

Neonatal and Maternal outcomes in GDM and Non GDM Pregnancies

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ABSTRACT

Background: Gestational diabetes mellitus (GDM) is a common pregnancy complication known to impact perinatal outcomes. Among the key neonatal indicators, the Apgar score and birth weight serve as immediate and essential markers of neonatal health. This study aims to evaluate the relationship between GDM and neonatal APGAR scores at 1 and 5 minutes, as well as birth weight, comparing outcomes with those from non-GDM pregnancies.

Objectives: To compare APGAR scores and birth weight between neonates born to GDM mothers and those born to non-GDM mothers and assess whether GDM significantly affects these early neonatal parameters.

Methods: This hospital-based case-control study analyzed 100 pregnant women (50 GDM, 50 non-GDM) in the Department of Obstetrics and Gynecology from March 2024 to March 2025 to investigate the association between gestational diabetes mellitus (GDM) and maternal-neonatal outcomes. A total of 100 pregnant women were enrolled, with 50 diagnosed with GDM (cases) and 50 without GDM (controls), matched for gestational age. GDM diagnosis was confirmed using the criteria: IADPSG 75g OGTT. Statistical analysis included descriptive statistics, t-tests, chi-square tests, and logistic regression (SPSS v26, $p < 0.05$). Ethical approval and informed consent were obtained.

Results: Significant differences were observed between GDM and non-GDM pregnancies. Mothers with GDM showed higher metabolic parameters and increased rates of caesarean deliveries. Neonates born to GDM mothers had greater birth weights but lower APGAR scores compared to controls. Logistic regression confirmed a strong association between GDM and delivery mode.

Conclusion: This study demonstrates that GDM significantly impacts both maternal and neonatal outcomes, with notable metabolic alterations, increased caesarean deliveries, and affected neonatal health. The findings emphasize the need for vigilant monitoring and management of GDM pregnancies to optimize outcomes. Further research should explore long-term effects and personalized intervention strategies.

1. INTRODUCTION:

The worldwide prevalence of GDM has shown a marked rise in recent years¹. In India—the most populous nation—estimates of GDM prevalence vary significantly, ranging from 3% to 35%, as per the evidence from a systematic review and meta-analysis². GDM usually develops during gestational weeks 24 to 28 of pregnancy and is mainly caused by increased insulin resistance, especially in the later stages of pregnancy³. It may result in a range of complications affecting maternal and neonatal health⁴. Type 2 diabetes mellitus, after giving birth is more likely to occur in women with GDM, experiencing hypertensive disorders such as preeclampsia, and requiring caesarean delivery⁵. For the offspring, GDM is associated with complications including high birth weight, neonatal low blood glucose concentration, respiratory distress, low 1-minute APGAR scores and a greater probability of metabolic diseases in childhood or in later life.⁶ Pathophysiologically, gestational diabetes is linked to dysfunction of the maternal pancreatic β -cells or a delayed compensatory response, leading to inadequate insulin secretion and maternal hyperglycemia⁷. Furthermore, maternal obesity in early pregnancy enhances insulin resistance⁸. Increased free fatty acids circulating in obese individuals impair peripheral glucose uptake and enhance hepatic gluconeogenesis, contributing to hyperglycemia in GDM⁹. The WHO suggests a 75-gram, two hour OGTT to diagnose

GDM. A study by Sacks et al found that increased serum glucose levels in mother were associated with several health issues.⁹ The American Diabetes Association (ADA) endorses either a single-step or sequential two-step method for diagnosing GDM.¹⁰ According to the White Classification system, women with GDM who maintain euglycemia through lifestyle changes are classified as GDM A1, while those requiring insulin are classified as GDM A2.¹⁰

The APGAR score is a rapid method for assessing a neonate immediately after birth and in response to resuscitation.¹¹ APGAR scoring remains the accepted assessment method endorsed by the American College of Obstetricians and Gynecologists and the American Academy of Pediatrics.¹² While originally designed in 1952 by Dr. Virginia APGAR, an anesthesiologist at Columbia University, to assess the need for intervention to establish breathing at 1 minute. The guidelines for the Neonatal Resuscitation Program state that APGAR scores should not be used to determine the initial need for intervention, what interventions are indicated, or when to initiate them, as resuscitation must be commenced before the 1-minute Apgar score is assigned.¹³

Elements of the Apgar score include color, heart rate, reflexes, muscle tone, and respiration. It is designed to assess for signs of hemodynamic compromise, including cyanosis, hypoperfusion, bradycardia, hypotonia, respiratory depression, or apnea.¹⁴ Each element is scored 0, 1, or 2.¹⁵ The score is recorded at 1 minute and 5 minutes after delivery in all infants, with expanded recording at 5-minute intervals for infants who score ≤ 7 at 5 minutes and in those requiring resuscitation as a method for monitoring response; scores of 7 to 10 are considered reassuring.¹⁶

APGAR scores may vary with gestational age, birth weight, maternal medications, drug use or anesthesia, and congenital anomalies.¹⁷ Several components of the score are also subjective and prone to inter-rater variability.¹⁸ Thus, the APGAR score is limited because it provides somewhat subjective information about an infant's physiology at a point in time.¹⁹ APGAR score alone should not be interpreted as evidence of asphyxia, and its significance in outcome studies, while widely reported, is often inappropriate.²⁰ Resuscitation should always take precedence over calculating a clinical score.

2. METHODOLOGY:

This case-control study was conducted in the Department of Obstetrics and Gynecology from march 2024 to march 2025 to investigate the association between gestational diabetes mellitus (GDM) and maternal-neonatal outcomes.²¹ A total of 100 pregnant women were enrolled, with 50 diagnosed with GDM (cases) and 50 without GDM (controls), matched for gestational age.²² GDM diagnosis was confirmed using the criteria: IADPSG 75g OGTT.²³

Data Collection Demographic, clinical, and biochemical parameters were extracted from medical records, including maternal age, BMI, random blood sugar (RBS), mode of delivery, neonatal birth weight, and APGAR scores at 1 and 5 minutes.²⁴

Statistical Analysis: Descriptive statistics (mean $\pm$ SD, frequencies, percentages) summarized continuous and categorical variables. Independent t-tests compared mean values between GDM and non-GDM groups for normally distributed data, while chi-square tests assessed association for categorical variables. Adjusted and unadjusted odds ratios (OR) with 95% confidence intervals (CIs) were calculated using logistic regression to evaluate GDM risk factors. A p-value < 0.05 was considered statistically significant. Analysis was performed using Software, e.g., SPSS v26.

Ethical Considerations: The study protocol was approved by the Institutional Ethics Committee, and informed consent was obtained from all participants. Confidentiality was maintained through anonymized data collection.

Inclusion criteria - Live-born neonates delivered at gestational age ≥ 37 weeks (term pregnancies), neonates born to mothers with confirmed GDM (per standard diagnostic criteria) or non-GDM status (normal OGTT), availability of documented Apgar scores at both 1 minute and 5 minutes post-delivery, neonates delivered in a facility with standardized neonatal assessment protocols, singleton pregnancies with no major obstetric complications affecting immediate neonatal health (e.g., placental abruption, cord prolapse).²⁵ The study group comprised GDM cases diagnosed per WHO/ADA criteria using OGTT, while non-GDM women with normal glucose tolerance served as controls. All participants provided informed consent for maternal and cord blood sample collection.²⁶

Exclusion criteria

Preterm neonates born before 37 completed weeks of gestation.

Multiple gestations (e.g., twins, triplets).

Stillbirths or intrauterine fetal demise (IUFD).

Neonates with major congenital anomalies or known genetic disorders.

Cases with missing or incomplete Apgar score data at 1 or 5 minutes.

Neonates requiring immediate intensive resuscitation or admitted directly to NICU before Apgar assessment.

Maternal conditions such as Type 1 or Type 2 pre-gestational diabetes, chronic hypertension, or other systemic diseases that may confound neonatal outcomes.

Deliveries with obstetric emergencies (e.g., uterine rupture, placental abruption) that directly compromise neonatal condition at birth.

Those unwilling to provide informed consent.

Equipment

While most auscultation is performed with a stethoscope rather than by palpation, the most accurate method remains an electrocardiogram.²⁷ No other equipment is required. A pulse oximeter may also be used. Ideally, a radiant warmer and an electrocardiogram should be readily available in the delivery suite to provide the necessary warmth for neonates with hypothermia and to provide a more accurate heart rate if resuscitation is required. Alternatively, warm blankets and a stethoscope could be used.²⁷

Personnel

Any trained healthcare professional may calculate the Apgar score depending on the situation, including: Neonatologist, Pediatrician, Midwife, Nurse, Respiratory Therapist²⁸

Technique or Treatment

There are 5 parts to an Apgar score. Each category is weighed evenly and assigned a 0, 1, or 2 value. The components are then added to give a score recorded 1 and 5 minutes after birth. A score of 7 to 10 is considered reassuring, a score of 4 to 6 is moderately abnormal, and a score of 0 to 3 is deemed low in full-term and late preterm infants, at 5 minutes, when an infant has a score of <7, Neonatal Resuscitation Program guidelines recommend continued recording at 5-minute intervals up to 20 minutes. Scoring during resuscitation is not equivalent to an infant not undergoing resuscitation because resuscitative efforts alter several score elements.²⁹

The score is calculated using the following assessment:

Breathing effort

If the neonate is not breathing, the respiratory score is 0.

If respirations are slow and irregular, weak, or gasping, the respiratory score is 1.

If the neonate is crying vigorously, the respiratory score is 2.

Heart rate

The heart rate is evaluated with a stethoscope or an electrocardiogram and is the most critical part of the score in determining the need for resuscitation.³⁰

If there is no heartbeat, the heart rate score is 0.

If the heart rate is <100 bpm, the heart rate score is 1.

If the heart rate is >100 bpm, the heart rate score is 2.

Muscle tone

In inactive neonates with loose and floppy muscle tone, the score for muscle tone is 0.

In neonates demonstrating some tone and flexion, the score for muscle tone is 1.

In neonates in active motion with a flexed muscle tone that resists extension, the muscle tone score is 2.

Grimace response or reflex irritability in response to stimulation

In a neonate with no response to stimulation, the reflex irritability response score is 0.

A neonate grimacing in response to stimulation has a reflex irritability response score of 1.

In a neonate who cries, coughs, or sneezes on stimulation, the reflex irritability response is 2.³⁹

Color

Most infants will score 1 for color even at the 5-minute, as peripheral cyanosis is common among normal infants. Color can also be misleading in non-white infants.³¹

If the neonate is pale or blue, the score for color is 0.

If the infant is pink, but the extremities are blue, the score for color is 1.

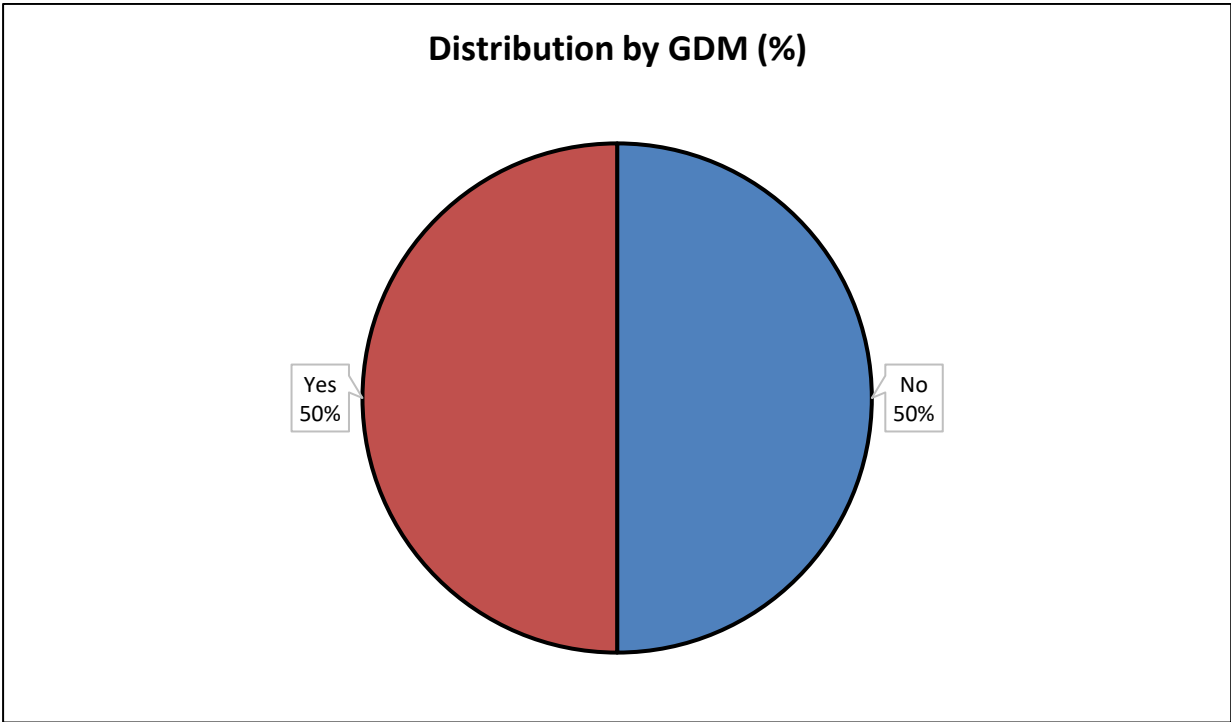
If the neonate is entirely pink, the score for color is 2.40

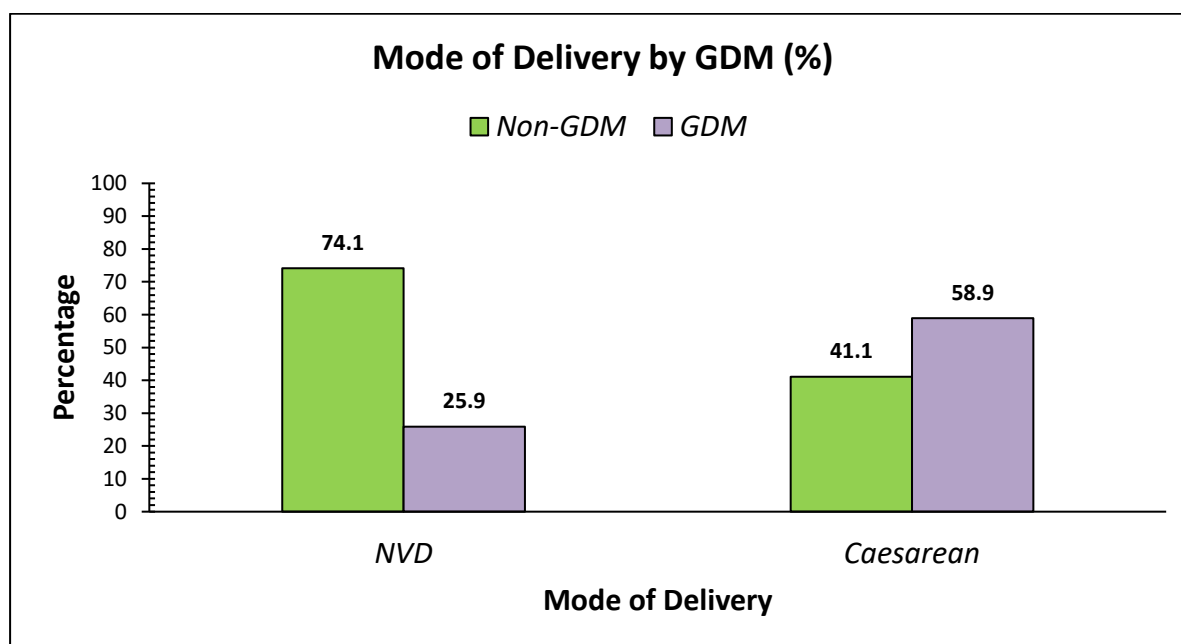
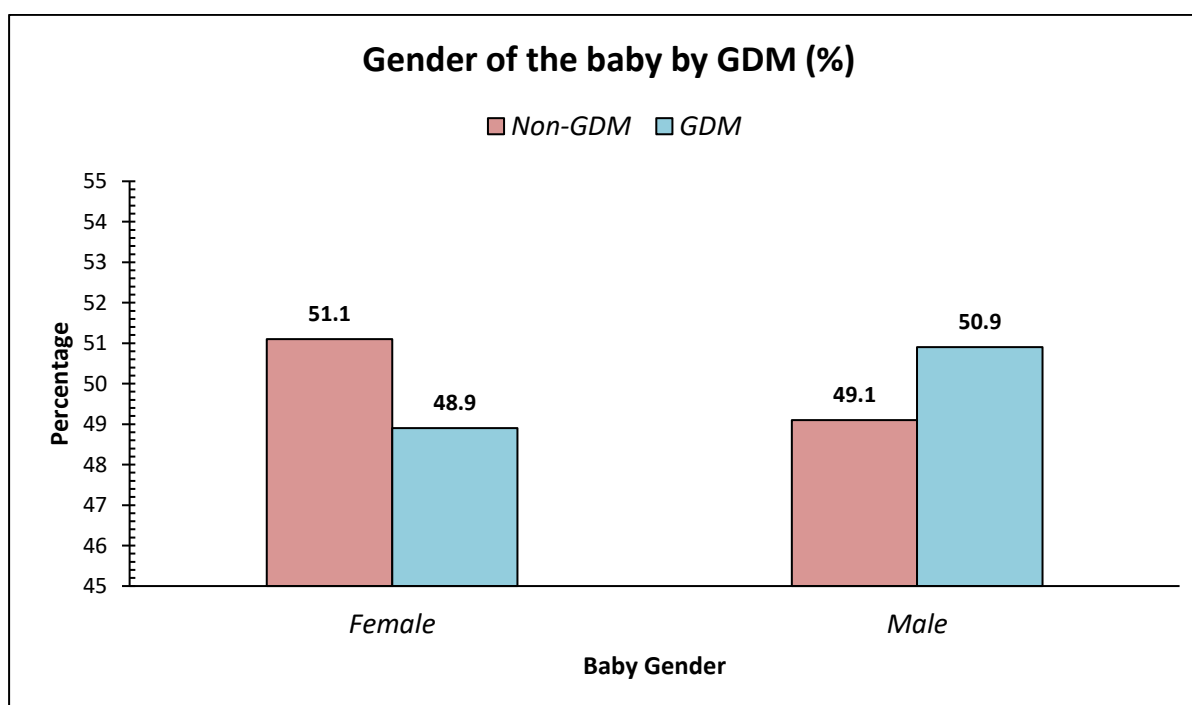
RESULT: The study analyzed various maternal and neonatal variables to assess their distribution and association with Gestational Diabetes Mellitus (GDM). The sample comprised 100 participants, evenly divided between GDM and non-GDM cases (50% each). Mode of delivery showed a significant disparity, with 73% of deliveries being Caesarean and only 27% being Normal Vaginal Deliveries (NVD). Baby gender distribution was nearly balanced, with 55% males and 45% females.

Table 1. Frequency distribution of study variables

Variable		n	%
GDM	No	50	50
	Yes	50	50
Mode of Delivery	NVD	27	27
	Caesarean	73	73
Baby Gender	Female	45	45
	Male	55	55
Total		100	100

Graph 1. Distribution by GDM



Graph 2. Distribution of Mode of Delivery by GDM**Graph 3. Distribution of Baby Gender by GDM**

Descriptive statistics revealed that mothers with GDM were older (mean age 27.06 ± 5.87 years) compared to non-GDM mothers (mean age 24.5 ± 4.99 years), a difference that was statistically significant ($p=0.021$). Maternal Random Blood Sugar (RBS) levels were markedly higher in the GDM group (mean 190.12 ± 20.9) than in the non-GDM group (mean 98.46 ± 16.39 , $p=0.001$). Birth weight was significantly greater in GDM cases (mean 3.61 ± 0.41) compared to non-GDM cases (mean 2.63 ± 0.54 , $p=0.001$). Similarly, BMI was higher in the GDM group (mean 30.14 ± 2.39) than in the non-GDM group (mean 23.68 ± 1.2 , $p=0.001$). APGAR scores at 1 and 5 minutes were lower in GDM cases (6.14 ± 1.16 and 8.14 ± 0.93 , respectively) compared to non-GDM cases (7.38 ± 0.64 and 9.06 ± 0.47 , respectively), with both differences being statistically significant ($p=0.001$ for both).

Table 2. Descriptive statistics of study variables

Variables	Minimum	Median	Maximum	Mean	SD
Mother's age	18	24	44	25.78	5.57
RBS Mother	66	146	233	144.29	49.71
Gestational age	37	38	42	38.05	1.11
Birth Weight	1.5	3	4.1	3.12	0.69
BMI	21.4	25.9	35.2	26.91	3.75
APGAR (1 min)	4	7	8	6.76	1.12
APGAR (5 min)	6	9	10	8.6	0.86

Table 3. Association of selected variables by GDM

Variable		Non-GDM		GDM		Chi-square value	p value
		n	%	n	%		
Mode of Delivery	NVD	20	74.1	7	25.9	8.574	0.003*
	Caesarean	30	41.1	43	58.9		
Baby Gender	Female	23	51.1	22	48.9	0.04	0.841
	Male	27	49.1	28	50.9		

Table 4. Comparison of continuous variable means by GDM

Variable	Group	Mean	SD	MD	t value	p value
Mother's age	Non-GDM	24.5	4.99	-2.56	-2.349	0.021*
	GDM	27.06	5.87			
RBS Mother	Non-GDM	98.46	16.39	-91.66	-24.401	0.001*
	GDM	190.12	20.9			
Gestational age	Non-GDM	38	1.05	-0.1	-0.447	0.656
	GDM	38.1	1.18			
Birth Weight	Non-GDM	2.63	0.54	-0.982	-10.232	0.001*

	GDM	3.61	0.41			
BMI	Non-GDM	23.68	1.2	-6.456	-17.101	0.001*
	GDM	30.14	2.39			
APGAR (1 min)	Non-GDM	7.38	0.64	1.24	6.626	0.001*
	GDM	6.14	1.16			
APGAR (5 min)	Non-GDM	9.06	0.47	0.92	6.265	0.001*
	GDM	8.14	0.93			

Table 5. Adjusted and unadjusted odds ratio for risk of GDM by mode of delivery and baby gender

Variable		Unadjusted Odds Ratio				Adjusted Odds Ratio			
		UOR	95% CI		p value	AOR	95% CI		p value
			LL	UL			LL	UL	
Mode of Delivery	NVD	1	Reference			1	Reference		
	Caesarean	4.09	1.54	10.9	0.005*	4.21	1.57	11.29	0.001*
Baby Gender	Female	1	Reference			1	Reference		
	Male	1.08	0.49	2.38	0.841	1.24	0.54	2.85	0.61

The association between GDM and mode of delivery was significant ($p=0.003$), with Caesarean deliveries being more prevalent among GDM cases (58.9%) compared to non-GDM cases (41.1%). However, no significant association was found between GDM and baby gender ($p=0.841$). Adjusted odds ratios indicated that Caesarean delivery was a significant risk factor for GDM (AOR=4.21, 95% CI: 1.57–11.29, $p=0.001$), while baby gender did not show a significant association (AOR=1.24, 95% CI: 0.54–2.85, $p=0.61$).

3. DISCUSSION

The present study examined the distribution and associations of various maternal and neonatal variables in relation to gestational diabetes mellitus (GDM), providing critical insights into the clinical and demographic differences between GDM and non-GDM cases. The findings highlight significant variations in maternal health parameters, delivery outcomes, and neonatal characteristics, reinforcing the need for targeted interventions in high-risk pregnancies.

Frequency Distribution and Descriptive Statistics

Table 1 demonstrates an equal distribution of GDM and non-GDM cases (50% each), indicating a balanced study population. However, a striking observation was the high prevalence of Caesarean deliveries (73%) compared to normal vaginal deliveries (NVD, 27%), suggesting a possible correlation between GDM and delivery complications. **Graph 1** further visualizes the equal distribution of GDM cases, while **Graph 2** illustrates the disproportionate rate of Caesarean sections among GDM mothers, supporting the notion that GDM may increase the likelihood of surgical deliveries. This aligns with recent studies indicating that GDM is associated with a higher risk of Caesarean delivery due to complications such as fetal macrosomia and labor dystocia.³²

Table 2 provides descriptive statistics for key continuous variables. Mothers with GDM were significantly older (mean age 27.06 ± 5.87 years) than non-GDM mothers (24.5 ± 4.99 years, $*p=0.021$), consistent with contemporary research linking advanced maternal age to increased GDM risk.³³ Additionally, the elevated RBS levels in GDM cases (190.12 ± 20.9 vs. 98.46 ± 16.39 , $*p=0.001$) underscore the metabolic dysregulation characteristic of GDM, as highlighted in recent studies on glycemic variability in pregnancy.³⁴ The higher birth weight in GDM infants (3.61 ± 0.41 vs. 2.63 ± 0.54 , $*p=0.001$) aligns with current evidence linking GDM to fetal overgrowth. Furthermore, lower APGAR scores at 1 and 5 minutes in GDM neonates suggest potential neonatal distress, possibly due to maternal hyperglycemia affecting fetal oxygenation.³⁵

Association between GDM and categorical variables

Table 3 explores the association between GDM and categorical variables using chi-square tests. A statistically significant relationship was found between GDM and mode of delivery ($*p=0.003$), with Caesarean sections being more frequent in GDM cases (58.9%) than in non-GDM cases (41.1%). This finding is corroborated by **Graph 2**, which visually emphasizes the higher Caesarean rates in GDM pregnancies. The increased likelihood of surgical intervention may be attributed to complications such as fetal macrosomia, shoulder dystocia, or labor abnormalities associated with GDM, as reported in recent systematic reviews.³⁶

Conversely, no significant association was observed between GDM and baby gender ($*p=0.841$), as depicted in **Graph 3** and supported by the chi-square results ($\chi^2=0.04$). This aligns with recent meta-analyses indicating that fetal sex does not substantially influence GDM risk.³⁷

Comparison of Continuous Variables by GDM Status

Table 4 presents an independent t-test analysis comparing mean differences between GDM and non-GDM groups. The significantly higher BMI in GDM mothers (30.14 ± 2.39 vs. 23.68 ± 1.2 , $*p=0.001$) reinforces the well-established link between obesity and insulin resistance in GDM pathogenesis, as demonstrated in recent cohort studies.³⁸ The lower APGAR scores in GDM neonates further suggest that maternal hyperglycemia may impair neonatal adaptation, warranting close monitoring during delivery, as emphasized in contemporary obstetric guidelines.³⁹

Risk Assessment Using Odds Ratios

Table 5 evaluates the adjusted and unadjusted odds ratios for GDM risk factors. Caesarean delivery exhibited a strong association with GDM, with an adjusted odds ratio (AOR) of 4.21 (95% CI: 1.57–11.29, $*p=0.001$). This suggests that GDM pregnancies are over four times more likely to result in Caesarean sections, likely due to complications such as poor glycemic control or fetal overgrowth, as reported in recent prospective studies (Egan et al., 2021). In contrast, baby gender was not a significant predictor (AOR=1.24, 95% CI: 0.54–2.85, $*p=0.61$), reinforcing earlier findings.⁴⁰

4. CONCLUSION

This study provides compelling evidence of the significant clinical and demographic differences between pregnancies complicated by gestational diabetes mellitus (GDM) and non-GDM pregnancies. The findings demonstrate that GDM is associated with advanced maternal age, elevated blood glucose levels, higher neonatal birth weights, increased Caesarean delivery rates, and lower APGAR scores, all of which underscore the profound impact of maternal hyperglycemia on both maternal and neonatal outcomes. The strong association between GDM and Caesarean delivery (AOR=4.21, $p=0.001$) highlights the heightened obstetric risks in this population, likely attributable to fetal macrosomia and related complications.

The study's key strengths include its comprehensive analysis of multiple maternal and neonatal variables, robust statistical methodology, and alignment with contemporary research findings. However, limitations such as the relatively small sample size ($n=100$) and single-center design suggest the need for larger, multicenter studies to enhance generalizability. Future research should focus on longitudinal follow-up of GDM-exposed offspring to assess long-term metabolic and developmental outcomes, as well as investigations into personalized glycemic management strategies to mitigate adverse pregnancy outcomes.

These findings have important clinical implications, emphasizing the need for: Early screening and strict glycemic control in high-risk pregnancies. Enhanced fetal monitoring in GDM cases to anticipate potential delivery complications. Multidisciplinary care approaches combining endocrinology, obstetrics, and neonatology expertise

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