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Original Research Article

Evaluation of triglyceride/glucose level index as a predictor of gestational diabetes mellitus: a comparative study with haemoglobin A_1c

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ABSTRACT

Background: Gestational diabetes mellitus (GDM) is a pregnancy complication characterized by chronic hyperglycaemia, which increases the risk of adverse outcomes for both the mother and foetus. Early identification and intervention are crucial for improving pregnancy outcomes. The triglyceride-glucose (TyG) index, calculated using fasting triglyceride and glucose levels, has shown promise as a predictor of insulin resistance and metabolic disturbances. This study aims to evaluate the potential of the TyG index, along with HbA1c, as early biomarkers for GDM prediction.
Methods: This prospective study was conducted at GS Medical College & Hospital, Pilkhuwa, Hapur, over 18 months (January 2022 to June 2024), involving 144 pregnant women aged 18-30 years. The study included fasting glucose, triglyceride, and HbA1c measurements, along with the oral glucose tolerance test (OGTT) to diagnose GDM. The TyG index was calculated as [fasting triglycerides (mg/dl) × fasting glucose (mg/dl)/2]. Statistical analysis was performed using SPSS version 26.0, with Chi-square, t-tests, and regression models.
Results: The study revealed that 11.8% of participants were diagnosed with GDM. The GDM group had significantly higher levels of HbA1c (6.34±0.59%) compared to the non-GDM group (4.32±1.26%) ($p<0.0001$). The TyG index was also significantly higher in the GDM group (150.4±25.2) compared to the non-GDM group (129.27±20.66) ($p = 0.0002$). Both markers showed strong associations with GDM, suggesting their utility for early prediction.
Conclusions: The study supports the use of HbA1c and the TyG index as effective early biomarkers for GDM. These markers can help identify high-risk women and enable timely intervention to reduce adverse maternal and fetal outcomes. Early screening using these biomarkers should be prioritized, particularly for high-risk populations. Further research is needed to validate their diagnostic utility and integrate them into routine clinical practice.

Keywords: Biomarkers, Early prediction, HbA1c, Insulin resistance, Gestational diabetes mellitus, Triglyceride-glucose index

INTRODUCTION

Gestational diabetes mellitus (GDM) is a serious pregnancy complication characterized by chronic hyperglycaemia during gestation, affecting approximately 16.5% of pregnancies worldwide (Plows et al, 2018). It is associated with various risk factors, including overweight, obesity, advanced maternal age, and family history of diabetes. GDM can lead to adverse outcomes for both mother and child, such as increased risk of cardiovascular disease, type 2 diabetes, macrosomia, and birth complications.[1,2]

The TyG index, calculated using fasting triglyceride and glucose levels, is emerging as a simple and reliable marker of insulin resistance, which plays a crucial role in the development of gestational diabetes mellitus (GDM).[3,4] Recent studies have explored its potential as a predictor for various metabolic disorders, including type 2 diabetes mellitus (T2DM) and GDM.[3-5] While the TyG index shows promise in GDM prediction, its relationship with HbA1c in the context of GDM is not explicitly discussed in the provided literature. HbA1c, a measure of long-term glycemic control, has been mentioned in some studies related to T2DM but not specifically in relation to GDM.[5,6]

The TyG index has shown promise in predicting GDM risk, particularly when measured pre-pregnancy or during the first trimester.[3,7] However, its effectiveness as a predictor may vary across different populations and ethnicities.[8,9] Some studies suggest that the TyG index could be a useful tool for early identification of women at high risk for developing GDM, potentially allowing for timely interventions and improved pregnancy outcomes.[3,7] Nevertheless, more research is needed to standardize optimal cut-off values and establish the TyG index as a reliable predictor of GDM across diverse populations.[8]

The rationale for this study is to explore the potential of lipid and glucose-related indices, particularly the triglyceride-glucose (TyG) index and HbA1c, as early predictors of gestational diabetes mellitus (GDM). Given the rising incidence of GDM and its adverse outcomes for both maternal and fetal health, early identification and intervention are crucial. Although various biomarkers have been proposed, the TyG index, as an accessible and cost-effective measure, has shown promise in predicting insulin resistance and metabolic disturbances associated with GDM. This study aims to delve deeper into the comparative effectiveness of the TyG index and HbA1c, and to assess their utility when combined with other markers like lipid profiles for improved prediction. Understanding these biomarkers' predictive capacity, especially in diverse populations, could ultimately contribute to more precise, timely interventions and better outcomes for pregnant women.

This study aimed to evaluate serum triglyceride/glucose level index of GDM and non–GDM groups in comparison with HBA1C level.

METHODS

This prospective study was conducted at the Department of Obstetrics and Gynaecology, OPD, GS Medical College & Hospital, Pilkhuwa, Hapur, over a period of 18 months (January 2022 to June 2024). The sample size was calculated based on the prevalence of gestational diabetes mellitus (GDM), resulting in 140 participants. Inclusion criteria involved pregnant women aged 18-30 years attending the obstetrics OPD. Exclusion criteria included women with pre-existing diabetes mellitus, chronic liver disease, renal impairment, or those on medications affecting glucose metabolism.

Data collection involved interviews and medical record reviews to gather demographic, medical, and obstetric history. The oral glucose tolerance test (OGTT) was performed according to FOGSI and WHO guidelines to diagnose GDM. Participants underwent fasting blood glucose measurements and post-OGTT blood glucose levels at one and two hours, alongside HbA1c and fasting triglyceride levels. The triglyceride-glucose (TyG) index was calculated as [fasting triglycerides (mg/dl)×fasting glucose (mg/dl)/2].

For the OGTT procedure, participants were instructed to fast overnight for at least 8 hours. They were then given a glucose solution (75g glucose in 250-300 ml water) and blood samples were collected at fasting, 1-hour, and 2-hour intervals for glucose analysis using GOD/POD methods. The WHO/FOGSI criteria were applied for diagnosing impaired glucose tolerance (IGT) and GDM with cutoffs at fasting ≥92 mg/dl, 1-hour ≥180 mg/dl, and 2-hour ≥153 mg/dl.

Ethical approval was obtained from the GS Medical College and Hospital Ethics Committee. Informed consent was obtained from all participants, and confidentiality was maintained throughout the study.

Statistical analysis was conducted using SPSS version 26.0. Descriptive statistics were used to summarize data, and Chi-square and t-tests were applied to compare the characteristics of non-GDM and GDM groups. Multivariate regression models were used to assess the relationship between the TyG index and GDM, adjusting for confounding factors such as age, BMI, triglyceride levels, and gestational age. The diagnostic accuracy of the TyG index was evaluated using the ROC curve analysis, with an AUC value calculated to determine its predictive capability for GDM.

RESULTS

In our study, 144 pregnant women who were initially free of diabetes were included. At their first prenatal visit, they underwent tests for serum triglycerides, HbA1c, and the serum triglyceride glycaemic index. An OGTT conducted between 24 and 28 weeks revealed that 127 women (88.2%) did not have Gestational Diabetes Mellitus (GDM), while 17 women (11.8%) were diagnosed with GDM as shown in Figure 1. The mean age for the GDM group was 27±2.4 years, and for the non-GDM group, it was 27.4±2.54 years.

Table 1 illustrates the distribution of Gestational Diabetes Mellitus (GDM) and Non-GDM cases across different gestational ages. In the earlier gestational weeks, such as 24 weeks and 25 weeks, the percentage of GDM cases was relatively low. Specifically, at 24 weeks, 17.6% of the cases were GDM, compared to 13.6% in the Non-GDM

group. At 25 weeks, the proportion of GDM cases decreased further, with only 5.8% compared to 14.17% in the Non-GDM group. However, as the pregnancy progressed to 26 weeks, there was a notable increase in the percentage of GDM cases, with 29.4% of cases being diagnosed with GDM, while the Non-GDM group had a slightly higher percentage at 32.2%. This trend continued at 28 weeks, where the proportion of GDM cases rose significantly to 41.1%, compared to 28.34% in the Non-GDM group. In contrast, the 27-week category showed a relatively balanced distribution, with both groups having smaller percentages, 5.8% for GDM and 11.8% for Non-GDM.

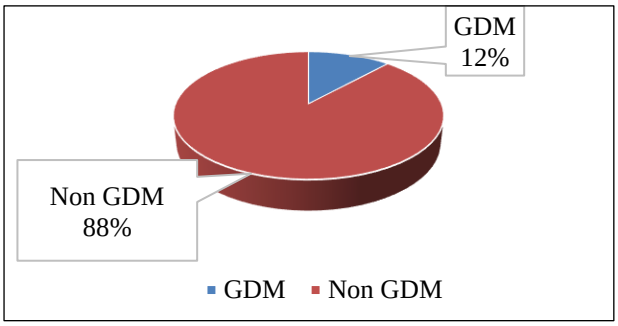

Figure 1: Distribution of study participants among GDM and Non GDM.

Table 1: Gestational age wise distribution of GDM and non-GDM group.

Gestational age	GDM		Non GDM	
	No. of cases	%	No. of cases	%
24 weeks	3	17.6	17	13.6
25 weeks	1	5.8	18	14.17
26 weeks	5	29.4	41	32.2
27 weeks	1	5.8	15	11.8
28 weeks	7	41.1	36	28.34

Table 2 depicts the data reveals a clear distinction in HbA1c levels between individuals with Gestational Diabetes Mellitus (GDM) and those without it. The GDM group exhibits a mean HbA1c of 6.34%, with a relatively small variation (±0.59), indicating a consistent elevation in blood sugar levels among these individuals. In contrast, the Non-GDM group has a lower mean of 4.32% and shows a greater spread in its values (±1.26), suggesting more variability in blood sugar levels within this group. The p-value of <0.0001 confirms that the difference between these two groups is statistically significant, implying that the higher HbA1c in the GDM group is not due to chance, but rather reflects a genuine difference in glycaemic control.

Table 3 reveals the data demonstrates a significant difference in the serum triglyceride/glucose level index between individuals with Gestational Diabetes Mellitus (GDM) and those without it. The GDM group has a higher mean index of 150.4, with a standard deviation of ±25.2, indicating a relatively elevated and consistent value within this group. On the other hand, the Non-GDM group has a lower mean index of 129.27, with a standard deviation of ±20.66, reflecting both a lower average and slightly less variability. The p-value of 0.0002 confirms that this difference is statistically significant, suggesting that the higher index observed in the GDM group is not due to random chance. This finding indicates that individuals with GDM tend to have a higher serum triglyceride/glucose level index, which may be linked to metabolic changes associated with gestational diabetes.

Table 2: Distribution of HbA1c level of GDM and non-GDM group.

Parameter	GDM (n=17)		Non-GDM (n=127)		P value
HbA1c	Mean	SD	Mean	SD	<0.0001
	6.34	±0.59	4.32	±1.26	

Table 3: Distribution of serum triglyceride /glucose level index of GDM and non-GDM groups.

Parameter	GDM (n=17)		Non-GDM (n=127)		P value
Serum Triglyceride /Glucose Level Index	Mean	SD	Mean	SD	0.0002
	150.4	±25.2	129.27	±20.66	

DISCUSSION

Gestational Diabetes Mellitus (GDM) remains a critical public health issue with wide-ranging implications for both maternal and foetal health. The prevalence of GDM is on the rise globally, reflecting complex interactions between genetics, lifestyle, and environmental factors. This study provides valuable insights into the epidemiology and early indicators of GDM, offering a deeper understanding of its prevalence, diagnostic markers, and the timing of its onset. With the inclusion of 144 pregnant women, our findings not only align with national and international trends but also underscore the importance of timely screening and early intervention in high-risk populations. By exploring key factors such as HbA1c levels and the Serum Triglyceride/Glucose Level Index, we aim to highlight potential biomarkers that could aid in early detection and improve pregnancy outcomes.

The prevalence of gestational diabetes mellitus (GDM) in this study was found to be 12% among the 144 participants, with 88% of women not having GDM. This prevalence rate aligns closely with the findings from other studies conducted in various regions of India and internationally. In a comprehensive systematic review and meta-analysis of GDM prevalence in India, the pooled prevalence was estimated to be 13% (95% CI: 9-16%) in Mantri et al, 2024.[10] This suggests that our study's findings

are consistent with the national average. Similarly, a study conducted in Kuwait reported a GDM prevalence of 12.6% (95% CI: 10.4-14.8) in Groof et al, 2019, further supporting the generalizability of our results.[11] Interestingly, our findings contradict some studies that reported lower prevalence rates. For instance, a study in mainland China found an overall GDM prevalence of 3.7% in Xu et al, 2017, while another study in Chengdu, China, reported a prevalence of 19.2% (48 out of 250 participants) by Li et al, 2020.[12,13] These variations highlight the importance of considering regional differences, diagnostic criteria, and population characteristics when interpreting GDM prevalence data.

The highest percentage of GDM diagnoses occurred at 28 weeks gestation (41.1%), followed by 26 weeks (29.4%). This aligns with recommendations to screen for GDM between 24-28 weeks gestation by Mustafa et al., 2020[14]. However, a notable proportion (17.6%) were diagnosed as early as 24 weeks, suggesting the potential benefit of earlier screening in high-risk women. Early diagnosis allows for a longer intervention period, which may positively impact pregnancy outcomes by Mustafa et al, 2020.[14] Interestingly, the distribution pattern differs between GDM and non-GDM groups. While the GDM group shows peaks at 26 and 28 weeks, the non-GDM group has a more even distribution across 24-28 weeks. This could indicate that GDM tends to develop or become detectable at specific gestational timepoints. The data highlights the importance of timely GDM screening, as diagnoses occur throughout the 24–28-week period. However, it's crucial to note that early GDM (diagnosed <24 weeks) is associated with higher risks of adverse pregnancy outcomes compared to standard GDM (diagnosed at 24-28 weeks), including increased rates of pregnancy-induced hypertension, premature birth, and need for neonatal intensive care by Mustafa et al, 2020.[14] This underscores the need for vigilant monitoring and management of GDM, particularly in early-diagnosed cases.

The significant difference in HbA1c levels between women with gestational diabetes mellitus (GDM) and those without GDM (6.34±0.59% vs 4.32±1.26%, $p<0.0001$) suggests that HbA1c may have potential as a diagnostic marker for GDM. This finding aligns with several studies that have explored the utility of HbA1c in GDM diagnosis. Research has shown that HbA1c levels are generally higher in women with GDM compared to those without GDM. For instance, Punnose et al (2019) reported mean HbA1c values of 5.04% and 4.9% for GDM and non-GDM women, respectively ($p<0.001$).[15] Similarly, Assaf-Balut et al (2018) noted higher HbA1c levels in GDM women at 24-28 gestational weeks (5.1% vs 4.9%, $p=0.001$).[16] These results, while showing smaller differences than the current data, consistently demonstrate elevated HbA1c in GDM. However, it's important to note that the diagnostic accuracy of HbA1c for GDM remains controversial. Punnose et al (2019) concluded that while HbA1c is an independent GDM predictor, it lacks sufficient sensitivity or specificity for use as a diagnostic test.[15] Siricharoenthai and Phupong (2019) similarly found that HbA1c values cannot replace the oral glucose tolerance test (OGTT) for GDM diagnosis, although it might be useful in reducing the number of OGTTs required.[17]

The study findings reveal a significant difference in the Serum Triglyceride/Glucose Level Index between women with Gestational Diabetes Mellitus (GDM) and those without GDM ($p = 0.0002$). Women with GDM had a higher mean index (150.4±25.2) compared to non-GDM women (129.27±20.66), suggesting a potential association between this index and GDM risk. This result aligns with previous research indicating that triglyceride and glucose levels are important factors in GDM development. A meta-analysis by Song et al (2021) found that women with the highest category of triglyceride-glucose (T/Gly) index had a significantly higher risk of subsequent GDM compared to those in the lowest category (OR: 2.52, 95% CI: 1.33-4.67).[18] The association was particularly strong in Asian women (OR: 3.30, 95% CI: 1.50-7.28), suggesting potential ethnic differences in the predictive value of this index. Interestingly, the relationship between lipid profiles and GDM may be influenced by obesity. O'Malley et al (2020) reported that women with GDM had higher triglycerides and lower HDL-Cholesterol compared to those with normal glucose tolerance.[19] However, this trend was only observed in women with a BMI >29.9 kg/m^2, suggesting that the association between GDM and dyslipidaemia might be mediated through maternal obesity.

our study highlights the importance of effective screening and management strategies for GDM, especially in areas with increasing prevalence. The findings emphasize the role of early markers like HbA1c and the Serum Triglyceride/Glucose Level Index in identifying women at risk, enabling timely interventions to reduce adverse outcomes. Despite regional and methodological differences in GDM prevalence, our results support early diagnosis and personalized care. Addressing GDM effectively requires a multifaceted approach that combines early detection, proper management, and a deeper understanding of metabolic factors, ultimately leading to better maternal and foetal health outcomes.

CONCLUSION

This study reinforces the importance of early screening for Gestational Diabetes Mellitus (GDM) using accessible biomarkers like HbA1c and the Serum Triglyceride/Glucose Level Index (TyG). Our findings highlight the elevated levels of both markers in women with GDM compared to those without, suggesting their potential as effective tools for early identification. Given the rising prevalence of GDM and its associated risks, early detection is crucial to prevent adverse maternal and foetal outcomes. These results contribute to the growing body of evidence supporting the use of the TyG index as a

reliable marker for GDM risk, alongside HbA1c, in diverse populations.

Recommendations

Early screening for Gestational Diabetes Mellitus (GDM) should be prioritized, particularly using markers like HbA1c and the Serum Triglyceride/Glucose Level Index (TyG), especially for high-risk populations, to facilitate timely intervention and reduce adverse outcomes. The TyG index should be integrated into routine clinical practice as a reliable tool for predicting and managing GDM risk. To further validate the diagnostic utility of these markers, larger, multicentre studies are needed, especially to assess their potential in reducing reliance on more invasive tests like the oral glucose tolerance test (OGTT). A personalized approach to GDM management, taking into account individual risk factors such as age, BMI, and family history, can help optimize care. Additionally, increasing public awareness of GDM, its risks, and the importance of early screening will be essential, particularly in regions experiencing rising prevalence, to improve early diagnosis and overall maternal and foetal health outcomes.

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