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# PRENTICE MODEL TO PREDICT GESTATIONAL DIABETES MELLITUS ON THE BASIS OF MATERNAL RISK FACTORS: A CROSS-SECTIONAL STUDY

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**Abstract**

**Objective**: The aim of this study was to develop a predictive model of gestational diabetes mellitus (GDM) using the Prentice-weighted logistic regression method and assessing the contribution of significant maternal risk factors.

**Methods**: In a cross-sectional survey on 52 pregnant women between the age range of 24–28 weeks gestation. Factors involved during the survey include the pre-pregnancy BMI, the mother's age, parity, activity levels, diabetic and glucose disorder familial histories, diabetes with hypertension as a chronic illness, HbA1c done at the first-trimester of gestation. Prentice-weighted logistic regression model derived aORs.

**Results**: GDM was diagnosed in 21 out of 52 women (40.4%). Strong predictors were pre-pregnancy BMI⩾30 (aOR=4.12, p=0.016), family history of diabetes (aOR=3.67, p=0.031), history of GDM (aOR=5.43, p=0.004), and high HbA1c>5.7% (aOR=6.88, p=0.002). The model discriminated well (AUC=0.84).

**Conclusion**: The Prentice model does predict risk for GDM in pregnant women using only available clinical and historical predictors.

**Keywords**: Gestational Diabetes Mellitus (GDM); Prentice Model; Case-Cohort Design; Risk Prediction; Maternal Risk Factors; HbA1c; Pre-pregnancy Body Mass Index (BMI); Family History of Diabetes; Multivariate Analysis; Logistic Regression.

## Introduction

Gestational diabetes mellitus (GDM) is glucose intolerance during pregnancy with short- and long-term maternal and neonatal complications [3, 18]. Early detection of women at risk enables early intervention [10, 15]. While conventional logistic regression has been the standard for risk prediction, it does not accommodate for bias due to subcohort sampling [1, 7, 16]. The Prentice model, originally for case-cohort studies, yields efficient and unbiased estimation for subcohort



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samples [8, 13]. Here, the Prentice model is used to estimate significant clinical, demographic, and behavioral risk factors for GDM in a cross-sectional sample.

## Methods

### 2.1 Study Design and Participants:

The cross-sectional study was carried out on 52 pregnant women attending routine antenatal care at a maternity hospital at Tashkent between 2024 and 2025. Singleton pregnancy between 24 and 28 weeks and absence of a prior history of diabetes were the inclusion criteria. Institutional board ethics permission and consent was rendered.

### 2.2 Variables and Measurements.

**Data collected were:**

- Pre-pregnancy BMI (kg/m²): categorized as <25, 25–29.9, and ≥30;
- Maternal age (years): continuous;
- Parity: nulliparous vs. multiparous;
- Family history for diabetes: yes/no;
- Previous pregnancy GDM history: yes/no;
- Chronic hypertension: present before pregnancy;
- Physical activity: self-reported average minutes/week;
- First-trimester HbA1c (%): continuous scale; 5.7% cut-off was diagnosed based on WHO 2013 criteria using a 75g.

### 2.3 Statistical Analysis

We reported descriptive statistics as proportions or means. We utilized the Prentice-weighted logistic regression model to correct for the stratified sample. We reported 95% CIs, ORs, and p-values. We evaluated model performance using AUC for ROC analysis. We carried out the analysis using StataV17. We considered p-value<0.005 as significant.

## Results

3.1 Participant Characteristics. Out of 52 women, 21 (40.4%) developed GDM. The maternal age was 29.8 ± 5.2 years; 38.5% had BMI ≥30, 25% had family history of diabetes, and 19.2% had previous GDM. As shown in table 1.



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Table 1. Baseline characteristics of study sample (N = 52).

| Variable | Total (N=52) | GDM (n=21) | Non-GDM (n=31) | p-value |
|---|---|---|---|---|
| Maternal age ≥35 years (%) | 14 (26.9%) | 8 (38.1%) | 6 (19.4%) | 0.117 |
| Pre-pregnancy BMI ≥30 (%) | 20 (38.5%) | 14 (66.7%) | 6 (19.4%) | 0.002 |
| Multiparity (%) | 31 (59.6%) | 13 (61.9%) | 18 (58.1%) | 0.800 |
| Family history of DM (%) | 13 (25.0%) | 9 (42.9%) | 4 (12.9%) | 0.017 |
| Prior history of GDM (%) | 10 (19.2%) | 8 (38.1%) | 2 (6.5%) | 0.007 |
| Chronic hypertension (%) | 6 (11.5%) | 4 (19.0%) | 2 (6.5%) | 0.168 |
| Physical activity <150 min/week | 32 (61.5%) | 15 (71.4%) | 17 (54.8%) | 0.214 |
| HbA1c > 5.7% (%) | 18 (34.6%) | 14 (66.7%) | 4 (12.9%) | <0.001 |

3.2 Multivariate Analysis. The Prentice-weighted regression model identified the following significant predictors of GDM as shown in table 2.

Table 2. Prentice-weighted regression model for GDM predictor

| Variable | Adjusted OR | 95% CI | p-value |
|---|---|---|---|
| Pre-pregnancy BMI ≥30 | 4.12 | 1.33–12.78 | 0.016 |
| Family history of diabetes | 3.67 | 1.13–11.91 | 0.031 |
| Prior history of GDM | 5.43 | 1.68–17.56 | 0.004 |
| HbA1c >5.7% | 6.88 | 2.03–23.27 | 0.002 |
| Physical activity <150 min/week | 2.03 | 0.61–6.75 | 0.241 |
| Maternal age ≥35 | 1.45 | 0.51–4.14 | 0.481 |
| Multiparity | 1.23 | 0.42–3.59 | 0.702 |

**Discussion**

This analysis highlights the utility for GDM prediction of the Prentice model due to the cumulative effects of clinical and lifestyle factors. As mentioned previously, obesity and prior GDM were the overall predictors. The fact that the association between pre-pregnancy BMI and GDM reflects the pre-pregnancy condition of prevalent insulin resistance is significant. The fact that 66.7% of GDM women within our analysis had a BMI of ≥30 supports the necessity for optimization prior to conception.

One of the strongest predictors was first-trimester HbA1c. While still never part of routine prenatal care, HbA1c>5.7% was the strongest independent correlate for GDM (aOR=6.88). This agrees with work by Riskin-Mashiah et al., demonstrating that HbA1c will identify impaired glucose control before overt hyperglycemia [14].



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Family histories for diabetes are consistent with the recognized genetic and behavioural clustering of metabolic risk [2, 4, 9, 17]. Prior GDM, as an established high-risk condition, was linked to five times increased risk within our population—highlighting the importance of complete obstetric history taking.

Interestingly, less than 150 min/week of physical activity and maternal age 35 or more years trended to increased risk but was not significant—presumably due to the modest sample size. Subsequent larger studies have corroborated both as etiologic factors in GDM pathophysiology [5, 12].

With the use of the Prentice model, we compensated for potential bias within our sample and increased validity to risk estimation. Compared to standard logistic regression, the Prentice approach gives us weights that are directly applicable for case-cohort studies—particularly useful when disease incidences are common and exposures are prevalent [6, 11].

The major advantages for this study are the use of a case-cohort-appropriate model, measurement using HbA1c as a marker for metabolism, and the use of both historical and lifestyle factors. Disadvantages are limited sample size, one-center recruitment, and self-reported physical activity, which can be affected by recall bias.

## Conclusion

The Prentice model is an evidence-based method for GDM prediction among high-risk women based on HbA1c, family or personal GDM history, and pre-pregnancy BMI. Adding a model such as this to clinical calculations can lead to more timely intervention and improvement in maternal-fetal outcomes.

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