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**Research Article**

# Comparison of Triglyceride-Glucose (TyG) Index in Patients with Ischemic Heart Disease with and Without Multivessel Coronary Artery Disease

**Dr Umair khalid[1], Dr.Abeera Saeed[2], Dr. Syed Ali Abbas Sherazi[3], Dr Sibgha Kanwal[4*], Dr Suhail Rafi Abbasi[5], Dr Rehman Mahmood Khan[6]**

[1]MBBS, MD, Medical Officer, Internal Medicine (KEMU), THQ Hospital Depalpur, Emergency department
[2]MBBS, FCPS 1, PGR Internal Medicine, Medical Unit 1, Akhtar Saeed Trust Hospital EME
[3]MBBS, MD Internal Medicine, Senior Registrar, Department of Accident & Emergency, Shaikh Zayad Hospital Lahore
[4*]MBBS, FCPS (Internal Medicine), Assistant Professor, Internal Medicine, King Edward Medical University, Mayo Hospital Lahore
[5]MBBS, Assistant Professor, Internal Medicine, Shahida Islam Medical and Dental College Lodhran
Senior Registrar Internal Medicine, Quid e Azam Medical Colleges Bahawalpur
[6]MBBS, Health Manager along with Medical officer, Maryam Nawaz Health Clinic (BHU at peripheral side)

**Corresponding Author:** Dr Sibgha Kanwal
[4]Qualification: MBBS, FCPS (Internal Medicine), Designation Assistant Professor, Department Internal Medicine, Hospital/college: King Edward Medical University, Mayo Hospital Lahore
**Email:** doctorsk33@gmail.com
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**ABSTRACT**

**Background:** The triglyceride-glucose (TyG) index is a readily available indicator of insulin resistance and may be related to the severity of coronary artery disease. This study compared the TyG index in patients with ischemic heart disease with and without multivessel coronary artery disease (MV-CAD).
**Methods:** A comparative analytical cross-sectional study was carried out on 208 patients with ischemic heart disease (IHD) who were undergoing coronary angiography. Participants were divided equally into MV-CAD group and non-MV-CAD group. Demographic, clinical and biochemical parameters were recorded and the TyG index was obtained from the fasting levels of triglycerides and glucose. Comparisons between groups, logistic regression, and ROC analysis were conducted.
**Results:** The mean TyG index was significantly higher in patients with MV-CAD compared with those without MV-CAD ($p<0.001$). There were also differences in fasting glucose and triglyceride levels, and in HDL-C levels, between the MV-CAD group and the non-MV-CAD group. TyG was independently related to MV-CAD after multivariable adjustment ($p<0.001$). The ROC analysis resulted in an AUC of 0.733 and a cut-off value of 8.91 with a sensitivity of 72.1% and specificity of 65.4%.
**Conclusions:** Higher TyG was independently associated with MV-CAD and had moderate discriminatory capability, suggesting that it could be a low-cost, supplementary marker of coronary disease burden.

**Keywords:** Triglyceride-Glucose Index, Insulin Resistance, Ischemic Heart Disease, Multivessel Coronary Artery Disease.

## INTRODUCTION

Ischemic heart disease (IHD) is still one of the most common causes of morbidity and mortality in the world.[1] The spectrum is from involvement of a single coronary vessel to multivessel coronary artery disease (MV-CAD); the latter is typically associated with more extensive atherosclerotic burden and with more complex revascularization, more frequent ischemic events and worse cardiovascular outcomes.[2] It is therefore important to be able to identify easily available markers which are linked to extensive coronary involvement, so that early risk stratification and optimization of management can be achieved.[3, 4]

Insulin resistance (IR) is known to be a key metabolic factor that contributes to atherosclerosis via endothelial dysfunction, increased oxidative stress, chronic inflammation and altered glucose and lipid metabolism.[5] The triglyceride-glucose (TyG) index is a simple mathematical combination of fasting triglycerides (FTG) and fasting glucose (FG) values and has been identified as an easy-to-use, cost-effective surrogate for IR.[6] TyG differs from the insulin-dependent methods

(HOMA-IR), which require glucose and insulin measurements, but are not routinely available, as it requires only fasting glucose and triglyceride levels, which are easily available in the routine cardiovascular assessment and particularly in resource-limited settings.[7, 8]

The accumulating evidence suggests not only that the TyG index is correlated with the presence of coronary artery disease (CAD) but also with the anatomical severity of CAD. A systematic review and meta-analysis including 41 studies showed that a higher TyG was found to be significantly associated with CAD (OR 1.94, 95% CI 1.20-3.14). Importantly, higher TyG was associated with stenotic coronary arteries (OR 3.49, 95% CI 1.71-7.12), plaque progression (OR 1.67, 95% CI 1.28-2.19), and involvement of multiple coronary vessels (OR 2.33, 95% CI 1.59-3.42). The results of this study indicate that metabolic abnormalities as measured by the TyG index may correlate with the degree of coronary atherosclerotic disease.[9]

Nevertheless, the association between TyG and the presence of MVD, particularly in patients with pre-existing IHD, continues to be clinically significant and should be studied in other cohorts. An inexpensive, easy-to-compute metabolic index that can help distinguish patients with limited coronary involvement from those with extensive multivessel disease could be used to further stratify cardiovascular risk and help identify patients who need more diligent evaluation. Thus, the present study was undertaken to compare the triglyceride-glucose (TyG) index between patients with ischemic heart disease (IHD) with and without multivessel coronary artery disease (CAD) and to assess the association between a high TyG index and multivessel coronary artery involvement.

## METHODS

A comparative analytical cross-sectional study was carried out to compare the triglyceride-glucose (TyG) index in patients with ischemic heart disease (IHD) having and not having multivessel coronary artery disease (MV-CAD). The study was carried out at the Department of Internal Medicine, King Edward Medical University, Mayo Hospital Lahore for six months from 1st October 2025 to 31st March 2026.

Patients were divided into two groups based on the results of coronary angiography: Group I, those with IHD and MV-CAD; and Group II, those with IHD and without MV-CAD (single-vessel CAD). Multivessel CAD was defined as ≥ 50% luminal stenosis in two or more major epicardial coronary arteries and/or their major branches.[10, 11]

The sample size was determined with the help of OpenEpi version 3.01 and the unmatched two-group comparison of proportions. According to the systematic review and meta-analysis conducted by Liang et al., the association between TyG index and multivessel coronary involvement was considered based on a pooled OR of 2.33 (95% CI: 1.59–3.42), which is the result of 41 studies.

For an expected exposure rate of 30% in the non-multivessel group, an OR of 2.33, 95% confidence, 80% power, and a ratio of 1:1 between the two groups, the sample size was calculated to be 104 per group, or a total of 208 participants.[9]

A non-probability consecutive sampling was used. Patients were eligible for inclusion if they were ≥18 years old, clinically diagnosed with IHD/CAD, had undergone coronary angiography during the study period, and had adequate fasting biochemical measurements for triglycerides and glucose to calculate the TyG index. Angiographic images of either single vessel or multivessel CAD were included. Patients who had previously undergone coronary artery bypass grafting, severe valvular heart disease, acute or chronic severe hepatic disease, severe renal dysfunction, active malignancy, acute infection or inflammatory disease, pregnancy or incomplete angiographic or biochemical data were excluded. Those receiving treatment or with conditions that were likely to significantly affect fasting triglyceride or glucose were also excluded.

Eligible patients were approached after obtaining approval from the institutional ethical review committee, and written informed consent was obtained. A structured proforma was used for data collection. Personal data such as age, sex, body mass index (BMI), and smoking status were collected. Medical history was also documented, including diabetes mellitus, hypertension, dyslipidaemia and previous cardiovascular disease. Clinical parameters such as blood pressure and heart rate were measured.

Venous blood samples collected following an overnight fast for determination of fasting plasma glucose and serum triglycerides were also drawn for routine biochemical investigations, which were conducted to assess the levels of total cholesterol, HDL-C and LDL-C. TyG index was derived by the following formula: TyG index = ln [fasting triglycerides

(mg/dL) × fasting glucose (mg/dL) / 2).[12] Coronary angiography was done in the normal course of routine institutional practice. Significant stenosed coronary vessels and their number were noted. Patients who had ≥50% stenosis in two or more major coronary vessels were deemed to have MV-CAD, while those with significant disease limited to a single major vessel were deemed to have non-MV-CAD. The SYNTAX score was additionally collected as an extra indicator of anatomical CAD complexity when available.[13]

The data were entered and analyzed in the IBM SPSS Statistics version 26 software. For the continuous variables, the Shapiro–Wilk test was used first to check their normality. Continuous variables were presented as mean ± standard deviation (SD), and skewed variables as median (IQR). Categorical data were reported as frequencies and percentages. The independent-samples t-test was used for normally distributed data while Mann–Whitney U test was used for non-normally distributed data for comparing the TyG index between patients with and without MV-CAD. A chi-square test and Fisher's test were used to compare categorical variables. The association between the TyG index and MV-CAD was first evaluated by univariable logistic regression, and then by multivariable logistic regression upon adjustment for clinically relevant covariates: age, gender, BMI, diabetes, hypertension, smoking, LDL-C, and other cardiovascular risk factors. Odds ratios (ORs) and 95% confidence intervals (CIs) were given. Receiver operating characteristic (ROC) curve analysis was used to measure the discriminatory power of the TyG index to detect MV-CAD. The area under the curve (AUC), best cut-off point, sensitivity, specificity, positive predictive value, and negative predictive value were determined. A two-sided p-value <0.05 was deemed statistically significant.

## RESULTS

A total of 208 patients with IHD were included, comprising 104 patients with MV-CAD and 104 with non-MV-CAD. The diabetes mellitus and dyslipidaemia prevalence rates were significantly higher, as was the age of the patients, in the MV-CAD group. There were no significant differences between the groups with regard to other demographic and clinical variables such as sex, BMI, smoking, previous cardiovascular disease, blood pressure or heart rate (Table 1).

Patients with MV-CAD had significantly higher mean TyG index compared to patients without MV-CAD (p<0.001). The MV-CAD group also had significantly elevated fasting glucose and triglyceride levels and lower HDL-C levels. There were no significant differences in total cholesterol and LDL-C between the groups (Table 2).

Coronary disease burden was significantly higher in the MV-CAD group, with a higher incidence of LAD, LCX, and RCA involvement and SYNTAX scores compared with the control group (Table 3). The TyG index was also independently associated with MV-CAD regardless of the inclusion of relevant cardiovascular risk factors (p<0.001) on multivariable logistic regression (Table 4).

The TyG index had moderate discriminatory ability for MV-CAD, with an AUC of 0.733 (p<0.001), according to ROC analysis. To achieve 72.1% sensitivity and 65.4% specificity, a cut-off value of 8.91 was obtained. Patients with MV-CAD were significantly more likely to have a TyG index ≥8.91 than those with non-MV-CAD (72.1% vs. 50.0%, respectively; p=0.001) (Table 5 and Table 6).

Table 1. Comparison of Demographic and Clinical Characteristics between Patients with and Without MV-CAD

| Variable | MV-CAD (n=104) n(%)/Mean± SD | Non-MV-CAD (n=104) n(%)/Mean± SD | p-value |
|---|---|---|---|
| Age (years) | 59.8 ± 10.2 | 56.4 ± 9.8 | 0.015 |
| Male sex | 78 (75.0) | 69 (66.3) | 0.174 |
| BMI (kg/m²) | 28.1 ± 3.7 | 27.2 ± 3.5 | 0.076 |
| Current smoker | 39 (37.5) | 27 (26.0) | 0.084 |
| Diabetes mellitus | 61 (58.7) | 40 (38.5) | 0.004 |
| Hypertension | 70 (67.3) | 57 (54.8) | 0.068 |
| Dyslipidemia | 63 (60.6) | 47 (45.2) | 0.027 |
| Previous cardiovascular disease | 32 (30.8) | 21 (20.2) | 0.078 |
| Systolic BP (mmHg) | 138.6 ± 18.4 | 134.1 ± 16.9 | 0.071 |
| Diastolic BP (mmHg) | 82.7 ± 10.5 | 80.4 ± 9.7 | 0.114 |

| | | | |
|---|---|---|---|
| Heart rate (beats/min) | 78.4 ± 11.2 | 76.8 ± 10.4 | 0.293 |

Table 2. Comparison of Biochemical Parameters and Tyg Index between the Two Groups

| Variable | MV-CAD (n=104) Mean ± SD | Non-MV-CAD (n=104) Mean ± SD | p-value |
|---|---|---|---|
| Fasting glucose (mg/dL) | 132.8 ± 38.6 | 116.4 ± 31.7 | 0.001 |
| Triglycerides (mg/dL) | 176 (142–224) | 143 (116–181) | <0.001 |
| Total cholesterol (mg/dL) | 198.4 ± 42.7 | 187.1 ± 39.5 | 0.052 |
| LDL-C (mg/dL) | 123.7 ± 32.8 | 116.1 ± 30.4 | 0.091 |
| HDL-C (mg/dL) | 39.6 ± 8.7 | 42.8 ± 9.2 | 0.014 |
| TyG index | 9.12 ± 0.52 | 8.74 ± 0.47 | <0.001 |

Table 3. Angiographic Characteristics of Patients with MV-CAD and Non-MV-CAD

| Angiographic characteristic | MV-CAD (n=104) n(%)median (IQR) | Non-MV-CAD (n=104) n(%)median (IQR) | p-value |
|---|---|---|---|
| Number of diseased vessels | 2 (2–3) | 1 (1–1) | <0.001 |
| LAD involvement | 89 (85.6) | 69 (66.3) | 0.001 |
| LCX involvement | 71 (68.3) | 31 (29.8) | <0.001 |
| RCA involvement | 76 (73.1) | 34 (32.7) | <0.001 |
| Three-vessel disease | 38 (36.5) | 0 (0.0) | <0.001 |
| SYNTAX score | 19 (14–27) | 9 (6–13) | <0.001 |

Table 4. Univariable and Multivariable Logistic Regression Analysis for Factors Associated with MV-CAD

| Variable | Univariable OR (95% CI) | p-value | Adjusted OR (95% CI) | p-value |
|---|---|---|---|---|
| Age (per year) | 1.03 (1.01–1.06) | 0.015 | 1.02 (0.99–1.05) | 0.083 |
| Male sex | 1.52 (0.84–2.76) | 0.168 | 1.39 (0.74–2.62) | 0.305 |
| BMI (per kg/m²) | 1.08 (1.00–1.16) | 0.064 | 1.06 (0.98–1.15) | 0.141 |
| Current smoking | 1.71 (0.94–3.11) | 0.078 | 1.52 (0.80–2.89) | 0.201 |
| Diabetes mellitus | 2.27 (1.29–3.99) | 0.004 | 1.79 (0.97–3.31) | 0.062 |
| Hypertension | 1.70 (0.96–3.01) | 0.068 | 1.42 (0.76–2.65) | 0.269 |
| Dyslipidemia | 1.86 (1.07–3.23) | 0.028 | 1.55 (0.85–2.83) | 0.151 |
| LDL-C (per 10 mg/dL) | 1.05 (0.99–1.11) | 0.091 | 1.03 (0.97–1.10) | 0.317 |
| TyG index (per 1-unit increase) | 2.91 (1.79–4.73) | <0.001 | 2.54 (1.49–4.34) | <0.001 |

Table 5. ROC Curve Analysis of Tyg Index for Prediction of MV-CAD

| Parameter | Value |
|---|---|
| Area under the curve (AUC) | 0.733 |
| 95% CI | 0.665–0.801 |
| p-value | <0.001 |
| Optimal TyG cut-off | 8.91 |
| Sensitivity | 72.1% |
| Specificity | 65.4% |
| Positive predictive value | 67.9% |
| Negative predictive value | 70.0% |

Table 6. Association of Elevated TyG index with MV-CAD

| TyG category | MV-CAD (n=104) n (%) | Non-MV-CAD (n=104) n (%) | p-value |
|---|---|---|---|
| **TyG <8.91** | 29 (27.9) | 52 (50.0) | 0.001 |
| **TyG ≥8.91** | 75 (72.1) | 52 (50.0) | |

## DISCUSSION

The present comparative analytical cross-sectional study showed a strong relationship between the TyG index and the degree of coronary artery disease in the patients with ischemic heart disease. The mean TyG index

was significantly higher in patients with multivessel coronary artery disease (MV-CAD) compared with patients with single-vessel disease ($p<0.001$). Furthermore, fasting glucose and triglyceride levels were significantly elevated, and HDL-C levels significantly decreased in patients with MV-CAD. Importantly, the association of TyG with MV-CAD remained significant following adjustment for age, sex, BMI, diabetes, hypertension, smoking, and LDL-C and other cardiovascular risk factors (OR 2.54, $p<0.001$). The results of this study indicate that the TyG index may offer clinically relevant information about the anatomic burden of CAD beyond the typical marker of individual metabolic parameters.

The results of the current research are consistent with the 2021 systematic review and meta-analysis by Luo et al., which comprised 12 studies with 28,795 patients with CAD. Patients with the highest TyG group had a 2.14-fold increased risk of a major adverse cardiovascular event compared with those in the lowest TyG group, while higher TyG was also related to myocardial infarction, stroke, and revascularisation. They were really interested in prognosis and not necessarily the extent of the disease on the angiogram, but supported the general notion that insulin resistance as measured by TyG is of clinical importance in established CAD.[14]

The strong relationship between TyG and MV-CAD in this study is also consistent with the multicenter study conducted by Su et al. in 2022. The researchers looked at 731 patients with coronary heart disease (CHD) in their study and categorized them based on single- or multivessel disease using coronary angiography. The TyG index was independently associated with the likelihood of multivessel CAD (OR 1.715 per unit increase; 95% CI: 1.182–2.471) and patients in the highest tertile of TyG had over twice the risk of multivessel disease when compared with the lowest tertile (OR 2.280, 95% CI: 1.530–3.398). The strength of association observed in the present study was greater (adjusted OR 2.54), but because of differences in the size of the study sample, patient characteristics, metabolic status, and adjustment variables, differences in this level of association could exist.[15]

Likewise, in 2022, Yang et al. found that a higher TyG index was independently associated with multivessel CAD in 2,792 patients with CAD. Demographic and cardiovascular risk factors and medication use were adjusted, and patients in the highest TyG tertile were at 1.496 times higher risk of multivessel CAD than those in the lowest TyG tertile. They also noted a dose-response relationship between TyG and the severity of CAD, which further corroborates our finding that high metabolic risk was associated with greater coronary involvement.[16]

The study of investigators that compared TyG with coronary artery calcification and multivessel disease in 935 patients with ACS in 2022 provided additional evidence. Importantly, each unit increase in TyG was associated with an increased risk of developing multivessel disease after comparison with non-MVCD, and TyG was still an independent predictor even when adjusted for potential confounders.[17] This is quite similar to our results, where the patients with MV-CAD had higher glucose and triglyceride and lower HDL-C levels, while the patients had significantly higher TyG values.

In 2023, Xiong et al. showed the relationship between TyG and anatomical complexity among 1,007 patients with acute coronary syndrome (ACS) who underwent coronary angiography. They found that TyG was independently associated with a mid/high SYNTAX score (>22), with an adjusted OR of 2.645. There was a weak but significant positive correlation between TyG and SYNTAX score ( $p<0.001$); progressively higher odds of complex CAD were seen with TyG tertiles. Patients with MV-CAD also had higher SYNTAX scores in present study than patients with single-vessel disease ($p<0.001$). The SYNTAX score was not used as the primary endpoint in present study, but this concordance further supports the association between a higher TyG index and increased anatomical complexity rather than the number of diseased vessels.[18]

The findings of the present study are also consistent with the results of the 2023 systematic review and meta-analysis by Liang et al. which pooled data from 41 studies, and found that patients with higher TyG levels had a significantly higher risk of CAD, and more severe coronary disease. The most important finding was that higher TyG was inversely correlated with the degree of coronary vessel involvement (pooled OR 2.33, 95% CI 1.59–3.42).[3] The present study's adjusted OR of 2.54 (95% CI: 1.49–4.34) was very similar in magnitude and further bolsters the overall evidence that TyG may be a measure of the magnitude of the coronary atherosclerotic burden. Our findings are especially relevant in

comparison to this large meta-analysis, as we restricted our measurements to patients with established IHD, and directly compared MV-CAD with single-vessel CAD.

Similarly, in an 870 patient cohort who were undergoing coronary angiography, Siverio-Morales et al. (2025) found TyG was significantly linked to both the presence and severity of CAD. They showed that the multivariable analysis revealed that the TyG index was independently associated with increased coronary stenotic involvement, and that patients in the highest tertile of the TyG index had a higher incidence of MACE in 5 years of follow-up.[19] The results of this study corroborate the present study observations and indicate that the link between TyG and anatomical coronary disease may also have prognostic significance. The fact that the present study was cross-sectional, however, means that the present findings provide only an association with MV-CAD and not whether increased TyG is associated with future cardiovascular events.

In more recent times, in 2025, Li et al. have assessed 821 patients with LDL-C below 2.6 mmol/L, and confirmed that the TyG index was still independently associated with the severity of coronary heart disease and coronary lesions despite good control of LDL-c levels. In patients with CHD, the TyG index was significantly higher in patients with multivessel disease compared with those with single-vessel disease.[20] This is significant for present study given that the LDL-C level was not significantly different between our MV-CAD and non-MV-CAD groups, while the TyG level was still highly correlated with multivessel involvement in present study after being adjusted for. Such results indicate that TyG might reflect some unaccounted-for metabolic risk not addressed by the usual calculation of LDL-C.

The results of the present study combined with those from the literature suggest that the TyG index would be useful as a simple additional tool for the identification of IHD patients with extensive coronary involvement. It has the benefits of being inexpensive, easily calculable, and using fasting glucose and triglyceride values that are regularly available. This could be helpful in clinical settings where more advanced assays of insulin resistance are not feasible due to limited resources. However, TyG should not be considered a substitute for coronary angiography or established anatomical scoring systems. Instead, it can offer supplementary metabolic information, which can then be integrated with the traditional cardiovascular risk assessment and used to select patients for careful anatomical assessment.

The present study confirmed that the TyG index was higher in MV-CAD patients than in single-vessel CAD patients, and was independently associated with multivessel coronary involvement, even after adjusting for conventional cardiovascular risk factors. These findings indicate moderate discriminatory ability (AUC of 0.733) and clinically useful sensitivity and specificity (cut-off of 8.91). The stability of these results over the past six years (2021–2026) reinforces the possibility of TyG being a low-cost and widely available indicator to monitor the burden of coronary diseases. Multicenter studies are recommended in South Asian populations to confirm the best TyG threshold and the ability of TyG to enhance existing cardiovascular risk models to predict multivessel disease and cardiovascular outcomes.

**Limitations**

This study had several limitations. The first is that the cross-sectional design did not allow the establishment of a temporal or causal relationship between the TyG index and multivessel coronary artery disease. Second, the study took place in one tertiary-care centre, which might mean the results cannot be extrapolated to wider populations. Third, the TyG index does not measure insulin sensitivity directly, but is an indirect surrogate measure of insulin resistance. Fourth, there remained a possibility of residual confounding with dietary factors, duration and control of diabetes, medications and other metabolic factors. Lastly, the ROC-derived TyG cut-off needs to be validated in larger prospective multicenter studies prior to clinical use.

## CONCLUSION

Patients with multivessel coronary artery disease had significantly higher TyG levels than those with single vessel disease and multivessel coronary artery disease remained an independent predictor of multivessel coronary involvement, after conventional cardiovascular risk factors had been taken into account. The TyG index had moderate discriminatory power at identifying MV-CAD, which could make it a feasible, easily available, and cost-effective marker for assessing coronary disease burden as an adjunctive measure. Additional multicenter prospective trials are suggested to confirm the best cut-off and determine its

incremental role in cardiovascular risk stratification.

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