

The Role of the Triglyceride-Glucose Index in Predicting Gestational Diabetes Mellitus

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Abstract

BACKGROUND/AIMS: The present study investigated whether the triglyceride-glucose (TyG) index could serve as a predictive marker for gestational diabetes mellitus (GDM).

MATERIALS AND METHODS: This retrospective case-control analysis included pregnant women who were followed and delivered at our institution between April 2018 and April 2024. Among 1,360 evaluated pregnancies, 64 women diagnosed with GDM were assigned to the study group, while 132 uncomplicated singleton pregnancies were assigned to the control group. Clinical characteristics, obstetric outcomes, and metabolic parameters were compared between groups. First-trimester laboratory measurements, including fasting glucose, triglycerides (TG), total cholesterol, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol, body mass index (BMI), TyG index, and TyG-BMI, were obtained from medical records.

RESULTS: Women with GDM demonstrated significantly higher BMI values than controls ($p=0.021$) and delivered at an earlier gestational age ($p<0.001$). In addition, TG levels, fasting glucose, TG/HDL-C ratio, TyG index, and TyG-BMI index were significantly elevated in the GDM group ($p<0.05$ for all comparisons). Multivariable logistic regression analysis, adjusted for maternal age, BMI, smoking status, and parity, revealed that the TyG index was independently associated with GDM [adjusted odds ratio: 1.85, 95% confidence interval (CI): 1.14-3.02, $p=0.013$]. Effect size estimates and CIs supported the clinical relevance of these findings.

CONCLUSION: The TyG index may represent a practical and cost-effective marker for identifying women at increased risk of GDM. Incorporating this index into routine antenatal evaluation could support earlier risk stratification and improve preventive care strategies.

Keywords: Triglyceride-glucose index, gestational diabetes mellitus, pregnancy, insulin resistance

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INTRODUCTION

Gestational diabetes mellitus (GDM) is impaired glucose regulation first recognized during pregnancy and typically resolves after delivery. Its development is mainly driven by progressive insulin resistance, accompanied by an inadequate compensatory response by pancreatic β -cells. Maternal hyperglycemia can negatively influence placental function, resulting in increased fetal glucose exposure and subsequent fetal hyperinsulinemia.¹⁻³ These metabolic disturbances are associated with adverse outcomes, including excessive fetal growth, neonatal hypoglycemia, and an increased risk of long-term metabolic disease. Therefore, early detection and appropriate management of GDM are crucial to reducing both maternal and neonatal morbidity.⁴

Various professional organizations, such as the World Health Organization, the International Association of Diabetes and Pregnancy Study Groups, the American College of Obstetricians and Gynecologists, and the National Institute for Health and Care Excellence, have proposed different screening and diagnostic strategies. Both one-step and two-step oral glucose tolerance test protocols are widely used in clinical practice.⁵

Pregnancy is also characterized by substantial alterations in lipid metabolism, particularly a gradual increase in circulating triglyceride (TG) levels.⁶ These changes become more pronounced in later trimesters and are largely driven by hormonal influences and increased energy requirements. Elevated estrogen levels promote hepatic lipoprotein production, while pregnancy-related insulin resistance contributes to reduced lipid clearance and enhanced lipolysis, leading to increased release of free fatty acids.⁷

Although these metabolic adaptations are essential for fetal development, excessive lipid accumulation has been associated with adverse pregnancy outcomes, including GDM, preeclampsia, and fetal macrosomia. In recent years, there has been growing interest in simple biochemical markers and composite indices for early disease prediction.^{8,9} Among these, the TG-glucose (TyG) index has been proposed as a practical and economical surrogate marker of insulin resistance.^{10,11} Since it is derived from routinely measured fasting glucose and TG levels, it may provide valuable insight into early metabolic alterations.

Accordingly, this study aimed to evaluate the potential role of the TyG index in predicting the development of GDM.

MATERIALS AND METHODS

This retrospective case-control study was performed in accordance with the ethical standards of the Declaration of Helsinki. Written informed consent was obtained from all participants prior to inclusion. Ethical approval was granted by the institutional review board of our hospital Buca Seyfi Demirsoy Training and Research Hospital Non-Interventional Research Ethics Committee (approval number: 2024/372, date: 25.12.2024).

A total of 1,360 pregnant women who were followed and who delivered at our center between April 2018 and April 2024 were evaluated retrospectively. The study group included 64 women aged between 18 and 45 years with singleton pregnancies who were diagnosed with GDM. The control group consisted of 132 women in the same age range who had uncomplicated singleton pregnancies and no diagnosis of GDM.

Women without pre-existing diabetes were screened for GDM between 24 and 28 weeks of gestation using a 75-g oral glucose tolerance test. All tests were performed in the morning following a fasting period of at least 8 hours. Plasma glucose concentrations were measured at baseline (fasting) and at 1 and 2 hours after glucose intake. GDM was diagnosed when at least one of these values met or exceeded the established diagnostic thresholds, based on internationally accepted criteria.¹²

Participants were excluded if they had a history of assisted reproductive techniques, a body mass index (BMI) greater than 30 kg/m² at the time of pregnancy diagnosis, multiple gestations, known chromosomal abnormalities, a previous preterm delivery, a prior complicated obstetric history, a chronic systemic disease, or use of immunosuppressive therapy.

Demographic features, obstetric parameters, and biochemical parameters were compared between the two groups. Laboratory data obtained during the first trimester were retrospectively retrieved from hospital records. The evaluated parameters included BMI, total cholesterol (TC), TGs, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), fasting blood glucose (FBG), TyG index, and TyG-BMI.

The TyG index was calculated as the natural logarithm of fasting TG and glucose levels [$\ln(TG \times \text{glucose}/2)$]. The TyG-BMI index was derived by multiplying the TyG index by BMI. Additionally, lipid ratios were calculated as TG/HDL-C and TC/HDL-C (mg/dL).

Statistical Analysis

A total of 1,360 pregnant women who were monitored and delivered at our center between April 2018 and April 2024 were retrospectively reviewed. Sixty-four women aged 18-45 years who had singleton pregnancies and were diagnosed with GDM constituted the study group. The control group consisted of 132 women of similar age who had uncomplicated singleton pregnancies and no evidence of GDM.

Participants without previously diagnosed diabetes were screened for GDM between 24 and 28 weeks of gestation using a standard 75-g oral glucose tolerance test. All measurements were obtained in the morning after fasting for at least 8 hours. Plasma glucose levels were recorded during fasting and at 1 and 2 hours after glucose administration. A diagnosis of GDM was established if one or more values met the accepted diagnostic thresholds.¹²

Exclusion criteria included conception via assisted reproductive techniques; a BMI above 30 kg/m² at initial evaluation; multiple pregnancies; known fetal chromosomal abnormalities; a history of preterm birth; previous complicated obstetric outcomes; chronic systemic disorders; and the use of immunosuppressive medications.

Clinical characteristics, obstetric outcomes, and biochemical parameters were compared between the groups. First-trimester laboratory results were obtained from hospital records. The variables analyzed included BMI, TC, TG, HDL-C, LDL-C, FBG, and the TyG and TyG-BMI indices.

The TyG index was calculated as the natural logarithm of the product of fasting TG and glucose levels [$\ln(TG \times \text{glucose}/2)$]. The TyG-BMI index was calculated as the product of the TyG value and the BMI. In addition, lipid ratios were determined as TG/HDL-C and TC/HDL-C (mg/dL).

RESULTS

BMI was higher in the GDM group compared with control group (p=0.021). Gestational age at delivery was lower in the GDM group than in the controls (p<0.001) (Table 1).

Biochemical parameters of the study groups are presented in Table 2. TG levels and FBG levels were higher in women with GDM than in controls (p=0.032 and p=0.018, respectively). Similarly, the TG/HDL-C ratio was elevated in the GDM group (p=0.012). In addition, both the TyG index and the TyG-BMI index were higher in women diagnosed with GDM (p=0.028 and p=0.034, respectively) (Table 2).

All biochemical variables included in Table 2 showed an approximately normal distribution; therefore, parametric tests were used for comparisons.

After adjusting for potential confounders, including maternal age, BMI, smoking status, and parity, the TyG index remained significantly associated with GDM [adjusted odds ratio (OR): 1.85, 95% confidence interval (CI):1.14-3.02, p=0.013]. In a separate model, the TyG-BMI index also showed an independent association with GDM (adjusted OR: 1.02, 95% CI: 1.01-1.04, p=0.008).

Table 1. Comparison of demographic and obstetric data according to the presence of GDM

	GDM n=64	Controls n=132	p-value
	Mean ± SD		
Age (years)	29.7±4.1s	29.2±3.9	0.78
BMI (kg/m ²)	24.4±3.9	23.5±3.7	0.021
Smoking, n (%)	7 (10.9%)	14 (10.6%)	0.88
Gravidity	3 (1-4)	3 (1-5)	0.82
Parity	2 (1-4)	2 (1-3)	0.88
Birth weight (g)	3370±380	3310±410	0.56
Gestational week	36.2±1.1	38.6±1.2	<0.001

BMI: Body mass index, GDM: Gestational diabetes mellitus, SD: Standard deviation.

DISCUSSION

This study evaluated the relationship between the TyG index and GDM and demonstrated that several metabolic parameters differed between women with and without GDM. Specifically, BMI, TG levels, fasting glucose, and TyG-related indices were higher in the GDM group. Because GDM is typically diagnosed in the late second trimester, identifying reliable markers earlier in pregnancy remains a clinical priority.

The underlying mechanism of GDM is primarily associated with progressive insulin resistance combined with an inadequate compensatory response of pancreatic β-cells.¹³ Although homeostasis model assessment of insulin resistance is commonly used to estimate insulin resistance, its routine clinical use is limited by cost and the absence of universally accepted cut-off values. In contrast, the TyG index has emerged as a practical alternative based on routinely available laboratory parameters,¹⁴ making it more feasible for integration into standard antenatal care.

Elevated TyG levels have previously been associated with a range of metabolic and cardiovascular disorders, including metabolic syndrome and type 2 diabetes.¹⁵⁻¹⁸ Consistent with these findings, our results showed higher TyG and TyG-BMI values in women with GDM, suggesting that these indices may reflect underlying metabolic disturbances during pregnancy.

In the present cohort, BMI was significantly greater in the GDM group, supporting the known link between increased adiposity and impaired glucose metabolism. Higher BMI contributes to insulin resistance and may predispose individuals to GDM. Additionally, an earlier gestational age at delivery observed in this group may indicate a higher burden of obstetric complications. Previous reports have shown that GDM is associated with conditions such as preeclampsia, fetal macrosomia, and polyhydramnios, which can lead to earlier delivery.¹⁹ Moreover, maintaining adequate glycemic control is essential, as maternal hyperglycemia is closely associated with adverse perinatal outcomes, including preterm birth.²⁰

Table 2. Comparison of biochemical parameters according to the presence of GDM

	GDM n=64	Controls n=132	p-value	Mean difference (95% CI)	Effect size (Cohen's d)	Adjusted p (FDR p-value)
	Mean ± SD					
TC (mg/dL)	204.2±36.52	199.68±33.8	0.26	4.52 (-6.24 to 15.28)	0.13	0.416
TG (mg/dL)	135.68±58.64	112.52±48.82	0.032	23.16 (6.36 to 39.96)	0.44	0.035
FBG (mg/dL)	98.18±18.72	87.26±10.24	0.018	10.92 (5.94 to 15.90)	0.80	0.042
TC/HDL-C	4.19±1.36	4.06±1.26	0.18	0.13 (-0.27 to 0.53)	0.10	0.360
TG/HDL-C	2.81±1.12	2.28±1.12	0.012	0.53 (0.19 to 0.87)	0.47	0.032
HDL-C (mg/dL)	48.62±16.66	49.12±15.76	0.68	-0.50 (-5.44 to 4.44)	-0.03	0.760
LDL-C (mg/dL)	128.36±25.8	129.12±20.64	0.76	-0.76 (-8.08 to 6.56)	-0.03	0.760
LDL-C/HDL-C	2.66±1.02	2.63±1.04	0.46	0.03 (-0.28 to 0.34)	0.03	0.613
TyG-	8.43±0.42	8.28±0.38	0.028	0.15 (0.03 to 0.27)	0.38	Not applicable (primary outcome)
TyG-BMI-	205.69±42.1	194.18±41.8	0.034	11.51 (0.92 to 22.10)	0.27	Not applicable (primary outcome)

All biochemical parameters in this table were compared using Independent Samples t-tests and are presented as mean ± SD. Effect sizes* are reported as Cohen's* d. Secondary biochemical comparisons were adjusted using the Benjamini-Hochberg FDR procedure (p=0.05). Since TyG and TyG-BMI were pre-specified as primary outcomes, FDR-adjusted p-values are not reported for these variables.

GDM: Gestational diabetes mellitus, TC: Total cholesterol, TG: Triglyceride, FBG: Fasting bloodxglucose, HDL-C: high-density lipoprotein cholesterol, LDL-C: Low-density lipoprotein cholesterol, TyG: Triglyceride glucose, BMI: Body mass index, SD: Standard deviation.

Analysis of lipid parameters revealed increased TG levels in the GDM group, which may indicate an underlying metabolic imbalance and heightened insulin resistance. Consistent with earlier studies, elevated TG appear more frequently in women with GDM and may play a role in its development.²¹ Furthermore, maternal lipid concentrations have been shown to influence fetal growth, with higher TG levels being linked to adverse fetal outcomes.²² The increased TG/HDL-C ratio observed in our study further supports the presence of an unfavorable metabolic profile in these patients.

Fasting glucose levels were also higher among women with GDM, reflecting impaired glucose regulation. The simultaneous elevation of the TyG and TyG-BMI indices highlights their potential as composite markers that integrate lipid and glucose metabolism. Since these parameters are routinely measured in early pregnancy, the TyG index represents a simple, non-invasive, and cost-effective tool for risk assessment in clinical practice.

A key strength of this study is the combined evaluation of multiple metabolic parameters using a comprehensive statistical approach. In addition to standard hypothesis testing, effect sizes and CIs were reported to clarify the findings' clinical significance. Furthermore, predefining primary outcomes and using false discovery rate correction helped reduce the likelihood of type I error.

Importantly, the association between the TyG index and GDM persisted after adjustment for potential confounding variables, suggesting that TyG may serve as an independent predictor. Our findings are consistent with previous studies reporting a link between higher TyG levels and increased risk of GDM. For example, Pazhohan et al.,¹⁰ reported associations between GDM and metabolic parameters such as fasting glucose, TG, TG/HDL-C ratio, and TyG index. Similarly, Sánchez-García et al.,^{11,23} demonstrated that second-trimester TyG measurements may have high sensitivity for GDM screening. Kim et al.,²⁴ also identified a relationship between pre-pregnancy TyG values and GDM risk, particularly in primiparous women. In addition, a meta-analysis by Song et al.,²⁵ confirmed that elevated TyG levels are independently associated with GDM.

Overall, these results emphasize the importance of early recognition of metabolic risk factors during pregnancy. Early identification and appropriate management strategies are essential to improving both maternal and neonatal outcomes. The inclusion of multiple biochemical indicators further enhances the clinical applicability of our findings.

Study Limitations

Several limitations of this study should be acknowledged. First, the retrospective nature of the design restricts the ability to draw definitive causal inferences and may result in incomplete or biased data collection. Second, the relatively small sample size may have reduced the statistical power of the analyses, particularly for subgroup analyses.

Furthermore, potentially influential factors, such as dietary habits, physical activity, and lifestyle characteristics were not assessed, which may limit interpretation of the findings. The single-center setting reduces external validity and may limit generalizability to broader populations.

Although adjustments were made using multivariable regression models, the possibility of residual confounding cannot be entirely ruled out. Unmeasured variables, including socioeconomic status, nutritional patterns, physical activity levels, and family history of diabetes, may still have influenced the observed associations.

CONCLUSION

This study highlights the potential utility of the TyG index as a predictor of GDM. Given its reliance on routinely obtained laboratory parameters, the TyG index may serve as a practical and accessible tool for early risk assessment during pregnancy and may be incorporated into standard obstetric care. Early identification of high-risk individuals may enable timely preventive strategies and improved clinical management. Nevertheless, larger-scale prospective studies are needed to further validate these findings and clarify the clinical applicability of the TyG index.

MAIN POINTS

- The TG/HDL-C ratio, triglyceride-glucose (TyG), and TyG-body mass index (BMI) values were higher in the gestational diabetes mellitus (GDM) group, demonstrating the role of metabolic disorders in GDM development.
- High TyG and TyG-BMI indices can be considered potential early biomarkers for GDM, thus offering a practical and easily applicable screening tool in addition to the classic oral glucose tolerance test.
- The gestational age at delivery was significantly earlier in the GDM group, highlighting the importance of early diagnosis and close follow-up to prevent pregnancy complications.

ETHICS

Ethics Committee Approval: This retrospective case-control study was conducted in accordance with the ethical standards of the Declaration of Helsinki. Ethical approval was obtained from the institutional Buca Seyfi Demirsoy Training and Research Hospital Non-Interventional Research Ethics Committee (approval number: 2024/372, date: 25.12.2024).

Informed Consent: Written informed consent was obtained from all participants prior to inclusion.

Footnotes

Authorship Contributions

Surgical and Medical Practices: C.A., M.E.P., Concept: U.A., M.E.P., Design: O.Y., T.B.B., Data Collection and/or Processing: H.A.A., M.E.P., Analysis and/or Interpretation: O.Y., M.E.P., S.E., Literature Search: O.Y., T.B.B., Writing: C.A., A.İ.

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