ACH Med J
(2025) 4: 110-116
ISSN:2822-5872
Doi : 10.5505/achmedj.2025.47955

RESEARCH ARTICLE

Adverse Obstetric and Neonatal Outcomes in Maternal Diabetes: Prediction by Glucose-to-Potassium Ratio

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Article Info

Received Date: 28.08.2025
Revision Date : 25.09.2025
Accepted Date: 30.09.2025

Keywords:
Diabetes,
Glucose,
GPR,
NICU,
Obstetric complications

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Abstract

Introductıon: The aim of this study is to investigate whether the glucose-to-potassium ratio (GPR) can predict adverse obstetric and neonatal outcomes in pregnant women diagnosed with diabetes.

Methods: This retrospective observational study included 80 pregnant women diagnosed with pregestational or gestational diabetes, as well as 120 healthy pregnant women, between 2023 and 2025. GPR was calculated by dividing the glucose level by the potassium level in the venous blood sample taken at the time of delivery. Receiver Operating Characteristic curves were constructed to evaluate the predictive value of GPR for adverse obstetric and neonatal outcomes.

Results: In maternal diabetes, multiparity and comorbid conditions were found to be higher. The gestational age at delivery was similar in both groups; however, the birth weight of neonates born to diabetic mothers was statistically higher. The NICU admission and adverse obstetric outcomes were higher in the case group. The median GPR level was 23.4 in the diabetes group and 20.3 in the control group ($p < 0.001$). When all participants were analysed, the optimal cut-off value of GPR for predicting NICU admission was found to be 21.7 (AUC 0.583, Sensitivity 55.3%, Specificity 55.1%, 95% CI 0.505–0.667, $p = 0.043$). Glucose levels were found to be statistically significant in predicting NICU admission and adverse obstetric outcomes ($p = 0.017$ and $p = 0.005$, respectively). However, these markers did not show predictive value within the diabetic group.

Conclusion: GPR and hyperglycemia may be associated with adverse obstetric outcomes.

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Introduction

Maternal diabetes is a serious metabolic disease with increasing prevalence and is associated with significant obstetric and neonatal complications. The majority of diabetes observed during pregnancy is gestational diabetes, but pregestational diabetes, defined as Type 1 and Type 2 diabetes, also negatively affects the health of both the mother and the fetus.[1] Due to factors such as a hyperglycemic environment, accompanying lipid abnormalities, chronic inflammation, and epigenetic differences, diabetes is associated with many complications in the newborn, including respiratory distress, hypoglycemia, the need for neonatal intensive care, neurodevelopmental disorders, and cardiac dysfunction.[2,3]

Potassium, the other determinant of the glucose-to-potassium ratio, also plays a key role in cellular homeostasis.[4] Insulin facilitates not only glucose but also potassium uptake into cells, and disturbances in this balance may further contribute to metabolic instability in diabetic pregnancies.

The glucose-to-potassium ratio has been calculated to provide prognostic information regarding various adverse medical conditions such as hypoxia, ischemia, intensive care unit admission, and cerebrovascular events. Since this ratio is derived from basic blood parameters, it provides ease of use in predicting mortality and morbidity.

It is known that diabetes disrupts the balance of oxygen by impairing its delivery due to microvascular damage caused by hyperglycaemia.[5] In this study, we aimed to investigate whether the glucose-to-potassium ratio (GPR), which is associated with ischemia and hypoxia, can predict adverse obstetric and neonatal outcomes in pregnant women diagnosed with diabetes.

Material and Methods

This study is a retrospective observational study, including a total of 80 pregnant women aged between 18 and 45 years, diagnosed with pregestational diabetes (PGD) and gestational diabetes (GDM), whose pregnancies were followed and deliveries occurred in the hospital between 2023 and 2025, and 120 healthy pregnant women as a control group. In the study group, 68 women (85%) were diagnosed with GDM, 4 patients (5%) with Type 1 diabetes (T1DM), and 8 patients (10%) with Type 2 diabetes (T2DM). Thus, the proportion of pregestational diabetes cases was 15%, of which 33% were type 1 and 67% were type 2 diabetes.

The study was approved by the Clinical Research Ethics Committee of Uşak University (Ethics Number: 732-732-05, Date: 23/06/2025). The study complies with the Declaration of Helsinki. Since the data were anonymized and collected retrospectively, written informed consent was waived. Exclusion criteria included poor glycemic control, multiple pregnancies, smoking, any inflammatory condition, a history of cancer, and fetal chromosomal or structural anomalies.

All patients were followed up in the endocrinology department, and information regarding glycemic control (fasting glucose and HbA1c values during follow-up) was available in hospital records. However, these data could not be comprehensively included in the analysis due to incomplete documentation in some cases.

More than 4.000 deliveries took place in our hospital within two years, and all patients diagnosed with diabetes and with good glycemic control by the endocrinology department were included in the study group through retrospective screening using the hospital archive and operating system. The control group consisted of randomly selected healthy pregnant women who were matched with each study patient based on the date of delivery and had random glucose or oral glucose tolerance test results within normal limits.

The diagnoses of T1DM, T2DM, and GDM were made according to the criteria accepted by the American Diabetes Association.[6] All patients were followed up in the endocrinology department. The demographic characteristics of the participants, as well as the treatment methods (diet or insulin) of the pregnant women diagnosed with diabetes, were recorded. GPR was calculated by dividing the glucose level by the potassium level in the venous blood sample taken at the time of delivery. Adverse obstetric outcomes were defined as hypertensive disorders of pregnancy, fetal growth restriction, preterm birth, birth weight over 4000 g (macrosomia), and amniotic fluid abnormalities. In addition, the need for emergency cesarean section and admission to the neonatal intensive care unit (NICU) was recorded.

Statistical analysis was performed using IBM SPSS Statistics 26.0. The normality of the variables was tested using both the Shapiro-Wilk and Kolmogorov-Smirnov tests. Non-normally distributed data were evaluated using the Mann-Whitney U test and

presented as median, minimum–maximum (min–max), number (n), and percentage (%). A p-value of < 0.05 was considered statistically significant.

To evaluate the predictive value of adverse obstetric and neonatal outcomes, Receiver Operating Characteristic (ROC) curves were generated and the Area Under the Curve (AUC) values were calculated using standard methods. The data were presented as AUC ROC (95% CI). Appropriate cut-off values for inflammatory indices were determined using the Youden index. In a similar study, for sample size estimation, a minimum of 35 patients per group was required with a 5% margin of error and 80% power with G-power .[7]

Results

Table 1 presents the demographic and obstetric baseline characteristics of both groups. The median age of patients in the diabetes group was found to be higher compared to the healthy group. A larger proportion of the pregnant women with maternal diabetes were multiparous, and the comorbidities were also found to be higher in the diabetes group. In the diabetes group, 47 patients (58.7%) were followed with diet therapy and 33 patients (41.2%) with insulin therapy. Regarding comorbidities, four patients in the diabetes group had chronic hypertension, four had hypothyroidism, and one patient each had a diagnosis of epilepsy and asthma. Although the gestational age at delivery was similar in both groups, the birth weight of neonates born to diabetic mothers was found to be statistically higher. The NICU admission and adverse obstetric outcomes were significantly higher in the maternal diabetes ($p < 0.001$ and $p = 0.012$, respectively). The most common complications in the case group were hypertensive disorders of pregnancy (n = 3), preterm labor (n = 5), and macrosomia (n = 4), whereas in the healthy group, the most frequent complication was preterm labor (n = 15).

Table 2 presents hematological and biochemical profiles of in diabetic and healthy pregnant women. Complete blood count, platelet count, white blood cell count, and potassium levels were similar in both groups. The serum glucose level in the diabetic group was 97 mg/dL (range: 62–314), while it was 84 mg/dL (range: 60–155) in the healthy group ($p < 0.001$). The GPR level was 23.4 (range: 17.2–74.4) in the study group and 20.3 (range: 12.5–40.7) in the control group ($p < 0.001$).

Table 1: Baseline characteristics of participants

	Case group (n=80)	Control group (n=120)	P value
Maternal age (years)	30 (20 - 41)	28 (18 - 41)	**<0.001**
Nulliparity (n, %)	19 (23.7)	55 (45.8)	**0.002**
Comorbidity (n, %)	10 (8)	0 (0)	**0.003**
Male fetal gender (n, %)	44 (55.5)	63 (52.5)	0.782
Gestational age at birth (week)	38 (35- 40)	37 (32 -41)	0.974
Birth weight (gram)	3377 (2350 - 4380)	2790 (1775 - 4700)	**0.001**
Emergency cesarean section (n, %)	8 (10)	15 (12.5)	0.587
APGAR score at 1st minute	9 (1- 9)	8 (3- 9)	0.883
APGAR score at 5th minute	10 (3 - 10)	9 (6 - 9)	0.476
NICU admission (n, %)	45 (56.2)	32 (26.6)	**<0.001**
Adverse perinatal outcomes (n, %)	22 (27.5)	16 (13.3)	**0.012**

Note: Data given as median (interquartile range), number, percentile (%). P-values < 0.05 were considered statistically significant. *Mann Whitney U test BMI, body mass index; NICU, neonatal intensive care unit

Table 2. Hematological and biochemical profiles of the study population

	Case group (n=80)	Control group (n=120)	P value
Hemoglobin (g/dL)	12.6 (8.7 - 15)	11.6 (8.2 - 15.5)	0.336
Platelet (10^9 /L)	254 (122 - 494)	248 (131- 524)	0.939
WBC (10^9 /L)	9.9 (6.8 - 20.3)	10.6 (5.8 - 25.3)	0.176
Glucose (mg/dL)	97 (62 - 314)	84 (60 - 155)	**<0.001**
Potassium (mg/dL)	4.2 (3.1 - 4.8)	4.1 (3.5 – 4.8)	0.187
GPR	23.4 (17.2 – 74.4)	20.3 (12.5 – 40.7)	**<0.001**

Note: Data given as median (interquartile range), number, percentile (%). P-values < 0.05 were considered statistically significant. *Mann Whitney U test GPR: Glucose-potassium ratio

Tables 3 and 4 show ROC analysis of glucose and GPR in predicting adverse obstetric outcomes and NICU need for all participants and the diabetes group. When all participants were analyzed, the optimal cut-off value of GPR for predicting NICU admission was found to be 21.7 (AUC 0.583, Sensitivity 55.3%, Specificity 55.1%, 95% CI 0.505–0.667, $p = 0.043$). Glucose levels were found to be statistically significant in predicting NICU admission and adverse obstetric outcomes ($p = 0.017$ and $p = 0.005$, respectively) (Figure 1, Figure 2).

Table 3: The ROC curve analysis for the performance of serum markers in predicting advers obstetric outcomes and NICU admission in all participants

	Cut-off	AUC	p value	95% CI	Sensitivity	Specificity
NICU						
Glucose (mg/dL)	90.5	0.601	**0.017**	0.522-0.680	%58.4	%59.3
GPR	21.7	0.586	**0.043**	0.505 - 0.667	%55.3	%55.1
Advers obstetric outcome						
Glucose (mg/dL)	93.5	0.647	**0.005**	0.551-0.742	%60.5	%63
GPR	21.7	0.585	0.101	0.485 - 0.685	%55.3	%52.6

Note: P-values < 0.05 were considered statistically significant.
AUC, area under the curve; NICU, neonatal intensive care unit ; GPR: Glucose-potassium ratio

Table 4: The ROC curve analysis for the performance of serum markers in predicting advers obstetric outcomes and NICU admission in maternal diabetes

	Cut-off	AUC	p value	95% CI	Sensitivity	Specificity
NICU						
Glucose (mg/dL)	97.5	0.442	**0.372**	0.310-0.537	%51.1	%48.6
GPR	24.7	0.417	**0.065**	0.289 - 0.545	%42.2	%45.5
Advers obstetric outcome						
Glucose (mg/dL)	98.5	0.519	**0.792**	0.381-0.657	%54.5	%53.4
GPR	23.3	0.422	0.071	0.282 - 0.562	%45.5	%46.4

Note: P-values < 0.05 were considered statistically significant.
AUC, area under the curve; NICU, neonatal intensive care unit ; GPR: Glucose-potassium ratio

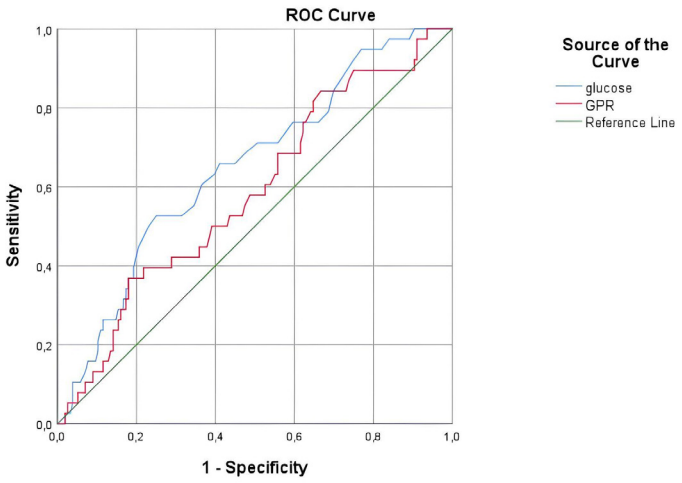

Figure 1: The ROC curve analysis for the performance of glucose and GPR in predicting advers obstetric outcomes in all participants

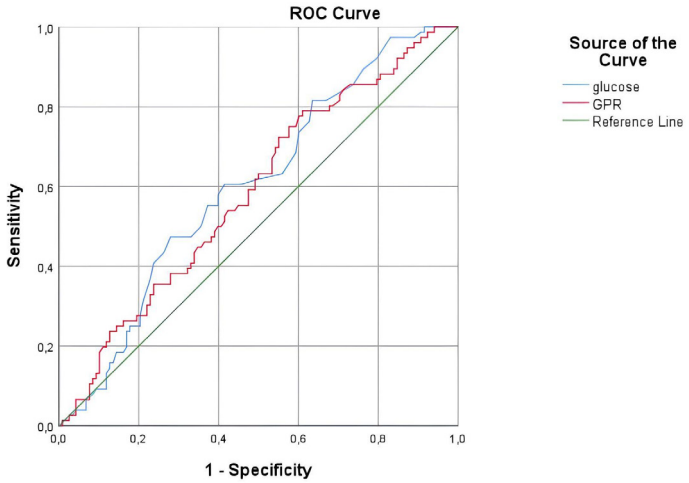

Figure 2: The ROC curve analysis for the performance of glucose and GPR in predicting NICU admission in all participants

Discussion

According to the World Health Organization, the prevalence of diabetes has increased fourfold over the past thirty years and continues to be a serious public health problem affecting more than 800 million people.[8] Advanced maternal age, family history of diabetes, obesity, ethnicity, comorbid metabolic diseases, and physical inactivity are among the risk factors for diabetes.[9] For gestational diabetes, additional factors such as a history of adverse obstetric outcomes in previous pregnancies, history of delivering large-for-gestational-age infants, excessive weight gain during pregnancy, and multiparity should also be considered. These risk factors are consistent with the baseline characteristics of the diabetes group in our study. In our study, diabetic pregnancies were associated with significantly higher NICU admission rates and adverse obstetric outcomes compared to controls. Although glucose levels and GPR were higher in pregnant women diagnosed with diabetes compared to the healthy group, they did not maintain statistical significance in predicting adverse obstetric and neonatal outcomes. Additionally, glucose and GPR were found to be statistically significant in predicting NICU admission among all participants.

Glucose metabolism functions optimally in the human body through hormones such as insulin and glucagon, which are secreted by the islets of Langerhans and specialized cells located in the pancreas. Although the exact mechanism has not been clearly elucidated, T1DM occurs as a result of the autoimmune destruction of specialized pancreatic cells, rendering them unable to produce insulin.[10] T2DM

is associated with a reduction in glucose sensitivity of pancreatic beta cells and an inadequate response of insulin-sensitive tissues to insulin.[11] GDM is a serious and common obstetric complication characterized by hyperglycemia, insulin resistance, and pancreatic dysfunction, and it is considered an indicator of the potential development of diabetes in later life.[12] The diagnosis of GDM is established between the 24th and 28th weeks of gestation using either a one-step 75 g oral glucose tolerance test or a two-step 50 g oral glucose challenge test. Since GDM is associated with adverse pregnancy outcomes such as preterm birth, preeclampsia, shoulder dystocia, increased cesarean section rates, neonatal hypoglycemia, and increased NICU admission, early diagnosis and glucose regulation through insulin or dietary modifications are of great importance.[13] In our study, the most common complications observed in the diabetic group were preterm labor and preeclampsia. Additionally, diabetes may affect microvascular structures through molecular mechanisms such as endothelial dysfunction and increased reactive oxygen species, leading to complications such as retinopathy, nephropathy, cerebrovascular events, and heart disease.[14] Interestingly, adverse outcomes such as macrosomia and preterm birth have also been observed in pregnant women with hyperglycemia despite normal OGTT results.[15,16]

Potassium is the most abundant cation in intracellular fluid. Insulin facilitates not only the uptake of glucose but also of potassium into the cell. Stimulation by insulin and other catecholamines activates the Na^+/K^+-ATPase pump in the cell membrane, thereby promoting the entry of potassium into cells and maintaining intracellular balance.[17] A previous study showed that potassium concentrations increased in patients with poorly controlled type 2 diabetes.[18] Our study revealed no significant difference in potassium levels between the diabetic and healthy groups. This may be because we included pregnant women with good glycemic control in the study.

GPR is a ratio that is easy to calculate as a predictor, especially in ischemic conditions. In subarachnoid hemorrhages accompanied by cerebral vasospasm, GPR has shown a significant correlation with the degree of vasospasm and infarction.[19] Similarly, in acute intracerebral hemorrhage, GPR levels have been found to be significant in predicting hematoma volume after bleeding and poor outcomes three months after the event.[20] In previous studies, high GPR has been associated with postoperative mortality in patients with aortic dissection and those admitted to the coronary care unit for any reason.[21,22] In studies conducted in Turkey on GPR, it has been found to be valuable in assessing morbidity, mortality, and prognosis in patients with blunt abdominal or thoracic injuries and carbon monoxide poisoning.[23-25]

To the best of our knowledge, our study is the first to investigate the predictive value of GPR levels for adverse obstetric and neonatal outcomes in pregnant women with maternal diabetes. Several studies have examined the link between blood parameter ratios and obstetric complications in women with maternal diabetes. These investigations have shown that high neutrophil-to-lymphocyte ratios and systemic inflammation markers are statistically significant predictors of poor obstetric outcomes.[26,27] In our study, GPR did not reach statistical significance in predicting adverse obstetric outcomes and NICU admission. However, the findings suggest a clinically meaningful trend, indicating the need for studies with larger sample sizes. When all participants were evaluated, GPR reached statistical significance in predicting NICU admission. Additionally, elevated glucose levels were successful in predicting poor outcomes. In diabetic mothers, not only hyperglycemia but also other contributing factors may be involved in the development of adverse outcomes.

Limitations

This study has several limitations. First, patients with GDM and pregestational diabetes mellitus were analyzed together. Although both conditions share hyperglycemia as a common pathway, their pathophysiology and risk profiles differ, which may have influenced the results. Second, data on longitudinal glycemic control (HbA1c, fasting glucose trends) could not be fully included due to missing records. Third, the ROC analysis of GPR in the diabetic subgroup was statistically insignificant with very low AUC values, limiting the predictive validity of the marker. Future multicenter studies with larger cohorts and subgroup analyses are warranted.

Conclusion

GPR and hyperglycemia may be associated with adverse obstetric outcomes.

Availability of Data and Materials

The data supporting the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to privacy or ethical restrictions.

Conflicts of Interest

The authors declare no conflicts of interest.

Funding

This study received no financial support.

Authors' Contributions

B.A.A.: Writing, data curation, original draft.
E.B.: Data curation, writing – review and editing.

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