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Comparative Analysis of Glucose and Calcium Profiles in Neonates Born to Diabetic Versus Non-Diabetic Mothers

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ABSTRACT

Background: Neonates born to diabetic mothers are at increased risk of early metabolic disturbances, particularly hypoglycemia and hypocalcemia, due to fetal hyperinsulinemia and abrupt withdrawal of maternal glucose and calcium at birth. These imbalances may predispose to neonatal complications if not promptly identified and managed. Aim of the study: To compare early glucose and calcium profiles in neonates born to diabetic versus non-diabetic mothers and evaluate the association between maternal diabetes and neonatal metabolic disturbances. **Methods & Materials:** A comparative cross-sectional study was conducted at Rajshahi Medical College Hospital, Bangladesh, enrolling 100 term neonates (60 born to diabetic mothers, 40 to non-diabetic mothers). Early capillary glucose was measured at 0.5, 2, 4, 6, 12, and 24 hours of life, and serum calcium was assessed at 24–48 hours. Maternal and neonatal clinical data were recorded. Data were analyzed using SPSS version 26.0, applying independent t-tests, Chi-square tests, and odds ratios to determine statistical significance ($p<0.05$). **Result:** Neonates of diabetic mothers had significantly lower glucose at all time points (0.5h: 39.8±12.5 vs. 52.1±13.8 mg/dL, $p<0.001$) and lower mean calcium levels (7.82±1.65 vs. 8.91±1.54 mg/dL, $p<0.001$) compared to controls. Hypoglycemia occurred in 70% vs. 28% (OR=3.61, 95% CI: 1.76–7.44, $p<0.001$) and hypocalcemia in 26% vs. 8% (OR=3.67, 95% CI: 1.29–10.47, $p=0.01$) of neonates, respectively. **Conclusion:** Maternal diabetes significantly increases the risk of early neonatal hypoglycemia and hypocalcemia. Early identification and management of these metabolic disturbances, along with optimized maternal glycemic control, are essential to improve neonatal outcomes.

Keywords: *Neonates, Diabetic mothers, Hypoglycemia, Hypocalcemia, Glucose profile, Calcium profile*

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Introduction

Glucose and calcium profiles in neonates born to diabetic mothers refer to the measurement and monitoring zlances [4]. At birth, neonates of diabetic mothers typically have lower cord-blood glucose and calcium levels compared to those born to non-diabetic mothers, reflecting the abrupt cessation of maternal glucose and calcium supply [1]. This sudden withdrawal, combined with fetal hyperinsulinemia, significantly raises the risk of early neonatal hypoglycemia and hypocalcemia in infants of diabetic mothers [5]. These metabolic disturbances raise the risk of neonatal complications like macrosomia, hypoglycemia, and hypocalcemia, highlighting the need for good maternal glycemic control and close newborn monitoring [6]. Despite advances in management, the altered intrauterine environment caused by maternal diabetes has lasting effects on offspring's metabolic health, highlighting the need for preventive strategies before and during pregnancy [7]. Neonates born to diabetic mothers show a markedly higher rate of hypoglycemia in the early hours of life, with many cases identified as early as the first hour and continuing to occur within the first 12 hours after birth [8]. This increased risk results from fetal hyperinsulinemia and the abrupt withdrawal of maternal glucose at birth, and many hypoglycemic neonates also develop early hypocalcemia, which is more common among infants of diabetic mothers [9]. The coexistence of hypoglycemia and hypocalcemia highlights the metabolic vulnerability of these infants, necessitating close monitoring of both glucose and calcium levels soon after birth [1]. Maternal factors such as poor glycemic control, insulin therapy during pregnancy, and gestational diabetes severity further increase the risk of these metabolic disturbances [2]. Early identification and management of hypoglycemia and hypocalcemia in neonates of diabetic mothers are critical to prevent complications and improve neonatal outcomes [10]. Infants of diabetic mothers (IDMs) experience hypocalcemia more frequently during the first 1 to 3 days of life compared to infants of non-diabetic mothers, with studies showing a clear association between maternal diabetes and lower neonatal calcium levels [9]. IDMs are more likely to require medical interventions such as glucose infusions, calcium supplementation, and NICU admission due to these metabolic disturbances, with intervention needs linked to the severity of maternal diabetes and neonatal metabolic instability [11]. Recovery patterns in IDMs may involve longer or less stable normalization of glucose and calcium levels compared to non-IDMs. [12]. This study aimed to compare early neonatal glucose and calcium levels between infants of diabetic mothers and those of non-diabetic mothers.

Methods & Materials

This comparative cross-sectional study was conducted in the Department of Pediatrics at Rajshahi Medical College Hospital, a major tertiary care referral center in Bangladesh. The study was carried out over an 18-month period from January 2017 to June 2018, enrolling neonates who met the eligibility criteria. A total of 100 neonates were enrolled, comprising 60 born to diabetic mothers and 40 born to non-diabetic mothers. Maternal diabetes included gestational diabetes mellitus (GDM) and pre-existing type 2 diabetes, diagnosed according to standard obstetric and ADA guidelines. A consecutive sampling technique was used to recruit eligible neonates during the study period.

Inclusion & Exclusion Criteria

Inclusion Criteria

- Term neonates born to diabetic mothers.
- Neonates within the first week of life (≤7 days).

Exclusion Criteria

- Neonates older than 7 days.
- Neonates of diabetic mothers with clinical sepsis.
- Neonates with emergency surgical conditions or major congenital anomalies affecting sampling or clinical assessment.

Data Collection Procedure

Data collection followed a structured and standardized protocol to ensure methodological consistency. Maternal information—including age, parity, type of diabetes (gestational or pre-existing), antenatal glycemic control, and mode of delivery—was extracted from hospital records and verified through bedside interviews when appropriate. Neonatal assessments were conducted within the first hour of life, and variables such as sex, gestational age, birth weight, Apgar scores, and early clinical status were recorded by the attending neonatologist.

For biochemical evaluation, capillary blood glucose samples were collected at predetermined intervals—0.5, 2, 4, 6, 12, and 24 hours of life—using aseptic techniques. Glucose levels were measured immediately using a validated glucose oxidase–peroxidase method. Serum calcium estimation was performed between 24 and 48 hours of life using venous blood samples analyzed in the central laboratory via the Arsenazo III colorimetric method. All laboratory measurements were carried out using calibrated automated analyzers to minimize inter-assay variability.

Clinical monitoring was performed throughout hospitalization to detect early neonatal complications, including respiratory distress, symptoms of hypoglycemia, jaundice requiring phototherapy, birth injuries, and congenital anomalies. All clinical and laboratory data were recorded in a dedicated case record form. The principal investigator reviewed data daily to ensure completeness, accuracy, and adherence to study protocols.

Statistical Analysis

Data analysis was performed using SPSS version 26.0. Continuous variables were tested for normality, expressed as mean ± standard deviation, and compared between groups using independent t-tests. Categorical variables were presented as frequencies and percentages, and group differences were assessed using Chi-square or Fisher's exact tests as appropriate. Odds ratios (OR) with corresponding 95% confidence intervals (CI) were calculated to determine the association between maternal diabetes and neonatal hypoglycemia or hypocalcemia. A p-value <0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the Institutional Review Board (IRB) of Rajshahi Medical College. Written informed consent was obtained from parents or legal guardians prior to enrollment. The study involved minimal-risk procedures, and confidentiality of maternal and neonatal information was strictly maintained following institutional guidelines and the principles outlined in the Declaration of Helsinki.

Result

Mothers with diabetes were significantly older than non-diabetic mothers (30.8±5.2 vs. 27.4±4.8 years, p = 0.001) (*Table I*).

Table I
Baseline maternal and neonatal characteristics of the study population (*n*=100).

Variables	Diabetic Mothers (n = 60)		Non-Diabetic Mothers (n = 60)		p-value
	n	%	n	%	
Maternal Age (years)					
Mean ± SD	30.8 ± 5.2		27.4 ± 4.8		0.001*
Neonatal age at assessment (hours)					
Mean ± SD	1.15 ± 1.14		1.20 ± 1.10		0.68
Gender					
Male	28	56.00	26	52.00	0.59
Female	22	44.00	24	48.00	
Gestational Age (weeks)					
Mean ± SD	37.1 ± 1.8		38.0 ± 1.5		0.002*
Birth Weight (kg)					
Mean ± SD	3.23 ± 0.62		2.92 ± 0.51		0.001*
Mode of Delivery					
Normal vaginal delivery	15	30.00	24	48.00	0.03*
Cesarean section	35	70.00	26	52.00	

Neonatal age at assessment did not differ between groups (p = 0.68); however, gestational age was lower in diabetic pregnancies (37.1±1.8 vs. 38.0±1.5 weeks, p = 0.002). Newborns of diabetic mothers had higher birth weights (3.23±0.62 vs. 2.92±0.51 kg, p = 0.001). Gender distribution was similar (p = 0.59), while mode of delivery differed significantly, with more cesarean sections in the diabetic group (70% vs. 52%, p = 0.03). Table 2 shows that early neonatal glucose levels were consistently lower in infants of diabetic mothers (*Table II*).

Table II
Early neonatal glucose levels (mg/dL).

Time Point	Diabetic Mothers, mean ± SD	Non-Diabetic Mothers, mean ± SD	p-value
0.5 hour	39.8 ± 12.5	52.1 ± 13.8	<0.001*
2 hours	45.6 ± 11.2	58.5 ± 14.1	<0.001*
4 hours	52.4 ± 13.0	65.2 ± 15.6	<0.001*
6 hours	60.5 ± 12.1	70.3 ± 14.7	<0.001*
12 hours	68.7 ± 12.8	76.4 ± 13.9	0.003*
24 hours	72.1 ± 11.4	78.3 ± 12.7	0.010*

At 0.5-hour, glucose was 39.8±12.5 vs. 52.1±13.8 mg/dL (p<0.001), remaining significantly lower at 2 hours (45.6±11.2 vs. 58.5±14.1 mg/dL, p<0.001), 4 hours (52.4±13.0 vs. 65.2±15.6 mg/dL, p<0.001), 6 hours (p<0.001), 12 hours (p=0.003), and 24 hours (p = 0.010). The proportion of neonates with low glucose was higher in the diabetic group at 0.5 hour (54% vs. 24%, p<0.001), 2 hours (44% vs. 16%, p = 0.002), and 4 hours (32% vs. 12%, p = 0.006), with no significant differences at 6, 12, or 24 hours (*Table III*).

Table III
Early neonatal glucose profiles at serial time points of the study population.

Time Point	Diabetic Mothers		Non-Diabetic Mothers		p-value
	n	%	n	%	
0.5 hour	27	54.00	12	24.00	<0.001*
2 hours	22	44.00	8	16.00	0.002*
4 hours	16	32.00	6	12.00	0.006*
6 hours	9	18.00	4	8.00	0.12
12 hours	5	10.00	3	6.00	0.51
24 hours	3	6.00	2	4.00	0.65

Table IV indicates that neonatal calcium levels were lower in infants of diabetic mothers (7.82±1.65 vs. 8.91±1.54 mg/dL, p<0.001), with hypocalcemia (<7 mg/dL) more frequent in the diabetic group (26% vs. 8%, p = 0.01).

Table IV
Neonatal calcium levels and hypocalcemia status of the study population.

Calcium Parameter	Diabetic Mothers (n = 60)	Non-Diabetic Mothers (n = 60)	p-value
Serum Calcium (mg/dL), mean ± SD	7.82 ± 1.65	8.91 ± 1.54	<0.001*
Hypocalcemia (<7 mg/dL), n (%)	13 (26.00)	4 (8.00)	0.01*

Early neonatal complications included higher, though non-significant, rates of respiratory distress (20% vs. 10%, p = 0.12) and jaundice requiring phototherapy (30% vs. 16%, p = 0.09), while birth injuries (8% vs. 6%, p = 0.47) and congenital anomalies (10% vs. 4%, p = 0.14) were similar (*Table V*).

Table V
Congenital and early neonatal complications of the study population.

Complication	Diabetic Mothers		Non-Diabetic Mothers		p-value
	n	%	n	%	
Respiratory distress	10	20.00	5	10.00	0.12
Birth injury	4	8.00	3	6.00	0.47
Jaundice requiring phototherapy	15	30.00	8	16.00	0.09
Congenital anomalies	5	10.00	2	4.00	0.14

Table VI demonstrates that Maternal diabetes significantly increased the risk of neonatal hypoglycemia (70% vs. 28%; OR = 3.61, 95% CI: 1.76-7.44, p<0.001).

Table VI
Association of maternal diabetes with neonatal hypoglycemia.

Group	Hypoglycemic n (%)	Not Hypoglycemic n (%)	Odds Ratio (95% CI)	p-value
Diabetic Mothers (n=50)	35 (70.00)	15 (30.00)	3.61 (1.76–7.44)	<0.001*
Non-Diabetic Mothers (n=50)	14 (28.00)	36 (72.00)	—	—

Neonatal hypocalcemia was more frequent among infants of diabetic mothers (26% vs. 8%; OR = 3.67, 95% CI: 1.29-10.47, p = 0.01) (*Table VII*).

Table VII
Association of maternal diabetes with neonatal hypocalcemia.

Group	Hypocalcemia n (%)	Normal Calcium n (%)	Odds Ratio (95% CI)	p-value
Diabetic Mothers (n=50)	13 (26.00)	37 (74.00)	3.67 (1.29–10.47)	0.01*
Non-Diabetic Mothers (n=50)	4 (8.00)	46 (92.00)	—	—

Discussion

This study explores whether newborns of diabetic mothers differ in glucose and calcium homeostasis compared with those of non-diabetic mothers, shedding light on metabolic risks in the perinatal period [1]. Diabetic mothers were older (30.8 vs. 27.4 y, $p = 0.001$); their neonates had lower gestational age (37.1 vs. 38.0 wk, $p = 0.002$), higher birth weight (3.23 vs. 2.92 kg, $p = 0.001$), and more cesarean deliveries (70% vs. 52%, $p = 0.03$). Islam et al. reported that mothers of neonates had a mean age of 25.36 ± 5.50 years, with diabetic mothers being older than their non-diabetic counterparts [1]. Muntean et al. stated that mothers with diabetes were older, had higher body mass index (BMI), and more gestations, while parity was comparable; cesarean section was the predominant mode of delivery [13]. Shahab et al. reported that macrosomic infants were predominantly male in both groups: 70% vs. 29.8% ($p = 0.005$) in diabetic mothers, and 66.6% vs. 33.3% ($p = 0.679$) in non-diabetic mothers [14]. Cordero et al. stated that 36% of infants were large for gestational age, 62% appropriate, and 2% small; 14% were born before 34 weeks, 22% between 34–37 weeks, and 64% at term [15]. Neonates of diabetic mothers had lower glucose levels early after birth: 0.5 h (39.8 vs. 52.1 mg/dL, $p < 0.001$), 2 h (45.6 vs. 58.5, $p < 0.001$), 4 h (52.4 vs. 65.2, $p < 0.001$), 6 h ($p < 0.001$), 12 h ($p = 0.003$), 24 h ($p = 0.010$); hypoglycemia was more frequent at 0.5 h (54% vs. 24%, $p < 0.001$), 2 h (44% vs. 16%, $p = 0.002$), 4 h (32% vs. 12%, $p = 0.006$). Anjum et al. reported hypoglycemia in 54% of infants of diabetic mothers, often accompanied by subsequent metabolic abnormalities [16]. Similarly, Islam et al. reported that 62.3% of infants of diabetic mothers experienced hypoglycemia versus 11.4% in controls in the first 30 minutes [1]. Begum et al. reported hypoglycemia in 38.3% of infants of diabetic mothers, mostly within the first 6 hours, peaking at 2 hours [17]. Another study by Agrawal et al. reported that 47% of infants of diabetic mothers developed hypoglycemia within the first 2 hours, despite relatively well-controlled maternal glucose [18]. Neonatal calcium was lower in infants of diabetic mothers (7.82 vs. 8.91 mg/dL, $p < 0.001$), with hypocalcemia more frequent (26% vs. 8%, $p = 0.01$). Similarly, Islam et al. reported hypocalcemia occurred in 22.5% of infants of diabetic mothers versus 5.3% of non-diabetic mothers [1]. Mimouni et al. stated that low cord-blood calcium and lower gestational age were the primary predictors of neonatal hypocalcemia [19]. Early complications in infants of diabetic mothers: respiratory distress 20% vs. 10% ($p = 0.12$), jaundice 30% vs. 16% ($p = 0.09$), birth injuries 8% vs. 6% ($p = 0.47$), congenital anomalies 10% vs. 4% ($p = 0.14$). Cordero et al. stated that macrosomic infants of diabetic mothers have higher risks of respiratory disorders (TTNB), NICU admission, hypoglycemia, and hyperbilirubinemia compared with those of non-diabetic mothers [20]. Gabbe et al. reported 9% incidence of RDS, 6% congenital malformations, 37% hyperbilirubinemia, and 13% hypocalcemia [21]. In this study, neonatal hypoglycemia occurred in 70% of infants of diabetic mothers versus 28% in controls (OR 3.61, 95% CI 1.76–7.44, $p < 0.001$) and hypocalcemia occurred in 26% of infants of diabetic mothers versus 8% in controls (OR 3.67, 95% CI 1.29–10.47, $p = 0.01$). Islam et al. reported that hypoglycemia and hypocalcemia were significantly associated with maternal diabetes ($p < 0.001$), with a markedly higher incidence in infants of diabetic mothers [1]. Wang et al. reported gestational diabetes mellitus as a significant risk factor for neonatal hypoglycemia (OR 1.65; 95% CI 1.11–2.46) [22]. Ali et al. stated that maternal vitamin D deficiency increased risk, affecting 42.4% of infants, and neonatal hypoglycemia was strongly linked to hypocalcemia, present in 40.0% of hypoglycemic neonates [23].

Limitations

This study had several limitations. Its single-center design and relatively small sample size may limit generalizability to broader populations. Only term neonates were included, excluding preterm infants who may have different metabolic profiles. Maternal glycemic control was assessed based on routine records rather than continuous monitoring, which could affect accuracy. Long-term follow-up of neonatal outcomes was not performed, preventing assessment of persistent metabolic or developmental effects. Additionally, potential confounding factors such as maternal nutrition and concurrent illnesses were not fully controlled.

Conclusion

Neonates born to diabetic mothers exhibit significantly lower early glucose and calcium levels compared to those born to non-diabetic mothers, with higher incidences of hypoglycemia and hypocalcemia. Maternal diabetes was strongly associated with metabolic instability in the first 24 hours of life, highlighting the vulnerability of these infants to early complications. These findings underscore the critical need for vigilant monitoring of glucose and calcium in neonates of diabetic mothers, particularly within the initial hours postpartum. Optimized maternal glycemic control during pregnancy, timely identification, and prompt management of metabolic disturbances are essential strategies to reduce neonatal morbidity and improve outcomes in this high-risk population.

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