonates is lower in comparison to serum zinc in mothers of normal birth weight neonates.

Our results showed that zinc level increase with increasing gestational age as shown by. Izquierdo et al [15]. The zinc deficiency found could be related to the increased plasma volume, increased requirements and poor intake or bio-absorption [16]. The nutritional status that lacks prior to pregnancy and low serum zinc levels may be the causative of low serum zinc levels during pregnancy [16]. In the current study, the high prevalence of zinc deficiency was seen among pregnant women was inadequate for vitamin deficiency but there is significantly different with zinc intake as found by Naher K et al [13]

Our study showed that the higher the parity of the women the lower their serum zinc levels this is also found by Paul et al [17] and Jyotsna et al [6].

We also found that for both term LBW and preterm infants the serum zinc is lower compared to the term normal birth weight baby, this is similar to what found by Jyotsna et al [6].

CONCLUSION

We conclude that significant zinc deficiency occurs in low birth weight neonates more than of normal birth weight and term neonates. In addition, the serum zinc level of mothers of LBW neonates is significantly lower those who delivered neonates appropriate for gestational age. and a positive correlation was found between decreased serum zinc level of the mothers and low birth weight.

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