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Association of Serum Magnesium and Serum Calcium Levels in Infants Born to Mothers with GDM and PGDM in Bangladesh

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Abstract **Original Research Article**

Background: Gestational diabetes mellitus (GDM) and pregestational diabetes mellitus (PGDM) are significant health concerns affecting maternal and neonatal outcomes worldwide, including in Bangladesh. Infants born to mothers with diabetes are at increased risk of metabolic imbalances, including potential disturbances in essential minerals like calcium and magnesium. Adequate levels of serum calcium and magnesium are crucial for various physiological functions, including bone development, muscle function, and neuromuscular stability in newborns. Studies suggest that maternal diabetes may impact these mineral levels in infants, potentially leading to complications such as hypocalcemia and hypomagnesemia. ***Objective:*** This study aims to compare serum magnesium levels and its association with serum calcium level in infants born to mothers with GDM and PGDM in Bangladesh, providing insights into the nutritional impacts of maternal diabetes on newborns. ***Methodology:*** This cross-sectional study was conducted at the Biochemistry and Molecular Biology Department, BIRDEM, Dhaka. Total 105 infants within 72 hours of birth were selected from the obstetrics and gynecology and pediatrics departments. Serum levels of magnesium and calcium were measured. Data were analyzed using t-tests and chi-square tests to assess differences between infants of GDM and PGDM mothers and Pearson correlation test to understand correlation between these two parameters in IDMs. ***Results:*** The study revealed that hypomagnesemia and hypocalcemia were higher in infants of PGDM mothers compared to GDM mothers (63.8% vs 24.1%) and (36.2% vs. 12.1%) accordingly. Association of serum magnesium and calcium levels were significantly lower in PGDM infants than in GDM infants (68.2% vs 31.8% p=0.001, 70.8% vs 29.2% p=0.005). Positive correlation found between serum magnesium and calcium level in IDMs. ***Conclusion:*** Infants of PGDM mothers are at a higher risk of hypomagnesemia, hypocalcemia. In order to improve neonatal health, these findings emphasize the necessity of customized prenatal care depending on the type of maternal diabetes.

Keywords: Gestational diabetes mellitus, Pre-gestational diabetes mellitus, Hypomagnesemia, Hypocalcemia.

INTRODUCTION

Gestational diabetes mellitus (GDM) and pre-gestational diabetes mellitus (PGDM) are significant health concerns, especially in developing countries like Bangladesh. These conditions not only affect maternal health but also have profound implications for the newborn. One of the key areas of interest in neonatal health is the role of micronutrients, such as magnesium and calcium, which are critical for many physiological functions, including neuromuscular activities, bone development, and enzyme reactions. Magnesium deficiency has been linked to various metabolic disorders, and its status in infants born to mothers with GDM or PGDM warrants investigation [1-4].

Magnesium and calcium plays an essential role in fetal growth, with magnesium being vital for enzyme function and neuromuscular regulation, and calcium being critical for bone formation and cardiovascular health. The reference range for serum magnesium in newboms typically falls between 0.65 to 1.05 mmol/L (1.58 to 2.55 mg/dL), and for calcium, the normal serum levels range from 2.1 to 2.7 mmol/L (8.5 to 10.8 mg/dL). When serum magnesium levels fall below 0.65 mmol/L, this is considered hypomagnesemia, while hypocalcemia is defined by serum calcium levels below 2.1 mmol/L. Both these deficiencies, if present in newborns, can lead to complications such as neuromuscular irritability, seizures, and cardiovascular issues [5-9].

Diabetes during pregnancy alters maternal and fetal metabolism, which may influence the transfer of essential nutrients, including magnesium and calcium, from mother to fetus. In GDM, blood glucose levels rise during pregnancy due to insulin resistance, whereas in PGDM, the mother has pre-existing diabetes before pregnancy. Both forms of diabetes can impact the nutritional status of the infant, potentially leading to imbalances in vital minerals. Since magnesium and calcium are crucial for fetal development, their deficiencies could have serious implications, including an increased risk of neurological and metabolic disorders in infants.

Several studies have indicated that infants born to mothers with diabetes, particularly those with poorly controlled blood sugar levels, may experience altered levels of these critical micronutrients [10-12]. However, the exact relationship between maternal diabetes and serum magnesium and calcium levels in newborns remains under-researched, especially in the context of Bangladesh, where maternal malnutrition and limited healthcare access may further exacerbate these issues. Investigating these relationships could provide valuable insights into improving maternal and neonatal healthcare in regions where diabetes is prevalent, highlighting the need for better prenatal care and monitoring of micronutrient levels to reduce neonatal complications.

METHODOLOGY

A cross sectional study was conducted in the Department of Biochemistry and Molecular Biology, BIRDEM, Dhaka from July 2016 to June 2017. From the admitted patients of department of Obstetrics and Gynecology and department of pediatrics, BIRDEM, Dhaka, around 105 newborns were selected aged within 72 hours of birth, according to inclusion and exclusion criteria.

Data Collection Technique

According to inclusion criteria parents of all IDMs were encouraged for voluntary participation from SCABU and Obstetrics and Gynecology department. A structural questionnaire was filled up for each IDM after taking informed written consent from their guardian. Detail socioeconomic, maternal medical and diabetic status, drug, obstetrical and neonatal birth history were recorded. Infant's serum magnesium and calcium level were estimated in the laboratory of BIRDEM-2 General Hospital, Dhaka.

At first 0.5ml blood was collected from the infants within 48-72 hours of birth in plain test tube to estimate serum magnesium and calcium level.

Blood was transported to the laboratory immediately after collection. Serum was separated after centrifugation at 3000 rpm for 5 minutes. Then the serum was collected in eppendorf tube and immediately measured serum magnesium and calcium in Auto analyzer in laboratory of BIRDEM-2 General Hospital.

Statistical Analysis

For comparison of characteristics, mean with standard deviation of serum magnesium and calcium were determined. Independent student's t-test was done for comparison between IPGDM and IGDM. Chi-square test was done to see any association between IPGDM and IGDM. Pearson correlation test was also done to observe correlation between serum magnesium and calcium level in IDMs. All statistical tests were considered significant at the level of ($p \leq 0.05$) was considered as test of significance. Statistical analysis was performed with the help of software SPSS (statistical package for social science) for windows, 17 version.

RESULTS

The total numbers of participants were 105. Among them, 55.2% infant of GDM mother and 44.8% were of PGDM mother. 62.9% were male and 37.1% were female.

Table I: Frequency distribution of study population (n=105)

Variable		Frequency	Percentage
IDM	IGDM	58	55.2
	IPGDM	47	44.8
Gender	Male	66	62.9
	Female	39	37.1
Total		105	100

n=number of study subject

The demographic characteristics of the study participants were shown in Table II. Among the IDMs 63.8% male and 36.2% female were from PGDM; 62.1% male and 37.9% female were from GDM. All 105 infants were delivered by caesarian section except one from each group. 97.9% of PGDM mother used to take insulin and 2.1% were on diet whereas 20.7% of GDM mother used to take insulin and 79.3% were on diet.

Table II: Demographic characteristics infant of PGDM & GDM mother of study population (n=105).

Variable		IPGDM		IGDM	
		Frequency	Percentage (%)	Frequency	Percentage (%)
Gender	Male	30	63.8	36	62.1
	Female	17	36.2	22	37.9
Maternal Mode of treatment	Insulin	46	97.9	12	20.7
	Diet	1	2.1	46	79.3
Total		47	100	58	100

n=no of study population

Frequency distribution of biochemical status of IDMs were shown in Figure I. Hypocalcemia and hypomagnesemia were higher in IPGDM group than IGDM (36.2% vs 12.1% and 63.8% vs 24.1% respectively).

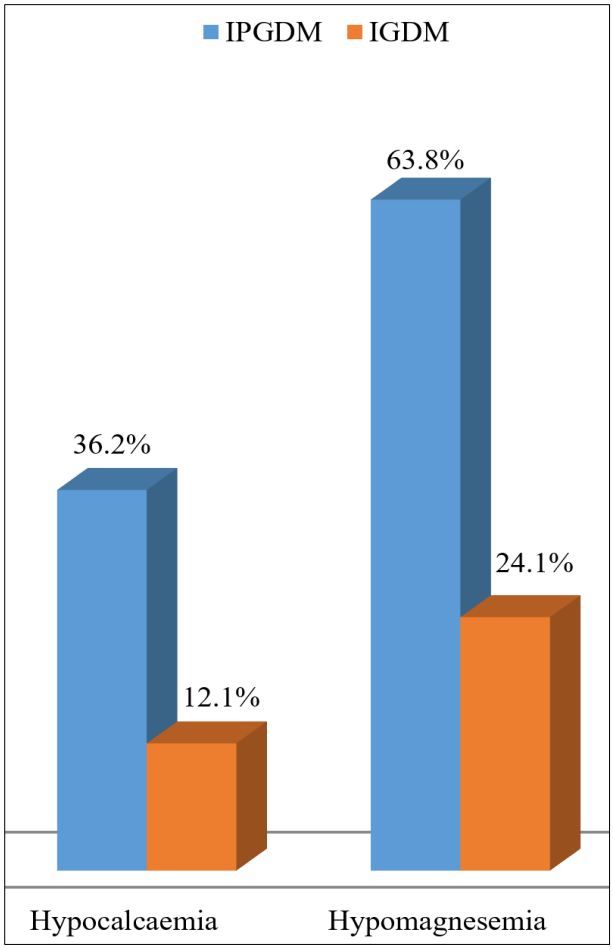

Fig 1: Frequency distribution of biochemical status of IPDM and IGDM

Table III showed that, mean serum magnesium and calcium level was significantly lower in IPGDM than IGDM

Table III: Comparison of Biochemical parameter in infants of PGDM and GDM mothers

Variable	IPGDM Mean ± SD	IGDM Mean ± SD	P-Value
S.magnesium (mmol/l)	0.71 ± 0.11	0.80 ± 0.14	0.001*
S. calcium (mg/dl)	7.44 ± 1.45	8.02 ± 0.93	0.015*

Table IV shows, serum magnesium and calcium was significantly lower in IPGDM than IGDM (68.2% Vs 31.8%, $\chi 2$= 16.80, p<0.001) and (70.8% Vs 29.2%, χ^2=8.55, p=0.005).

Table IV: Association of serum magnesium and calcium level in IDMs

Variables	IPGDM	IGDM	χ2	p-value
Magnesium(mmol/L)				
Normal	**17(27.9%)**	**44(72.1%)**	**16.80**	**<0.001**
Low(<0.7)	**30(68.2%)**	**14(31.8%)**		
Calcium (mg/dl)				
Normal	**30(37.0%)**	**51(63.0%)**	**8.55**	**0.005**
Low(<7)	**17(70.8%)**	**7(29.2%)**		

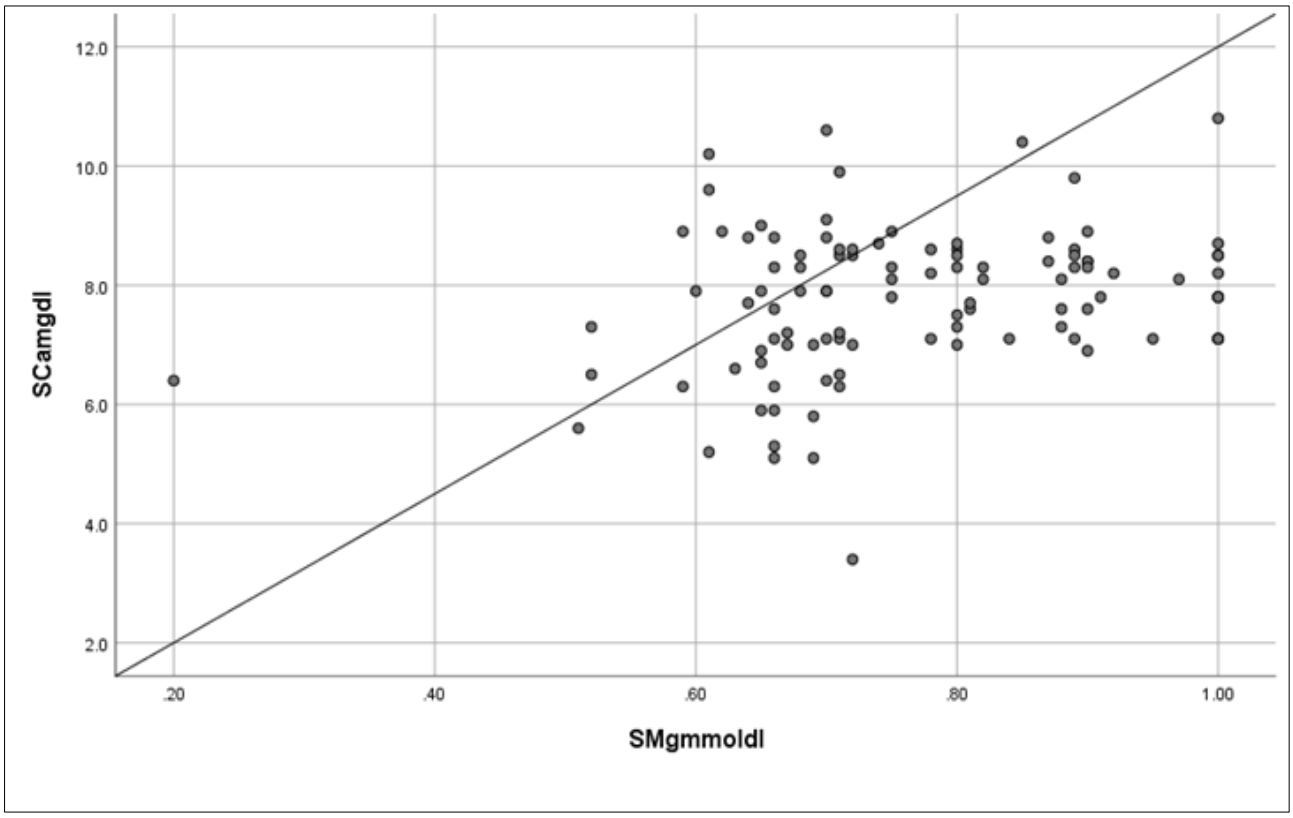

Fig 2: Positive correlation between serum Mg^{2+} and serum Ca^{2+} level in IDMs

DISCUSSION

Our study compared the status of serum magnesium and calcium between infants born to mothers with gestational diabetes mellitus (GDM) and pre-gestational diabetes mellitus (PGDM) in Bangladesh. The study included 105 infants, of which 55.2% were from GDM mothers and 44.8% were from PGDM mothers. The findings of this study align with and diverge from previous research in various ways, especially concerning the serum magnesium levels and other associated biochemical markers in infants of diabetic mothers (IDMs) [12].

A key finding of our study was that hypomagnesemia was significantly higher in infants born to PGDM mothers (63.8%) compared to those born to GDM mothers (24.1%). This result is consistent with earlier studies that also reported lower serum magnesium levels in infants born to diabetic mothers, particularly those with PGDM. Fetal magnesium deficiency results from maternal glycosuria caused by poor glycemic control and urinary Mg^{2+} loss [13]. That indicates the higher rate of hypomagnesemia in the PGDM group may be attributed to the long-standing diabetes in mothers, which can affect placental function and fetal nutrient transfer. Other studies have similarly shown that pre-gestational diabetes leads to a more pronounced disruption in mineral metabolism than gestational diabetes, likely due to the longer duration of maternal hyperglycemia [14].

Our findings on serum calcium levels further showed that hypocalcemia was more prevalent in the IPGDM group (36.2%) compared to the IGDM group (12.1%). This is in agreement with studies that have linked pre-gestational diabetes to calcium metabolism disturbances in newborns. The lower serum calcium in PGDM infants could be due to chronic fetal hypoxia and alterations in parathyroid hormone regulation, which are more pronounced in long-standing diabetes.

Overall, the significant association between IPGDM and hypomagnesemia observed in our study underscores the importance of close monitoring of serum magnesium levels in infants born to diabetic mothers, particularly those with long-standing diabetes. Our study also showed a positive correlation between serum magnesium and calcium level in IDMs. That means, hypomagnesemia has been shown to influence calcium metabolism, as magnesium plays a critical role in maintaining calcium homeostasis. Magnesium deficiency can impair the release of parathyroid hormone (PTH), which is essential for calcium regulation, leading to hypocalcemia. In our study, the co-occurrence of hypomagnesemia and hypocalcemia in infants born to diabetic mothers further supports this biochemical interaction. The disrupted balance between magnesium and calcium in these infants highlights the need for comprehensive metabolic monitoring and potentially maternal magnesium supplementation, to prevent both hypomagnesemia and associated hypocalcemia in high-risk pregnancies [11-15].

Meanwhile, the lower rates of hypocalcemia in GDM infants could reflect better glycemic control during pregnancy, as many GDM mothers in our study (79.3%) were managed with diet alone.

Additionally, the mean serum magnesium levels were lower in IPGDM (0.71 ± 0.11 mmol/L) compared to IGDM (0.80 ± 0.14 mmol/L), which was statistically significant (p=0.001). This aligns with research that highlights the role of magnesium in insulin regulation and glucose metabolism. The prolonged exposure to hyperglycemia in PGDM may lead to greater depletion of magnesium stores, thus affecting the infants more severely [16-17].

CONCLUSION

In conclusion, our study reveals both parallels and divergences with other research concerning the biochemical outcomes in infants of diabetic mothers. The greater prevalence of hypomagnesemia and hypocalcemia in the IPGDM group, as well as positive correlation between serum magnesium and calcium level in IDMs highlights the complexity to manage diabetes in pregnancy. These findings suggest a need for tailored interventions depending on the type of maternal diabetes to optimize neonatal outcomes.

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