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ORIGINAL ARTICLE

Gestational Diabetes Mellitus and Associated Neonatal Complications in Pakistani Women: A Comparative Study

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ABSTRACT

Background: Gestational diabetes mellitus (GDM) is increasingly prevalent and linked to adverse neonatal outcomes, yet its impact remains under-characterized in many low-resource settings.

Objective: To determine the association between GDM and neonatal complications including macrosomia, hypoglycemia, respiratory distress, intensive care admission, and stillbirth at a tertiary care center in Pakistan.

Methods: In this Comparative Study conducted from January to December 2022 at Sandeman Provincial Hospital, 70 pregnant women (≥ 28 weeks' gestation) were enrolled. Thirty-five women diagnosed with GDM by 75 g oral glucose tolerance testing (IADPSG criteria) were matched by age and gestational age to 35 normoglycemic controls. Neonatal outcomes were recorded within 24 hours of birth. Continuous and categorical variables were compared using t tests and chi-square or Fisher's exact tests, respectively, with $p < 0.05$ denoting significance.

Results: Infants of mothers with GDM exhibited significantly higher rates of macrosomia (28.6 % vs. 8.6 %; $p = 0.02$) and neonatal hypoglycemia (20.0 % vs. 5.7 %; $p = 0.04$). Although more GDM-exposed neonates required intensive care (25.7 % vs. 11.4 %; $p = 0.09$), this did not reach statistical significance. There were no significant differences in respiratory distress (11.4 % vs. 5.7 %; $p = 0.68$), stillbirth (2.9 % vs. 0 %; $p = 0.31$), Apgar scores, or length of hospital stay.

Conclusions: GDM significantly elevates the risk of macrosomia and early hypoglycemia. These findings underscore the need for universal antenatal screening, stringent glycemic management, and standardized neonatal monitoring protocols to mitigate perinatal morbidity in resource-constrained settings.

Keywords: gestational diabetes mellitus; neonatal complications; macrosomia; hypoglycemia; Pakistan; prospective observational study.

INTRODUCTION

Gestational diabetes mellitus (GDM), defined as glucose intolerance first recognized during pregnancy, has emerged as one of the most significant metabolic complications affecting both maternal and neonatal health worldwide [1]. Over recent decades, its incidence has risen in parallel with increasing rates of maternal overweight and obesity, delayed childbearing, and sedentary lifestyles. Reported prevalence varies widely from approximately 1 percent in some Northern European cohorts to more than 20 percent in South Asian populations reflecting differences in genetic susceptibility, nutritional patterns, and diagnostic criteria. In pregnant women, GDM not only increases the risk of obstetric complications such as preeclampsia, polyhydramnios, and cesarean delivery but also confers long-term risks of type 2 diabetes mellitus and cardiovascular disease for both mother and child [2].

The pathogenesis of GDM involves a physiologic rise in insulin resistance during mid to late gestation, mediated by placental hormones including human placental lactogen, progesterone, cortisol, and placental growth hormone. When pancreatic β-cells are unable to secrete sufficient insulin to overcome this resistance, maternal hyperglycemia ensues [3]. The fetus, exposed to elevated maternal glucose levels, responds with increased insulin production. Fetal hyperinsulinemia drives accelerated somatic growth and fat deposition, leading to macrosomia and attendant delivery complications such as shoulder dystocia. At birth, abrupt cessation of the maternal glucose supply unmasks persistent neonatal hyperinsulinemia and predisposes to hypoglycemia, which can result in seizures or neurologic injury if not promptly managed. Furthermore, excessive fetal adiposity combined with relative surfactant deficiency may precipitate respiratory distress syndrome, often necessitating intensive monitoring and supportive care [4].

In Pakistan, where maternal and neonatal mortality remain unacceptably high, GDM has been variably reported in 7 to 17 percent of pregnancies, depending on local screening practices and diagnostic thresholds. Universal screening is not uniformly implemented, and many women undergo testing only in the late third trimester or not at all [5]. Limitations in laboratory infrastructure, inconsistent quality control, and gaps in clinician awareness contribute to delayed diagnosis and suboptimal glycemic management. Consequently, the true burden of neonatal complications ranging from hypoglycemia and macrosomia to longer-term metabolic sequelae remains poorly characterized in this context [6].

To address these gaps in knowledge, this prospective observational study was undertaken in representative tertiary care settings in Pakistan. By enrolling women diagnosed with GDM according to current international criteria alongside gestational age-matched normoglycemic controls, and by systematically capturing neonatal outcomes such as birth weight, incidence of hypoglycemia, respiratory distress, intensive care admission, and stillbirth, current study aim to quantify the relative risk of key neonatal morbidities, identify predictors of adverse outcomes within the GDM cohort, and generate local evidence to inform screening guidelines and perinatal management protocols. The ultimate goal was to strengthen maternal neonatal care pathways and reduce perinatal morbidity and mortality associated with gestational hyperglycemia in resource-constrained settings [7, 8].

MATERIALS AND METHODS

Study Design and Setting: This Comparative Study was conducted at Sandeman Provincial Hospital, Quetta, Pakistan, between January 2022 and December 2022. The hospital serves a broad catchment area including urban and peri-urban populations and follows standardized antenatal screening protocols.

Participants: A total of seventy pregnant women were enrolled at or after 28 weeks' gestation. Women aged 18 to 45 years with singleton pregnancies were eligible. Those with preexisting type 1 or type 2 diabetes, multiple gestations, known major fetal anomalies, or chronic systemic illnesses (such as hypertension, renal disease, or thyroid dysfunction) were excluded. Consecutive sampling yielded thirty-five women diagnosed with gestational diabetes mellitus (GDM) and thirty-five normoglycemic controls

matched by maternal age (±2 years) and gestational age at enrollment (±1 week).

Screening and Diagnosis of Gestational Diabetes Mellitus: All participants underwent a 75-gram oral glucose tolerance test (OGTT) between 24 and 28 weeks of gestation after an overnight fast of at least eight hours. Venous blood samples were obtained at fasting, one hour, and two hours post-load. GDM was diagnosed according to International Association of Diabetes and Pregnancy Study Groups criteria when any one of the following plasma glucose values was met or exceeded: fasting 92 mg/dL, one-hour 180 mg/dL, or two-hour 153 mg/dL.

Data Collection: Trained research staff recorded maternal demographic and clinical characteristics using a structured case report form. Variables included maternal age, parity, body mass index at enrollment, family history of diabetes, and gestational age at delivery. Delivery details mode of delivery and intrapartum complications were documented. Neonatal data were extracted from delivery room and neonatal care unit records within the first 24 hours of life.

Outcome Measures: Primary neonatal outcomes comprised macrosomia (birth weight ≥ 4.0 kg), hypoglycemia (capillary blood glucose < 40 mg/dL within two hours of birth), respiratory distress (clinical signs of tachypnea, retractions, or need for supplemental oxygen, with or without characteristic radiographic findings), admission to neonatal intensive care, and stillbirth (fetal demise at or beyond 28 weeks' gestation). Secondary outcomes included Apgar scores at one and five minutes and total duration of neonatal hospitalization.

Statistical Analysis: Data were analyzed using SPSS version 27. Continuous variables are presented as mean ± standard deviation and compared using independent-samples t tests. Categorical variables are expressed as numbers and percentages and compared by chi-square test or Fisher's exact test, as appropriate. Relative risks with 95 percent confidence intervals were calculated for each neonatal outcome. Multivariate logistic regression adjusted for maternal body mass index, parity, and family history of diabetes. A two-sided p value < 0.05 was considered statistically significant.

Ethical Considerations: Ethical approval was obtained from the institutional review board. Written informed consent was secured from all participants prior to enrollment, and data confidentiality was maintained in accordance with the Declaration of Helsinki.

RESULTS

Seventy women completed the study, with thirty-five in the GDM group and thirty-five normoglycemic controls. As shown in Table 1, the two cohorts were well matched for age, body mass index (BMI), parity, and gestational age at delivery, thereby minimizing confounding by these demographic factors. The only significant baseline difference was a higher frequency of positive family history of diabetes among women with GDM (42.9 % vs. 20.0 %; p = 0.03), underscoring the heritable component of impaired glucose regulation in pregnancy.

Table 1. Baseline Demographic and Clinical Characteristics

Characteristic	GDM (n = 35)	Control (n = 35)	p-value
Maternal age, years (mean ± SD)	29.5 ± 4.0	28.7 ± 4.3	0.45
BMI at enrollment, kg/m² (mean ± SD)	27.1 ± 3.2	26.4 ± 3.0	0.38
Gestational age at delivery, weeks	38.0 ± 1.3	38.2 ± 1.0	0.56
Nulliparous, n (%)	20 (57.1 %)	18 (51.4 %)	0.62
Family history of diabetes, n (%)	15 (42.9 %)	7 (20.0 %)	0.03*

*Significant at p < 0.05.

Primary Neonatal Outcomes

Table 2 summarizes the key neonatal outcomes. The incidence of macrosomia a birth weight of at least 4.0 kg was significantly greater in the GDM group (28.6 % vs. 8.6 %; p = 0.02). This three-fold elevation reflects the well-established mechanism by which maternal hyperglycemia stimulates fetal pancreatic β-cells to secrete excess insulin, promoting accelerated somatic growth and increased adiposity. Clinically, macrosomia poses heightened risks of shoulder dystocia, birth trauma, and the need for operative delivery, and in our cohort, it correlated with a higher, though non-significant, cesarean-section rate (data not shown).

Neonatal hypoglycemia occurred in 20.0 % of infants born to mothers with GDM compared with 5.7 % of controls (p = 0.04). This finding is consistent with the abrupt transition from a hyperglycemic intrauterine environment to normoglycemia after cord clamping, unmasking persistent fetal hyperinsulinemia. Early postnatal hypoglycemia can manifest as irritability, tremors, poor feeding, and seizures, and if not promptly identified and corrected, may result in adverse neurodevelopmental outcomes. In our setting, all hypoglycemic infants received immediate dextrose therapy, which likely mitigated more severe sequelae.

Although NICU admissions were more frequent among GDM-exposed infants (25.7 % vs. 11.4 %; p = 0.09), this did not achieve statistical significance, possibly due to sample size limitations. Nevertheless, the trend suggests that GDM-related metabolic perturbations and birthweight extremes necessitate closer monitoring and additional supportive care. Respiratory distress affected 11.4 % of neonates in the GDM group compared to 5.7 % of controls (p = 0.68), a non-significant difference that nonetheless aligns with reports linking fetal hyperinsulinemia to surfactant synthesis impairment. Stillbirths were rare in both cohorts (2.9 % vs. 0 %; p = 0.31), indicating that rigorous intrapartum surveillance and timely obstetric intervention can successfully avert many of the most severe consequences of gestational hyperglycemia.

Table 2. Primary Neonatal Outcomes

Outcome	GDM (n = 35)	Control (n = 35)	p-value
Macrosomia	10 (28.6 %)	3 (8.6 %)	0.02*
Neonatal hypoglycemia	7 (20.0 %)	2 (5.7 %)	0.04*
NICU admission	9 (25.7 %)	4 (11.4 %)	0.09
Respiratory distress	4 (11.4 %)	2 (5.7 %)	0.68
Stillbirth	1 (2.9 %)	0 (0 %)	0.31

*Significant at p < 0.05.

Secondary Neonatal Outcomes: As detailed in Table 3, Apgar scores at one and five minutes were marginally lower in the GDM group (7.8 ± 0.6 vs. 8.0 ± 0.5 at one minute, p = 0.12; 8.9 ± 0.3 vs. 9.0 ± 0.2 at five minutes, p = 0.08), suggesting slightly delayed initial adaptation, although these differences were not statistically significant. The average duration of neonatal hospitalization was longer for infants of GDM mothers (3.2 ± 1.1 days vs. 2.8 ± 0.9 days; p = 0.15), reflecting added time for metabolic stabilization and feeding support.

Table 3. Secondary Neonatal Outcomes

Measure	GDM (n = 35)	Control (n = 35)	p-value
Apgar score at 1 min (mean ± SD)	7.8 ± 0.6	8.0 ± 0.5	0.12
Apgar score at 5 min (mean ± SD)	8.9 ± 0.3	9.0 ± 0.2	0.08
Hospital stay, days (mean ± SD)	3.2 ± 1.1	2.8 ± 0.9	0.15

Collectively, these findings reinforce the considerable impact of gestational diabetes on neonatal health. The statistically significant elevations in macrosomia and hypoglycemia carry immediate clinical consequences and potential long-term implications for metabolic programming. The non-significant trends toward increased NICU admissions and respiratory distress further underscore the complex neonatal care needs associated with in utero hyperglycemia. Importantly, comparable rates of stillbirth and only minor differences in Apgar scores suggest that, with vigilant prenatal surveillance and prompt postnatal interventions, many of

the most severe outcomes can be mitigated. These results highlight the critical need for universal GDM screening, structured intrapartum management, and standardized neonatal monitoring protocols to optimize outcomes in resource-constrained settings.

DISCUSSION

In this Comparative Study, gestational diabetes mellitus (GDM) was associated with a more than threefold increase in the risk of neonatal macrosomia and a similar increase in the risk of early hypoglycemia [9]. These findings are consistent with the well-described pathophysiology in which maternal hyperglycemia drives excess fetal insulin secretion, thereby accelerating somatic growth and fat deposition. Our macrosomia rate of 28.6 percent among GDM-exposed infants falls within the upper range reported in similar low-resource settings, where rates between 20 and 30 percent have been observed. Likewise, the 20 percent incidence of hypoglycemia aligns with published cohorts in which neonatal hypoglycemia complicates up to one-quarter of GDM pregnancies when glucose control is suboptimal [10, 11].

Although NICU admissions were more frequent among infants of mothers with GDM, this did not reach statistical significance in our sample. Nevertheless, the observed trend toward increased intensive care utilization underscores the broader resource implications of GDM. In environments where neonatal care capacity is limited, even modest increases in NICU demand can strain services and divert attention from other high-risk neonates[12]. Importantly, rates of respiratory distress and stillbirth remained low and comparable between groups, suggesting that vigilant intrapartum monitoring and prompt obstetric intervention can mitigate the most severe perinatal risks of GDM [13].

The clinical implications of these results are twofold. First, they reinforce the necessity of universal rather than risk-based GDM screening; earlier identification of glucose intolerance allows for timely initiation of dietary management, self-monitoring of blood glucose, and, when needed, pharmacotherapy[14]. Such interventions have been shown to reduce the incidence of macrosomia and neonatal hypoglycemia in randomized and observational trials. Second, our data support the implementation of standardized postnatal protocols for infants born to GDM mothers including routine glucose monitoring at defined intervals and clear thresholds for enteral dextrose supplementation to ensure rapid recognition and treatment of hypoglycemia before neurologic injury can occur[15,16].

This study has several strengths, including its prospective design, strict matching of GDM and control participants by age and gestational age, and systematic collection of both maternal and neonatal data using predefined criteria. Nonetheless, limitations must be acknowledged[17]. The single-center setting and relatively small sample size may limit external validity; larger, multi-center studies are needed to confirm these findings and to explore geographic or ethnic variations within Pakistan. Additionally, follow-up was limited to the immediate neonatal period; longer-term follow-up would clarify the impact of GDM on infant growth trajectories and neurodevelopmental outcomes. Finally, we did not evaluate maternal glycemic control metrics (such as HbA1c or daily glucose profiles), which could further elucidate the dose-response relationship between hyperglycemia severity and neonatal risk[18].

finally, our findings highlight GDM as a strong predictor of macrosomia and neonatal hypoglycemia in this Pakistani cohort. To improve perinatal outcomes, it is imperative to adopt universal screening policies, optimize antenatal glycemic management, and enact standardized neonatal monitoring and intervention protocols in resource-constrained settings [19].

CONCLUSION

Gestational diabetes significantly elevates the risks of neonatal macrosomia and hypoglycemia in Pakistani women. To mitigate these adverse outcomes, implementation of universal screening, robust antenatal glycemic control, and structured neonatal monitoring protocols is essential particularly in resource-limited settings where perinatal care demands continue to rise.

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