Birth weight in Relation to the concentrations of Zinc, Copper, Magnesium and Calcium in cord and maternal serum

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Introduction

Birth weight is probably the most important single factor that affects infant's survival and future quality of life. Low-birth-weight babies are likely to be at higher risk of mortality and morbidity[1-3]. Birth weight is determined by intrauterine growth, which in turn, is determined by maternal nutritional status[2-3]. Importance of minerals in course and outcome of human pregnancy is being increasingly recognized in recent studies[4-7]. Maternal nutrtional status of zinc[5-6], copper and iron[7-8] has positive influence on intrauterine development and hence on birth weight and well-being of newborns. Recent studies have revealed positive relationship between birth weight and the concentrations of zinc[9-11], copper[8-9], magnesium[10-12], and calcium[8] in infant's cord serum. Episodes of low birth weight are quite rampant in developing countries. Some forty five percent low birth weight (LBW) has been reported in Bangladesh[13]. In view of the important role that minerals can play in pregnancy outcome, the present study was undertaken where we sought to determine the levels of some important minerals such as zinc, copper, magnesium and calcium in cord and maternal serum during delivery. Moreover, the degree of association between birth weight and the concentrations of these minerals in cord and maternal serum were also addressed in the present study.

Materials and Methods

Subjects-The study was conducted on one hundred and sixty five live-born babies and ninety three mother-infant pairs in a hospital at Dhaka City (Dhaka National Medical Institute and Hospital). Thus the total number of babies is two hundred and fifty eight and that of mother is ninety three. Only full term babies (gestational age $\geq$ 37 weeks) of normal delivery were selected for the study. Mother's age

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ranged between 15 and 40 years. Babies whose mothers had chronic disease, diabetes, hypertension or complicated pregnancy was excluded from the study. Gestational age was calculated from last menstrual period and actual date of delivery.

Determination of birth weight-Baby's birth weight was measured by a balance (YAMATO-Japan) to the nearest of 20 g, usually within half an hour of delivery. Blood collection-Mixed venous-arterial cord blood (10 ml) from the clamped umbilical cord (placental line), just after delivery (prior to expulsion of placenta), was collected into an acid washed glass tube. Maternal venous blood (5 ml) was drawn by disposable syringe. Serum was separated by centrifugation at 3000 r. p. m for 15 minutes, and preserved at-18°C until further analysis.

Biochemical Analysis-Minerals in cord and maternal serum were determined by Atomic Absorption Spectrophotometry[14] after appropriate dilution and treatments.

Statistical Analysis-Data analysis was accomplished by using SPSS (SPSS/PC, version 3.0. Inc. Chicago). Mean and Variations between groups were assessed by Student's -t-test and one way analysis of variance. Pearson-correlation-test was employed to assess the correlation between the variables.

Results

As depicted in table-1, mean (± S. E.) birth weight of neonates was found to be 2850 (± 27) g. Mean concentrations of zinc and copper in cord serum were found to be 160.0 (±5.1) µg/dl and 51.4 (±1.9) µg/dl respectively, while concentrations of magnesium and calcium were found to be 1.34 (± 0.05) mg/dl and 9.2 (± 0.3) mg/dl respectively. Birth weight did not differ significantly between male and female, though male-value tended to be higher than female. Concentrations of zinc, copper and magnesium in cord serum did not differ significantly between male and female, while concentration of calcium was significantly ($P < 0.05$) higher for male as compared to that for female. As shown in table-2, concentration of maternal serum zinc was significantly ($P < 0.001$) lower, while concentration of maternal serum copper was significantly ($P < 0.001$) higher than their concentrations in cord serum. Magnesium and calcium concentrations did not differ significantly between cord and maternal serum, though maternal serum calcium tended to be lower. As depicted in table-3, zinc, copper, magnesium

and calcium concentrations in cord and maternal serum did not differ significantly between low and normal birth weight. Though not significantly, zinc in cord and maternal serum, while copper in maternal serum tended to be higher for normal birth weight as compared to low birth weight. As table- 4 indicates, there were found positive correlations between cord and maternal serum copper ($r = 0.39$, $P < 0.01$) and between cord and maternal serum magnesium ($r = 0.33$, $P < 0.05$). There was found a trend of positive correlation between cord and maternal serum calcium ($r = 0.20$). Birth weight correlated positively ($r = 0.39$, $P < 0.01$) to cord serum zinc, and tended to correlate positively ($r = 0.21$) to maternal serum zinc.

Discussion

This study presents the neonatal birth weight in relation to the concentrations of some essential minerals such as zinc, copper, magnesium and calcium in cord and maternal serum. Mother's age, in the present study, ranged between 15 and 40 years. There was only one case of 15 years, the rest were 18 years and above. Mothers upto 15 years were rather purposively included in the study in order to find if lower maternal age may affect baby's birth weight. Interesting enough, lower maternal age tended to be associated with lower birth weight of babies, which has been published elsewhere[23]. Mean neonatal birth weight in the present study is 2850 g, which is lower than Western value-3230 g[15], but is comparable to the Indian value 2701g[16]. Values for cord serum zinc and copper are comparable to the Indian values-159 -164 µg/dl reported for zinc[10-11] and 59 µg/dl reported for copper[10]. Means for zinc and copper appear to be higher than Western means [9,17]. In this study, cord serum magnesium is lower than Western (2.07 mg/dl) and Indian (2.84 mg/dl) values[9-10], while calcium level is comparable to the Western (9.94 mg/dl) and Indian (10.71 mg/dl) values[9-10]. Birth weight, in present study, tended to be higher for male as compared to that for female (table-1). This is in agreement with the finding of Canosa[13] who also reported higher birth weight for male babies. No sex difference was found for the concentrations of zinc, copper and magnesium in cord serum, excepting that calcium level was higher for male as compared to that for female (table-1). This is in accordance with

the observations of previous investigators[9-10]; but in contrast to our finding, they reported the cord serum calcium to be independent of sex.

In the present study, maternal serum zinc was significantly (P< 0.001) lower than that in cord serum, while maternal serum copper was higher. Moreover, magnesium and calcium in cord and maternal serum did not vary significantly, though maternal serum calcium tended to be lower (table-2). In the present study, maternal serum

Table 1. Mean (± S. E)birth weight and concentrations of zinc, copper, magnesium and calcium in cord serum

Measures	Male	Female	Combined sex	*P
Birth weight (g)	2880 ± 40 (132)	2820 ± 36 (126)	2850 ± 27 (258)	NS
CS zinc (µg/dl)	159.9 ± 7.2 (131)	161.3 ± 7.2 (125)	160.0 ± 5.1 (256)	NS
CS copper (µg/dl)	50.7±2.6 (122)	52.0 ± 2.7 (121)	51.4 ± 1.9 (243)	NS
CS magnesium (mg/dl)	1.35 ± 0.08 (47)	1.30 ± 0.06 (54)	1.34 ± 0.05 (101)	NS
CS calcium (mg/dl)	9.9 ± 0.4 (45)	8.6 ± 0.4 (46)	9.2 ± 0.3 (91)	<0.05

*CS- cord serum, and NS-not significant. Figure in the parentheses indicates the number of samples. *P- calculated by Student's- t- test.*

Table 2. Mean (± S, E) concentrations of zinc, copper, magnesium and calcium in cord and corresponding maternal serum.

Measures	Cord serum	Maternal serum	*P
Zinc (µg/dl)	158 ± 5.1 (91)	89.9 ± 5.2 (91)	<0.001
Copper (µg/dl)	61.5 ± 4.1 (87)	289.4 ±11.7 (87)	<0.001
Magnesium (mg/dl)	1.29 ± 0.51 (80)	1.17 ± 0.04 (80)	NS
Calcium (mg/dl)	9.2 ± 0.3 (80)	8.7 ± 0.3 (80)	NS

*Figures in the parentheses indicate the number of samples. *P-calculated by Student's - t - test. NS-not significant.*

zinc is higher than the reported values-70-72 μg/dl[11,18], and copper is higher than the reported mean-194 μg/dl[18]. Maternal serum magnesium is lower than the mean -2.04 mg/dl reported by Sapatnekar et al[19] in an Indian study. Lower concentration of zinc, and higher concentration of copper in maternal serum as compared to cord serum are in accordance with the findings of previous workers[11,18]. Physiological changes during pregnancy involve decreased zinc and increased copper in maternal blood. This decrease in zinc, perhaps, reflects a maternal-fetal transfer, an expansion of maternal plasma volume, decreased zinc-binding affinities or decreased transport protein concentrations and increased zinc requirement or inadequate zinc intakes[9,20,21]. This increase in copper can be attributed to increased ceruloplasmin, the result of increased estrogen concentrations[9,22]. Higher concentration of zinc in cord serum may reflect an active transport of zinc across the placenta[9,21]. The low copper concentration in cord serum may be attributed to a low fetal ceruloplasmin concentration[22].

In the present study, concentrations of zinc, copper, magnesium and calcium in cord and maternal serum did not vary significantly between low and normal birth weight. Though not significantly, zinc in cord and maternal serum, while copper in maternal serum tended to be higher for normal birth weight as compared to low birth weight (table-3). This higher trend of zinc in cord serum for normal birth weight is in agreement with previous studies[9-11], which demonstrated a positive relationship between birth weight and cord serum zinc. The higher trend of copper in maternal serum for normal birth weight is in accordance with the finding of Bogden *et al* [8], who demonstrated a positive influence of maternal copper status on intrauterine development and birth weight of new borns. Like present finding, Sapatnekar *et al* [19] also reported a lack of association between birth weight and cord serum magnesium.

In this study, cord serum copper correlated positively to maternal serum copper, and cord serum magnesium also correlated positively to maternal serum magnesium. Moreover, cord and maternal serum calcium tended to correlate positively (table-4). Correlations between cord and maternal serum copper, magnesium and calcium were also demonstrated by Bogden *et al.*[8]. These correlations illustrate the dependence of fetal nutritional status on maternal nutritional status. Remarkably,

Table 3. Relationship between birth weight and the concentrations of zinc, copper, magnesium and calcium in cord and maternal serum.

Measures	Birth weight (g)		*F
	Low (≤ 2500)	Normal (2600 - 4500)	
Zinc :			
CS zinc (µg/dl)	144.5 ± 10.1 (64)	165.8 ± 5.9 (192)	1.34
MS zinc (µg/dl)	80.2 ± 6.5 (22)	91.7 ± 5.8 (69)	1.37
Copper :			
CS copper (µg/dl)	51.6 ± 3.6 (60)	48.2 ± 1.7 (183)	1.13
MS copper (µg/dl)	274.7 ± 22.0 (21)	302.6 ± 13.6 (68)	1.18
Magnesium :			
CS magnesium (mg/dl)	1.37± 0.13 (25)	1.34 ± 0.04 (76)	1.21
MS magnesium (mg/dl)	1.10 ± 0.08 (21)	1.22 ± 0.04 (62)	1.16
Calcium :			
CS calcium (mg/dl)	9.1 ± 0.4(22)	9.2 ± 0.3 (69)	1.04
MS calcium (mg/dl)	8.3 ± 0.7 (19)	8.7 ± 0.3 (62)	1.05

*Values are mean ±S. E. Figures in the parentheses indicate the number of samples. CS-cord serum and MS-maternal serum. *F calculated by one way analysis of variance.*

Table 4. Correlation Co-efficients (r) between minerals in cord and corresponding maternal serum and between birth weight and mineral concentrations in cord and maternal serum.

Factors compared	r-value	Factors compared	r-value
CS Zn/MS Zn	0.05	BW/CS Cu	- 0.05
CS Cu/MS Cu	0.39*	BW/MS Cu	- 0.02
CS Mg/MS Mg	0.33**	BW/CS Mg	- 0.01
CS Ca/MS Ca	0.20	BW/MS Mg	0.09
BW/CS Zn	0.39*	BW/CS Ca	0.06
BW/MS Zn	0.21	BW/MS Ca	- 0.004

CS-Cord serum, MS-Maternal serum and BW - Birth weight. r - value was calculated by Pearson Co-rrelation test. P^{*} <0.01, P^{**} <0.05.

birth weight correlated positively to cord serum zinc, and tended to correlate positively to maternal serum zinc (table-4), indicating an important role of zinc in fetal development. Because zinc is an essential component of many enzymes implicated in normal cell division and is required for protein synthesis, the impairment of these vital process may retard fetal growth and reduce birth weight.

Summary

Infant's birth weight was studied in relation to the concentration of minerals in cord and maternal serum. The study was conducted on one hundred and sixty five live born babies and ninety three mother-infant pairs. Only full term babies (gestational age≥ 37 weeks) of normal delivery were selected randomly for the study. Mineral in cord and maternal serum were determined by atomic absorption spectrophotometry. Mean (± S.E) concentrations of zinc, copper, magnesium and calcium in cord serum were found to be 160.0 (± 5.1) µg/dl, 51.4 (± 1.9) µg/dl, 1.34 (± 0.05) mg/dl and 9.2 (± 0.3) mg/dl respectively, while their concenrations in maternal serum were found to be 89.9 (± 5.2) µg/dl, 289.4 (± 11.7) µg/dl, 1.17 (± 0.04) mg/dl and 8.7 (± 0.3) mg/dl respectively. No sex difference was found for these minerals in cord serum, excepting that calcium level was higher ($p < 0.05$) for male. Concentrations of zinc, copper, magnesium and calcium in cord and maternal serum did not differ significantly between low birth weight (LBW) and normal birth weight babies. Copper and magnesium in cord serum correlated positively to their concentrations in maternal serum. Birth weight correlated positively ($r=0.39$, $P < 0.01$) to cord serum zinc, and tended to correlate positively to maternal serum zinc.

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