

Assessment of serum Calcium level of exclusively breastfed newborns and infants up to 6 months of age and its correlation with maternal serum Calcium

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Abstract

Background: Calcium is essential to maintain normal body homeostasis and breast milk is an important source of this nutrient in exclusively breast-fed infants. This study objective was to assess the serum calcium level of exclusively breast-fed newborns and babies upto 6 months of age and their mothers to find out a correlation between them.

Methods: A total 50 mother and baby pairs aging 0 to 6 months, exclusively breastfed, term and appropriate for gestational age, who came at vaccination center or outpatient department during the study period were randomly selected. Among the 50 mothers, 20 took regular calcium supplementation during pregnancy, 20 took calcium irregularly and the rest took no calcium at all. During lactation, 15 mothers were on regular calcium intake, 19 on irregular intake and 16 did not take any calcium after delivery. Total serum calcium and albumin level of the babies along with their mothers were measured and corrected serum calcium levels were calculated.

Result: Among the 50 babies, 35 (70%) had normal serum calcium level, 11 (22%) had mild hypocalcemia and 4 (8%) had moderate serum calcium level. So total 15 (30%) out of 50 babies had hypocalcemia. Of the 50 mothers, 42 (84%) had normal calcium level and the rest 8 (16%) had mild hypocalcemia. Among the 20 babies with mothers on regular antenatal calcium, 13 (65%) maintained normal serum calcium level, 5 (25%) developed mild hypocalcemia and 2 (10%) moderate hypocalcemia. Among the babies (20) whose mother took antenatal calcium irregularly, the result was exactly the same. 9 (90%) of the rest 10 babies whose mother took no calcium supplementation maintained normal serum calcium level while 1 (10%) developed mild hypocalcemia.

Conclusion: No significant statistical association was detected between maternal calcium supplementation during pregnancy & lactation and serum calcium level of exclusively breastfed newborns and infants up to 6 months of age.

Introduction:

Calcium is essential to maintain total body health.¹ It is the free, ionized calcium (Ca^{2+}) in the body fluids that is a vital second messenger and is necessary for blood coagulation, muscle contraction, and nerve function.²

Hypocalcemia is the reduction of total serum concentration after making an allowance for a variation in the simultaneously measured albumin concentration.³ During pregnancy and lactation, there

is a greater depletion of calcium from the mother and the intake needs to be increased. On an average, 10 mg per kg of body weight per day should be sufficient.¹ Intake of calcium is low in the general population of Bangladesh, with potential serious and persistent effects on public health. These effects are especially pertinent to young children and women of reproductive age, by virtue of increased physiologic needs, poorer access to dietary calcium sources, and

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a confluence of other local determinants of calcium status in these groups.⁴

Maternal deficiency of calcium may lead to hypocalcemia in the breastfeeding infants.⁵ The fetus must actively transport sufficient calcium across the placenta to meet the large demand of the rapidly mineralizing skeleton, whereas the neonate must quickly adjust to loss of placental calcium transport, while continuing to undergo rapid skeletal growth.⁶ To compensate for the calcium requirements of lactation, the maternal adaptations could, in theory, include increased intestinal absorption of calcium, renal conservation of calcium, and increased resorption of calcium from the skeleton. In fact, the studies reviewed in this section indicate that a temporary demineralization of the skeleton is the main mechanism by which lactating humans and animals meet these calcium requirements.⁶ Infants less than 6 months are reliant on their mothers for their daily calcium requirements. As such maternal deficiency of calcium may lead to hypocalcemia in the breastfeeding infants.⁶ Hypocalcemia is often asymptomatic in neonates and may present as lethargy, poor feeding, vomiting and abdominal distension which can mimic sepsis. Severe hypocalcemia may present with seizure.⁷

Serum calcium is present in two forms: the free (ionized) and the bound form. Only about 50% of circulating calcium is present in the physiologically free form. The rest is either bound to proteins (40%) or complexed (10%) with bicarbonate, citrate, and phosphate.^{5,8} Serum Calcium is maintained by several biochemical factors in the body. Three hormones are primarily concerned with the regulation of calcium homeostasis - parathyroid hormone secreted from the parathyroid glands, Vit D₃ (1,25 Dihydroxycholecalciferol), a steroid hormone formed from vitamin D, and Calcitonin, a calcium lowering hormone secreted in mammals by the parafollicular cells (C-cells) of the thyroid gland.²

Measurement of the total calcium alone may sometimes be misleading, since this measurement can change without alteration in the ionized calcium concentration. In hypoalbuminemia, although ionized calcium levels remain normal, total calcium levels decrease. Despite having a high prevalence of hypocalcemia among women of reproductive age

group and neonates and infants, there are few useful studies to find out the relationship between maternal serum calcium and baby's serum calcium. This study can be useful to sort out the relation and further evaluation can help us to prevent maternal hypocalcemia to protect their children from the complications of hypocalcemia.

Materials and Methods:

This study was conducted at the Paediatric outpatient department of Dhaka Shishu Hospital, Dhaka from February, 2019 through July, 2019. Total 50 mother and baby pairs who came at vaccination centre for vaccination or outpatient department for checkup were randomly selected. All of the babies enrolled were term and exclusively breastfed without having any significant complications. 21 babies were neonate and the rest 29 babies were in the age group of 1 month to 6 months of age. The total serum calcium and serum albumin levels of the mothers and the babies were assessed and corrected serum calcium levels were calculated for both groups. Then the correlation between serum calcium level of both mothers and babies were assessed. The equation used to measure corrected calcium in cases of hyperalbuminemia/hypoalbuminemia is as follows:

Corrected (Ca²⁺) in mg/dL = Measured total (Ca²⁺) in mg/dL + [0.8x{4.5 - (albumin in mg/dL)}]^{9,10,11}

or, Corrected total calcium (mmol/L) = Total Ca (mmol/L) + 0.02[40(g/L) - albumin(g/L)]¹²

Statistical analyses were carried out by using the Statistical Package for Social Science version 20.0 for Windows (SPSS Inc, Chicago, Illinois, USA). The mean values were calculated for continuous variables. Chi-square test was used to analyze the categorical variables, shown with cross tabulation. P values < 0.05 was considered as statistically significant. Pearson's correlation coefficient was used to study the statistical correlation.

Results:

The study included 50 baby-mother pairs. All the babies were term with appropriate for gestational age and exclusively breast-fed since birth. Mean maternal age was 25.34±5.4 SD years. Babies were divided into two groups- neonate and infants. Mean age of the neonates were 9.7±6.22 SD days and that of infants were 2.6±1.27 months.

Table 1. Socio-demographic factors Age distribution

Age distribution	Mean $\pm$ SD
Maternal age (n=50)	25.34 $\pm$ 5.4 years
Neonates (n=21)	9.7 $\pm$ 6.22 days
Infants (n=29)	2.6 $\pm$ 1.27 months
Sex distribution of the babies	
Male	31(62%)
Female	19(38%)
Socioeconomical status (Groups)	N =50
Lower class	0
Upper-lower class	21(42%)
Lower-middle class	17(34%)
Upper-middle class	12(24%)
Upper class	0
Maternal education	N=50
Illiterate	6(12%)
Primary	15(30%)
SSC	16(32%)
HSC	8(16%)
Graduate	5(10%)
Maternal nutritional status according to BMI	N=50
Underweight	10(20%)
Normal	25(50%)
Overweight	15(30%)
Obese	3(6%)

Among the 50 mothers, 20(40%) mothers took regular calcium supplements during pregnancy, 20(40%)

mothers had irregular calcium supplements and 10(20%) took no calcium supplements at all.

During lactation 15(30%) mothers were taking regular calcium supplements, 19(38%) mothers were taking irregular calcium supplements and 16(32%) mothers did not take any calcium after delivery.

Table III shows the mean serum total serum calcium and serum albumin level of both the babies and the mothers. Corrected serum calcium level was calculated for each from total serum calcium and serum albumin level for the study with the help of the equation mentioned at operational definition in methodology.

Table II : Distribution of maternal factors related to pregnancy and lactation- maternal antenatal checkup, calcium intake and mode of delivery

Maternal antenatal check up	N=50
Regular check-up	32(64%)
Irregular check up	17(34%)
No check up	1(2%)
Calcium intake during pregnancy	N=50
Regular intake	20(40%)
Irregular intake	20(40%)
No intake	10(20%)
Calcium intake during lactation	N=50
Regular intake	15(30%)
Irregular intake	19(38%)
No intake	16(32%)

Table III: Laboratory results; serum total calcium and serum albumin level of the babies and the mothers

Groups	Total serum calcium(mmol/L) Mean $\pm$ SD	Serum albumin(g/L) Mean $\pm$ SD
Mothers	2.27 $\pm$ 0.16 (2.11-2.43)	37 $\pm$ 4.47 (32.53-41.47)
Babies	2.23 $\pm$ 0.25 (2.48- 1.98)	37.57 $\pm$ 5.27 (32.3-42.84)

Table IV : Serum calcium distribution of the mothers and the babies.

Serum calcium level of the babies'	N	Min(mmol/L)	Max(mmol/L)	Mean $\pm$ SD
Normal Calcium level	35(70%)	2.2	2.9	2.4($\pm$ 0.17SD)
Mild hypocalcemia	11(22%)	1.9	2.1	2.04($\pm$ 0.08SD)
Moderate hypocalcemia	4(8%)	1.5	1.8	1.6($\pm$ 0.13SD)
Severe hypocalcemia	0			
Serum calcium level of the mothers	N	Min(mmol/L)	Max(mmol/L)	Mean $\pm$ SD
Normal Calcium level	42(84%)	2.20	2.70	2.37($\pm$ 0.15 SD)
Mild hypocalcemia	8(16%)	2.0	2.1	2.07($\pm$ 0.05 SD)
Moderate hypocalcemia	0			
Severe hypocalcemia	0			

The corrected serum calcium level was obtained from total serum calcium and serum albumin level. Among the 50 babies 35 (70%) had normal serum calcium level, 11(22%) babies had mild hypocalcemia and only 4(8%) babies had moderate hypocalcemia. Not a single baby had severe hypocalcemia. So, total 15(30%) out of 50 babies had hypocalcemia. Prevalence of hypocalcemia of the babies was 0.3.

Among the mothers 42(84%) mothers had normal serum calcium level and 8(16%) mothers had mild hypocalcemia. No one had moderate or severe hypocalcemia.

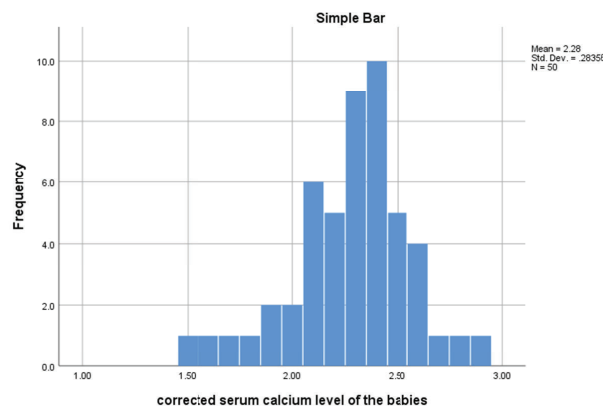


Fig .-1: Simple bar diagram showing corrected serum calcium distribution of the babies

The mean corrected serum calcium level of the babies was 2.28 mmol/L $\pm$ 0.28 SD.

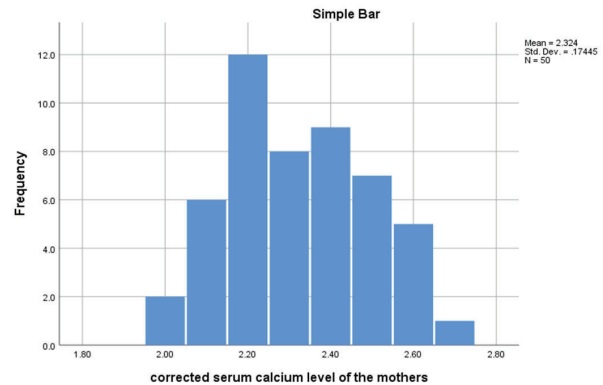


Fig2: Simple bar diagram showing corrected serum calcium level of the mothers.

The mean corrected serum calcium level of the mothers was 2.324 mmol/L $\pm$ 0.17 SD.

Nutritional status and educational qualification of the mothers were assessed for any correlation with the serum calcium level of the babies by chi square test. In all cases P value >0.05. so, no significant association was found among these variables.

ns : not significant

There is no relation of the socio-economic status of the families included in the study to serum calcium level of the babies. P value 0.304 (not significant)

Table V: Maternal calcium intake during pregnancy and lactation and it's relation to serum calcium status of the babies

During pregnancy n=50		Babies' S. Calcium level			P value
	Normal (n=35)	Mild hypocalcemia (n=11)	Moderate hypocalcemia (n=4)	Severe hypocalcemia (n=0)	
Regular (n=20)	13(37.14%)	5(45.45%)	2(50%)	0	0.639
Irregular (n=20)	13(37.14%)	5(45.45%)	2(50%)	0	
No intake(n=10)	9(25.71%)	1(9.09%)	0	0	
During lactation n=50		Babies' S. Calcium level			P value
	Normal (n=35)	Mild hypocalcemia (n=11)	Moderate hypocalcemia (n=4)	Severe hypocalcemia (n=0)	
Regular (n=15)	10(28.57%)	4(36.36%)	1(25%)	0	0.346
Irregular (n=19)	15(42.85%)	4(36.36%)	0	0	
No intake(n=16)	10(28.57%)	3(27.27%)	3(75% %)	0	

ns: not significant

Maternal calcium supplement intake during pregnancy and lactation were assessed for association with serum calcium level of the babies by chi square test. In both cases P value is more than 0.05. So no significant statistical association was detected among these variables.

Discussion:

The present study was conducted to find out the correlation between maternal serum calcium and serum calcium of exclusively breastfed baby up to 6 months of age. A total 50 mother and baby pairs were included. All the babies were born term. The total serum calcium and serum albumin levels of the mothers and babies were assessed and corrected serum calcium levels were calculated for both groups. Then the correlation between the groups was assessed. The result shows no correlation between maternal serum calcium and serum calcium level of their exclusively breastfed babies up to 6 months of age (Pearson's correlation coefficient, $r = -0.089$ and $p \text{ value} = 0.538$). The study statistically signifies that there is no correlation of serum calcium between the two study groups. This result is in unison with the study conducted by Jacqueline Lin National Kenyatta Hospital, Kenya in 2014. The study was conducted on 100 pairs of mothers and their babies. In that study no significant correlation was found between serum calcium level of the mothers and their babies ($p = 0.443$). Both term and preterm babies were included in that study⁵ while in our study, only term babies were included.

On the other hand, a study to find any association between maternal and neonatal hypocalcemia and found a significant association ($p = 0.013$) which does not support the present study⁹. The study was conducted in term neonates of Kenyatta hospital, Kenya in 2011. Total 121 mothers and their neonates were included in that study.³⁰ The study population was larger than the present study and only included neonates.^{10,13} The present study included both term neonates and exclusively breastfed infants but no association was found between serum calcium level of the babies and their mothers ($p > 0.05$). The study conducted by Jacqueline L⁴ in 2014 arises conflict with the study done by Kisiangani¹³ in same hospital in 2011. The study which took place in later period shows no association between serum calcium level of the babies and their mothers unlike the study done in 2011. It indicates an improvement of antenatal and neonatal care in this time period.

In India Neelam Deshpande and Lalit Patil⁷ in their study conducted at 2014 found that a statistically significant correlation exists between maternal ionic calcium and cord blood ionic calcium ($r = 0.86$), cord blood ionic calcium and baby's ionic calcium at 48 h of age ($r = 0.51$), maternal ionic calcium and baby's ionic calcium at 48 h of age ($r = 0.67$). This result does not support the present study. It included 500 population which is 10 folds higher than present study. But the direct correlation of serum calcium level of the babies and the mothers were not assessed in that study.⁷

A frank correlation was noted between the maternal serum calcium and serum calcium levels of the newborn ($R = 0.34$) in a study conducted in Pregnant Women and their Newborns in Sidi Bel Abbes Region, Algeria by Amina Imene Benali and Abbassia Demmouche in the year 2014. The result arises conflict with the present study as no correlation was found between maternal and babies' serum calcium level. The above-mentioned study was conducted on a large population of 900 pregnant women and their newborn babies.¹⁴ But the present study included both newborns and infants up to 6 months of age.

Beside maternal serum calcium some other factors were assessed to determine correlation with serum calcium level of the babies in the present study. These variables are maternal education, nutritional status, socio-economic condition, maternal intake of calcium supplements during pregnancy and lactation but no direct correlation with maternal serum calcium level was assessed. No significant correlation was found between these variables and serum calcium status of the babies. ($p > 0.05$). In another series assessed relation between serum calcium level of the babies and maternal dietary intake of calcium rich foods but no significant correlation between them was found in his study^{10,11}.

But the study conducted by Neelam Deshpande and Lalit Patil⁷ showed with calcium supplementation antenatally, the mean values for serum calcium of maternal blood, cord blood and baby's blood at 48 hours of age were higher than those without antenatal calcium supplementation which is non supportive to present study.⁷

There was a big series to find the effects of restricting milk intake in lactating mothers on selected nutrients, It was found that milk restriction compromised

calcium intake in lactating mothers.¹⁵ Milk intake was considered as calcium supplementation in that study. In the present study baby's serum calcium level was not affected by maternal calcium intake during pregnancy or lactation.

Welime KJ studied association between serum calcium level of the babies and maternal education but did not find any relation which supports the present study.¹³

Serum calcium level is maintained by other hormones and factors like Vitamin D₃, parathormone and calcitonin.² That's why it may not depend solely on maternal serum calcium. Though total body calcium content of the newborns and exclusively breastfed babies depend on maternal calcium status but they can maintain their own serum calcium level individually. Another explanation for insignificant correlation between serum calcium level of babies and their mothers may be the impact of regular antenatal checkup and providing calcium and other nutritional supplements during pregnancy and lactation which creates awareness among general population.

Conclusion:

In this study no correlation was found between maternal serum calcium level and serum calcium level of their exclusively breastfed baby up to 6 months of age. Though the study has some limitations like small sample size, conducting in a short period of time but It implies that the serum calcium level of the baby is not directly related to maternal serum calcium level though, they are totally dependent on their mothers for their source of calcium during fetal life and lactation period as well. So, it can be said that maternal serum calcium level does not have any predictive value for their babies' serum calcium.

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