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Original Research Article

Association of maternal serum zinc status with neonatal birth weight

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ABSTRACT

Background: Zinc, a vital micronutrient, plays a significant role in cellular growth and immune function. Insufficient maternal zinc levels can impact fetal growth, leading to low birth weight, a risk factor for neonatal morbidity and mortality. The aim of this study was to evaluate the association of maternal serum zinc status with neonatal birth weight.
Methods: This case-control study was conducted in Department of Obstetrics and Gynaecology of Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladeshfrom November 2019 to October 2021. A total of 60 women in their postnatal period were included in this study among which 30 women having a baby weighing < 2.5 kg were considered as the cases and 30 women having babies weighing ≥ 2.5 kg were enrolled as the controls.
Results: In the present study, none of the socio-demographic characteristics in both case and control groups were statistically significant (p > 0.05). Mean BMI was 23.88±1.36 kg/m2 in cases and 24.39±1.39 kg/m2 in controls, with 16.7% of cases overweight (p>0.05). Cases had lower maternal serum zinc (58.33±27.63 mcg/dL) than controls (82.96±16.94 mcg/dL), significantly affecting neonatal birth weight (p=0.001, r=+0.406). Low zinc levels (<68 mcg/dL) increased the risk of birth weight <2.500 Kg by nearly six times (OR 5.67, 95% CI 1.84-17.49; p=0.002).
Conclusions: From the findings, it can be concluded that serum zinc status is associated with the birth weight of the neonates. Low serum level of zinc is related to neonatal LBW.

Keywords: Association, Maternal serum zinc status, Neonatal birth weight

INTRODUCTION

Birth weight is the first weight of the baby at delivery, which is a strong predictor of prenatal growth and new-borns future chances of survival and is dependent on maternal health and nutrition during pregnancy.[1] Low birth weight (LBW) is defined as a birth weight of less than 2500 grams (up to and including 2499 grams). Compared to normal birthweight infants, LBW neonates experience increased morbidity, including acute neonatal complications as well as childhood stunting and risk of adult-onset chronic conditions (e.g. cardiovascular disease).[2] LBW continues to be one of the most important causes of death during the first year of life in both developed and developing countries. In Bangladesh, nearly half of newborns are not weighed at birth. According to the Multiple Indicator Cluster Survey (MICS) 2019, the percentage of children weighed at birth is only 52% in Bangladesh.[3] The mean birth weight of infants in Bangladesh was recorded as 2,898 gm, average for boys was higher than girls and average weight more in non-slum than slum newborns. The LBW rate was 22.6% and more among girls and in slums.[4] Pregnancy is a period of fetal growth and development which necessitates an increase in nutrients.[5] Maternal micronutrients especially zinc deficiency are one of the contributing factors for the higher incidence of FGR and LBW neonates in developing countries.[6] The estimated average requirement of zinc

during pregnancy ranges from 10.0 to 12.0 mg/day.[7] Zinc deficiency is one of the common micronutrient deficiencies in developing countries, where multiple micronutrient deficiencies often present concomitantly as a result of diets with limited diversity, poor bioavailability, and limited micronutrient content, in addition to poor hygiene and infections.[8] Serum zinc is considered the best biochemical indicator of zinc status in a population. A major consideration for use of serum zinc is the fact that it is a negative acute phase reactant, and therefore declines in response to inflammation.[9] Reference ranges is defined as 70 - 120 µg/dL, while the values lower than 70 µg/dL is defined as zinc deficiency.[10] Zinc deficiency affects around 17% of the world's population but mainly embraces sub-Saharan Africa and South Asia.[11] Zinc is intimately linked to bone metabolism, thus, zinc acts positively on growth and development. Zinc concentration in bone is very high compared with that in other tissues, and it is considered an essential component of the calcified matrix. Zinc also enhances vitamin D's effects on bone metabolism through the stimulation of DNA synthesis in bone cells.[12] Moreover, an optimum level of zinc concentration helps in the secretion of the growth hormone.[13] Severe maternal zinc deficiency has been associated with poor fetal growth, spontaneous abortion, and congenital malformation. Whereas milder forms of zinc deficiency have been associated with LBW, fetal growth restriction, and preterm delivery. Maternal complication includes pregnancy-induced hypertension, pre-eclampsia, intrapartum hemorrhage, infection, and prolonged labor.[14] Maternal nutrition, therefore, is an important factor for fetal development and pregnancy outcome including birth weight. Particularly the babies born with low birth weight remain vulnerable to which many researchers have found a correlation with maternal zinc deficiency, while others didn't.[14-16] Therefore, considering the inconsistent previous study findings, the current study on maternal serum zinc status in pregnancy might clarify its potential relationship with birth weight.

METHODS

This case-control study was conducted in Department of Obstetrics and Gynaecology of Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, during the period from November 2019 to October 2021. A total of 60 women I at their 37-40 weeks of gestation were included in this study among which 30 women who had just given birth to a baby weighing <2.5 kg were considered as the cases and the rest of the 30 women who delivered babies weighing ≥2.5 kg were enrolled as the controls. In this study, controls were taken matched with the cases for their age (±3 years) and gestational age. Women with multiple gestation, pre-existing hypertension, chronic renal failure or cardiovascular disease were excluded. Ethical clearance for the study was taken from the Institutional Review Board and concerned authority, Bangabandhu Sheikh Mujib Medical University (BSMMU).

The reference range for normal serum zinc level is 68–107 mcg/dL. Maternal zinc level is considered as low if the serum level is <68 mcg/dL. Thorough clinical examination was done in all the subjects. Blood (5ml) was collected from the antecubital vein of the mothers immediately after giving birth using a sterile needle and syringe. Then samples were sent for analysis in the laboratory of the Department of Biochemistry and Molecular Biology, BSMMU. Serum zinc concentration was measured using a fully automated Thermo Scientific™ Indiko™ Plus Clinical Chemistry Analyzer (Thermo Scientific, USA) using a colorimetric method.

Data were collected with informed written consent from the patients on variables of interest using the semi-structured questionnaire designed for the interview, observation, clinical examination, hematological investigations of the patients. For each subject, a separate data sheet was used.

Statistical analysis

Data were analyzed by using the latest version of SPSS software (v 27.0). The birth weight of the neonates was measured immediately after birth (within hours) without any clothing by the electronic baby weighing scale. Maternal serum zinc level was categorized based on the cut off value. To understand the relationship between case and control variables Pearson's correlation coefficient (r) test was done. The strength of association was determined by estimating the odds ratio (OR) and their 95% confidence interval (CI). The p-value <0.05 was considered statistically significant.

RESULTS

Table 1 exhibits thecomparison of socio-demographic characteristics between case and control groups. In this present study, it was observed that half (50.0%) of the cases and three-fifths (60.0%) of the control group of respondents aged were between 21-29 years. But these differences in distribution were statistically not significant (p=0.714). Educational qualification up to secondary school certification was observed in 53.3% of the cases and 46.7% in the control group of respondents. In regards to participants' occupations, homemakers comprised 73.3% of the cases and 66.7% of the control group of respondents (66.7%). Majority of the participants monthly family income was 10,000-25,000 Tk (cases: 63.3% vs. controls: 70.0%). None of these differences in the distribution of respondents according to their socio-demographic characteristics in both case and control groups were statistically significant (p>0.05).

Table 2 shows the Distribution of the study subjects according to their obstetrical characteristics by group. The gestational age of the respondents was taken matched in this study where there mean (±SD) gestational age in the cases was 39.00±0.83 weeks and in the control group was

38.87±0.86 weeks, which was statistically non-significant (p=0.544).

Table 1: Distribution of the respondents according to socio-demographic characteristics by group (case = 30, control = 30).

Socio-demographic variables	Case (N=30) (%)	Control (N=30) (%)	P-value
Age (in years)			
< 20 years	8 (26.7)	7 (23.3)	0.714[a]
21-29	15 (50.0)	18 (60.0)	
30-35	7 (23.3)	5 (16.7)	
Education qualification			
S.S.C.	16 (53.3)	14 (46.7)	0.871[a]
H.S.C	9 (30.0)	10 (33.3)	
Above H.S.C.	5 (16.7)	6 (20.0)	
Occupation			
Housewife	22 (73.3)	20 (66.7)	0.107[a]
Student	2 (6.7)	4 (13.3)	
Service holder	6 (20.0)	6 (20.0)	
Monthly family income (in BDT)			
10,000-25,000 Tk.	19 (63.3)	21 (70.0)	
> 25,000 Tk.	11 (36.7)	9 (30.0)	

[a]Chi square test was done to measure the level of significance

Table 2: Distribution of the study subjects according to their obstetrical characteristics by group (case=30, control=30).

Obstetrical characteristics	Case (N = 30) (%)	Control (N = 30) (%)	P-value
Gestational age (in weeks)			
Mean±SD	39.00±0.83	38.87±0.86	0.544[c]
Gravida			
Primigravida	15 (50.0)	17 (56.7)	0.760[a]
Multigravida	15 (50.0)	13 (43.3)	

[a]Chi square test was done to measure the level of significance.
[c]Unpaired t test was done to measure the level of significance

Table 3: Distribution of the study subjects according to BMI by group (case = 30, control = 30).

BMI (kg/m^2)	Case (N = 30) (%)	Control (N = 30) (%)	P-value
Normal (18.5 - 24.9)	25 (83.3)	19 (63.3)	0.760[a]
Overweight (25.0-29.9)	5 (16.7)	11 (36.7)	
Mean±SD	23.88±1.36	24.39±1.39	0.156[c]

[a]Chi square test was done to measure the level of significance
[c]Unpaired t test was done to measure the level of significance

Table 3 presents the distribution of the study subjects according to BMI by group. In this study, the mean body mass index (BMI) of the case and control group of respondents were 23.88±1.36 and 24.39±1.39 kg/m^2, whereas only 16.7% of the cases were observed overweight. These were not statistically significant (p>0.05).

Table 4 demonstrates the distribution of mean (±SD) maternal zinc level by group. Lower maternal serum zinc level was observed in the cases (58.33±27.63 mcg/dL) compared to the control group of respondents (82.96±16.94 mcg/dL), which was statistically highly significant (p=0.001).

Table 4: Distribution of mean (±SD) maternal zinc level by group (case=30, control = 30).

Maternal serum zinc level (mcg/dL)	Case (N = 30)	Control (N = 30)	P-value
Maternal serum zinc leve	58.33±27.63	82.96±16.94	0.001[c]

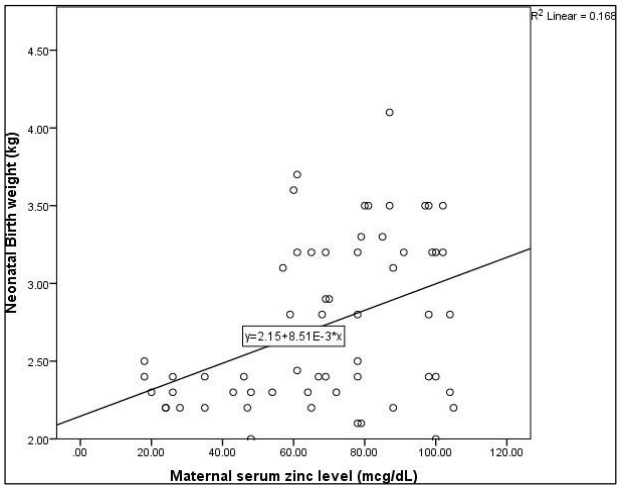

Figure 1: Scatter plot diagram showing correlation between maternal serum zinc level and neonatal birth weight (r=0.406, p=0.001).

Figure 1 shows the Scatterplot diagram showing correlation between maternal serum zinc level and neonatal birth weight. Maternal serum zinc level was found positively correlated with neonatal birth weight (r=+0.406, p=0.001).

Table 5 represents the Odds ratios (OR) and 95% confidence intervals (CI) for neonatal birth weight according to serum zinc level in pregnancy. The risk of birth weight of <2.500 Kg was almost six times (OR 5.67, 95% CI 1.84-17.49; p=0.002) more with low maternal serum zinc levels (< 68 mcg/dL).

Table 5: Odds ratios (OR) and 95% confidence intervals (CI) for neonatal birthweight according to serum zinc level in pregnancy (case = 30, control = 30).

Maternal serum zinc level (mcg/dL)	Case (N = 30) (%)	Control (N = 30) (%)	P-value	Odds ratio	(95% CI)
< 68 mcg/dL	19 (63.3)	7 (23.3)	0.002[a]	5.67	1.84-17.49
≥ 68 mcg/dL	11 (36.7)	23 (76.7)			

[a]Chi-square test was done to measure the level of significance

DISCUSSION

This case-control study was carried out to compare the maternal serum zinc level in women given birth of low birth weight (<2.5 kg) neonates with women given birth of normal weight (≥2.5 kg) neonates, and to find out its association with occurrence. A total of 60 singleton pregnant women at their third trimester between 37 and 40 weeks of gestation given birth to neonates were included in this study. The study population was divided into case and control groups depending on the neonatal birth weight. Mothers who gave birth to a neonate weighing below 2.5 kg were the cases (n=30). Mothers who had given birth to a neonate weighting ≥ 2.5 kg were considered the controls (n=30), who were matched based on age 18-35 years and gestational period were enrolled in this study. In this present study, it was observed that half (50.0%) of the cases and three-fifths (60.0%) of the control group of respondents aged were between 21-29 years. But these differences in distribution were statistically not significant (p=0.714). Educational qualification up to secondary school certification was observed in 53.3% of the cases and 46.7% in the control group of respondents. In regards to participants' occupations, homemakers comprised 73.3% of the cases and 66.7% of the control group of respondents (66.7%). Majority of the participants monthly family income was 10,000 – 25,000 Tk (cases: 63.3% vs. controls: 70.0%). None of these differences in the distribution of respondents according to their socio-demographic characteristics in both case and control groups were statistically significant (p>0.05). These findings were consistent with the study of Wang et al.[17] They demonstrated that majorities belonged to the 25-29 years age group in maternal zinc level deficient and sufficient group, 60.7% and 62.9% respectively. Similarly, middle-income participants were 49.8% in the maternal zinc deficiency group and 52.3% in the adequate respondents. No significant difference in the mother's age, BMI before pregnancy, and monthly income per person was observed between the two groups. While Rwebembera et al conferred that maternal age of <19 years was associated with low infant birth weight and low maternal zinc levels.[18] The gestational age of the respondents was taken matched in this study where there mean (±SD) gestational age in the cases was 39.00±0.83 weeks and in the control group was 38.87±0.86 weeks, which was statistically non-significant (p=0.544). In a similar study by Rwebembera et al, all infants in the control group were full term.[18] The mean gestational age was 36.16±2.67 weeks for cases and 39.19±0.93 weeks for controls. In the current study, multigravida participants were observed in 50.0% of cases and 43.3% of the controls. This difference was statistically non-significant (p=0.760). Endalamaw et al, in a systematic review and meta-analysis, illustrated that women with higher gravidity and short pregnancy interval (< 24 months) are more likely to experience LBW compared with lower gravidity counterparts due to malnutrition which is highly related to frequent pregnancy with short interpregnancy interval.[19] This difference in the findings was probably due to variation in the study design and geographical location. In this study, the mean body mass index (BMI) of the case and control group of respondents were 23.88±1.36 and 24.39±1.39 kg/m^2, whereas only 16.7% of the cases were observed overweight. These were not statistically significant (p>0.05). This finding was probably due to the small sample size of the study. A similar observation was enumerated by Maamouri et al, who demonstrated the mean maternal weight in the case and control groups were 54.41 Kg and 60.0 Kg, respectively, and there was no significant difference for mother's BMI (p=0.11) between two groups.[20] This finding was in agreement with the present study result. Lower maternal serum zinc level was observed in the cases (58.33±27.63 mcg/dL) compared to the control group of respondents (82.96±16.94 mcg/dL), which was statistically highly significant (p=0.001). This deficiency can be due to expanded blood volume, increased demands, and poor intake or bio-absorption, though this was not assessed. Maternal serum zinc level was found positively correlated with neonatal birth weight (r=+0.406, p=0.001), and the risk of birth weight of <2.500 Kg was almost six times (OR 5.67, 95% CI 1.84-17.49; p=0.002) more with low maternal serum zinc levels (< 68 mcg/dL). This was similar with the study by Maral I et al, where they found that the mean zinc level of women with LBW infants was significantly lower than that of their counterparts with normal birth weight infants (58.6±11.2 mg/dL versus 70.6±23.3 mg/dl, p<0.05).[21] Of the 20 women with LBW infants, 18 (90.0%) had low serum zinc levels, whereas of the 40 women with normal birth weight infants, 22 (52.5%) had normal serum zinc levels (Odds Ratio = 7.36). Jyotsna, Amit, and Kumar found that serum zinc level of mothers of LBW newborns was significantly low, and this deficiency was correlated with zinc deficiency in their neonates (Pearson correlation value -0.938).[22] Bellad GC and Laxmi KS conferred that the mean zinc levels in maternal serum in the study group: 67±16.6 µgm/dl, were less as compared to mean values of the control group: 82.35±19.45 µgm/dl.[23] The difference in mean values was statistically significant. They also showed a positive correlation of maternal zinc levels with birth weight and prematurity. Ahmed S and Sagar AK

found that the mean maternal serum levels of zinc 66.04±18.66 µg/dL in the study group was less as compared to the maternal serum levels of zinc in the control group with a mean level of 84.78±21.62 µg/dL.[24] Pearson's correlation done comparing the maternal serum zinc levels and birth weight showed an 'r' value of 0.44.

This study has some limitations. The study population was relatively small and pregnant women were chosen from BSMMU, Dhaka; so, the results of this study may not reflect the exact picture of the whole country. The present study was conducted in a short period of time. The sample was taken purposively. So, there may be a chance of bias that can influence the results. Therefore, the study findings cannot be generalized to the entire population.

CONCLUSION

In this study, comparing the maternal serum zinc level between the cases and controls, it can be concluded that serum zinc status is associated with the birth weight of the neonates. Low serum level of zinc is related to neonatal LBW. This suggests the need to advocate zinc intake by pregnant women, either in the diet or in the form of supplements. It is recommended to undertake further prospective study with a larger sample size to find out the validity of the findings of the present study. Other risk factors of low birth weight should be evaluated. Multi-centric studies may be undertaken to conclude the role of maternal serum zinc level in determining the birth weight of neonates.

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