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The Predictive Role of Triglyceride-Glucose Body Mass Index (TyG-BMI) for Acute Kidney Injury Following Coronary Artery Bypass Grafting in Patients with Type 2 Diabetes Mellitus

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ABSTRACT

Background: Acute kidney injury (AKI) that may follow coronary artery bypass grafting (CABG) is a serious problem that is aggravated in both incidence and severity by the concurrent state of perioperative dysglycemia in type 2 diabetes mellitus (T2DM) patients. Recently, it has been acknowledged that the triglyceride-glucose body mass index (TyG-BMI), a composite measure of insulin resistance, is a promising predictor of renal and cardiovascular outcomes.

Objective: In this study, we aimed to investigate the predictive role of the TyG-BMI for postoperative AKI in T2DM patients undergoing CABG.

Methods: Starting in June 2020 and continuing over the last 5 years, we enrolled 185 patients with T2DM who underwent elective CABG to correlate the preoperatively calculated TyG-BMI with the incidence of AKI occurring within the first 3 days following surgery, as defined by the kidney disease: Improving Global Outcomes (KDIGO) criteria. Logistic regression and ROC curve analyses were used to determine the association and predictive power of TyG-BMI for AKI.

Results: Fifty-five patients (29.7%) experienced AKI. TyG-BMI levels were substantially higher in patients with AKI (mean 202.4 ± 21.6 vs. 185.7 ± 18.9, $p < 0.001$). After controlling for age, baseline creatinine, BMI, and ejection fraction, TyG-BMI continued to be an independent predictor of AKI (adjusted OR 1.042, 95% CI: 1.017–1.068, $p < 0.001$). An area under the curve (AUC) of 0.78 from ROC curve analysis indicated strong predictive performance. AKI was predicted with 74.5% sensitivity and 71% specificity using a TyG-BMI cutoff of 192.5.

Conclusion: TyG-BMI is a reliable, simple, and independent predictor of AKI following CABG in T2DM patients. Preoperative TyG-BMI assessment may help identify high-risk individuals for closer monitoring and prophylactic interventions.

Keywords: *Triglyceride-glucose index, AKI, CABG, T2DM.*

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1. INTRODUCTION

The growing issue of cardiac surgery-associated acute kidney injury (CSA-AKI) affects nearly thirty percent of patients undergoing open heart surgery. This condition negatively impacts both morbidity and mortality rates in recent studies [1, 2].

Patients with prolonged dysglycemia before surgery face a higher risk due to ongoing metabolic and microvascular changes, inflammation, oxidative stress, and hemodynamic instability. They are more likely to develop this serious condition. CSA-AKI is also more common in patients with elevated levels of preoperative glycated hemoglobin (HbA1C) and insulin resistance (IR) [3, 4].

The TyG index is a well-known marker of IR. It combines fasting triglyceride and glucose measurements to reflect metabolic and glycemic status. When combined with TyG-BMI, it offers a better assessment of metabolic stress related to obesity [5].

Numerous studies indicate that TyG-BMI can forecast cardiovascular and renal outcomes in both diabetes and non-diabetic groups [6–8]. However, its ability to predict AKI after cardiac surgery, especially in patients with T2DM, has not been thoroughly researched.

This study aims to assess the predictive value of preoperative TyG-BMI for AKI in T2DM patients undergoing CABG.

2. PATIENTS AND METHODS

Methods

A total of 185 T2DM patients who met our inclusion criteria and underwent isolated on-pump CABG (ONCAB) at Kasr Al-Ainy, Fayoum, and Beni Suef University Hospitals between June 2020 and June 2025 were enrolled in this prospective study. Patients were subsequently divided into two groups based on the occurrence of postoperative AKI within the following 3 days after surgery based on the criteria defined by the KDIGO organization: group A (standard group; 139 patients) and group B (AKI group; 46 patients).

Baseline demographic, anthropometric, clinical, and laboratory variables, including the TyG-BMI, were compared between the two groups. Following surgery, Data on the incidence of CSA-AKI, hospitalization, and early mortality were gathered and interpreted**.** Data were collected and statistically analyzed concerning the occurrence of postoperative atrial AKI, the length of prolonged ICU stays, and early mortality rates.

Inclusion Criteria: Adult T2DM patients (>18 years) with ischemic heart disease mandating elective on -pump CABG.

Exclusion criteria: We excluded patients with impaired renal function, those who had previously required renal replacement therapy, and individuals at risk for AKI due to factors other than open-heart surgery. This includes patients with a history of prolonged use of nephrotoxic drugs, recurrent kidney stones, repeated urinary tract infections, and those with uncontrolled diabetes (HbA1C> 7 mg/dL). We also excluded patients with concomitant valvular and/or aortic surgeries.

Definitions:

Diagnosis of T2DM depended upon criteria described by the American Diabetes Association Professional Practice Committee [9].

Indications and recommendations for CABG and the other cardiac procedures were all decided following the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines [10,11].

CSA-AKI was defined as AKI occurring within the first week following open-heart surgeries. Determinants of AKI were defined regarding criteria described recently by the KDIGO and included an increase in serum creatinine (sCr) by ≥0.3 mg/dL (≥26.5 μmol/L) within 48 hours, an increase in sCr by ≥1.5 times baseline, or a urine volume <0.5 mL/kg/h for 6 hours [12].

Prolonged MV (> 24 hours), prolonged ICU stay (> 3 days), prolonged hospital stays (> 14 days), and early postoperative mortality (within 30 days postoperatively) were defined regarding guidelines from the Society of Thoracic Surgeons (STS) [13].

Data collection:

Baseline variables and demographic data were collected including age, sex, BMI, smoking status, comorbidities (hypertension, dyslipidemia, COPD) and preoperative left ventricular ejection fraction (LVEF).

Laboratory data were obtained after an overnight fast within 48 hours before surgery, including fasting plasma glucose (FPG), serum triglycerides (TG), creatinine, HbA1c, and other routine biochemical parameters.

Calculation of TyG-BMI:

The TyG index was calculated as: TyG index = Ln (TG [mg/dL] ×glucose [mg/dL]/2).

TyG-BMI was derived as: TyG-BMI=TyG index×BMI(kg/m²).

Study endpoints:

The **primary endpoint** of the study was to determine the predictive value of the TyG-BMI index for the occurrence of AKI in patients with T2DM following CABG.

The **secondary endpoints** included evaluating the association between the TyG-BMI index and the severity of AKI, as well as its relationship with short-term postoperative outcomes such as length of intensive care unit (ICU) stay, total hospitalization duration, and in-hospital mortality.

Ethical approval:

The study protocol was authorized by Cairo University's ethics council and Fayoum University hospitals [Approval No.: 715]. An informed written permission form was signed by each patient to authorize the procedure. Throughout its implementation, the study complied with the Helsinki Declaration [14].

Measures before surgical intervention:

Besides investigating the detailed coronary artery anatomy using coronary angiography and, in some cases, viability studies, all patients in this study followed strict preoperative glycemic and renal state observation and control starting with a complete history, a general and local clinical examination, and laboratory work-up, reaching daily follow-up with a diabetologist and nephrologist keeping optimum general state before surgical intervention.

All patients with fluctuating random blood sugar were shifted to insulin from the ordinary oral hypoglycemics, and we followed the regimen of strict glycemic control, keeping the blood glucose range of approximately 80–110 mg/dL and HbA1c 6.5–7.0% [15].

Intraoperative Measure:

For all patients, a standard median sternotomy was performed with standard cardiopulmonary bypass (CPB) techniques. Myocardial protection was achieved using intermittent warm K+ cardioplegia. CPB time, aortic cross-clamp time, number of grafts, and high-dose inotropic or vasopressor therapy were recorded as part of the operation. Perioperative glycemic control aimed to keep blood glucose levels between 80 and 110 mg/dL via weight-based insulin infusion protocols.

Postoperative measures:

Along with continuous monitoring of vital signs and all cardiac parameters, including electrocardiogram (ECG) changes throughout the ICU stay, we maintained strict glycemic control and paid special attention to urine output, fluid balance, the need for diuretics, and daily assessment of renal function tests, as well as electrolyte balance via frequent arterial blood gas studies.

Data on mechanical ventilation support, ICU and hospital stays, the need for high vasopressor support, blood product transfusion, renal dialysis, and in-hospital mortality were gathered for statistical analysis.

Follow up after hospital discharge:

For three months after being discharged, every patient was observed monthly in our clinics. In order to monitor renal function and identify any ongoing or recently developed issues, the follow-up process comprised wound care, a chest examination, a plain chest X-ray, an ECG, blood glucose levels, and serum creatinine.

Statistical analysis:

Sampling method:

A consecutive sampling method was used, as all patients with T2DM who were planned for elective CABG at Kasr Al-Ainy, Fayoum, and Beni Suef University Hospitals from June 2020 to June 2025 were offered screening for eligibility. All eligible patients with T2DM who provided informed consent were included in the study until the study sample size was reached. This consecutive sampling method endeavored to have a complete representation of eligible patients throughout the study duration to reduce selection bias. A total of 185 patients were enrolled into the study and prospectively followed to assess the development of AKI within the first three days postoperatively, as defined by the KDIGO definition for AKI. Consecutive sampling is best used in retrospective observational studies, as it reduces selection bias and ensures that all eligible cases within the defined time frame are included [16].

Data analysis:

Data collection and statistical analysis were performed using IBM SPSS Statistics for Windows, Version 26.0 [17]. Student's t-test was used to evaluate continuous variables that were checked for normality using the Shapiro-Wilk test. The variables were reported as Mean. ± SD. The Mann-Whitney U test was used to compare and represent non-normally distributed data as a median with [IQR (25th-75th percentile)]. The chi-square test or Fisher's exact test was used to examine categorical data that was presented as percentages. Multivariate logistic regression was utilized to assess the CSA-AKI predictors, and 95% CIs were computed for the adjusted odds ratios (ORs) of the CSA-AKI. We calculated the area under the curve (AUC) using Receiver Operating Characteristic (ROC) curve analysis to assess the predictive ability of preoperative TyG-BMI for CSA-AKI. All P values that have been presented are two-sided, and statistical significance was defined as P values of < 0.05. The assistance of a qualified statistician was obtained for all statistical analyses.

3. RESULTS

Demographic and pre-operative variables; Fig. 1, Table 1:

On analyzing the patient's demographic and preoperative data, we found that the AKI group showed significantly older patients with higher TyG-BMI index and poorer glycemic control (P value < 0.05). Despite higher BMI among the same group, the difference didn't reach a level of significance. Aside from these factors, no other significant differences were observed between the groups regarding demographic and clinical baseline characteristics (p > 0.05).

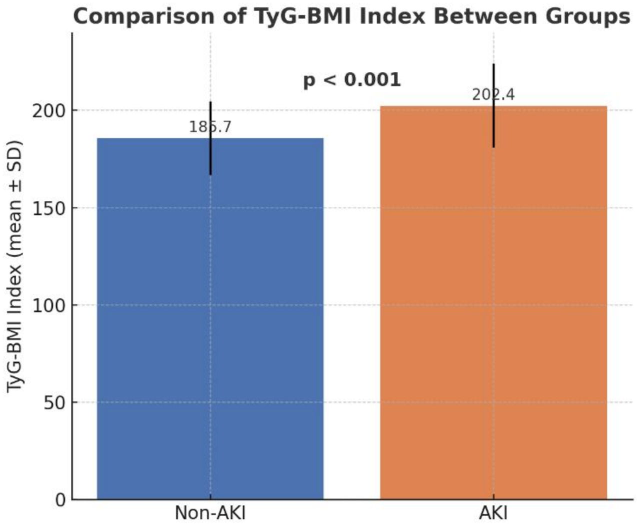

Fig. (1): Box-and-whisker plot illustrating the distribution of TyG-BMI index between patients with and without postoperative AKI following CABG.

Table (1): Preoperative parameters.

Preoperative parameter	**Group A; Non- AKI (130)**	**Group B; AKI (55)**	**P Value**
Age (years)	58.65 ± 9.4	62.82 ± 8.6	P = 0.0052
Male sex (number %)	95 (73.08%)	36 (65.45%)	P = 0.2981
Comorbidities:			
Smoking	67 (51.54%)	29 (52.72%)	P = 0.8836
Hypertension, *n* (%)	89 (68.46%)	39 (70.90%)	P = 0.7432
Dyslipidemia, *n* (%)	76 (58.46%)	24 (43.64%)	P = 0.2708
COPD, *n* (%)	62 (47.69%)	20 (36.36%)	P = 0.1573
Uncontrolled Diabetes mellitus (HbA1c ≥7.0%)[18]	34 (26.15%)	14 (25.45%)	P = 0.9211
LVEF<50%, *n* (%)	23 (17.69%)	9 (16.36%)	P = 0.8274
BMI	28.1 ± 3.5	28.9 ± 3.8	P = 0.1678
TyG-BMI index	185.7 ± 18.9	202.4 ± 21.6	p < 0.001

COPD:Chronic obstructive pulmonary disease, HBA1C:Glycated hemoglobin, LVEF:Left ventricular ejection fraction, BMI:Body Mass Index.

Intra-operative variables; Table 2:

The number of grafts, CPB time, aortic cross-clamp time, and the need for high-dose inotropic or vasopressor medication did not differ statistically significantly between the AKI and non-AKI groups when the intraoperative data was analyzed (all p > 0.05).

Tables (2): Intra-operative parameters.

Preoperative parameter	Group A; Non- AKI (130)	Group B; AKI (55)	P Value
Number of Grafts (mean ± SD)	3.1 ± 0.7	3.2 ± 0.8	0.368
CPB time (minutes)	89.4 ± 16.5	90.8 ± 15.9	0.412
Aortic cross-clamp time (minutes)	62.3 ± 11.8	63.1 ± 12.2	0.587
High-dose inotropic/vasopressor therapy, n (%)[19]	18 (13.85%)	15 (27.27%)	0.064

CPB: cardiopulmonary bypass

Post-operative variables; Tables 3:

In the postoperative ICU, more patients with AKI experienced longer ICU stays and needed longer mechanical ventilator support and renal replacement therapy till renal function improvement, thus subsequently mandating longer hospital stays. Moreover, those patients were at higher risk of postoperative atrial fibrillation and its potentially lethal consequences, such as cerebrovascular strokes. Despite the higher percentages of patients in the AKI group needing more blood transfusions and facing early postoperative mortality, the differences between the two groups were not statistically significant (P value >0.05).

Table (3): Postoperative parameters.

Postoperative variable	Group A; Non-AKI (130)	Group B; AKI (55)	P value
Prolonged ICU stay, n (%)	13 (10%)	12 (21.81%)	P = 0.0322
Prolonged MV time, n (%)	15 (11.54%)	13 (23.64%)	P = 0.0363
RRT, n (%)	0 (0%)	11 (20%)	<0.001
Prolonged Hospital stay, n (%)	25 (19.23%)	20 (90.91%)	P < 0.0001
POAF, n (%)	21 (16.15%)	19 (34.55%)	P = 0.008
CVS, n (%)	4 (3.08%)	9 (16.36%)	P = 0.0013
Re-exploration for bleeding, n (%)	5 (3.85%)	4 (7.27%)	P = 0.312
Mortality, n (%)	4 (3.08%)	5 (9.09%)	P = 0.118

MV: Mechanical Ventilation, RRT: Renal replacement therapy, POAF: Postoperative atrial fibrillation, CVS: Cerebrovascular strokes.

Univariate analysis; Tables 4, 5:

Univariate analysis revealed that older age and higher TyG-BMI index were significantly associated with the development of post-CABG AKI. Furthermore, the need for higher vasopressor support showed a trend of statistical significance.

Focusing on consequences, patients among the AKI group faced worse postoperative outcomes in terms of longer ICU stay, MV support, need for renal replacement therapy, and POAF and its hustle effects, denoting that AKI significantly worsens the outcomes following CABG.

Table (4): Univariate Logistic Regression Analysis, predictors of AKI after CABG

Variable	Group A: Non-AKI (n=130)	Group B: AKI (n=55)	P value
Age (years)	58.65 ± 9.4	62.82 ± 8.6	0.0052

TyG-BMI index	185.7 ± 18.9	202.4 ± 21.6	<0.001
High-dose inotropic/vasopressor therapy, n (%)	18 (13.85%)	15 (27.27%)	0.064*

**Borderline statistical significance.*

Table (5): Univariate Logistic Regression Analysis, Consequences of AKI after CABG

Outcome	Group A: Non-AKI (n=130)	Group B: AKI (n=55)	P value
Prolonged ICU stay, n (%)	13 (10%)	12 (21.8%)	0.0322
Prolonged MV time, n (%)	15 (11.5%)	13 (23.6%)	0.0363
Renal replacement therapy, n (%)	0 (0%)	11 (20%)	<0.001
Prolonged hospital stays, n (%)	25 (19.2%)	20 (90.9%)	<0.0001
POAF, n (%)	21 (16.1%)	19 (34.6%)	0.008
Cerebrovascular stroke, n (%)	4 (3.1%)	9 (16.4%)	0.0013

Multivariate Logistic Regression Analysis; Table 6:

After adjustment for age, baseline creatinine, BMI, and ejection fraction, TyG-BMI remained an independent predictor of postoperative AKI (adjusted OR 1.042, 95% CI: 1.017–1.068, p<0.001). Other covariates did not reach statistical significance in the final model.

Table (6): Multivariate Logistic Regression Analysis for Predictors of AKI after CABG.

Predictor	Adjusted OR	95% CI	P value
Age	1.012	0.984 – 1.041	0.345
BMI	1.008	0.963 – 1.055	0.682
Baseline Creatinine	1.119	0.921 – 1.359	0.264
Ejection Fraction	0.978	0.942 – 1.015	0.235
TyG-BMI	**1.042**	**1.017 – 1.068**	**<0.001**

ROC Curve Analysis; Fig. 2, Table 7:

On using the ROC curve to yield an accurate assessment of the predictability of TyG-BMI in operating diabetic patients with ischemic heart disease, the analysis revealed an AUC curve of 0.78, indicating excellent discriminatory ability. A cut-off value of 192.5 was associated with a sensitivity of 74.5% and specificity of 71.0% in predicting AKI following CABG in T2DM patients.

Table 7: ROC Curve Analysis.

Predictor	AUC	CI 95%	Cut-off	Sensitivity	Specificity	P Value
TyG-BMI	0.78	0.71 – 0.85	192.5	74.5%	71.0%	P < 0.001

** CI approximation based on AUC distribution.*

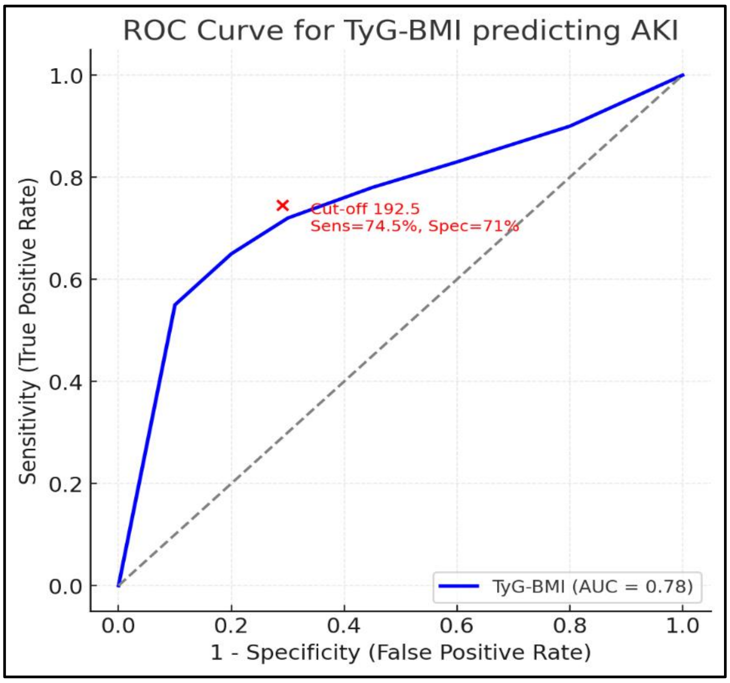

Fig. (2): ROC curve Analysis.

4. DISCUSSION

In this retrospective observational multicenter study, we aimed to assess the value of the TyG-BMI as a predictor of CSA-AKI in T2DM patients undergoing on-pump CABG, and we found that, after adjusting for the other possible risk factors for developing AKI in such patients, including senility, halted cardiac function, and preoperative renal dysfunction, TyG-BMI was an independent With a threshold value of 192.5, TyG-BMI predicted AKI with 74.5% sensitivity and 71.0% specificity. Finally, our findings identified TyG-BMI as an economical and viable preoperative predictor of post-CABG AKI and its associated higher morbidity and death.

Previously, raised TyG-BMI has long been recognized as a predictor of hustle outcomes in patients with prolonged insulin resistance and dysglycemia, especially regarding the cardiovascular and renal outcomes, but recently the same index has gained increased popularity as strong evidence for possible chronic kidney disease in both diabetic and non-diabetic patients [20-21].

In 2022, Li et al. and colleagues correlated raised preoperative TyG-BMI and the risk of AKI following CABG and concluded that logistic regression analysis indicated that for each unit increase in the TyG index, the odds of developing AKI post-CABG surgery increased by 30.573 times [odds ratio (OR)=30.573, 95% confidence interval (CI) 3.930–237.807, P<0.001]. The AUC curve for the TyG index in predicting postoperative AKI in CABG patients was 0.802 (P<0.001; 95% CI: 0.753–0.851) [22].

Moreover, in their prospective study conducted in 2023, Wang et al. confirmed that TyG-BMI provided a more reliable indicator for possible CSA-AKI compared to the TyG index alone in patients undergoing major cardiovascular procedures [23].

Again, Zheng and colleagues in their meta-analysis have highlighted the robust association between insulin resistance–related indices, including TyG-BMI, and adverse renal outcomes in both cardiac and non-cardiac surgical populations [24].

Our results support the use of TyG-BMI as a simple, affordable, and repeatable preoperative biomarker for predicting adult risk of AKI. Nevertheless, to our best knowledge, this is the first multicenter trial that focuses on the predictive function of TyG-BMI for CSA-AKI in patients with T2DM who are having CABG on-pump.

Taking our multicenter findings into consideration, assessing the preoperative TyG-BMI in diabetic patients prior to cardiac surgeries provides a simple, affordable, and efficient tool that could be incorporated into the multifactorial risk stratification, including the other evidenced predictors such as senility, raised baseline renal enzymes, and halted LVEF.

Additionally, this simple index could allow the managing multidisciplinary team, including surgeons and intensivists, to fashion a tailored preventive strategy in the form of careful hemodynamic monitoring, fluid balance, and careful use of the nephrotoxic drugs.

From the financial point of view, this inexpensive index could replace other sophisticated biomarkers such as NGAL or KIM-1 (Neutrophil Gelatinase-Associated Lipocalin or Kidney Injury Molecule-1) [25-26] that are commonly unavailable in centers with limited resources such as ours.

Moreover, From the practical point of view, TyG-BMI provided a dynamic reflection of both glucose and lipid metabolism, making it a more applicable alternative for the other conventional predictors, such as serum creatinine or the estimated glomerular filtration rate, to the fine metabolic derangements that precede AKI [27].

Unlike advanced biomarkers, TyG-BMI requires no additional cost or laboratory resources beyond routine fasting glucose, triglycerides, and BMI, making it a practical tool in both tertiary centers and resource-limited settings [28].

5. LIMITATIONS

Even while adhering to the best available standards to achieve precise outcomes, our research encountered the following limitations. The retrospective design of this study does not entirely eliminate the possibility of residual confounding. Additionally, confining the study group to patients receiving on-pump CABG has constrained our results from being relevant to other types of open-heart surgeries. Ultimately, additional prospective, large-scale meta-analyses should be performed to explore the integration and final inclusion of the TyG-BMI into globally validated risk scores

6. CONCLUSION

TyG-BMI is a simple, affordable, and independent predictor of CSA-AKI in diabetic patients undergoing on-pump CABG. Incorporating this index into preoperative risk assessment may help guide preventive strategies, especially in resource-limited settings.

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REFERENCES

[1] Wiersema R, Jorritsma W, Nieuwenhuijs-Moeke GJ, Absalom AR, van Meurs M, Wouters D, et al. Acute kidney injury following cardiac surgery: a systematic review and meta-analysis of incidence, risk factors and mortality. J Crit Care. 2022;72:153996.

[2] Ortega-Loubon C, Fernández-Molina M, Carrascal-Hinojal Y, Fulquet-Carreras E. Cardiac surgery-associated acute kidney injury. Ann Card Anaesth. 2021;24(1):1–14.

[3] Gao Y, Wu Y, Li C, Wang L, Zhao W, Li Y, et al. Preoperative HbA1c levels and postoperative acute kidney injury in patients undergoing coronary artery bypass grafting: a prospective observational study. BMC Cardiovasc Disord. 2022;22(1):231.

[4] Van den Berg VJ, Boersma E, de Keizer NF, van Domburg RT, Noyez L, Mariscalco G, et al. Diabetes, glycemic control, and acute kidney injury after cardiac surgery: a multinational cohort study. J Thorac Cardiovasc Surg. 2023;165(5):1733–42. e2.

[5] Lambrinoudaki I, Kazani MV, Armeni E, Georgiopoulos G, Tampakis K, Kaparos G, et al. The TyG index as a marker of subclinical atherosclerosis and arterial stiffness in lean and overweight postmenopausal women. Heart Lung Circ. 2018;27(6):716–24.

[6] Ding X, Wang X, Wu J, Zhang M, Cui M. The relationship between the triglyceride–glucose index and the risk of cardiovascular disease in the general population: a systematic review and meta-analysis. Cardiovasc Diabetol. 2021;20(1):76.

[7] Zhu B, Wang J, Chen K, Yan W, Wang A, Wang W, et al. Triglyceride–glucose index as a novel marker to predict the risk of kidney disease: a systematic review and meta-analysis. Front Endocrinol (Lausanne). 2022;13:940214.

[8] Zhao Q, Zhang TY, Cheng YJ, Ma Y, Xu YK, Yang JQ, et al. Triglyceride–glucose index and risk of adverse cardiovascular events in patients with type 2 diabetes mellitus and acute coronary syndrome. Cardiovasc Diabetol. 2020;19(1):80.

[9] American Diabetes Association Professional Practice Committee. 2. Classification and diagnosis of diabetes: Standards of Care in Diabetes—2024. Diabetes Care. 2024;47(1):S16–S27.

[10] Correction to: 2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines., Circulation. 2024; 150 (5) e105.

[11] 2022 AHA/ACC/HFSA Guideline for the Management of Heart Failure: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines, Circulation.

2022;145 (18).

[12] Kidney Disease: Improving Global Outcomes (KDIGO) Glomerular Diseases Work Group. KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S): S1-S276.

[13] Rotar EP, Beller JP, Smolkin ME, Chancellor WZ, Ailawadi G, Yarboro LT, Hulse M, Ratcliffe SJ, Teman NR. Prediction of Prolonged Intensive Care Unit Length of Stay Following Cardiac Surgery. Semin Thorac Cardiovasc Surg. 2022;34(1):172-179.

[14] World Medical Association. World Medical Association Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects. JAMA. 2013;310(20):2191–2194.

[15] American Diabetes Association Professional Practice Committee. Summary of revisions: Standards of Care in Diabetes—2025. Diabetes Care. 2025;48(1): S6–S13.

[16] Acharya AS, Prakash A, Saxena P, Nigam A. Sampling: Why and how of it? Indian J Med Spec 2013;4(2):330–333.

[17] BM Corp. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp; 2019.

[18] Glycemic targets: Standards of Medical Care in Diabetes—2024. Diabetes Care. 2024; 47(1): S113–S122.

[19] Bassi E, Park M, Azevedo LC. Therapeutic strategies for high-dose vasopressor-dependent shock. Crit Care Res Pract. 2013; 2013:654708.

[20] Jiang Y, Lai X. Association between the triglyceride glucose index, triglyceride-glucose body mass index and diabetic kidney disease in adults with newly diagnosed type 2 diabetes. Front Med (Lausanne). 2024; 11:1328601.

[21] Sbriscia, M., Colombaretti, D., Giuliani, A. et al. Triglyceride glucose index predicts long-term mortality and major adverse cardiovascular events in patients with type 2 diabetes. Cardiovasc Diabetol. 24, 115 (2025).

[22] Li J, Chen Y, Xu Y, et al. Association between triglyceride-glucose index and acute kidney injury after coronary artery bypass grafting. Front Cardiovasc Med. 2022; 9:861452.

[23] Wang H, Zhang Y, Zhao X, et al. Predictive value of triglyceride-glucose-body mass index for postoperative acute kidney injury in cardiovascular surgery: a prospective cohort study. BMC Cardiovasc Disord. 2023; 23:412.

[24] Zheng R, Cao Y, Chen X, Wang J. Association of triglyceride–glucose index with adverse renal outcomes: a systematic review and meta-analysis. Diabetes Res Clin Pract. 2022; 188:10993

[25] McMahon BA, Murray PT. Urinary liver fatty acid-binding protein: another novel biomarker of acute kidney injury. Kidney Int. 2010;77:657–659. doi: 10.1038/ki.2010.5.

[26] Shao X, Tian L, Xu W, Zhang Z, Wang C, Qi C, Ni Z, Mou S. Diagnostic value of urinary kidney injury molecule 1 for acute kidney injury: a meta-analysis. PLoS One. 2014;9:e84131.

[27] Lee SB, Ahn CW, Lee BK, Kang S, Nam JS, You JH, et al. Association between triglyceride glucose index and arterial stiffness in Korean adults. Cardiovasc Diabetol. 2018;17(1):41.

[28] Miao R, Yu Y, Xu D, Song F. Triglyceride-glucose index as a predictor of adverse outcomes after cardiac surgery: evidence from a multicenter cohort. Front Cardiovasc Med. 2023; 10:1129451.