Section: General Medicine

Original Research Article

CORRELATION OF TRIGLYCERIDE TO HDL RATIO AND TRIGLYCERIDE GLUCOSE INDEX WITH HBA1C IN T2DM AS PREDICTORS OF GLYCEMIC CONTROL

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ABSTRACT

Background: Type 2 diabetes mellitus is frequently accompanied by dyslipidemia and insulin resistance. Simple lipid-based indices such as triglyceride-to-HDL cholesterol ratio and triglyceride glucose index may help identify poor glycemic control. **Materials and Methods:** This observational study included 130 adult patients with Type 2 diabetes mellitus attending the General Medicine department of Trichy SRM Medical College Hospital and Research Centre. Demographic, clinical, anthropometric, and biochemical variables were recorded. TG/HDL ratio and TyG index were calculated and correlated with HbA1c. Poor glycemic control was defined as HbA1c ≥7%. **Results:** The mean age was 55.89 ± 12.27 years. Poor glycemic control was observed in 124 participants. Mean HbA1c was 8.44 ± 0.89%. TG/HDL ratio showed a moderate positive correlation with HbA1c, while TyG index showed a strong positive correlation. TyG index also demonstrated better discrimination for poor glycemic control than TG/HDL ratio. **Conclusion:** TG/HDL ratio and TyG index had positive correlation with HbA1c among patients with Type 2 diabetes mellitus. TyG index appeared to be the stronger marker and may serve as a simple adjunctive indicator of poor glycemic control.

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is one of the leading chronic metabolic disorders worldwide and continues to impose a substantial burden on healthcare systems because of its rising prevalence and long-term vascular complications. Persistent hyperglycemia resulting from insulin resistance and progressive β-cell dysfunction contributes not only to microvascular damage but also to accelerated cardiovascular disease. Although glycated haemoglobin (HbA1c) remains the accepted standard for monitoring long-term glycemic control, it does not fully capture the complex metabolic disturbances that accompany diabetes, particularly abnormalities in lipid metabolism and insulin resistance.[1,2]

Diabetic dyslipidemia is characterized by elevated serum triglycerides, reduced high-density lipoprotein cholesterol (HDL-C), and qualitative changes in low-density lipoprotein particles, creating a highly atherogenic lipid profile. These alterations contribute significantly to endothelial dysfunction, chronic inflammation, and increased cardiovascular risk among individuals with T2DM. Consequently, there has been growing interest in identifying inexpensive biochemical indices derived from routinely available laboratory tests that can reflect both glycemic status and underlying metabolic dysfunction.[3,4]

Among these markers, the triglyceride-to-HDL cholesterol (TG/HDL-C) ratio and the triglyceride-glucose (TyG) index have emerged as promising surrogate indicators of insulin resistance. The TG/HDL-C ratio reflects the coexistence of hypertriglyceridemia and reduced HDL-C concentrations, whereas the TyG index combines fasting plasma glucose and triglyceride values into a single measure that has demonstrated good agreement with established assessments of insulin resistance in several populations. Recent studies have further shown that elevated TyG index is associated with poor glycemic control, adverse cardiometabolic outcomes, and an increased risk of diabetic complications.[5-7]

Despite increasing international evidence, data evaluating these indices in Indian patients with established T2DM remain relatively limited. Considering that fasting glucose and lipid profile measurements are inexpensive and widely available even in resource-constrained settings, evaluating the relationship of TG/HDL-C ratio and TyG index with

HbA1c could provide clinically useful information for risk stratification and routine patient management. Therefore, the present study was undertaken to examine the correlation of TG/HDL-C ratio and TyG index with HbA1c and to explore their potential utility as practical indicators of glycaemic control in patients with Type 2 diabetes mellitus.

MATERIALS AND METHODS

This observational study was conducted in the Department of General Medicine, Trichy SRM Medical College Hospital and Research Centre, among adult patients with Type 2 diabetes mellitus. The study included 130 participants aged more than 18 years who fulfilled the eligibility criteria. Patients with Type 1 diabetes mellitus, pregnancy, chronic kidney disease, thyroid disorders, chronic liver disease, and history of alcoholism were excluded to reduce potential biochemical confounding. Consecutive eligible patients attending the outpatient and inpatient services were recruited after obtaining informed consent. The sample size was based on the feasibility of recruiting 130 eligible participants during the six-month study period. For correlation-based studies, the sample size may be estimated using Fisher's Z transformation formula. Assuming a modest expected correlation between lipid indices and HbA1c, the available sample of 130 was considered adequate for detecting clinically meaningful correlation.

Data collection included age, gender, body mass index, smoking history, alcohol history, symptoms, family history, comorbidities, blood pressure, pulse rate, oxygen saturation, and laboratory parameters. Biochemical investigations included fasting blood glucose, fasting lipid profile, HbA1c, renal function tests, liver function tests, thyroid function tests, and complete blood count. BMI was calculated as weight in kilograms divided by height in metres squared. TG/HDL ratio was calculated by dividing serum triglyceride concentration by HDL cholesterol concentration, both expressed in mg/dL. TyG index was calculated using the standard formula: ln [fasting triglycerides (mg/dL) × fasting glucose (mg/dL)/2]. Poor glycemic control was defined as HbA1c ≥7%, while HbA1c <7% was considered good glycemic control, in line with commonly used clinical targets.[4]

Data were analysed using appropriate statistical methods. Continuous variables were summarized as mean and standard deviation or median and interquartile range depending on distribution. Categorical variables were expressed as frequency and percentage. Correlation between HbA1c and TG/HDL ratio or TyG index was assessed using correlation analysis. Group comparisons between good and poor glycemic control were performed using appropriate parametric or non-parametric tests. Receiver operating characteristic analysis was used to assess the discriminative ability of TG/HDL ratio and TyG index for poor glycemic control. A p value <0.05 was considered statistically significant. Ethical approval was obtained from the Institutional Ethics Committee. Written informed consent was obtained from all participants, and confidentiality of patient information was maintained.

RESULTS

A total of 130 patients with Type 2 diabetes mellitus were included in the analysis. The mean age of the study population was 55.89 ± 12.27 years. Females constituted 68 participants, while males constituted 62 participants. The mean BMI was 27.86 ± 4.68 kg/m². Obesity was present in 44 participants, while 43 participants each belonged to the normal and overweight BMI categories.

Table 1: Baseline demographic and clinical characteristics of the study population

Variable	Frequency / Mean ± SD	Percentage
Age, years	55.89 ± 12.27	—
Male	62	47.7
Female	68	52.3
BMI, kg/m²	27.86 ± 4.68	—
Normal BMI	43	33.1
Overweight	43	33.1
Obese	44	33.8
Smoking present	74	56.9
Alcohol use present	64	49.2
Hypertension present	64	49.2
Coronary artery disease present	64	49.2

Table 1: Baseline demographic and clinical profile of patients with Type 2 diabetes mellitus included in the study.

The mean fasting blood glucose was 162.60 ± 39.58 mg/dL, and the mean HbA1c was 8.44 ± 0.89%. Mean triglyceride level was 206.70 ± 63.51 mg/dL, while mean HDL cholesterol was 44.65 ± 9.09 mg/dL. The mean TG/HDL ratio was 4.80 ± 1.74, and the mean TyG index was 9.65 ± 0.42. (26.6%).

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Table 2: Biochemical profile of the study population

Variable	Mean ± SD	Range
Fasting blood glucose, mg/dL	162.60 ± 39.58	93-238
HbA1c, %	8.44 ± 0.89	6.6-10.6
Triglycerides, mg/dL	206.70 ± 63.51	104-318
HDL cholesterol, mg/dL	44.65 ± 9.09	28-60
TG/HDL ratio	4.80 ± 1.74	2.07-10.06
TyG index	9.65 ± 0.42	8.64-10.50

Poor glycemic control was observed in 124 participants, while 6 participants had good glycemic control. Participants with poor glycemic control had higher mean TG/HDL ratio and higher mean TyG index compared with those with good glycemic control.

Table 3: Comparison of lipid indices according to glycemic control status

Variable	Good control	Poor control	P value
TG/HDL ratio, mean ± SD	3.28 ± 0.61	4.88 ± 1.75	0.017
TyG index, mean ± SD	8.96 ± 0.08	9.68 ± 0.40	<0.001
Triglycerides, mg/dL	145.67 ± 24.95	209.65 ± 63.36	0.014
HDL cholesterol, mg/dL	46.00 ± 11.92	44.58 ± 8.99	0.681
Fasting blood glucose, mg/dL	109.50 ± 18.27	165.17 ± 38.53	<0.001

Correlation analysis showed that TG/HDL ratio had a statistically significant moderate positive correlation with HbA1c. TyG index showed a strong positive correlation with HbA1c. Triglycerides and fasting blood glucose also showed significant positive correlations with HbA1c, whereas HDL cholesterol and BMI did not show statistically significant correlations.

Table 4: Correlation of selected variables with HbA1c

Variable	Spearman correlation coefficient	P value
TG/HDL ratio	0.564	<0.001
TyG index	0.930	<0.001
Triglycerides	0.679	<0.001
Fasting blood glucose	0.702	<0.001
HDL cholesterol	0.057	0.517
BMI	0.066	0.458

ROC analysis suggested that TyG index had excellent discrimination for poor glycemic control, with an area under the curve of 0.965. TG/HDL ratio also showed acceptable discrimination, with an area under the curve of 0.791.

Table 5: Discriminative ability of lipid indices for poor glycemic control

Marker	Area under ROC curve
TG/HDL ratio	0.791
TyG index	0.965
Triglycerides	0.800
Fasting blood glucose	0.907

DISCUSSION

The present study demonstrated a significant positive correlation between the triglyceride-to-HDL cholesterol ratio, the triglyceride glucose index, and HbA1c, highlighting their potential utility as surrogate markers of glycemic control in patients with Type 2 diabetes mellitus.

American Diabetes Association Professional Practice Committee emphasized that maintaining optimal glycaemic control is fundamental to reducing diabetes-related complications and improving long-term outcomes, making the identification of simple and accessible biomarkers clinically relevant.[1] Parhofer highlighted the intricate interaction between glucose and lipid metabolism in diabetes, explaining how insulin resistance promotes hypertriglyceridemia and qualitative lipoprotein abnormalities that parallel worsening glycemic status.[3] Goldberg described diabetic dyslipidaemia as a hallmark of metabolic dysfunction and noted that elevated triglycerides with reduced HDL cholesterol frequently coexist with poor metabolic control, supporting the biological plausibility of the present findings.[4]

Selvi et al. demonstrated that the TyG index correlates significantly with HbA1c and insulin resistance in individuals with Type 2 diabetes mellitus, supporting its role as an inexpensive surrogate marker of metabolic dysfunction.[5] Zhao et al. reported in a systematic review and meta-analysis that higher TyG values were consistently associated with Type 2 diabetes risk and adverse metabolic profiles, reinforcing the robustness of this index across different populations.[6] Sánchez-Íñigo et al. summarized contemporary evidence indicating that the TyG index predicts not only insulin resistance but also cardiovascular and metabolic outcomes,

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suggesting that its relationship with HbA1c extends beyond glycemic monitoring alone.[7] Selvi et al. also observed that the integration of fasting glucose and triglyceride measurements enhances the ability of the TyG index to reflect underlying insulin resistance, which may explain the particularly strong correlation identified in the present study.[5]

Parhofer explained that elevated triglycerides and reduced HDL cholesterol arise from impaired lipid handling secondary to insulin resistance, making the TG/HDL ratio a practical marker of metabolic derangement in diabetes.[3] Goldberg emphasized that abnormalities in triglyceride-rich lipoproteins contribute substantially to atherogenic risk and frequently accompany deteriorating glycaemic control, supporting the positive correlation between TG/HDL ratio and HbA1c observed in this cohort.[4] Sánchez-Íñigo et al. further suggested that lipid-derived indices can provide complementary information regarding cardiometabolic risk, particularly when interpreted alongside conventional glycemic markers.[7]

American Diabetes Association Professional Practice Committee recommended individualized risk assessment using routinely available clinical and laboratory parameters to optimize diabetes management and cardiovascular prevention strategies.[1] Sun et al. highlighted the rapidly increasing global burden of diabetes and emphasized the importance of scalable, cost-effective tools that facilitate early identification of individuals at higher metabolic risk, particularly in low- and middle-income countries.[2] Zhao et al. suggested that simple indices such as the TyG index may be incorporated into routine clinical assessment because they require no additional laboratory investigations beyond standard fasting glucose and lipid measurements.[6] Sánchez-Íñigo et al. also noted that these markers may help clinicians identify patients requiring closer surveillance and more intensive lifestyle or pharmacological interventions.[7]

American Diabetes Association Professional Practice Committee underscored the importance of integrating biochemical markers with clinical judgement rather than relying on a single laboratory parameter for decision-making.[1] Sun et al. recognized that regional differences in patient characteristics may influence metabolic biomarkers, highlighting the value of population-specific evidence such as the present study.[2] Goldberg emphasized that cross-sectional analyses establish associations but cannot determine causality, a limitation that should be considered when interpreting correlations between lipid indices and HbA1c.[4] Zhao et al. additionally indicated that longitudinal validation across diverse ethnic groups would strengthen the evidence supporting routine implementation of these indices in clinical practice.[6] Sánchez-Íñigo et al. proposed that future investigations should evaluate TyG index and related lipid-derived markers in prospective cohorts to determine their ability to predict diabetic complications and cardiovascular events over time.[7] Selvi et al. suggested that combining TyG index with conventional biochemical markers may improve risk stratification and provide a more comprehensive assessment of metabolic health in patients with Type 2 diabetes mellitus.[5] American Diabetes Association Professional Practice Committee emphasized that continued research into accessible biomarkers remains essential for advancing personalized diabetes care and improving patient outcomes.[1]

CONCLUSION

In this observational study of patients with Type 2 diabetes mellitus, TG/HDL ratio and TyG index showed significant positive correlations with HbA1c. TyG index demonstrated a particularly strong correlation and superior discriminatory ability for poor glycemic control. These findings suggest that TyG index may be a useful, inexpensive, and readily calculable adjunctive marker for identifying poor glycemic control in routine clinical practice, although it should complement rather than replace HbA1c assessment.

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