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## Research Article

# Primary and secondary Pregnancy outcomes of Rural Women with Early Gestational Glucose Intolerance (EGGI) of a Tertiary care hospital in India

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## Abstract:

**Background:** The rising prevalence of GDM is primarily driven by modifiable risk factors like obesity, poor diet, sedentary lifestyle, and pre-existing insulin resistance, which can be reduced through early interventions. **Aim of study:** It was to determine early prediction of Hyperglycemia and gestational diabetes mellitus in Rural Women in pregnancy by early screening of Dysglycemia in 8-10 weeks of Gestation **Methodology:** This study was focused on 135 antenatal care (ANC) mothers in rural areas, given the importance of this population. It explored various parameters, including demographic factors, postprandial blood sugar (PPBS) levels, and Oral Glucose Challenge Test (OGCT) at specific times. **Results:** It was found that elevated early PPBS levels were linked to a greater risk of adverse pregnancy outcomes, including low birth weight, large for gestational age (LGA) babies, preterm births, increased NICU admissions, and elevated rates of pregnancy-related hypertension and gestational hypertension**. Conclusion:** Women with elevated early PPBS levels ≥110 mg/dl who received targeted management showed improvements in controlling blood glucose levels, potentially reducing adverse maternal and neonatal outcomes. The study advocates for early detection of elevated blood glucose levels, which enables timely interventions such as dietary education and lifestyle modifications.

**Key words:** Early Gestational Glucose Intolerance, Gestational Diabetes Mellitus, Rural Women, Gestational Glucose Intolerance.

## Introduction

The American Diabetes Association's 1997 classification, which divides diabetes into type 1, type 2, other specific types, and gestational diabetes mellitus (GDM), continues to be widely accepted.[1]

Gestational diabetes mellitus (GDM) is glucose intolerance first detected during pregnancy. Women with GDM are at risk for high blood pressure, preeclampsia, eclampsia, type 2 diabetes, and cardiovascular diseases later in

life. Their babies may experience macrosomia, low blood sugar, breathing problems, and later development of type 2 diabetes. GDM is a carbohydrate intolerance of variable severity with onset or first recognition during the present pregnancy and according to DIPSI (Diabetes in Pregnancy Study Group of India): which recommends Single-step Test with 75 gm oral glucose without regard to the time of the last meal. A venous plasma glucose value at 2-hour more than ≥140 mg/dL is diagnosed GDM.[2]GDM has long-term effects on both the mother and offspring, influencing health outcomes across generations.

Recent research has revealed that fetal overgrowth associated with GDM starts early in pregnancy, underscoring the importance of detecting glucose intolerance sooner. Previous studies have examined whether first-trimester HbA1c levels can predict GDM, but these studies often focused on high-risk groups, considered a threshold of 5.7% HbA1c (indicative of prediabetes), or used first-trimester GDM diagnosis as the primary outcome measure.[3]According to NIH researchers, performing a blood test as early as the 10th week of pregnancy could aid in identifying women who are at risk of developing gestational diabetes. This condition carries significant health risks for both mothers and infants, emphasizing the importance of early detection.[4]

The global prevalence of GDM varies due to differing diagnostic criteria. A 2021 meta-analysis by Saeedi et al. found a 14.7% global prevalence based on the widely used IADPSG criteria. In 2019, a meta-analysis reported the highest prevalence in South Asia (11.4%) compared to 3.6–6.0% in other regions.[5]Approximately 4 million women in India are affected by GDM, with a notably higher prevalence compared to other Asian countries. GDM prevalence ranges from 6% to 9% in rural areas and from 12% to 21% in urban areas at any given time.[6]

The overall prevalence of diabetes is 13.6% in Chandigarh, 10.4% in Tamil Nadu, 8.4% in Maharashtra, and 5.3% in Jharkhand. For prediabetes, the prevalence is 14.6% in Chandigarh, 12.8% in Maharashtra, 8.3% in Tamil Nadu, and 8.1% in Jharkhand. In Maharashtra, an estimated 9.2 million people have prediabetes, while 6.0 million have diabetes.[7]
Studies on GDM prevalence in northeast India are limited and mainly conducted in hospital settings. These studies show a lower prevalence in the northeast (Assam 3%, Manipur 0%–1%) compared to other states (Jammu and Kashmir 3.8%–11%; Maharashtra 0.5%–9.5%; Andhra Pradesh 17.20%–21.81%; Uttar Pradesh 13.38%–41.87%).[8]

Gestational diabetes (2-hour OGTT > 140 mg/dL anytime during pregnancy) in one study was associated with risk factors such as higher age, higher early-pregnancy BMI, and higher HbA1c levels.[9]GDM is associated with major risk factors such as maternal age > 35 years, obesity (BMI ≥ 30 kg/m²), family history of diabetes, previous GDM, and previous macrosomia (neonate weight ≥ 3500 gm). Additionally, a previous history of stillbirth is significantly linked to adverse maternal and perinatal outcomes, including preeclampsia, oligohydramnios, polyhydramnios, emergency CS, PROM, preterm delivery, fetal death, macrosomia, IUGR, low Apgar scores, congenital malformations, NICU admission, neonatal hypoglycemia, hyperbilirubinemia, and respiratorydistress.[10] So there is a need of urgent study to identify early indicators of hyperglycemia among these mothers.

## MATERIAL AND METHODS

1. **Study design:**
   Hospital based prospective Cohort study

2. **Study setting:**
   Department of Obstetrics & Gynecology, SRTR Govt Medical College, Ambejogai, Maharashtra, India

3. **Ethical considerations:**
   Ethical committee approval was obtained from the Institutional ethical committee prior to the start of the study.

4. **Study duration:**
   The present study was carried out over a period of 2 years from October 2022 to September 2024.

5. **Study population:**
   All ANC mothers visiting tertiary care Centre.

**Inclusion criteria:**

ANC mothers at 8-10 weeks

**Exclusion criteria:**

ANC mothers are not willing to participate and are not willing to give consent for study of Pre Gestational diabetes or Type 2 Diabetes or PCOS

**6. Sample Size:**

**Total population (N)**: 30,000
**Prevalence (P)**: 0.10 (10%)
**Confidence level**: 95%
**Z value (Z)**: 1.96

**Margin of error (D)**: Not directly specified, but let's assume a commonly used margin of error of 5% (0.05)

Using the simplified formula for calculating the sample size n for a proportion:

$n=Z2\times P(1-P)/D2$

Where:

- Z=1.96 (Z-score for 95% confidence)
- P=0.07
- 1−P=0.93
- D=0.05

$n=1.96^2\times 0.07\times (1-0.10)/0.05^2$

$n=3.8416\times 0.10\times 0.9/0.0025$

$n=3.8416\times 0.0651/0.0025$

$n=0.2501/0.0025$

$n=138$

Final sample size was taken 135 ANC mothers, attending weekly ANC check-ups. It took 3 months to gather the sample size, and participants were included from the 8-10th week of pregnancy onwards.

**7. Conduct of the Study:**

Permission was obtained from the Head of the Department of Obstetrics and Gynecology to conduct ANC examinations, including measurements of height, weight, BMI, blood pressure (BP), postprandial blood sugar (PPBS), and oral glucose tolerance test (OGTT). The ANC mothers were screened for Gestational Diabetes Mellitus (GDM) starting from the 8th week of gestation.

**8. Consent of study participants:**

Those who were willing to participate in the study, their written informed consents were taken and enrolled in the study.

**9. Data collection:**

Prior to enrolment in the study, pregnant women attending Obs & Gynae OPD were provided with detailed information about the study objectives, procedures, potential risks, and benefits. Written informed consent was obtained from each participant before their inclusion in the study. Participants were assured of the confidentiality of their information and were informed of their right to withdraw from the study at any time without any impact on their ANC services. Participants who declined to provide consent for participation in the study were excluded. Only those who willingly consented to be part of the study were included in the cohort.

After enrolling in the study, participants will have their postprandial blood sugar (PPBS) levels checked at the 8th and 12th weeks. Participants with PPBS levels above 110 mg/dL will receive dietary education, while those with levels below 110 mg/dL will not receive dietary education. Subsequently, both groups will undergo an Oral Glucose Tolerance Test (OGTT) at the 16th, 24th, and 32nd weeks. Additionally, PPBS levels will be measured postpartum for all participants.

10. **Blood Sugar Level (BSL) Assessment**: between $8^{th}$ and $10^{th}$ week of gestation visit, participants underwent a PPBS (post prandial blood sugar) assessment to screen for risk for gestational diabetes mellitus (GDM).
11. **Health education on prevention of GDM:**

The dietary advice emphasizes promoting better health and managing conditions such as gestational diabetes by consuming smaller, more frequent meals and ensuring adequate fluid intake through water, juices, and soups while limiting caffeine and artificial sweeteners. A balanced diet rich in essential nutrients is also crucial during pregnancy, including vegetables (such as carrots, spinach, and tomatoes),

fruits (like mangoes and bananas), dairy products (such as low-fat yogurt and milk), grains high in iron and folic acid, and protein sources like eggs, beans, nuts, and certain types of fish to support maternal health and fetal development.

12. **Oral Glucose Tolerance Test (OGTT):** Starting from the 16th or 24th or 32 weeks of gestation, participants underwent an oral glucose tolerance test (OGTT) during subsequent visits to tertiary care centre. OGTT is a diagnostic test used to confirm the presence of gestational diabetes mellitus (GDM) by assessing the body's ability to metabolize glucose effectively. Participants consumed 75gm of glucose solution, and blood samples were taken after 2 hours to measure glucose levels.

13. **Postnatal Data Collection:** Following delivery, postprandial blood glucose (PPBS) testing was conducted, and data on delivery outcomes, including the baby's weight and any complications experienced during pregnancy and childbirth, were documented.

**Results:**

**Primary Pregnancy Outcomes**

135 pregnant women were performed Post prandial blood glucose at 8-10 weeks of gestation, where 57 were detected with ≥ 110 mg/dl, and 78 with < 110 mg/dl; were followed up till delivery in both the groups.

In this study women (PPBS ≥110mg/dl) during 8-10 weeks were followed up for PPBS in 12 and 14 weeks and OGCT in 16, 24 and 32 weeks;

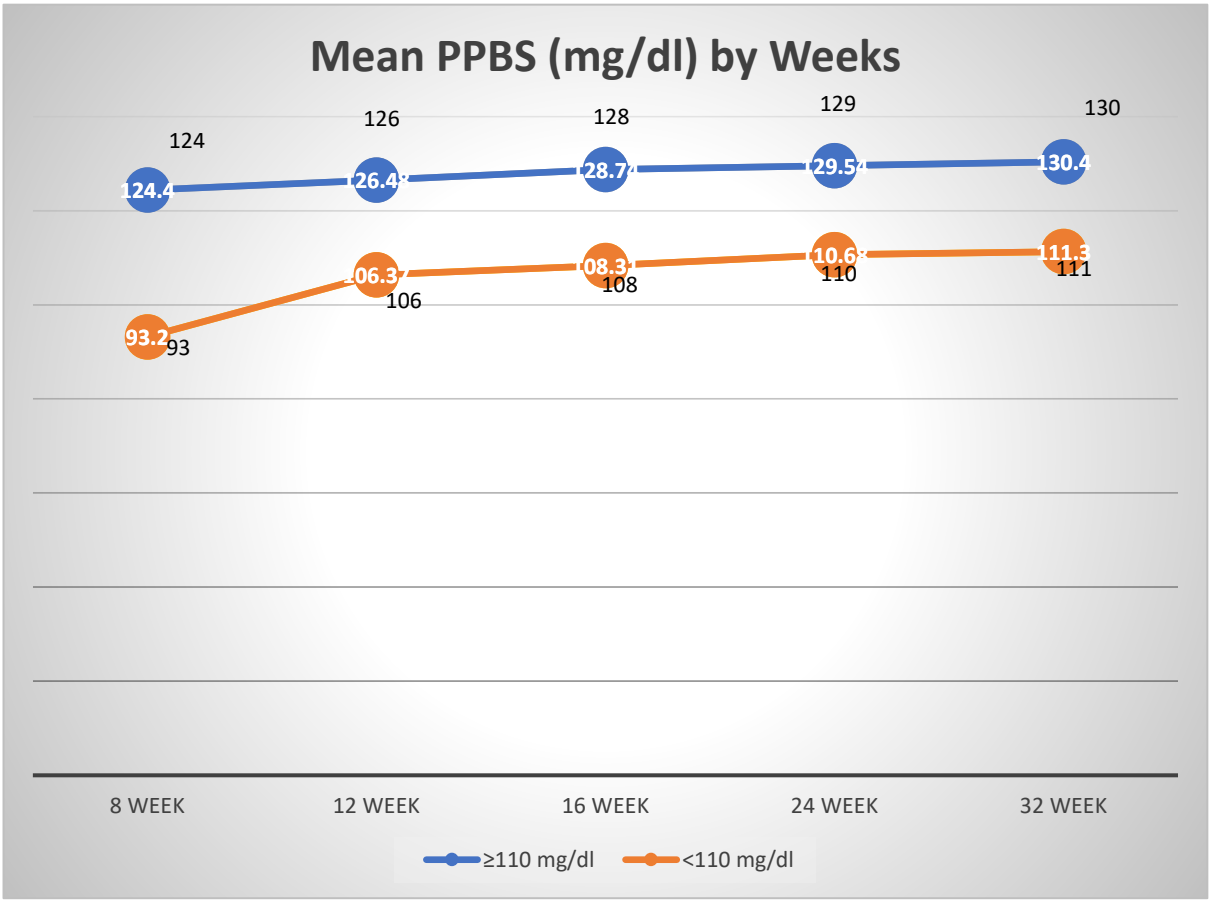
all the women in >110mg/dl received standard care of diet education and group with <110 mg/dl No diet education was given.

It is observed that the mean age SD (23.04 ± 3.73) and (23.55 ± 4.47), mean birth PPBS at 8-10 weeks (124.40 ± 15.05) and 93.20 ±11.35 were significant in respective study groups and difference continued to be significant by 32 weeks (130.40 ± 20.8 Vs 111.39 ± 13.66) **(Table 1a, Figure 1)**

**Table 1a Primary pregnancy outcomes based on PPBS values:**

| **Outcome** | **PPBS≥110 mg/dl Fetal-maternal outcomes (**Diet education+) **Mean ± SD** | **PPBS ≤110 mg/dl Fetal-maternal outcomes** (Diet education-) **Mean ± SD** | **P-value** |
|---|---|---|---|
| **Primary pregnancy outcomes** | | | |
| PPBS– 8 weeks | 124.40 ±15.05 | 93.20±11.36 | **0.000** |
| PPBS- 12 weeks | 126.48± 16.6 | 106.37 ± 12.2 | **0.000** |
| OGCT – 16 weeks | 128.7 ± 18.2 | 108.31 ± 12.8 | **0.000** |
| OGCT – 24 weeks | 129.54 ± 19.2 | 110.68 ±13.2 | **0.000** |
| OGCT – 32 weeks | 130.4±20.8 | 111.39±13.66 | **0.000** |
| PPBS Post-Partum | 124.69± 15.7 | 108.29± 11.9 | **0.000** |

**Figure 1: Distribution of PPBS at various weeks from mean glycaemic level (mg/dl) by weeks in the (≥110 mg/dl) group, n (57) and (<110 mg/dl) group, n (78): Primary Pregnancy Outcomes**




There was 1 participant in spontaneous abortion (1.75%) in the group with blood glucose levels >110 mg/dL and 1 participant (1.28%) in the group with levels <110 mg/dLTthe results in Phototherapy were in 4 (7.02%) in the group with blood glucose levels >110 mg/dL, with a p-value of 0.017.The results in RDS were in 5 (8.77%) in the group with blood glucose levels >110 mg/dL and 2 (2.56%) were in <110 mg/dl group with a p-value of 0.11.The rate of preterm birth (<37 weeks) was 8 (14.04%) in the >110 mg/dl group compared to 1 (1.28%) in the <110 mg/dl group (p=0.0033).Large for gestational age (LGA) occurred in 9 (15.79%) of the >110 mg/dl group versus 1 (1.28%) of the <110 mg/dl group (p=0.0015).

Under secondary outcomes, the birth weight distribution showed that 12 infants (21.05%) in one group had a birth weight below 2.5 kg compared to 5 infants (6.41%) in the other group, with a statistically significant difference (p = 0.011). For birth weights between 2.5 and 3.49 kg, 39 infants (68.42%) were in one group versus 71 infants (91.03%) in the other, also showing a significant difference (p = 0.0008). However, for birth weights of 3.5 kg or more, there were 6 infants (10.53%) in one group and 2 infants (2.56%) in the other, with a p-value of 0.052, indicating a result close to statistical significance. **[Table no: 1b]**

Cephalopelvic Disproportion (CPD): 4 participants (7.02%) in the >110 mg/dL group versus 2 participants (2.56%) in the <110 mg/dL group (p = 0.21). Fetal Distress (FD): 3 participants (5.26%) in the >110 mg/dL group, none in the <110 mg/dL group (p = 0.040). Meconium-Stained Liquor (MSL): 7 participants (12.28%) in the >110 mg/dL group compared to 3 participants (3.85%) in the <110 mg/dL group (p = 0.064).

Premature Rupture of Membranes (PROM): 4 participants (7.02%) in the >110 mg/dL group and 2 participants (2.56%) in the <110 mg/dL group (p = 0.064). Breech Presentation: 3 participants (5.26%) in the >110 mg/dL group and 3 participants (3.85%) in the <110 mg/dL group (p = 0.69). Previous Lower Segment Cesarean Section (LSCS): 5 participants (8.77%) in the >110 mg/dL group versus 2 participants (2.56%) in the <110 mg/dL group

(p = 0.11). History of Stillbirth/Abortion: 15 participants (26.32%) in the >110 mg/dL group compared to 4 participants (5.13%) in the <110 mg/dL group (p = 0.0004). Hyperbilirubinemia: 6 participants (10.53%) in the >110 mg/dL group and 1 participant (1.28%) in the <110 mg/dL group (p = 0.017). Hypoglycemia: 8 participants (14.04%) in the >110 mg/dL group, none in the <110 mg/dL group (p = 0.017). NICU Admission: 13 participants (22.81%) in the >110 mg/dL group compared to 5 participants (6.41%) in the <110 mg/dL group (p = 0.0056). **[ Table no: 1b]**

**Table 1b Primary Neonatal outcomes and Secondary pregnancy outcomes based on PPBS values**

| Sr.no | Outcomes | PPBS≥110 mg/dl Fetal-maternal outcomes Diet education+ no =57 (%) | PPBS ≤110 mg/dl Fetal-maternal outcomes Diet education- no= 78 (%) | P-value |
|---|---|---|---|---|
| **I** | **Adverse-neonatal outcomes*[a,b,c,d,e]** | **27(47.37)** | **5(6.4)** | **0.000** |
| a | IUD/Spontaneous abortion | 1(1.75) | 1(1.28) | 0.82 |
| b | Phototherapy | 4(7.02) | 0(0.0) | **0.017** |
| c | RDS | 5(8.77) | 2(2.56) | 0.11 |
| d | Preterm Birth <37th week | 8(14.04) | 1(1.28) | **0.0033** |
| e | LGA | 9(15.79) | 1(1.28) | **0.0015** |
| **II** | **Secondary outcomes** | | | |
| I | ***Birth weight kg** | | | |
| | <2.5 | 12 (21.05) | 5(6.41) | 0.011 |
| | 2.5 – 3.49 | 39(68.42) | 71(91.03) | **0.0008** |
| | ≥3.5 | 6 (10.53) | 2(2.56) | 0.052 |
| Ii | ***≥28 Weeks Still birth** | 1(1.75) | 1(1.28) | 0.82 |
| Iii | ***CPD** | 4(7.02) | 2(2.56) | 0.21 |
| iv | ***FD** | 3(5.26) | 0(0.0) | 0.040 |
| v | ***MSL** | 7(12.28) | 3(3.85) | 0.064 |
| vi | ***PROM** | 4(7.02) | 2(2.56) | 0.064 |
| vii | ***Breech** | 3(5.26) | 3(3.85) | 0.69 |
| viii | ***Previous LSCS** | 5(8.77) | 2(2.56) | 0.11 |
| ix | ***History of Still birth/Abortion** | 15(26.32) | 4(5.13) | **0.0004** |
| x | ***Hyperbilirubinemia** | 6(10.53) | 1(1.28) | 0.017 |
| Xi | ***Hypoglycemia** | 8(14.04) | 0(0.0) | 0.017 |
| Xii | ***NICU** | 13(22.81) | 5 (6.41) | **0.0056** |

*The study participants experienced multiple outcomes, which resulted in the total percentage exceeding 100%.
Adverse neonatal outcomes (composite|) includes; preterm delivery less than 37 weeks, Still birth >28 weeks of Pregnancy, (LGA) Large for gestational age or new born weight more than 3.45 kg, new born received phototherapy or any trauma to new born during delivery or RDS(respiratory distress in new born); +Pregnancy related hypertension includes composite of gestational hypertension(GHTN), preeclampsia and eclampsia; MSL(Meconium stain liquor); hypoglycaemia includes blood sugar <40 during 4 hour of birth; hyper bilirubinaemia, NICU admission, FD (Foetal distress);PROM (Premature rupture of membrane); CPD (Cephalic Pelvic Disproportionate);OGCT(Oral Glucose challenge Test), GGI Gestational Glucose Intolerance

In this study, several complications were significantly more prevalent in the group with blood glucose levels >110 mg/dl compared to the group with levels <110 mg/dl.
The rate of stillbirths at or after 28 weeks was 1.75% (1 case) in one group and 1.28% (1 case) in the other group, with a p-value of 0.82, indicating no significant difference between the groups.

In the study, adverse neonatal outcomes were significantly more common in the group with blood glucose levels >110 mg/dl, with 27 (47.37%) experiencing adverse outcomes compared to 5 (6.4%) in the <110 mg/dl group, and this difference was highly significant with a p-value of 0.000.

In this study, maternal morbidity was similar between the two groups, with 30 (32.3%) in the >110 mg/dl group and 40 (32%) in the <110 mg/dl group, resulting in a p-value of 0.88.
However, pregnancy-related hypertension was significantly more prevalent in the >110 mg/dl group at 9 (15.79%) compared to 1 (1.28%) in the <110 mg/dl group (p=0.0015).
Gestational hypertension (GHTN) also showed a significant difference, with 8 (14.04%) in the >110 mg/dl group versus 1 (1.28%) in the <110 mg/dl group (p=0.0033). Severe preeclampsia was observed in 1 (1.75%) of the >110 mg/dl group and was absent in the <110 mg/dl group, but this difference was not statistically significant (p=0.24). **[ Table no :1C]**

Gestational glucose intolerance (GGI) at 32 weeks was more prevalent in the >110 mg/dl group, with 44 (77.19%) having glucose levels between 121-<140 mg/dl compared to 11 (14.10%) in the <110 mg/dl group (p=0.001). The >110 mg/dl group also had a higher incidence of GDM with glucose levels ≥140 mg/dl at 8 (14.04%) versus 1 (1.28%) in the <110 mg/dl group (p=0.0033) **[ Table no :1C]**

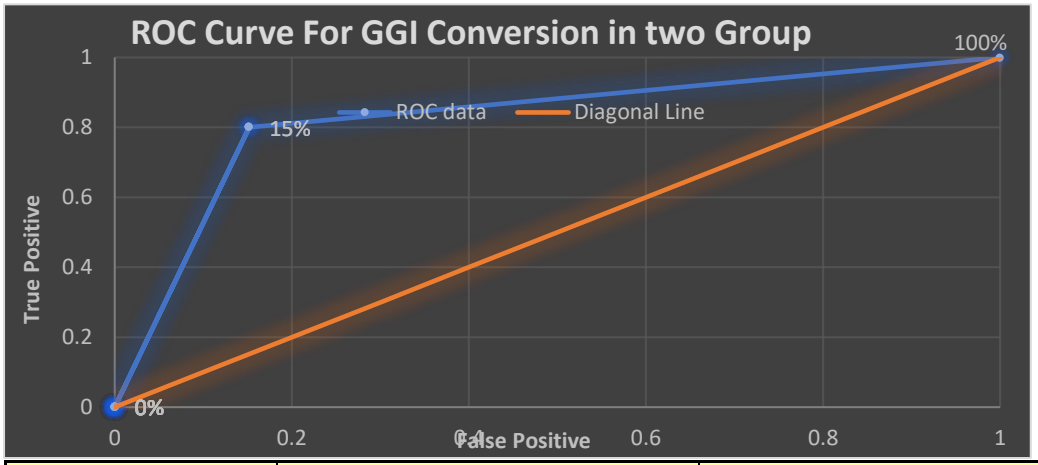
**Table 1c Secondary pregnancy outcomes**

| Sr no | Outcome | PPBS≥110 mg/dl Fetal-maternal outcomes Diet education+ no= 57 (%) | PPBS ≤110 mg/dl Fetal-maternal outcomes Diet education- No= 78 (%) | P-value |
|---|---|---|---|---|
| **III** | **Maternal morbidity** | 30(32.3) | 40(32) | 0.88 |
| a | +Pregnancy related hypertension | 9(15.79) | 1(1.28) | **0.0015** |
| B | GHTN | 8(14.04) | 1(1.28) | **0.0033** |
| C | Severe Preeclampsia | 1(1.75) | 0(0.0) | 0.24 |
| **IV** | **GDM status change** | | | |
| A | GGI at 32 weeks (at risk for GDM) 121-<140 mg/dl | 44(77.19) | 11(14.10) | **0.001** |
| B | GDM 32 weeks ≥140 mg/dl | 8(14.04) | 1 (1.28) | 0.0033 |

**Diagnostic performance**: PPBG exhibited high sensitivity (80.0%) and specificity (84.0%), indicating its ability to identify both true positive and negative cases of GGI Gestational Glucose Intolerance accurately by 32 weeks of Gestation at risk for Gestational Diabetes GDM.

**Diagnostic accuracy**: PPBG achieved a diagnostic accuracy of 82.84. Area under the curve is 0.824 with Confidence interval of (0.74-.89). **[ Figure no: 02]**

**Figure 2 Showing ROC data for GGI Conversion and Profile of Gestational Glucose Intolerance**




| Cut Points: | Normal Cases | Gestational Glucose Intolerance |
|---|---|---|
| <110 | 67 | 11 |
| >110 | 12 | 44 |
| | 79 | 55 |

| | | |
|---|---|---|
| | Area Under the Curve | .8241 |
| | Stderr* | .0385 |
| Confidence Interval | .749 | .899 |
| | Accuracy of Test | Good |

***Stderr = Standard Error**

**Discussion:**

The study assessed the early prediction of gestational diabetes mellitus (GDM) by monitoring postprandial blood glucose (PPBS) levels at 8-12 weeks of gestation among 135 pregnant women. Participants were divided into two groups based on their early PPBS levels: PPBS ≥ 110 mg/dl (n=57) and PPBS < 110 mg/dl (n=78). Those in the group with PPBS ≥ 110 mg/dl, identified as having higher blood sugar levels, received diet education to manage their blood glucose, while those in the group with PPBS < 110 mg/dl did not receive any special dietary guidance. Both groups were closely monitored with follow-up Oral Glucose Tolerance Tests (OGTT) at 16, 24, and 32 weeks to track the development of GDM or abnormal glucose levels. The results revealed that women with higher PPBS levels (≥ 110 mg/dl) in early pregnancy were at a significantly higher risk for adverse outcomes, including low birth weight (21.05% vs. 6.41%), large for gestational age (LGA) babies (15.79% vs. 1.28%), preterm birth before 37 weeks (14.04% vs. 1.28%), and increased neonatal intensive care unit (NICU) admissions (22.81% vs. 6.41%). Additionally, these women exhibited a higher prevalence of pregnancy-related hypertension (15.79% vs. 1.28%) and gestational hypertension (14.04% vs. 1.28%) compared to those in the PPBS < 110 mg/dl group.

**Primary pregnancy outcomes:**

A total of 135 pregnant women underwent postprandial blood glucose (PPBS) testing at 8-12 weeks of gestation, with 57 women detected with PPBS levels ≥110 mg/dL and 78 women with PPBS levels <110 mg/dL. Both groups were followed up until delivery. In this study, women with PPBS ≥110 mg/dL at 8-10 weeks underwent an Oral Glucose Challenge Test (OGCT) at 16, 24, and 32 weeks. All women in the ≥110 mg/dL group received standard care with diet education, whereas women in the <110 mg/dL group did not receive diet education.

At 8-10 weeks, the Mean ± SD of PPBS in the ≥110 mg/dL group was 124.40 ± 15.05 compared to 93.20 ± 11.36 in the <110 mg/dL group. At 12, 16,24 and 32 weeks the Mean ± SD was 126.48 ± 16.6 Vs 106.37 ± 12.2, 128.7 ± 18.2 Vs 108.31 ± 12.8, 129.54 ± 19.2 Vs 110.68 ± 13.2 in ≥110 mg/dL group versus in the <110 mg/dL group

respectively with significant P value. At. At 32 weeks, the values were 130.4 ± 20.8 in the ≥110 mg/dL group and 111.39 ± 13.66 in the <110 mg/dL group. Postpartum PPBS showed a Mean ± SD of 124.69 ± 15.7 in the ≥110 mg/dL group compared to 108.29 ± 11.9 in the <110 mg/dL group. All outcomes were statistically significant. **(figure 1, table 1a)**

The present study predicted gestational diabetes mellitus (GDM) using postprandial blood sugar (PPBS) followed by an oral glucose tolerance test (OGTT). In contrast, the study by **Stefanie N. Hinkle et al. (2018)**[10] used HbA1c as a measurement to predict GDM, and their results were statistically significant (P ≤ 0.001).**İnci Hansu et al. (2022)**[11] also used HbA1c as a measurement to predict GDM, followed by an OGTT, and found that HbA1c levels were higher in the GDM group, with results that were statistically significant (p<0.001).

**In our study, maternal morbidity was similar between the two groups, with 30 (32.3%) in the >110 mg/dl group and 40 (32%) in the <110 mg/dl group, resulting in a p-value of 0.88.**

**However, pregnancy-related hypertension was significantly more prevalent in the >110 mg/dl group at 9 (15.79%) compared to 1 (1.28%) in the <110 mg/dl group (p=0.0015).**

**Gestational glucose intolerance:**

The present study shows that at 32 weeks, gestational glucose intolerance (GGI) in the range of 121–<140 mg/dL was observed in 44 participants (77.19%) in the >110 mg/dL group who were at risk for GDM, compared to 11 participants (14.10%) in the <110 mg/dL group with lower values (p = 0.001). Additionally, a GDM diagnosis with glucose levels ≥140 mg/dL was more frequent in the higher-risk group (8 participants, or 14.04%%) than in the lower-risk group (1 participant, or 1.28%), with a statistically significant p-value of 0.0033. This suggests a strong association between elevated GGI levels and the risk of GDM**. (table 1b, serial no: IV a)**

Similar observation was found in the study by **Pradeep K. Gautam et al (2023)**[12] conducted at Urban Community Health Centres (UCHCs) in Lucknow, the prevalence of gestational diabetes mellitus (GDM) was found to be 11.6%, while gestational glucose intolerance (GGI) was observed in 16.8% of the participants. **Agrawal et al. (2018)**[13]**,** in their study at a tertiary care facility in Lucknow, reported the prevalence of gestational diabetes mellitus (GDM) as 13.6% and gestational glucose intolerance (GGI) as 19.8%.

**Pregnancy related HTN and Gestational HTN:**

Present study shows that, pregnancy-related hypertension was significantly more prevalent in the >110 mg/dl group at 9 (15.79%) compared to 1 (1.28%) in the <110 mg/dl group (p=0.0015). Gestational hypertension (GHTN) also showed a significant difference, with 8 (14.04%) in the >110 mg/dl group versus 1 (1.28%) in the <110 mg/dl group (p=0.0033) in **(table 1b, serial no: III a,b)**Similar observation were found in few studies :**Farah Aziz et al. (2024)**[14] found that systolic and diastolic blood pressures were significantly higher in the GDM group (161 ± 3.2 mmHg and 106.6 ± 2.19 mmHg, respectively) compared to the non-GDM group (120.9 ± 3.3 mmHg and 81.2 ± 1.77 mmHg, respectively), with p-values < 0.0001. **Tesfaye Abera et al. (2019)**[15] found that the prevalence of pregnancy-induced hypertension was 7.9%, with 15.2% having gestational hypertension, 36.4% experiencing mild preeclampsia, 45.5% having severe preeclampsia, and 3% having eclampsia.

**Pre-eclampsia:**

Severe preeclampsia was observed in 1 (1.75%) of the >110 mg/dl group and was absent in the <110 mg/dl group, but this difference was not statistically significant (p=0.24). **(table 13 b, serial no IIIc).** Similar observation was found in studies such as **Azam Kouhkan et al. (2020)**[16] reported that preeclampsia was significantly more common in the GDM group (13.69%) compared to the non-GDM group (4.17%), with an odds ratio of 3.64 (95% CI: 1.81-7.33) and a p-value of 0.001.**Ting Zhang et al (2024)**[17] observed that among women with GDM, those aged 20–24 years had a significantly higher risk of preeclampsia compared to those aged 25–29 years, with an adjusted odds ratio (aOR) of 1.31 and a 95% confidence interval (CI) of 1.03–1.17.

**Secondary pregnancy outcomes:**

The incidence of low birth weight (<2.5 kg) was 12 (21.05%) in the >110 mg/dl group versus 5 (6.41%) in the <110 mg/dl group (p=0.011). Moderate birth weight (2.5–3.49 kg) was observed in 39 (68.42%) of the >110 mg/dl group compared to 71 (91.03%) in the <110 mg/dl group (p=0.0008). Large for gestational age (LGA) occurred in 9 (15.79%) of the >110 mg/dl group versus 1 (1.28%) of the <110 mg/dl group (p=0.0015). **(table 1 b, serial no :IIa)**

The present study found that low birth weight (LBW) was higher and moderate birth weight was lower in the >110mg/dl group compared to the <110mg/dl group, where LBW was lower and moderate birth weight was higher. Additionally, the incidence of large for gestational age (LGA) was also elevated in the >110mg/dl group. In contrast, **Ting Zhang et al. (2024)**[17] reported that both macrosomia (aOR: 1.25, 95% CI: 1.08–1.45, P < 0.05) and LGA infants (aOR: 1.16, 95% CI: 1.02–1.31, P < 0.05) were more common among women with GDM.Similarly, **Yi Yang et al. (2018)**[18] found an increased risk of both large for gestational age (LGA) infants (OR = 1.79, 95% CI: 1.11–2.89) and macrosomia (OR = 2.13, 95% CI: 1.34–3.40) in women with GDM. **Wenrui Ye et al. (2022)**[19] observed that infants born to mothers with GDM were significantly more likely to experience macrosomia, with odds 1.70 times higher compared to those born to non-GDM mothers (95% CI: 1.23-2.36). Additionally, the likelihood of being born large for gestational age (LGA) was 1.57 times greater in the GDM group (95% CI: 1.25-1.97), highlighting a significant association between GDM and increased birth size

outcomes.

**Neonatal hyperbilirubinemia and hypoglycemia:**

In the present study shows, Maternal blood glucose levels above 110 mg/dL are linked to a significantly higher incidence of neonatal hyperbilirubinemia (6(10.53%) vs. 1(1.28%)) and hypoglycemia 8(14.04%), with p-values of 0.017. **(table 13b, serial no: II (x,xii)**Similar observation found in **Azam Kouhkan et al (2020)**[20] study where significantly higher risk of neonatal hyperbilirubinemia in the GDM group (OR: 2.00, p = 0.008) compare to non GDM group. neonatal hypoglycemia was slightly more common in the GDM group compared to the non-GDM group, the difference was not statistically significant (OR: 1.41, p = 0.55).**Wenrui Ye et al. (2022)**[19] found that neonates born to mothers with GDM have a 1.28 times higher risk of developing jaundice compared to those born to mothers without GDM, with a 95% confidence interval (CI) of 1.02 to 1.62.

**Preterm and NICU admission:**

The present study shows that maternal blood glucose levels above 110 mg/dL are linked to a significantly higher rate of preterm birth (8(14.04%) vs. 1(1.28%), p = 0.0033) and more NICU admissions (13(22.81%) vs. 5(6.41%), p = 0.0056) compared to levels below 110 mg/dL. **(table 13b, serial no: Id, II xii)** Similar observation were found in : **Azam Kouhkan et al. (2020)**[18] found that preterm delivery was significantly higher in the GDM group (11.93%) compared to the non-GDM group (5.11%) with an OR of 2.52 (p = 0.008), while NICU admission was also higher in the GDM group (11.18%) compared to the non-GDM group (6.21%) but not statistically significant (OR: 1.90, p = 0.11).**Wenrui Ye et al. (2022)**[19] found that the odds of preterm delivery were 1.51 times higher and the likelihood of NICU admission was 2.29 times higher in the GDM group compared to the non-GDM group, with confidence intervals of 95% CI: 1.26-1.80 and 95% CI: 1.59-3.31, respectively. In **Ting Zhang et al (2024)**[17] study, women with GDM aged 40–44 years had the highest rate of preterm birth at 13.9%, which was statistically significant (P < 0.001). However, although the frequency of NICU admission also increased in this age group, these differences were not statistically significant (P > 0.05).

**In our study, adverse neonatal outcomes were significantly more common in the group with blood glucose levels >110 mg/dl, with 27 (47.37%) experiencing adverse outcomes compared to 5 (6.4%) in the <110 mg/dl group, and this difference was highly significant with a p-value of 0.000.** This can be explained by fact that Maternal hyper glycemia leads glucose to cross placenta leading to increase fetal insulin production, this excess insulin acts as a growth factor, causing the fetus to grow larger than normal (macrosomia). and neonatal hypoglycemia. it leads to preterm birth, hyper bilirubinemia.

**In present study shows that the Diagnostic performance** of PPBG exhibited high sensitivity (80.0%) and specificity (84.0%), indicating its ability to identify both true positive and negative cases of GGI Gestational Glucose Intolerance accurately by 32 weeks of Gestation at risk for Gestational Diabetes GDM. **Diagnostic accuracy:** PPBG achieved a diagnostic accuracy of 82.84. Area under the curve is 0.824 with Confidence interval of (0.74-.89). (figure 15, table 13b) Similar observation was found in: According to **Pikee Saxena et al. (2024)**[21]**,** PPBG showed excellent diagnostic performance with a sensitivity of 95.88% and a specificity of 95.65%, accurately detecting GDM cases and ruling out non-cases, and achieving an overall diagnostic accuracy of 95.77%.

**Conclusion:**

This study underscores the importance of early PPBS screening at 8-12 weeks as a valuable tool for predicting the risk of GDM and associated complications, allowing for early interventions, such as diet modifications, to mitigate these risks and improve pregnancy outcomes.It can be concluded that elevated early PPBS levels were linked to a greater risk of adverse pregnancy outcomes, including low birth weight, large for gestational age (LGA) babies, preterm births, increased NICU admissions, and elevated rates of pregnancy-related hypertension and gestational hypertension. Women with elevated early PPBS levels who received targeted management showed improvements in controlling blood glucose levels, potentially reducing adverse maternal and neonatal outcomes. Extending the follow-up period beyond delivery, particularly up to one year postpartum, would provide valuable insights into the long-term effects of gestational diabetes on maternal and infant health, including the risk of developing type 2 diabetes and other non-communicable diseases. In future studies, consider adjusting for more confounding variables such as mental health, sleep patterns, or even environmental exposures that may contribute to gestational diabetes. This would lead to a more refined analysis of the risk factors.

**Ethical Considerations**: The research strictly adhered to the principles set forth in the Declaration of Helsinki, demonstrating our unwavering commitment to ethical standards.

**Conflicts of Interest and Funding**: The authors reaffirm their absolute lack of conflicts of interest. They confirm there are no financial relationships with any organizations that could be seen as having an interest in this work, both currently and within the past three years. Importantly, no funding was received from any source, institution, or pharmaceutical agency for this study or its publication.

**Data Availability**: All data and materials have been made readily available to every author, each of whom has consented to publication, further enhancing transparency and accountability.

**Human Rights Declaration**: All authors affirm their strong commitment to the UN's Declaration of Human Rights, positioning it as a guiding principle for this manuscript submission. This research reinforces that commitment, emphasizing clear and steadfast dedication to ethical research practices.

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- **Informed Consent:** The written Informed consent from all the Participants were taken
- **Conflict of Interest Statement**

  The authors declared “No Conflict of Interest” with this publication.

- **Additional Information**



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