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Serum Magnesium Level in Umbilical Cord Blood of Preterm and Term Babies

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Abstract

Background: Serum magnesium has important influence on the health of pregnant women and the growing fetus. The lack of this minerals can lead to major impairment of physiological and biological functions, may also induce premature birth, neurological disorder, fetal growth retardation and various abnormalities. ***Objectives:*** To evaluate serum magnesium level in umbilical cord blood of pre-term and term babies. ***Methodology:*** This cross-sectional study was conducted in the Department of Biochemistry, Dhaka Medical College, Dhaka, from July 2017 to June 2018 to evaluate the serum magnesium level in umbilical cord of preterm and term babies. For this study, one hundred newborns were chosen from Dhaka Medical College Hospital's Department of Obstetrics, following the selection criteria. Fifty of them were preterm (Group A), and the other fifty were full-term (Group B). Researchers made sure to get written permission (informed consent) from the mother or legal guardian for every baby after fully explaining what the study involved. ***Results:*** In Group A, mean ± SD of serum magnesium level was 1.67 ± 0.45 (mg/dl), where as in Group B, mean ± SD of serum magnesium level was 2.08 ± 0.35 (mg/dl). The value was significantly lower ($p<0.001$) in Group A than Group B. Serum magnesium level has significant ($p<0.001$) positive correlation with gestational age but no significant correlation with birth weight. ***Conclusion:*** Finding of this study might be helpful for early diagnosis of magnesium deficiency in the preterm babies and also help to prevent the deficiency related neonatal morbidity and mortality.

Key words: Preterm, Term, Serum magnesium, Gestational age, Birth weight. Umbilical Cord Blood

Introduction:

Preterm birth (delivery before 37 weeks of gestation) is a growing threat to newborn survival worldwide. Currently, an estimated 15 million babies are born preterm annually, translating to an 11.1% global preterm birth rate that is continuing to increase. Preterm birth complications are the leading cause of death for children under five, accounting for roughly one million deaths each year. The highest burden is concentrated in Southern Asia (3.87 million), followed by Sub-Saharan Africa (3.2 million), and South-Eastern Asia/Oceania (1.9 million). Risk factors and causes for preterm birth are diverse, including conditions like multiple pregnancies, placental issues (e.g., previa or abruption), maternal factors (e.g., teenage motherhood,

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pre-eclampsia, diabetes, chronic illness, infection), and uterine abnormalities (e.g., bicornuate uterus, incompetent cervix). [1]

Pregnancy is a natural process that causes extensive internal physiological changes in women. Because this period involves rapid growth and cell differentiation for both the mother and the fetus, both are highly sensitive to changes in their dietary intake, especially concerning nutrients that are already in marginal supply. [2]

The way minerals transfer to the fetus changes throughout pregnancy. Initially, minerals move from the amniotic fluid to the fetus via simple diffusion because the fetal skin is not yet hardened (keratinized). As pregnancy advances, the placenta and umbilical cord blood become the primary means of transferring minerals from the mother. A pregnant woman's mineral status can be influenced by several factors, including diet and supplements, her gestational age, overall health, and whether she smokes. Furthermore, it's suggested that stress and blood loss during delivery might also impact the mother's mineral levels. Research also indicates a potential correlation between the mineral composition of the mother's serum and the newborn's cord blood. [3]

The later stages of pregnancy are vital for transferring mineral stores to the fetus. Research indicates that various minerals, such as calcium, are inter-related and their levels naturally fluctuate. Since pregnancy requires significantly higher nutrient intake, a deficiency in any required nutrient poses a risk to the progression of the pregnancy, the delivery process, and the health of the newborn.[4]

Magnesium, the body's fourth most plentiful cation, is vital for numerous physiological processes. Its functions include supporting bone structure, synthesizing essential biomolecules (DNA, RNA, proteins), and enabling energy production (glycolysis). Furthermore, magnesium helps maintain cell system stability and regulates the transport of calcium and potassium across cell membranes, thereby controlling muscle contraction, nerve conduction, vascular tone, and heart function. The body primarily maintains magnesium balance (homeostasis) through the kidneys, which reabsorb it mainly in the loop of Henle and, to a lesser degree, in the distal convoluted tubule. This regulation is influenced by various factors, both hormonal and non-hormonal, and is closely tied to the reabsorption of calcium.[5]

Essential for human health, magnesium is necessary for bone formation and intracellular enzyme activity. This mineral has a well-established role in obstetrics as a key element for healthy fetal development. Insufficient magnesium during gestation may be associated with negative outcomes, including pre-eclampsia, preterm birth, and potentially low birth weight. Critical research indicates that magnesium deficiency during this period significantly elevates the chance of neonatal death and illness, and could result in the development of a chronic neurological deficit.3 There's a strong correlation between a mother's mineral status and the baby's health, affecting both fetal development and the neonate's subsequent well-being. Mineral deficiencies are implicated in numerous poor pregnancy outcomes, including miscarriage, preterm birth, birth defects, and immune system issues. Observations of mineral deficiency in the cord blood of preterm newborns led to the current study, which aims to compare serum magnesium levels in the cord blood of preterm and term infants. The results will be used to improve early detection of deficiency and aid in preventing related neonatal morbidity and mortality. To achieve better outcomes, preventive measures are required. These should include routine antenatal screening for maternal serum magnesium and providing supplementation, given that the mother's magnesium level affects the baby's gestational age and birth weight. Overall, adequate and balanced nutrition during pregnancy is essential for a healthy infant.

Materials and methods

This cross-sectional study was executed in the Department of Biochemistry at Dhaka Medical College, Dhaka, spanning one year from July 2017 to June 2018. The research involved 100 newborn babies recruited from the Department of Obstetrics using purposive sampling. The participants were divided into two equal groups of 50: Group A (preterm babies) and Group B (term babies), all of whom were diagnosed cases of labor. Crucially, infants were excluded if their mothers had a history of specific chronic illnesses, including DM, malignancy, COPD, CKD, or liver diseases, to ensure the study population was relatively healthy in relation to these factors. Before any procedure, ethical standards were met by thoroughly explaining the study's nature and risks, and obtaining written informed consent from the baby's mother or legal guardian.

Immediately after delivery, a 5 ml blood sample was carefully collected from the maternal end of the umbilical cord of each subject, taking all aseptic precautions. The samples were placed in clean, dry, deionized test tubes without anticoagulant, labeled, and then kept slanted for up to 30 minutes. To isolate the serum, the samples were centrifuged at 3000 rpm for 10 minutes. The separated serum was transferred into labeled Eppendorf tubes. To avoid contamination or loss of bioactivity, any samples experiencing a delay in analysis were stored in an ultra-freezer. All subsequent biochemical testing was performed in the Department of Biochemistry.

Only about 10 μl of serum from each sample was required to determine the serum magnesium level, which was measured by using Xylidyl blue method in semi-automated machine and magnesium kit manufacturer was Human. Serum magnesium reference range was 1.9-2.5 mg/dl. For the statistical evaluation, continuous data were summarized using the mean ± Standard Deviation (SD). The two groups (preterm vs. term) were compared using the unpaired Student's t-test. Relationships between variables were assessed using Pearson's correlation coefficient. Statistical analysis was performed by using the SPSS software (version 22, IBM). Statistical significance was defined as a two-tailed p-value of less than 0.05 ($p < 0.05$) at a 95% confidence interval, ensuring the reliability of the findings regarding the difference in magnesium levels between the two groups.

Result:

In this study, the mean ± SD of birth weight was 2.10±0.51 kg and 2.93±0.40 kg in Group A and Group B respectively. The gestational age was 33.96±1.93 weeks in Group A and 38.68±1.17 weeks in Group B. There was significant difference p<0.001 0f birth weight and gestational age between two groups. (Table-I)

Table I: Demographic profile of the preterm and term babies (N=100)

Variables	**Groups**		**t value**	**p value**
	Group A (n=50) mean±SD	**Group B (n=50) mean±SD**		
Birth weight (kg)	2.10 ± 0.51	2.93 ± 0.40	8.97	<0.001
Gestational age (weeks)	33.96 ± 1.93	38.68 ± 1.17	14.81	<0.001

Unpaired Student's 't' test was done to measure the level of significance. p< 0.05 is considered as significant.

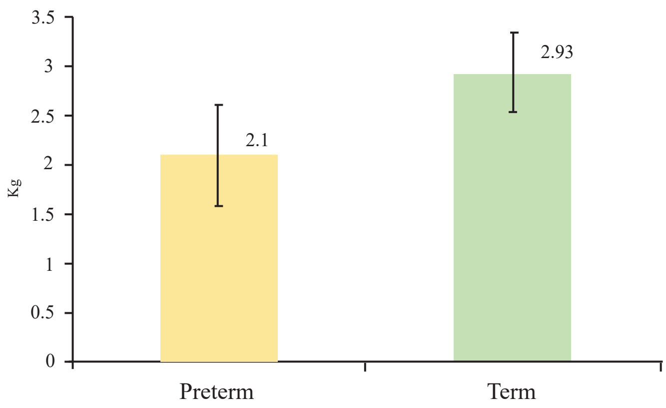

Figure 1: Bar diagram showing birth weight in preterm and term babies

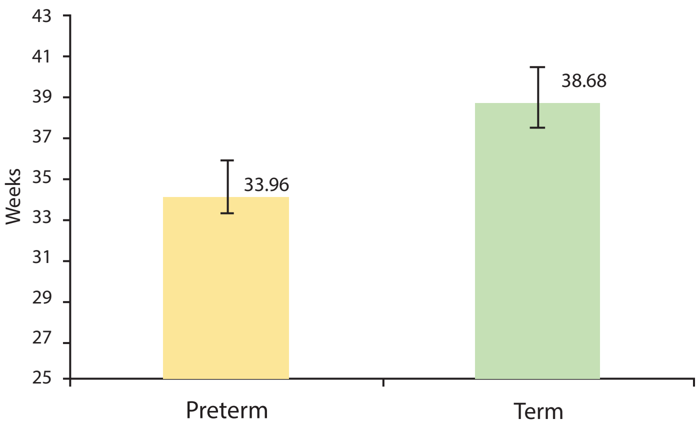

Figure 2: Bar diagram showing gestational age in preterm and term babies

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Table II: Laboratory findings of the preterm and term babies (N=100)

Parameters	**Groups**		**t value**	**p value**
	Group A (n=50) mean ± SD	**Group B (n=50) mean ± SD**		
Serum magnesium (mg/dl)	1.67 ± 0.45	2.08 ± 0.35	5.06	<0.001

Unpaired Student's 't' test was done to measure the level of significance. p< 0.05 is considered as significant.

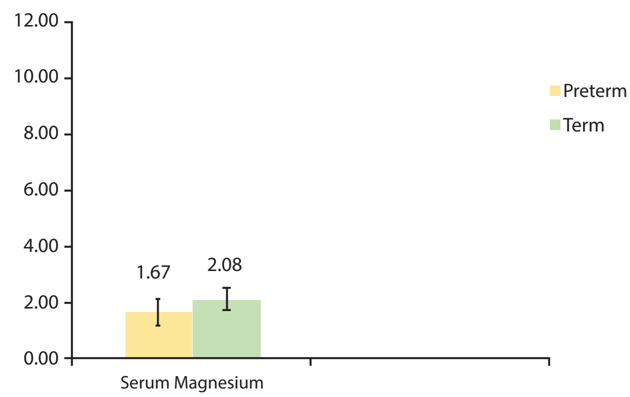


Figure 3: Bar diagram showing serum magnesium in preterm and term babies.

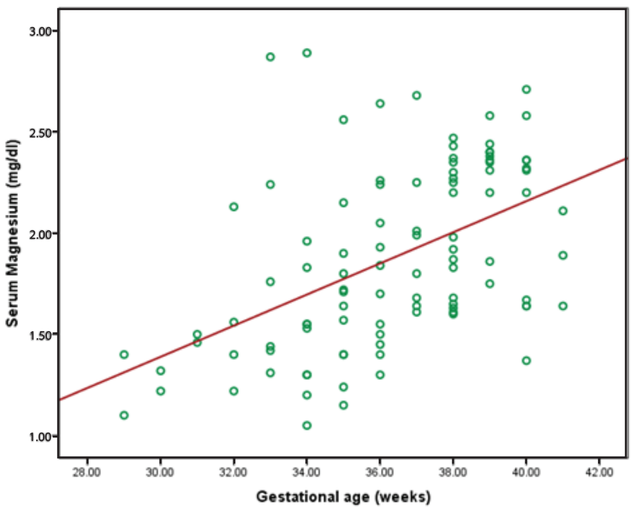
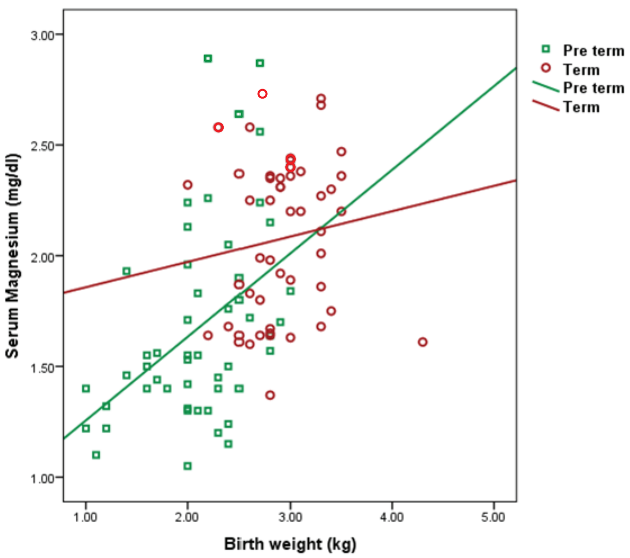


Figure 4: Scattered diagram showing correlation between gestational age and serum magnesium (r = 0.490; p= <0.001). Serum magnesium has significant positive correlation of gestational age.



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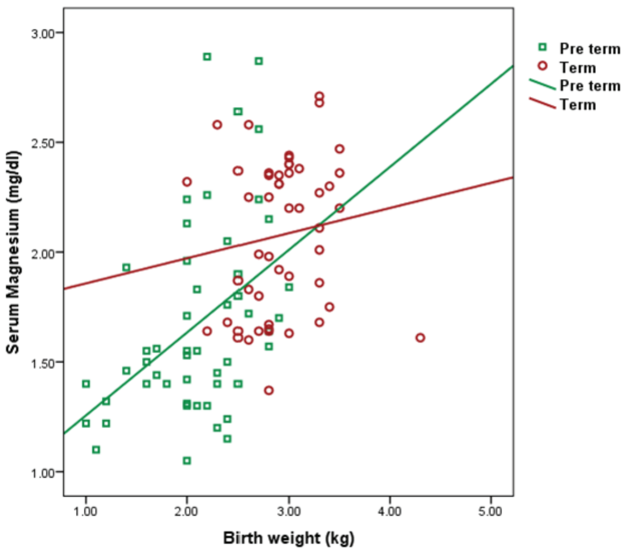

Figure 5: Scattered diagram showing correlation between birth weight and serum magnesium in preterm and term (r = +0.443; p= 0.002 and r = +0.131; p=0.364). No significant positive correlation.

Discussion

A baby born before 37 completed weeks of pregnancy is defined as a preterm birth. Conversely, a term baby is one born between 37 and 42 completed weeks of gestation. Preterm birth is an increasingly common complex condition with multiple risk factor and has substantial medical, psychological, economic and social impacts. The organ most commonly affected by preterm delivery are the lungs, as the lungs are one of the last organs to develop in utero.[6]

Preterm delivery is a critical issue in modern perinatal medicine, with stable rates of 7–10% in developed nations over the last 30 years. The incidence is rising, driven by factors such as assisted reproductive technology, multiple gestations, and increased medical intervention. The crucial hormone for sustaining pregnancy is progesterone. It triggers maternal lymphocytes to produce PIBF, which mediates its protective, anti-abortion effects by adjusting the immune system. During a normal pregnancy, the maternal immune system recognizes the pregnancy, leading to increased progesterone receptors on specific lymphocytes (including placental and CD8+ cells). Sufficient progesterone then prompts these cells to synthesize PIBF. However, patients facing a risk of preterm delivery show an abnormal immune response, characterized by elevated pro-inflammatory cytokines, decreased PIBF, and lower expression of IL-10 on lymphocytes.[7]

Now a day's progress has been made to improve the survival of premature neonates, mostly by timely interventions, antenatal administration of corticosteroids, better NICU care and exogenous surfactant therapy but still prematurity is the leading cause of neonatal morbidity and mortality8. The most frequent neonatal morbidities are respiratory abnormalities, patent ductus arteriosus, intra cranial hemorrhage, jaundice, necrotizing enterocolitis, infections, chronic lung disease and retinopathy of prematurity9.

Serum magnesium is critical for development of fetus. Deficiency one or more of the minerals can lead to the adverse maternal and fetal outcome. This study was done to see the serum magnesium level in cord blood of preterm and term babies.

According to this study, mean ± SD of serum magnesium was 1.67±0.45 mg/dl and 2.08 ± 0.35 mg/dl in preterm and term babies respectively. Mean serum magnesium level was significantly lower (p<0.001) in preterm than term babies. This result was consistent with an observational study of Elizabeth et al.9 who found significant lower magnesium level in cord blood of preterm than term babies.

In the present study, serum magnesium level was positively connected with gestational age and birth weight. During search, no study was found about correlation of serum magnesium level with gestational age and birth weight.

The limitations of this study were- sample was taken purposively, so there may be chance of bias which can influence the result, correlation of serum magnesium between mother and baby was not done. Large scale prospective study may be carried out nationwide to confirm the alteration of serum magnesium level in the umbilical cord blood between preterm and term babies. Correlation of serum magnesium levels between mother and baby would be done. Routine estimation of serum calcium, magnesium and zinc levels of pregnant women during antenatal check-up would be done.

Conclusion

It is concluded from this study that, serum magnesium level in cord blood of preterm babies is lower than the term babies. There is significant positive correlation of serum magnesium level with gestational age but no significant correlation with birth weight. So, routine checkup of mother for serum magnesium and level is needed to prevent hypomagnesemia of babies and to prevent this element deficiency related neonatal morbidity and mortality.

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