



TyG Index and Risk of Cardiovascular Disease in Diabetes Mellitus- A Systemic Review and Meta-Analysis of Severity and Prognosis

Suganya Sribalaji¹, Augustiya Natarajan¹, Reena Mohan², Jeyakumar M¹, J. Jenifer Florence Mary³, Preethi Tamilarasan⁴, Suja Xavier⁵

¹ Department of Biochemistry, ² Department of Community Medicine, Sri Manakula Vinayagar Medical College and Hospital, ³ Department of Community Medicine Mahatma Gandhi Medical College and Research Institute, SBV (Deemed to be University), ⁴ Department of Paediatrics, ⁵ Department of Pharmacology Sri Manakula Vinayagar Medical College and Hospital.

(Received: 28 January 2026 Revised: 16 March 2026 Accepted: 09 April 2026)

KEYWORDS

TyG Index, Diabetes Mellitus, CVD, Meta-analysis, Biomarker

ABSTRACT:

Background:

The triglyceride-glucose index (TyG index) has emerged as a reliable surrogate marker for insulin resistance and an independent predictor of cardiovascular outcomes. However, the association between the TyG index and cardiovascular risks in individuals with diabetes remains unclear.

Objective:

To assess the predictive value of the TyG index for cardiovascular disease (CVD) risk in patients with diabetes mellitus (DM).

Data Sources:

A systematic search was conducted on PubMed and Google Scholar up to June 2024.

Study Selection:

The meta-analysis included all published randomized controlled trials investigating the TyG index as a risk predictor for CVD in patients with DM.

Data Extraction:

Data extraction was guided by a predefined checklist.

Analytical Approach:

Using RevMan 5 software, the mean and standard deviation for DM patients and healthy controls were pooled from the selected studies. A fixed-effects model was employed to compare the prognosis of CVD between the DM and control groups. Data analyses were conducted in July 2024.

Main Outcomes and Measures:

- **Primary Outcome:** Evaluation of the TyG index as a predictor for CVD risk in DM patients.
- **Secondary Outcome:** Assessment of CVD severity in DM patients.

Results:

The initial search yielded 48 records, of which 22 articles underwent full-text evaluation. Seven studies were eligible, including a total of 34,347 DM patients and 58,896 healthy controls. The meta-analysis demonstrated the predictive significance of the TyG index for CVD in diabetic patients (Mean Difference = -2.39, 95% CI -2.53 to -2.25, $P < 0.00001$). A significant Q statistic ($P < 0.00001$) indicated the presence of heterogeneity ($I^2 = 99\%$).



Conclusion:

This systematic review and meta-analysis demonstrated that the TyG index is a significant predictive marker for CVD in DM patients.

Trial Registration:

PROSPERO Identifier

1. Introduction

The majority of deaths worldwide are caused by cardiovascular disease (CVD), which imposes the highest global burden of illness. Better prediction models for CVD risk are required, as the traditional classification of cardiovascular risk factors is inadequate for the growing number of patients currently being treated in clinical settings. A rising body of research has demonstrated that insulin resistance (IR) is a key factor in the pathophysiology of both diabetes and CVD. Despite being the most accurate diagnostic approach for IR, the hyperinsulinaemic-euglycaemic clamp is not frequently employed in large-scale epidemiological studies due to its complexity and cost. The triglyceride-glucose (TyG) index has recently been promoted as a quick, inexpensive, and reasonably easy marker for IR.

The TyG index, a relatively new and promising marker for assessing insulin resistance and metabolic health, is calculated using the formula:

$$\text{TyG index} = \ln(\text{fasting triglycerides (mg/dL)} \times \text{fasting glucose (mg/dL)} / 2)$$

The linked pathology of type 2 diabetes mellitus (T2DM) and CVD includes obesity as a risk factor for IR, highlighting the importance of evaluating IR in overweight and obese individuals as early as possible.

In recent years, there has been growing interest in studying the TyG index to better understand its potential as a predictor of metabolic abnormalities and cardiovascular risk. Research in this area has focused on:

- **Insulin Resistance and Type 2 Diabetes:** Studies explore the relationship between the TyG index and IR, an underlying factor in the development of T2DM.
- **Cardiovascular Health:** Researchers examine the association between the TyG index and cardiovascular risk factors such as high blood

pressure, dyslipidemia, and atherosclerosis. Elevated TyG index values have been linked to an increased risk of cardiovascular events.

Overall, research on the TyG index contributes to the early identification of individuals at risk of metabolic abnormalities and CVD, potentially enabling targeted interventions and lifestyle modifications to improve health outcomes.

Methods

This study protocol was prospectively registered with PROSPERO and conducted according to the "Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)" guidelines.

Eligibility Criteria

The inclusion criteria based on the PICOS framework were:

- **Population:** Adults aged ≥ 18 and < 40 years with a history of diabetes mellitus diagnosed according to standard criteria suggested by the American Diabetes Association.
- **Intervention:** TyG index.
- **Control:** Healthy adults aged ≥ 18 and < 40 years with no clinical symptoms or medications for diabetes mellitus.
- **Outcomes:** Severity and prognosis of CVD.
- **Studies:** Cohort studies, randomized controlled trials, and longitudinal cohort studies.

Search Strategy

A comprehensive literature search was conducted using PubMed and Google Scholar databases up to June 2024. Keywords included "Diabetes Mellitus," "Triglyceride-Glucose Index," "Cardiovascular Disease," "Prognosis," and "Randomized Controlled Trial." Manual searches of reference lists were also performed.



Study Selection

Search results were uploaded into the systematic review program Rayyan for study selection. Two independent authors (S.S., A.N.) performed title, abstract, and keyword screening. Disagreements were resolved through consensus or consultation with a third author (R.M.). Conflicts were moderated by the fourth and fifth reviewers (J.F.M., S.X.).

Data Extraction and Management

Relevant study characteristics were extracted independently by the first and co-author using a predetermined checklist. Extracted data included author names, publication year, total sample size, gender, study design, participant age, diabetes mellitus status, duration of diabetes, TyG index, and prognosis of CVD. Data entry was double-checked by a second author.

Outcome Measures

- **Primary Outcome:** Evaluation of the TyG index as a predictor for CVD risk in diabetes mellitus patients.
- **Secondary Outcome:** Assessment of CVD severity in diabetes mellitus patients.

Quality Assessment

The Revised Cochrane Risk-of-Bias Tool (RoB 2) was used to assess the risk of bias in selected studies, categorizing them as "low risk," "some concerns," or "high risk" of bias.

Statistical Analysis

A comprehensive quantitative meta-analysis was performed using RevMan 5.3. For studies with multiple arms, only relevant arms were included. A logistic-normal random-effects model was used due to heterogeneity among studies. The 95% confidence interval (CI) was calculated, and heterogeneity was assessed using I^2 statistics, with significant heterogeneity defined as $p < 0.05$ or $I^2 > 50\%$.

Results

Study Selection and Characteristics

A total of 48 studies were initially retrieved. After screening, 22 studies were assessed for eligibility, and seven met the inclusion criteria. These studies involved

34,347 diabetes mellitus patients and 58,896 healthy controls. The PRISMA flowchart illustrates the study selection process.

Scope of Reviewed Studies

The selected studies, conducted between 2018 and 2023, included five randomized controlled trials and two cohort studies.

Meta-Analysis Findings

The meta-analysis demonstrated the predictive significance of the TyG index for CVD in diabetic patients (Mean Difference = -2.39, 95% CI -2.53 to -2.25, $p < 0.00001$). A significant Q statistic ($p < 0.00001$) and high heterogeneity ($I^2 = 99\%$) were observed.

Discussion

This systematic review and meta-analysis of seven studies involving 93,216 participants (34,347 diabetes mellitus patients and 58,896 healthy adults) investigated the TyG index as a predictive marker for CVD. Insulin resistance, a key feature of T2DM, has been linked to an increased risk of CVD. The TyG index may aid in enhancing cardiovascular risk stratification in both primary and secondary prevention settings.

The diagnostic accuracy of the TyG index was analyzed in two studies. The ideal cutoff value for predicting major adverse cardiovascular events (MACEs) was 9.323 (sensitivity 46.0%, specificity 63.6%), with an area under the curve (AUC) of 0.560 (95% CI: 0.524–0.595, $p = 0.001$).

The findings suggest that individuals with higher TyG index values face a greater risk of MACEs. This index may serve as a useful tool for risk stratification and prognosis in diabetic patients with acute coronary syndrome (ACS). Wang et al. confirmed its predictive value for future MACEs, while Lu et al. highlighted gender-specific associations.

Conclusion

The meta-analysis demonstrates that the TyG index is a significant predictive marker for CVD in diabetic patients. The incidence and risk of MACEs rise with higher TyG index values, indicating its utility as a standalone predictor.

Author Contributions

- **Concept and Design:** Natarajan A, Sribalaji S



- **Data Acquisition:** Natarajan A, Sribalaji S, Mohan R
- **Data Analysis and Interpretation:** Mohan R, Mary JJF
- **Drafting of Manuscript:** Natarajan A, Sribalaji S, Mohan R
- **Critical Revision:** Mohan R
- **Statistical Analysis:** Mohan R, Mary JJF

Conflict of Interest Disclosures: No conflicts of interest were reported.

Support/Funding: None.

References:

1. Guo, D., Wu, Z., Xue, F. et al. Association between the triglyceride-glucose index and impaired cardiovascular fitness in non-diabetic young population. *Cardiovasc Diabetol* 23, 39 (2024). <https://doi.org/10.1186/s12933-023-02089-8>
2. Liu L, Wu Z, Zhuang Y, Zhang Y, Cui H, Lu F, et al. Association of triglyceride–glucose index and traditional risk factors with cardiovascular disease among non-diabetic population: a 10-year prospective cohort study. *Cardiovasc Diabetol* [Internet]. 2022 Dec 1 [cited 2023 Aug 1];21(1):1–11. Available from: <https://cardiab.biomedcentral.com/articles/10.1186/s12933-022-01694-3>
3. Wang A, Tian X, Zuo Y, Chen S, Meng X, Wu S, et al. Change in triglyceride-glucose index predicts the risk of cardiovascular disease in the general population: a prospective cohort study. *Cardiovasc Diabetol* [Internet]. 2021 Dec 1 [cited 2023 Aug 1];20(1):1–9. Available from: <https://cardiab.biomedcentral.com/articles/10.1186/s12933-021-01305-7>
4. Yoon JS, Shim YS, Lee HS, Hwang IT, Hwang JS. A population-based study of TyG index distribution and its relationship to cardiometabolic risk factors in children and adolescents. *Sci Rep* [Internet]. 2021 Dec 1 [cited 2023 Aug 1];11(1):23660. Available from: [/pmc/articles/PMC8654923/](https://pmc/articles/PMC8654923/)
5. Zhou Q, Yang J, Tang H, Guo Z, Dong W, Wang Y, Meng X, Zhang K, Wang W, Shao C, Hua X, Tang YD. High triglyceride-glucose (TyG) index is associated with poor prognosis of heart failure with preserved ejection fraction. *Cardiovasc Diabetol*. 2023 Sep 29;22(1):263. doi: 10.1186/s12933-023-02001-4. PMID: 3775762; PMCID: PMC10541699.
6. da Silva, A., Caldas, A.P.S., Hermsdorff, H.H.M. et al. Triglyceride-glucose index is associated with symptomatic coronary artery disease in patients in secondary care. *Cardiovasc Diabetol* 18, 89 (2019). <https://doi.org/10.1186/s12933-019-0893-2>
7. Jung, MH., Yi, SW., An, S.J. et al. Associations between the triglyceride-glucose index and cardiovascular disease in over 150,000 cancer survivors: a population-based cohort study. *Cardiovasc Diabetol* 21, 52 (2022). <https://doi.org/10.1186/s12933-022-01490-z>
8. Moon JH, Kim Y, Oh TJ, Moon JH, Kwak SH, Park KS, Jang HC, Choi SH, Cho NH. Triglyceride-Glucose Index Predicts Future Atherosclerotic Cardiovascular Diseases: A 16-Year Follow-up in a Prospective, Community-Dwelling Cohort Study. *Endocrinol Metab (Seoul)*. 2023 Aug;38(4):406-417. doi: 10.3803/EnM.2023.1703. Epub 2023 Aug 3. PMID: 37533176; PMCID: PMC10475965.
9. Liu, Y., Zhu, B., Zhou, W. et al. Triglyceride–glucose index as a marker of adverse cardiovascular prognosis in patients with coronary heart disease and hypertension. *Cardiovasc Diabetol* 22, 133 (2023). <https://doi.org/10.1186/s12933-023-01866-9>
10. Jin JL, Cao YX, Wu LG, You XD, Guo YL, Wu NQ, Zhu CG, Gao Y, Dong QT, Zhang HW, Sun D, Liu G, Dong Q, Li JJ. Triglyceride glucose index for predicting cardiovascular outcomes in patients with coronary artery disease. *J Thorac Dis*. 2018 Nov;10(11):6137-6146. doi: 10.21037/jtd.2018.10.79. PMID: 30622785; PMCID: PMC6297409.
11. Liu, L., Wu, Z., Zhuang, Y. et al. Association of triglyceride–glucose index and traditional risk factors with cardiovascular disease among non-diabetic population: a 10-year prospective cohort study. *Cardiovasc Diabetol* 21, 256 (2022). <https://doi.org/10.1186/s12933-022-01694-3>



12. Muhammad IF, Bao X, Nilsson PM, Zaigham S. Triglyceride-glucose (TyG) index is a predictor of arterial stiffness, incidence of diabetes, cardiovascular disease, and all-cause and cardiovascular mortality: A longitudinal two-cohort analysis. *Front Cardiovasc Med.* 2023 Jan 4;9:1035105. doi: 10.3389/fcvm.2022.1035105. PMID: 36684574; PMCID: PMC9846351.
13. Wang L, Cong HL, Zhang JX, Hu YC, Wei A, Zhang YY, Yang H, Ren LB, Qi W, Li WY, Zhang R, Xu JH. Triglyceride-glucose index predicts adverse cardiovascular events in patients with diabetes and acute coronary syndrome. *Cardiovasc Diabetol.* 2020 Jun 13;19(1):80. doi: 10.1186/s12933-020-01054-z. PMID: 32534586; PMCID: PMC7293784.
14. Lu YW, et al. Gender difference in the association between TyG index and subclinical atherosclerosis: results from the I-Lan Longitudinal Aging Study. *Cardiovasc Diabetol.* 2021;20(1):206.
15. Tian X, et al. Triglyceride-glucose index is associated with the risk of myocardial infarction: an 11-year prospective study in the Kailuan cohort. *Cardiovasc Diabetol.* 2021;20(1):19.

Table 1. Characteristics of study population

Year of publication	Journal	Study setting	Study design	Study period	Study population	Sampling strategy	Intervention group	Type of comparator	Type of analysis (PP/ITT)	Intervention (mean and SD or median (IQR))	Control (mean and SD or median (IQR))	Intervention n	Control n
2019	springer link	Hospital	A randomized controlled clinical trial	Not mentioned	Adults	Randomization	TyG Index	Normal	Not mentioned	34.5 (5.6)	34.3 (5.2)	777	778
2022	frontiers	Hospital	A randomized controlled trial	Not mentioned	Adults	Randomization	TyG Index	Normal	Not mentioned	56.05 (5.66)	57.45 (5.96)	2697	4571
2022	springer link	Hospital	A randomized controlled trial	Not mentioned	Adults	Randomization	TyG Index	Normal	Not mentioned	45.87 (9.79)	49.98 (9.77)	1514	1543
2018	pubmed	Hospital	A randomized controlled trial	Not mentioned	Adults	Randomization	TyG Index	Normal	Not mentioned	59.5 (10.8)	59.4 (10.0)	1450	290
2023	springer link	Hospital	A randomized controlled trial	Not mentioned	Adults	Randomization	TyG Index	Normal	Not mentioned	61.4 (9.1)	59.1 (9.5)	490	488
2023	kamje synapse	Hospital	A randomized controlled trial	Not mentioned	Adults	Randomization	TyG Index	Normal	Not mentioned	52.2 (8.9)	50.8 (8.1)	1009	1011
2022	springer link	Hospital	A randomized controlled trial	Not mentioned	Adults	Randomization	TyG Index	Normal	Not mentioned	56.1 (12.9)	59.6 (12.1)	26410	49993



Fig 1 - PRISMA flow diagram of the study selection process

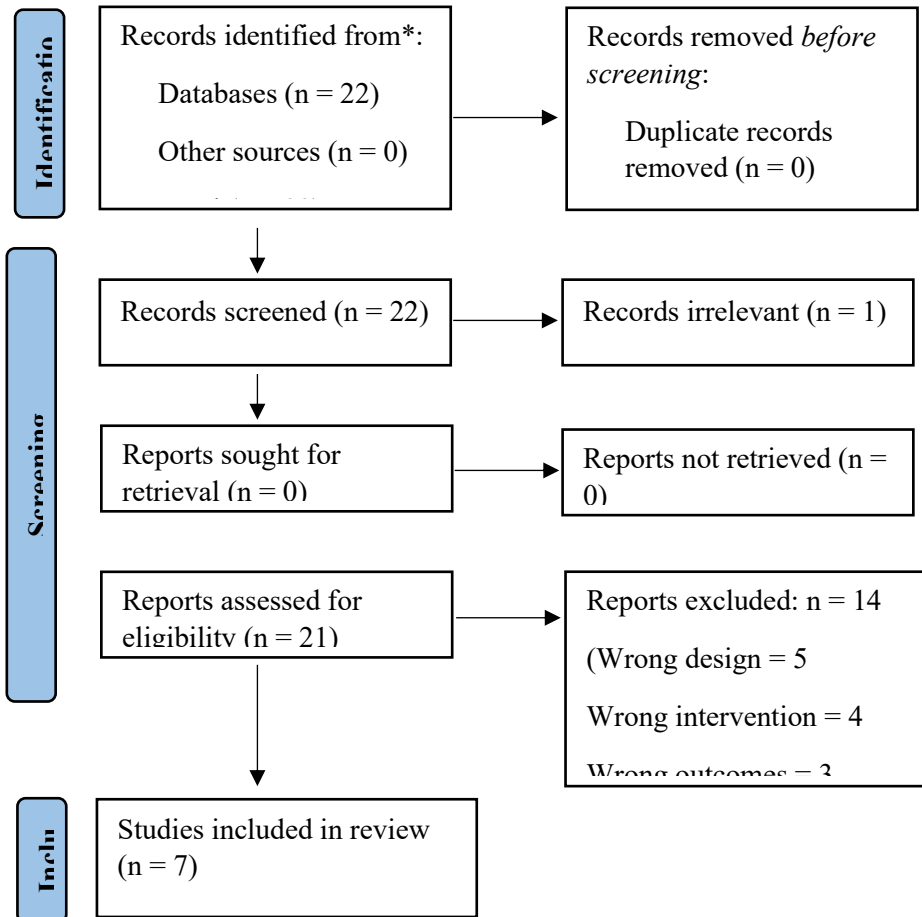


Figure 2: The size of the square box is proportional to the weight that each study contributes in the meta-analysis. The overall estimate and confidence interval are marked by a diamond.

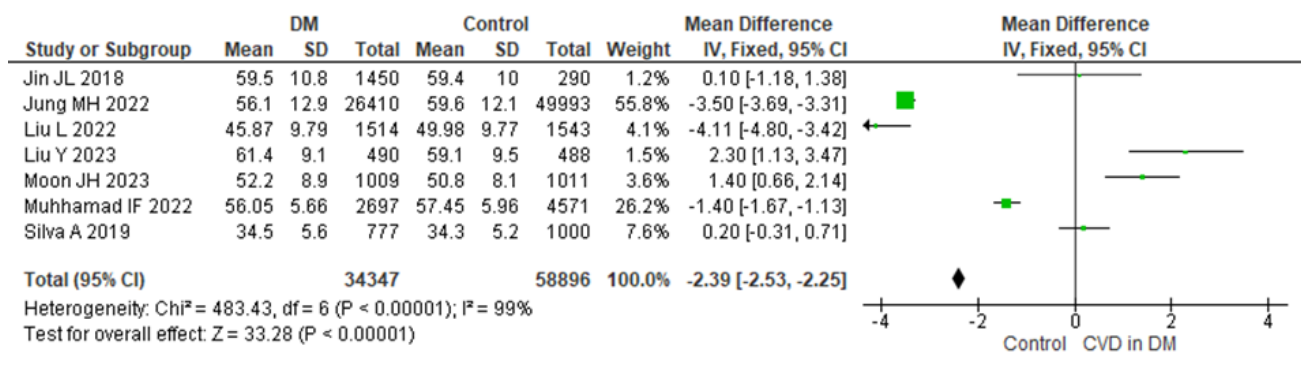




Fig 3: Risk of Bias Graph

First Author	Year of publication	ROB_Domain-1 (Arise from the randomization process)	ROB_Domain-2 (Deviations from the intended interventions)	ROB_Domain-3 (missing ourcome data)	ROB_Domain-4 (Measurement of outcome)	ROB_Domain-5 (Selection of the reported result)	Overall ROB
Alessandra da silva	2019	Green	Green	Green	Green	Yellow	Some concerns
Li Liu	2022	Green	Green	Green	Green	Red	High
Jing-Lu-Jin	2018	Yellow	Green	Green	Green	Yellow	Some concerns
Yahui Liu	2023	Yellow	Green	Green	Green	Green	Some concerns
Mi Hyang Jung	2022	Yellow	Green	Red	Green	Yellow	High

Fig 4: Risk of Bias Summary

	Domain 1	Domain 2	Domain 3	Domain 4	Domain 5
Jing JL 2018	+	+	?	+	-
Jung MH 2022	+	?	-	-	+
Liu L 2022	+	+	+	+	+
Liu Y 2023	?	?	+	+	-
Moon JH 2023	?	?	+	+	+
Muhammad IF 2022	+	?	+	+	+
Silva A 2019	+	+	+	-	-