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Coronary artery disease severity prediction by the use of Triglyceride-glucose index marker

Omar Moyasser Hameed[1]

[1]Resident in chemical pathology , Iraqi board of chemical specialization (IBMS) , Mosul, Iraq

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Corresponding author E mail: Umarmoyasser@gmail.com

ABSTRACT

Background: Coronary artery disease is a prevalent cardiac condition that affects millions of people worldwide and is one of the leading causes of morbidity and death.Triglyceride-Glucose Index is a thorough statistical metric that accounts for both fasting triglyceride and fasting glucose levels . It may be used in a variety of applications clinical settings and epidemiological research since it is easy to calculate and has less time and expense limits making it appropriate for large populations

Patient and methods: This research case control study carried out at Al Mosul Center for Cardiology and Cardiac Surgery. It involved 120 patients, included 40 control samples and 80 patients with coronary artery disease .

Results : The triglyceride-glucose index , total cholesterol found to be strongly associated with the severity of coronary artery disease. Good ability to distinguish between the studied groups is demonstrated by the Receiver Operating Characteristic analysis of the triglyceride-glucose index.An elevated triglyceride-glucose index was linked to a higher risk of multi-vessel coronary artery disease

INTRODUCTION

Cardiovascular diseases (CVDs) continue to be the world's leading cause of mortality and significantly increase health care expenses [1]. It is a disorder where the myocardium does not get enough blood or oxygen due to coronary artery blockage, which results in an oxygen demand-supply mismatch [2].There are two categories of risk factors for CAD, modifiable and non-modifiable [3].

NON-MODIFIABLE RISK VARIABLES ARE :

• **Age :** After the age of 35, CAD is more common in both men and women [4] .

• Gender: The risk is higher for men than for women before the age of 35 [5] .

•**Ethnicity:** The risk of CAD morbidity and death is higher among Blacks, Hispanics, Latinos, and Southeast Asians [6].

• **Family history:** Individuals under 50 years of age who have a family history of early heart disease are at higher risk of dying from CAD [7].

MODIFIABLE RISK FACTORS:

Medications

•**Hypertension:** About 1 out of every 3 CVDs patients have hypertension[8] .

• **Hyperlipidemia:** The second most prevalent risk factor for ischemic heart disease is thought to be hyperlipidemia [9].

• **Diabetes mellitus:** When comparing adult patients with diabetes to those without the condition, the heart disease risk is 2.4 times higher for women and 2.5 times higher for men [10] .

• **Obesity:** Obesity raises the likelihood of developing diabetes mellitus, hypertension, and hyperlipidemia, among other CAD risk factors, and is an independent risk factor for CAD [11].

• **Smoking:** According to estimates from the Food and Drug Administration (FDA), CAD results in 400,000 premature deaths and 800,000 fatalities annually. Approximately one-third and one-fifth of these are caused by smoking, respectively [12] .

• **Diet:** There has been a long history of correlation between coronary heart disease and saturated fat[13] .

•**Sedentary lifestyle:** One preventive factor against the onset of CAD is exercise. People who choose to exercise on their own had reduced rates of illness and death [14] .

CAD is brought on by the accumulation of lipids, cholesterol, and other materials in and on the heart artery walls. We term this condition atherosclerosis. The accumulation is known as plaque. Blood flow can be obstructed by narrowing arteries due to plaque. Moreover, the plaque may rupture, resulting in a thrombosis [15] . The major risk factor for (CVD), the world's leading cause of death, is atherosclerosis [16] Triglyceride-Glucose Index (TyG index) is A thorough statistical metric that accounts for both fasting triglyceride and fasting glucose levels [17] .The TyG index may be used in a variety of applications, clinical settings, and epidemiological research since it is easy to calculate and has less time and expense limits, making it appropriate for large populations [18] .It is an easy-to-use supplemental indicator test for CVD screening and can be used for early assessment of the severity of vascular disease [19] .Those with higher baseline TyG index values and a trajectory of prolonged or progressive rise in early adulthood Its levels have shown noticeably higher risks of all-cause mortality and CVD events in later life [20] . So, it is critical to take advantage of the TyG index's potential in order to reduce mortality rates and improve patient outcomes [21].

TyG index was first developed in 2008 and is calculated using the formula: Ln [fasting triglyceride (mg/dl) × fasting glucose (mg/dl) /2] . This composite indicator is made up of fasting triglyceride (TG) and fasting plasma glucose (FPG) readings [22] . It has exceptional sensitivity and specificity, making it a viable substitute biomarker for CAD[23] .Hypercholesterolemia is a significant risk factor regarding atherosclerotic CVD . [24] . Myocardial infarction, ischemic cardiomyopathy, sudden cardiac death, ischemic stroke, erectile dysfunction, claudication, and acute limb ischemia are among the complications that can arise from hypercholesterolemia and atherosclerosis [25] .

Hypertriglyceridemia is one of the reemerging therapeutic targets, and it is one of the modifiable residual cardiovascular risk factors[26] .

AIM AND OBJECTIVES OF THE STUDY

The aims of this study are:

1. Is to identify the role of Triglyceride glucose index as a predictor of coronary artery disease in Mosul city.
2. Identify the role of serum lipid profile parameters in assessing the severity of coronary arteries occlusion.
3. To determine the ideal TyG index cut-off value for forecasting substantial CAD

MATERIAL

This study is a case control study that was done at Al Mosul Centre for Cardiology and Cardiac Surgery . It involved 120 persons (from the age of 45 to 73 years old) with suspected coronary artery disease who had undergone coronary angiography at the catheterization unit by Consultant Cardiologists. They were classified into three groups depending on findings of their coronary angiography:

Group 1 : consisted of persons who have no coronary artery stenosis, (n=40) , (control)

Group 2 : consisted of patients who were found to have single vessel occlusion (n=40) , (case)

Group 3 : involved patients who were found to have 2 vessels or more occlusion (n=40) , (case)

The included patients were defined to have or have not CAD as vessel was narrowed by 50% or more which reflect 50% reduction in the luminal diameter by obstruction in one or more of coronary arteries as found by angiography [27] .

INCLUSION CRITERIA:
Adult patients of both genders above the age of 45 years old with suspected CAD who attend Al Mosul Center for Cardiology and Cardiac Surgery during the period of this study and are referred for coronary angiography.

EXCLUSION CRITERIA:

1. Coronary artery bypass grafting history.
2. Severe liver disease, such as cirrhosis.
3. A history of cancer that is now being treated.
4. Patients that used drugs that impact glucose or lipid metabolism in the last three months, such as fibrates, systemic corticosteroids.
5. Alcoholic patients.
6. Age below 30 years old.
7. Pregnant woman.

Five milliliters (ml) of peripheral venous blood was collected from each included persons after 10-12 hour fasting state and just before undergoing angiography study, which was divided into two parts, each of them was treated in a different way as follows:
One milliliter was put into sodium fluoride/potassium oxalate tubes to measure plasma glucose, while the remaining four milliliters were put into plain tubes, left to clot, and centrifuged for five minutes at 4000 rpm to separate the serum. Aliquoting the serum and freezing it at -20°C allowed for the future investigation of the fasting cholesterol and triglyceride.

STATISTICAL ANALYSIS :
The data obtained in the current study was analyzed using Statistical Package of IBM SPSS-29 (IBM Statistical Packages for Social Sciences-version 29, Chicago, IL, USA). to determine the mean, standard deviation (SD), and range (minimum-maximum) of the variables under study, descriptive statistics were employed ,Shapiro-Wilk test used to determine the distribution . The means of continuous parameters in the cases and controls were compared using the one way ANOVA and then by Duncans Multiple Range test. The chi-squared test was employed to compare categorical (non-continuous) variables. The Ordinal Logistic Regression was used to predict the severity of coronary artery disease and other parameters. Receiver Operating Characteristic "ROC" curve technique was used in order to determine the use of TyG index as a predictive tool for CAD and the ability to determine the "cut-off value" which is of optimum sensitivity and specificity for diagnosing disease.

RESULTS

BASIC STUDY FEATURES SUBJECTS:
A total of 120 individual participated in the study. They were divided into three groups according to the severity of the coronary artery disease: group 1; 40 participants without coronary artery stenosis (control group), group 2, 40 patients with single vascular blockage (case group) and group 3 consisted of 40 individuals who had been discovered to

have two or more vessels occluded. (case group).

Participants in the group1 were between the ages of 45 and 73 (33.3%) with mean (59.8 ± SD 9.1), whereas 33.3 % of those in group 2 were in age (46-75) range with mean (60.7± 8) , and in group 3 age range (42_73) which form 33.3% of total and with mean (61.5± 7.9) (Table 1). Given the higher frequency of coronary artery disease in this age range. There were 27 men (67.5%) and 13 women (32.5%) in Group 1, and 24 men (60%) and 16 women (40%) in Group 2, while in group 3 there were 25 men (62.5%) and 15 women (37.5%).

THE BIOCHEMICAL CHARACTERISTICS OF THE GROUPS UNDER STUDY :

Using ANOVA and Duncan tests,the mean ± standard error (SE) values of the biochemical parameters in the groups under study are shown In (Table 2)

For every parameter, there was a notable difference between the three groups. Throughout the study's groups, the mean total cholesterol levels increased gradually; Group1 had the lowest mean (115.2 ± 4.05), followed by Group 2 (144.9 ± 6.89), and Group 3 had the highest mean (223.4 ± 2.48). All groups were significantly different from one another, according to Duncan's multiple range test ($p < 0.001$).

Group 2 and Group3 had considerably greater mean serum triglyceride levels than Group 1 ($P < 0.0001$). Notably, despite having noticeably higher TG levels, there was no discernible difference between Group 2 and Group3.

TheTyG levels increased gradually; Group1 had the lowest mean (8.3±0.03), followed by Group 2(8.9±0.01), and Group 3 had the highest mean (9.4±0.05). All groups were significantly different from one another ($p < 0.001$).

DISCUSSION

Cardiovascular disease is regarded as a leading cause of death and morbidity for men and women .It significantly increases health care expenses in different health care systems [1]. In the current study the baseline demographic and anthropometric characteristics of the study population were comparable across the three groups (table 1). There was no statistically significant difference in the mean ages of the participant in groups 1, 2, and 3, which were 59.8 ± 9.1, 60.7 ± 8.0, and 61.5 ± 7.9, respectively ($p = 0.66$).The age distribution balance between the groups indicates that there was less chance of age-related confounding.

This disagree with study of Nicholas which was done in UK at 2023 who found significant association between age and CAD, this may be attributed to difference in life style, genetic and due to narrow range of age between groups [28] .

Sex distribution was well balanced. Male participants comprised (67.5%, 60%, 62% in groups 1,2,and 3 respectively), while females accounted for (32.5% , 40%, 37.5% in groups 1,2,and 3 respectively), with no significant differences observed ($p = 0.77$ for males; $p = 0.78$ for females) , (table 1).

This was in line with Baligar et al who found that there were no statistical significance in age, and sex between patients with single-vessel obstruction and those with multi-vessel obstruction [29]. This implies sufficient baseline comparability. This kind of equilibrium is crucial because it reduces the possibility of confusion brought on by anthropometric or demographic parameters.

Total cholesterol levels were significantly higher in group 3 compared with groups 1 and 2 , and in group 2 is higher than in group 1 with p value < 0.001 ,(table 2), reflecting worsening dyslipidemia [30] .

TG showed a striking increase across the groups, with Group 3 demonstrating nearly double the levels of group 1, and in group 2 the TG is higher than in group1with p value < 0.0001(table 2). Elevated TG is strongly associated with the cardiovascular risk, even after LDL-C control (Toth et al.) [31] .

The TyG index showed gradual increase in the three groups, with group 3 showing the highest mean (9.4 ± 0.05), significantly higher than both group 2 (8.9 ± 0.01) and group 1 (8.3 ± 0.03) with p< 0.001 , (table 2).

The significant differences (p < 0.001) among all groups indicate that the TyG score is a useful tool for differentiating between different levels of insulin resistance and the corresponding cardiovascular risk. This finding is consistent with earlier research showing a substantial correlation between metabolic abnormalities and a higher risk of coronary artery disease and higher TyG readings. The steady rise from group 1 to group 3 demonstrates the TyG index's value as a sensitive indicator for risk assessment and early diagnosis in clinical practice. (Shi et al., 2024; [98] Zheng et al., 2025) [32] .

The findings of ordinal logistic regression looking at CAD predictors are shown in table 3 , the TyG index was a very reliable independent predictor (OR = 1.36, 95% CI: 1.24–1.49, p < 0.001),revealing a strong association with the risk of CAD. This result is consistent with several recent studies showing an elevated relationship between the TyG index and the existence of CAD [32]; [33].

Likewise, there is a positive relation between CVD risk and total cholesterol (OR = 1.01, p = 0.017). Elevated total cholesterol are strongly linked with atherosclerotic cardiovascular disease, and their progressive increase explain a higher cardiometabolic burden [34].

The TG levels and cardiovascular risk were significantly positively correlated (OR = 1.03, 95% CI: 1.02–1.03, p < 0.001). According to Toth results, showing hypertriglyceridemia is a major contributor to the development of atherosclerosis and cardiovascular disease. By encouraging atherogenic residual particles and endothelial dysfunction, elevated triglycerides raise the risk of cardiovascular disease [31] .

The findings of the Receiver Operating Characteristic (ROC) study for the TyG index as a coronary artery disease predictor are displayed in (table 4), (figure 1): The TyG index demonstrated good discriminatory ability in differentiating individuals with CAD from those without, as evidenced by the area under the curve (AUC) of 0.829 ($p < 0.001$).

With an 81% specificity and 70% sensitivity, the ideal cut-off value for TyG was 8.72. According to this, the TyG index correctly excludes 81% of patients without CAD (true negatives) and correctly detects 70% of patients with CAD (true positives) at this threshold. The usefulness of this cut-off for clinical prediction is supported by the Youden's index of 0.518. These results demonstrate that the TyG index is a useful, non-invasive, and reasonably priced marker for the early detection of patients who are more likely to develop CAD. It may be especially helpful in populations where insulin resistance is a major contributing factor to atherosclerosis, and its predictive ability is on par with other well-established metabolic indicators. Early detection of high-risk patients enables prompt management with medication or lifestyle changes, which may slow the progression of CAD. According to similar research, the TyG index's AUC values for predicting subclinical atherosclerosis and cardiovascular events range from 0.78 to 0.85, confirming its applicability as a stand-in for insulin resistance and cardiometabolic risk (Zhang et al., 2025; Liu et al., 2025) [32] [35] . These results are supported by the study's reported sensitivity and specificity, which further supports the TyG index's therapeutic utiliy.

CONCLUSION

According to the results of the current study:

1. This study showed that CAD are significantly associated with an elevated triglyceride–glucose index.
2. The TyG index may be a useful surrogate marker for identifying those at increased risk of sever CAD because its easy-to-use, cheap, and simple indicator that is obtained from standard laboratory measures.
3. Having an ideal cut-off value of 8.72 and an AUC of 0.829, the TyG index showed great discriminatory accuracy, making it a dependable tool for predicting significant CAD.

CONFLICT OF INTEREST

1. This study was conducted at two institutions only which may limit the generalizability of the findings to other populations or healthcare settings.
2. The relatively small number of participants may reduce the statistical power of the study and affect the accuracy of subgroup analyses.
3. Inclusion of patients undergoing coronary angiography may introduce selection bias, as these individuals may represent

patients with more symptomatic or advanced disease.

4. The study did not evaluate long-term cardiovascular outcomes, limiting assessment of the prognostic value of the TyG index over time.

RECOMMENDATION

anti-inflammatory

1. Adding the TyG index into regular cardiovascular risk assessment could help identify high-risk individuals earlier, enable prompt intervention, and possibly improve clinical results.
2. More extensive prospective and multicenter research is necessary to confirm our results, determine the ideal threshold values, and elucidate the function of the TyG index in clinical judgment and risk assessment.

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TABLES

Table 1. Demographic parameters comparison (Age , body mass index and gender distribution among studied cases)

Parameter		Group I (N = 40)	Group II (N = 40)	Group III (N = 40)	P value
Age (year)	Mean±SD	59.8 ± 9.1	60.7 ± 8	61.5 ± 7.9	*0.66
Gender	Male	27 (67.5 %)	24 (60%)	25 (62.5 %)	**0.77
	Female	13 (32.5%)	16 (40%)	15 (37.5%)	**0.78

Table 3. prediction of coronary artery disease using ordinal logestic regression.

predictors	Odds ratio	Confidence interval (CI) 95% Lower bound	Confidence interval (CI) 95% Upper bound	P value
TyG	1.36	1.24	1.49	< 0.001
Total cholesterol (mg / dl)	1.01	1.00	1.01	0.017
Triglyceride (mg / dl)	1.03	1.02	1.03	< 0.001
Age (year)	1.02	0.979	1.06	0.363

Table 2. The biochemical parameters in the studied groups

Parameter	Group I (N = 40) Mean ± SE	Group II (N = 40) Mean ± SE	Group III (N = 40) Mean ± SE	P value
Total Cholesterol (mg/dl)	115.2 ±4.05 a	144.9 ±6.89 b	223.4 ± 2.48 c	< 0.001
Triglyceride (mg/dl)	108.3 ± 5.39 a	198.7 ±4.35 b	204.9 ±11.10 b	< 0.0001
TyG	8.3 ±0.03 a	8.9 ±0.01 b	9.4 ± 0.05 c	< 0.001

Table 4. ROC Parameters for TyG Index.

Parameters	(AUC)	P-value	Cut off value	Sensitivity	Specificity	Youden's index	95% Confidence Interval	
							Lower bond	Upper bond
TyG	0.829	0.0001	8.72	70%	81%	0.518	0.803	0.854

FIGURES

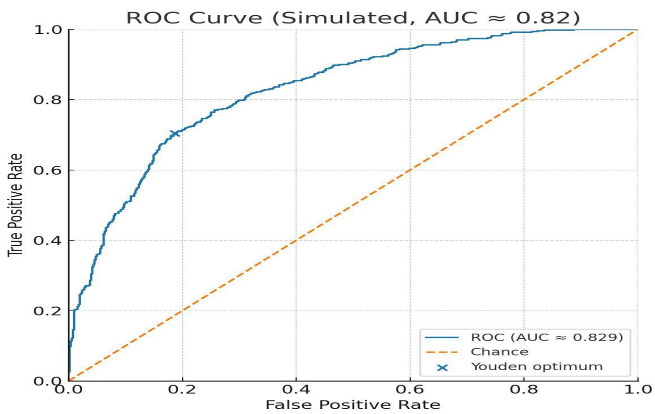

Figure 1. Receiver Operating Characteristic curve for TyG index