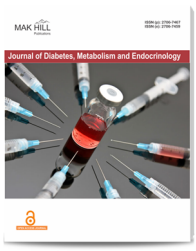
ISSN Print: 2708-2709
ISSN Online: 2708-2717

Journal of Diabetes, Metabolism and Endocrinology
https://jdmeonline.com/



Research Article

Correlation of TyG Index, TyG-BMI Index, TG/HDL-C ratio with Metabolic Syndrome

Narayana Swamy Y. N[1*], Mallikarjun[2] and Madhuvan H. S[3]

[1,2]Associate Professor, Department of General Medicine, Akash Institute of Medical Sciences and Research Centre (AIMSRC), Bengaluru, Karnataka, India

[3]Professor & Unit Head, Department of General Medicine, Akash Institute of Medical Sciences and Research Centre (AIMSRC), Bengaluru, Karnataka, India

***Corresponding Author**
Narayana Swamy Y. N

Article History
Received: 11.07.2026
Accepted: 21.08.2026
Published: 10.09.2026

doi: 10.61336/jdme.0703.08

Abstract: Background: Metabolic syndrome (MetS), associated with increased risk of cardiovascular diseases (CVDs), diabetes and non-alcoholic fatty liver disease (NAFLD). Insulin Resistance (IR) is a key component in the pathophysiology of many metabolic diseases, including MetS. The preset study was undertaken to assess and correlate TyG index, TyG-BMI index, TG/HDLC ratio with metabolic syndrome. **Materials and Methods:** A total of 260 subjects were involved in this study. They were categorized into 130 patients with metabolic syndrome as cases and 130 non- metabolic syndromes as controls. This prospective cross-sectional study was conducted at in Department of General Medicine, Akash Institute of Medical Sciences and Research Centre (AIMSRC), Bengaluru, Karnataka, India. A detailed physical, clinical examination was done for all the study participants. The BMI, waist circumference (WC) and blood pressure was measured. Five ml fasting blood samples were collected from all the study participants, transferred 2 ml into fluoride tube for glucose and 3 ml in plain tube. The samples were centrifuged at 3000rpm for five minutes to obtain plasma/serum. Obtained plasma/serum sample was used for estimation of glucose, total cholesterol, triglycerides, HDLC were estimated by using Biochemistry fully auto analyzer. LDLC, VLDLC, non-HDLC, TyG index, TyG-BMI and TG/HDLC were calculated. **Results:** In the present study, mean age 49.4±14.1 years, WC 125.2±12.1 cm, WHR 0.91±0.06 and BMI 30.1±3.5 kg/m2, SBP 138.6±15.2 mmHg, DBP 82.6±10.5 mmHg, serum glucose 116.9±19.2 mg/dl, cholesterol 199.4±30.8 mg/dl, triglycerides 187.7±40.4 mg/dl, LDLC 130.4±12.9 mg/dl, VLDLC 37.5±8.1 mg/dl, non-HDLC 167.9±21 mg/dl, TyG index 9.9±3.2, TyG-BMI index 129.1±13.6 and TG/HDLC 7.0±3.2 were significantly increased whereas HDLC 31.5±9.8 mg/dl was significantly decreased in patients with metabolic syndrome compared to non- metabolic syndrome subjects. In this, TyG index showed positive correlation with WC (r = 0.219), TGL (r = 0.621), SBP (r = 0.515), DBP (= 0.510) and glucose (r = 0.715) whereas HDLC (r = -0.694) showed negative correlation. TyG-BMI index showed positive correlation with WC (r = 0.225), TGL (r = 0.612), SBP (r = 0.532), DBP (r = 0.216) and glucose (r = 0.669) whereas HDLC (r = -0.668) showed negative correlation. Similarly, TG/HDLC also showed positive correlation with WC (r = 0.231), TGL (r = 0.662), SBP (r = 0.532), DBP (r = 0.419) and glucose (r = 0.649) whereas HDLC (r = -0.519) showed negative correlation. **Conclusion:** TyG index, TyG-BMI index and TG/HDLC showed significant positive correlation with all the metabolic syndrome parameters except HDLC.

Keywords: Metabolic Syndrome, Insulin Resistance, TyG Index, TyG-BMI Index

INTRODUCTION

Metabolic syndrome (MetS), characterized by the presence of any three of the following cardiometabolic risk factors: abdominal obesity, elevated fasting blood glucose levels, high Triglycerides (TG), low High-Density Lipoprotein (HDL) cholesterol and hypertension. MetS associated with the increased risk of (CVDs), diabetes and Non-Alcoholic Fatty Liver Disease (NAFLD). And also associated with 2 to 3-fold increased risk of ischemic heart disease and that of diabetes by 5-fold [1]. The global prevalence of MetS is increasing rapidly. It was reported that the MetS prevalence ranged between 12.5% and 31.4% based on the diagnostic criteria used [2]. In India, it was reported that one in three Indian adults suffers from MetS, making it a major health concern in the country [3].

It is well established that Insulin Resistance (IR) is a key component in the pathophysiology of many metabolic diseases, including T2DM, MetS and NAFLD. MetS induces a chronic low-grade inflammatory state, which results in adipose tissue inflammation, which finally causes individuals to develop cardiovascular diseases, arthritis and NAFLD. Even, it also disrupts the antioxidant systems by overloading Reactive Oxygen Species (ROS), causing DNA and protein modifications and lipid peroxidation. [4] Studies have reported that IR as the link between metabolic and hemodynamic abnormalities in individuals with MetS. IR plays a crucial role in the development of MetS and is one of its primary causes [5,6].

Given the importance of early diagnosis of MetS, various criteria and methods are used to assess an individual's condition. Identifying predictive parameters for the condition is essential for diagnosing and managing patients with MetS. The method for measuring IR and MetS is the hyperinsulinemic-euglycemic glucose clamp technique, which is an

invasive and time-consuming procedure. While it directly measures IR, its high cost limits its use in areas with high prevalence and among the general population [7]. The Homeostatic Model Assessment of Insulin Resistance (HOMA-IR) is another method for evaluating IR, using fasting glucose and insulin levels. Although accurate, its use is limited due to the lack of insulin availability in all laboratories and its high cost [8].

Therefore, there is a need to establish simple and convenient markers to assess the IR. Considering the challenges and difficulties associated with these tests, there is a need to find an alternative marker without the requirement for insulin has become increasingly important. In view of this, Simental-Mendia *et al*. in 2008 proposed Triglyceride Glucose (TyG) index as a noble biomarker to assess the IR and is calculated by the formula Ln [fasting triglyceride (mg/dL) × fasting glucose (mg/dL)/2] [9]. TyG index can accurately identify IR, which may be related to its integrated consideration of both blood glucose and lipid factors, making it a more comprehensive reflection of the metabolic status of the body [10]. A few studies have reported that, TyG index can predict IR better than the homeostatic model assessment of insulin resistance (HOMA-IR) [11,12]. Lopez-Jaramillo P *et al*. in 2022 reported a significant association of TyG index with future cardiovascular mortality, myocardial infarction (MI), stroke and T2DM [13].

Er LK *et al*. in 2016 proposed another noble biomarker to identify IR, that is triglyceride glucose-body mass index (TyG-BMI), calculated by using the formula: Ln [TG (mg/dL) ×FBG (mg/dl)/2] × BMI (kg/m2). TyG-BMI index, emerged as a valuable tool for evaluating insulin safety and resistance in individuals with MetS [14]. This index offers greater accessibility and cost-effectiveness when compared to other methods [15]. Recently, some scholars have proposed triglyceride glucose-body mass (TyG-BMI) index, which combines glucose metabolism indicators, lipid metabolism indicators and anthropometric indicators. After comparing traditional blood lipid parameters, glucose parameters and obesity related indicators, it was found that TyG-BMI has high diagnostic value in identifying IR. Increase in the TyG-BMI index is significantly linked to a higher risk of diabetes and suggests the presence of insulin resistance [16].

In addition to above, TG/HDL-C ratio has been strongly correlated with IR and central obesity, both of them being aspects of the MetS, which can enhance the risk of CVD [17]. Atherogenic dyslipidemia, characterized by increased triglycerides (TG), reduced high density lipoprotein cholesterol (HDL-C) and postprandial lipemia. In addition, Low Density Lipoprotein Cholesterol (LDL-C) is converted to small, dens LDL that is more atherogenic. The TG/HDL-C, known as atherogenic index of plasma, is one of the major risk factors for cardiovascular diseases and metabolic syndrome. Even, these increased triglycerides levels were associated with impaired glucose tolerance, fasting glucose and subsequent development of T2DM. HDL-C has been linked to cardioprotective effects via its antioxidant and anti-inflammatory properties [18].

However, a limited studies were conducted in relation with TyG index, TyG-BMI index, TG/HDLC ratio. Therefore, the preset study was undertaken to assess the TyG index, TyG-BMI index, TG/HDLC ratio in patients with metabolic syndrome and non-metabolic syndrome.

MATERIALS AND METHODS

Study Subjects

A total of 260 subjects were involved in this study. They were categorized into 130 patients with metabolic syndrome and 130 non- metabolic syndromes. This prospective cross-sectional study was conducted at in Department of General Medicine, Akash Institute of Medical Sciences and Research Centre (AIMSRC), Bengaluru, Karnataka, India. The study has been approved by the Institutional Ethics Committee (AIMSRC/IEC/97/2024-25) and informed consent was obtained from all the study participants.

Sample Size Calculation

The sample size was calculated by using the formula n = (Z21-α/2.P.Q/d2). Simple random sampling method was followed for recruiting the study subjects.

Inclusion Criteria

Subjects willing to participate in the study, individuals of both sexes aged >18 years, subjects with metabolic syndrome, non-metabolic syndrome, non-alcoholic patients, diabetes without comorbidities were included in the study.

Exclusion Criteria

Subjects not willing to participate in the study, patients with secondary obesity brought on by genetic diseases, congenital heart disease, endocrine abnormalities, patients with hypothyroidism, celiac disease, history of myocardial infarction, dermatomyositis etc. were excluded.

Anthropometric Measurements

Body weight and height were measured using a scale with stadiometer. The BMI was calculated as weight (kg)/height (m)2. Waist Circumference (WC) was measured at the midpoint between the last rib and the iliac crest and hip circumference (HC) was measured at the largest parts around the buttocks using a flexible tape measure. Systolic

(SBP) and Diastolic Blood Pressure (DBP) was measured by using sphygmomanometer using appropriated sized cuffs. A detailed physical, clinical examination was done for all the study participants. Demographic details and other details of all the participants were recorded.

Sample Collection and Estimation of Biochemical Parameters

Five mL fasting blood samples were collected from all the study participants, transferred 2 ml into fluoride tube and 3 mL in plain tube. The samples were centrifuged at 3000rpm for five minutes to obtain plasma/serum. Obtained plasma/serum sample was used for estimation of glucose (GOD-POD) total cholesterol (cholesterol oxidase/peroxidase), triglycerides (glycerol phosphate oxidase/peroxidase), HDLC (HDLC- Direct) were estimated by using Biochemistry fully auto analyzer. LDLC, VLDLC and non-HDLC were calculated.

Indexes

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

$$\text{TyG-BMI} = \text{TyG index} \times \text{BMI}$$

$$\text{TG/HDL} = \text{TG (mg/dL)}/\text{HDL-C (mg/dL)}$$

Diagnosis of Metabolic Syndrome

The diagnosis of metabolic syndrome was made based on the IDF criteria [19], adult patients with obesity were identified as having metabolic syndrome if they had three or more of the following altered factors:

- Abdominal obesity (WC ≥ 102 cm for males; ≥88 cm for females)
- **Elevated triglycerides:** ≥150 mg/dL (1.7 mmol/L) or specific treatment for this
- Lipid abnormality
- **Reduced HDL-C:** <40 mg/dL (1.0 mmol/L) in males; <50 mg/dL (1.3 mmol/L) in females, or specific treatment for this lipid abnormality
- **Increased BP:** SBP ≥ 130 mmHg or DBP ≥ 85 mmHg and/or the treatment of previously diagnosed hypertension
- An increased fasting plasma glucose (FPG) concentration ≥100 mg/dL (5.6 mmol/L)
- or previously diagnosed type 2 diabetes mellitus

Statistical Analysis

Continuous variables were expressed as mean±standard deviation and categorical variables as numbers and percentage. The Mann Whitney U test was applied. Spearman's rho correlation was applied to correlate TyG index, TyG-BMI index and TG/HDLC ratio with metabolic syndrome parameters. The p value ($p < 0.05$) was considered as statistically significant. Data was analysed by using SPSS 22.0.

RESULTS

In the present study, mean age 49.4±14.1 years, WC 125.2±12.1 cm, WHR 0.91±0.06 and BMI 30.1±3.5 kg/m2 were significantly increased in patients with metabolic syndrome compared to non-metabolic syndrome subjects as shown in Table 1.

In this study, mean SBP 138.6±15.2 mmHg, DBP 82.6±10.5 mmHg, serum glucose 116.9±19.2 mg/dl, cholesterol 199.4±30.8 mg/dl, triglycerides 187.7±40.4 mg/dl, LDLC 130.4±12.9 mg/dl, VLDLC 37.5±8.1 mg/dl, non-HDLC 167.9±21 mg/dl, TyG index 9.9±3.2, TyG-BMI index 129.1±13.6 and TG/HDLC 7.0±3.2 were significantly increased whereas HDLC 31.5±9.8 mg/dl was significantly decreased in patients with metabolic syndrome compared to non-metabolic syndrome subjects as shown in Table 2.

Table 1: Comparison of Demographic and Anthropometric Parameters Among of Study Subjects

Parameters	MetS cases, (n = 130) Mean±SD	Non-MetS, (n = 130) Mean±SD	p-value
Demographic			
Age (Years)	49.4±14.1	45.4±11.6	<0.001
Male (n, %)	80 (61.5%)	75 (57.7%)	-
Female (n, %)	50 (38.5%)	55 (42.3%)	-
Anthropometric parameters			
WC (cm)	125.2±12.1	110.5±10.1	<0.001
HC (cm)	132.4±10.4	130.8±13.5	0.081
WHR	0.91±0.06	0.61±0.45	<0.001
BMI (kg/m^2)	30.1±3.5	23.8±2.4	<0.001

* p-value<0.05 is considered as statistically significant

Table 2: Comparison of Clinical and Laboratory Parameters Among of Study Subjects

Parameters	MetS cases, (n = 120) Mean±SD	Non-MetS, (n = 120) Mean±SD	p-value
SBP (mmHg)	138.6±15.2	112.5±10.3	<0.001
DBP (mmHg)	82.6±10.5	76.5±8.3	<0.001
Serum glucose (mg/dl)	116.9±19.2	82.6±15.7	<0.001
Total Cholesterol (mg/dl)	199.4±30.8	146.4±24.4	<0.001
Triglycerides (mg/dl)	187.7±40.4	115.8±28.2	<0.001
HDLC (mg/dl)	31.5±9.8	49.5±11.8	<0.001
LDLC (mg/dl)	130.4±12.9	73.3±7.1	<0.001
VLDL (mg/dl)	37.5±8.1	23.2±5.6	<0.001
Non-HDLC (mg/dl)	167.9±21	96.9±12.6	<0.001
Markers of insulin resistance			
TyG index	9.9±3.2	5.4±2.4	<0.001
TyG-BMI index	129.1±13.6	106.6±5.6	<0.001
TG/HDLC	7.0±3.2	2.3±1.1	<0.001

* p-value<0.05 is considered as statistically significant

Table 3: Correlation of TyG Index, TyG-BMI, TG/HDLC with Metabolic Syndrome Parameters

Parameters		WC	TGL	HDLC	SBP	DBP	Glucose
TyG index	r-value	0.219*	0.621**	-0.694**	0.519**	0.510**	0.715**
	p-value	0.031	0.000	0.000	0.000	0.000	0.000
TyG-BMI index	r-value	0.225*	0.612**	-0.668**	0.532**	0.216*	0.669**
	p-value	0.000	0.000	0.000	0.000	0.045	0.000
TG/HDLC	r-value	0.231*	0.662**	-0.519**	0.532**	0.419**	0.649**
	p-value	0.045	0.000	0.000	0.000	0.000	0.000

**: Correlation is significant at the 0.01 level (2-tailed), *: Correlation is significant at the 0.05 level (2-tailed)

In the present study, TyG index, TyG-BMI index and TG/HDLC showed significant positive correlation with metabolic syndrome parameters. TyG index showed positive correlation with WC (r = 0.219), TGL (r = 0.621), SBP (r = 0.515), DBP (= 0.510) and glucose (r = 0.715) whereas HDLC (r = -0.694) showed negative correlation. TyG-BMI index showed positive correlation with WC (r = 0.225), TGL (r = 0.612), SBP (r = 0.532), DBP (r = 0.216) and glucose (r = 0.669) whereas HDLC (r = -0.668) showed negative corelation. Similarly, TG/HDLC also showed positive correlation with WC (r = 0.231), TGL (r = 0.662), SBP (r = 0.532), DBP (r = 0.419) and glucose (r = 0.649) whereas HDLC (r = -0.519) showed negative correlation as shown in Table 3.

DISCUSSION

MetS, represents a cluster of interrelated physiological, clinical and metabolic abnormalities that synergistically increase the risk of cardiovascular disease (CVD), Type 2 Diabetes Mellitus (T2DM) and premature mortality. It is generally characterized by the presence of central obesity, dyslipidemia, hypertension and IR. Therefore, early identification could allow for proper nutritional or pharmacological treatments, which are crucial in preventing the occurrence of cardiovascular diseases and mortality associated with the progression of those conditions [20].

For these reasons, the preset study was designed to assess the Cardiometabolic Index (CMI), Lipid Accumulation Product (LAP) index in patients with metabolic syndrome. In the present study, mean age, WC, WHR and BMI were significantly increased in patients with metabolic syndrome. Concerned with clinical and biochemical parameters, mean SBP, DBP, serum glucose, cholesterol, triglycerides, LDLC, VLDLC, non-HDLC, TyG index, TyG-BMI index and TG/HDLC were significantly increased whereas HDLC was significantly decreased in patients with metabolic syndrome compared to non- metabolic syndrome subjects.

The association of the increased of triglycerides and glucose levels in IR is the basis for the use of both (indicated in the TyG index) to assess various abnormalities related to insulin sensitivity disorders. Among patients with IR, blood insulin production in normal amounts cannot optimally trigger the transfer of glucose from within the blood to peripheral tissues, including muscle and fat tissues, so blood glucose levels tend to rise. To maintain normal blood glucose levels, more insulin production is needed due to IR [21,22].

In a study conducted by Min-Su Park. reported that the TyG index is a highly effective and robust tool for identifying individuals at risk for MetS, demonstrating superior sensitivity and predictive accuracy over HOMA-IR [23]. Another study by Afshar M *et al*. reported that TyG index combined with anthropometric measures is more effective for diagnosis of MetS in the overall and male populations, while the TyG index alone is more valuable for females [24]. Yet, another study by Gounden, V *et al*. in 2024 reported that the use of the TyG index as a valid biomarker to assess the risk of developing MetS, T2DM, as well as atherosclerotic cardiovascular disease.[25]. Another study by Li X *et al*. in 2024 reported that TyG index is positively associated with albuminuria and CKD in patients with T2DM and may be a marker for predicting the occurrence of early kidney injury in patients with T2DM [26].

The increased TyG-BMI index among individuals with metabolic syndrome showed positive correlation with WC, can be linked to the substantial amounts of fat found in adipose tissue, particularly in the abdominal region. The fat accumulation serves as an independent contributor to the onset of IR and the metabolic alterations that are associated with risks for CVDs and diabetes. [27,28] In support of this findings, a study conducted by Moulavi P *et al*. reported a significant correlation was identified between the TyG-BMI index and the PRAL index (β = 0.094, p-value = 0.026), WC (β = 0.627, p-value<0.001), BAI (β = 0.396, p-value<0.001) and blood pressure (β = 0.063, p-value = 0.002). Furthermore, the findings indicated a notable association between the GI and blood pressure (β = 0.610, p-value<0.001). The results of this study suggest that managing the PRAL index, body weight and blood pressure may be associated with an enhanced status of TyG-BMI. Additionally, appropriate GI may be linked to regulated blood pressure [29]. A similar study by Guan M *et al*. reported that TyG-BMI was positively association with IR (OR: 2.747, 95% CI: 1.942–3.887) and MetS (OR: 4.176, 95% CI: 2.278–7.653). TyG-BMI had a strong predictive performance, with AUCIR of 0.841 and AUC MetS of 0.899. They concluded that Elevated TyG-BMI is strongly associated with worsened IR and MetS in PCOS women [30]. Another study by Huang N *et al*. in 2024 reported that TyG-BMI is increased in T2DM patients and associated with kidney impairment in these patients, suggested that TyG-BMI may serve as a novel parameter of IR [31]. Li W *et al*. in a cohort study demonstrated a positive linear association between TyG-BMI index and increased CVD incidence in a population with CKM syndrome stage 0-3. This finding suggests that enhanced assessment of TyG-BMI index may provide a more convenient and effective tool for individuals at risk for CVD in CKM syndrome stage 0-3 [32].

In addition, TG/HDL-C ratio reported to be an indicator of IR, one of the main risk factors for development of diabetes mellitus [33]. Glucose metabolism is closely associated with metabolism of lipids. The lipid ratios are well established and are better predictors of coronary artery disease (CAD), reflecting the interaction between atherogenic and anti-atherogenic fractions [34]. Among the lipid ratios, the TG/HDL-C ratio is closely associated with IR, atherogenesis, evidence of denser and atherogenic LDL particles, arterial stiffness and acute cardiovascular event in diabetic patients, serves as an important cardiovascular risk predictor [35]. The possible underlying mechanism for the association of TG/HDL-C with IR: the pathophysiology of IR reveals that one of the physiological functions of insulin is to inhibit the release of free fatty acids from adipose tissue and promote the storage of triglycerides in adipocytes. However, in IR, this regulatory mechanism is impaired. Firstly, an increased rate of unchecked lipolysis leads to an accelerated release of Free Fatty Acids (FFAs) into the bloodstream [36]. Consequently, the liver, inundated with excess FFAs, increases triglyceride production, packaging them into very low-density lipoprotein (VLDL) particles, resulting in hypertriglyceridemia. On the other hand, IR also augments the catabolism of HDL particles, partly due to the heightened activity of hepatic lipase, an enzyme that hydrolyses HDL triglycerides and phospholipids, leading to smaller and less stable HDL particles that are more rapidly cleared from circulation. Additionally, IR impairs the synthesis of apolipoprotein A-I (ApoA-I), a primary structural protein of HDL. Finally, IR alters the structural characteristics of HDL, making it more prone to oxidative stress, negatively affecting its protective properties [3,4,6]. The resulting lipid profile, characterized by elevated triglycerides and reduced HDL cholesterol, can be succinctly represented by the TG/HDL ratio [37]. Therefore, the combination of increased triglycerides and reduced HDL-C, known as atherogenic dyslipidemia. Hence, the TG/HDL-C ratio was considered a potential predictive marker of IR and β-cell dysfunction. It is closely associated with T2DM as well as CVD development [38].

In accordance to our study findings, a study conducted by Ebrahimi A *et al*. reported that TG/HDL-C ratio demonstrated strong predictive power for MetS, with AUC values of 0.828 for men and 0.832 for women. Sex-specific optimal cutoffs were identified at 3.42 (men) and 2.80 (women), with high sensitivity (83.6 % and 72.2 %) and specificity (69.0 % and 80.9 %). Logistic regression revealed a significant association between the TG/HDL-C ratio and MetS risk, with adjusted odds ratios of 1.49 (men) and 3.02 (women) per unit increase. They concluded that TG/HDL-C ratio is a robust and cost-effective biomarker for predicting MetS, particularly in resource-limited settings [39]. In a study by Nie G *et al*. reported a significant positive correlation of TG/HDL-C ratio with metabolic syndrome (r = 0.420, p<0.001) in the elderly Chinese population. Binary logistic regression analysis showed that the TG/HDL-C ratio was an independent risk factor for metabolic syndrome (OR = 3.07 (95% CI: 2.402 to 3.924), p<0.001) after adjusting for blood pressure, blood glucose, age, sex and BMI. The receiver operating characteristic curves of TG/HDL-C ratio and metabolic syndrome showed that in the elderly population, a TG/HDL-C ratio of 1.49 can be used as the critical value for a higher risk of metabolic syndrome. At this value, the specificity and sensitivity of the measure were optimal (80.8% and 72.4%, respectively). They concluded that a significant correlation between TG/HDL-C ratio and metabolic syndrome. And high TG/HDL ratio suggests a higher risk of metabolic syndrome among an elderly Chinese population [40].

CONCLUSION

The present study may conclude that significant increase in mean age, WC, WHR and BMI, SBP, DBP, serum glucose, cholesterol, triglycerides, LDLC, VLDLC, CMI and LAP index whereas HDLC showed significant decrease in patients with metabolic syndrome. TyG index, TyG-BMI index and TG/HDLC showed significant positive correlation with all the metabolic syndrome parameters except HDLC. Further studies with large sample size are recommended.

Acknowledgements
We would like to thank the authorities of Akash Institute of Medical Sciences and Research Centre (AIMSRC), Bengaluru, Karnataka, India.

REFERENCES

1. Neeland, I.J. *et al*. "Metabolic syndrome." *Nature Reviews Disease Primers*, vol. 10, 2024, pp. 1–22.
2. Noubiap, J.J. *et al*. "Geographic distribution of metabolic syndrome and its components in the general adult population: A meta-analysis of global data from 28 million individuals." *Diabetes Research and Clinical Practice*, vol. 188, 2022, pp. 109924.
3. Krishnamoorthy, Y. *et al*. "Prevalence of metabolic syndrome among adult population in India: A systematic review and meta-analysis." *PLoS One*, vol. 15, 2020, pp. e0240971.
4. Santos-Moreno, P. *et al*. "Metabolic abnormalities, cardiovascular disease and metabolic syndrome in adult rheumatoid arthritis patients: Current perspectives and clinical implications." *Open Access Rheumatology*, vol. 14, 2022, pp. 255–267.
5. Alberti, K.G.M.M. *et al*. "Harmonizing the metabolic syndrome." *Circulation*, vol. 120, no. 16, 2009, pp. 1640–1645.
6. Kang, S.W. *et al*. "Risk prediction of the metabolic syndrome using TyG index and SNPs: A 10-Year longitudinal prospective cohort study." *Molecular and Cellular Biochemistry*, vol. 478, no. 1, 2023, pp. 39–45.
7. DeFronzo, R.A., J.D. Tobin and R. Andres. "Glucose clamp technique: A method for quantifying insulin secretion and resistance." *American Journal of Physiology*, vol. 237, 1979, pp. E214–E223.
8. Aslan Çin, N.N. *et al*. "Triglycerides/high-density lipoprotein cholesterol is a predictor similar to the triglyceride–glucose index for the diagnosis of metabolic syndrome using international diabetes federation criteria of insulin resistance in obese adolescents: A cross-sectional study." *Journal of Pediatric Endocrinology and Metabolism*, vol. 33, no. 6, 2020, pp. 777–784.
9. Simental-Mendía, L.E., M. Rodríguez-Morán and F. Guerrero-Romero. "The product of fasting glucose and triglycerides as surrogate for identifying insulin resistance in apparently healthy subjects." *Metabolic Syndrome and Related Disorders*, vol. 6, no. 4, 2008, pp. 299–304.
10. Pan, Y. *et al*. "Role of Triglyceride-glucose index in type 2 diabetes mellitus and its complications." *Diabetes, Metabolic Syndrome and Obesity*, vol. 17, 2024, pp. 3325–3333.
11. Toro-Huamanchumo, C.J. *et al*. "Triglycerides and glucose index as an insulin resistance marker in a sample of healthy adults." *Diabetes & Metabolic Syndrome*, vol. 13, no. 1, 2019, pp. 272–277.
12. Yu, X. *et al*. "Fasting triglycerides and glucose index is more suitable for the identification of metabolically unhealthy individuals in the Chinese adult population: A nationwide study." *Journal of Diabetes Investigation*, vol. 10, no. 4, 2019, pp. 1050–1058.
13. Lopez-Jaramillo, P. *et al*. "Association of the triglyceride glucose index as a measure of insulin resistance with mortality and cardiovascular disease in populations from five continents (pure study): A prospective cohort study." *Lancet Healthy Longevity*, vol. 4, no. 1, 2023, pp. e23–e33.
14. Er, L.K. *et al*. "Triglyceride glucose-body mass index is a simple and clinically useful surrogate marker for insulin resistance in nondiabetic individuals." *PLoS One*, vol. 11, no. 3, 2016, pp. e0149731.
15. Pacini, G. and A. Mari. "Methods for clinical assessment of insulin sensitivity and β-cell function." *Best Practice & Research Clinical Endocrinology & Metabolism*, vol. 17, 2003, pp. 305–322.
16. Yan, S., D. Wang and Y. Jia. "Comparison of insulin resistance-associated parameters in us adults: A cross-sectional study." *Hormones*, vol. 22, no. 2, pp. 331–341.
17. Nosrati, M. *et al*. "The atherogenic index log (Triglyceride/HDL-Cholesterol) as a biomarker to identify type 2 diabetes patients with poor glycemic control." *International Journal of Preventive Medicine*, vol. 12, 2021, pp. 160.
18. Babic, N. *et al*. "The Triglyceride/HDL ratio and triglyceride glucose index as predictors of glycemic control in patients with diabetes mellitus type 2." *Medical Archives*, vol. 73, no. 3, 2019, pp. 163–168.
19. Alberti, K.G.M.M. *et al*. "Harmonizing the metabolic syndrome: A joint interim statement of the international diabetes federation task force on epidemiology and prevention; national heart, lung and blood institute; American heart association; world heart federation; international atherosclerosis society; and international association for the study of obesity." *Circulation*, vol. 120, 2009, pp. 1640–1645.
20. Pokharel, D.R. *et al*. "Diagnostic potential of waist–triglyceride index, triglyceride-glucose index and related indices for the detection of metabolic syndrome in Nepali adults: A cross-sectional study." *Human Nutrition & Metabolism*, vol. 41, 2025, pp. 200324.
21. Li, M. *et al*. "Trends in insulin resistance: Insights into mechanism and therapeutic strategy." *Signal Transduction and Targeted Therapy*, vol. 7, 2022, pp. 216.
22. Petersen, M.C. and G.I. Shulman. "Mechanism of insulin action and insulin resistance." *Physiological Reviews*, vol. 98, 2018, pp. 2133–2223.

23. Park, Min-Su. "Triglyceride-glucose index predicts future metabolic syndrome in an adult population, Korea: A prospective cohort study." *Annals of Clinical Nutrition and Metabolism*, vol. 16, 2024, pp. 168–172.
24. Afshar, M. *et al*. "Diagnostic performance of the TyG index in detecting metabolic syndrome: A cross-sectional study from western Iran." *The Open Public Health Journal,* vol. 18, 2025, pp. 1–11.
25. Gounden, V. *et al*. "The role of the triglyceride-glucose index as a biomarker of cardio-metabolic syndromes." *Lipids in Health and Disease,* vol. 23, no. 1, 2024, pp. 416.
26. Li, X. and Y. Wang. "Associations of the TyG index with albuminuria and chronic kidney disease in patients with type 2 diabetes." *PLoS One*, vol. 19, no. 10, 2024, pp. e0312374.
27. Miyazaki, Y. *et al*. "Abdominal Fat Distribution and Peripheral and Hepatic Insulin Resistance in Type 2 Diabetes Mellitus." American Journal of Physiology-Endocrinology and Metabolism, vol. 283, 2002, pp. E1135–E1143.
28. Wagenknecht, L.E. *et al*. "Insulin sensitivity, insulin secretion and abdominal fat: The insulin resistance atherosclerosis study (IRAS) family study." *Diabetes,* vol. 52, 2003, pp. 2490–2496.
29. Moulavi, P. *et al*. "Relationship between TyG-BMI index and glycemic index with diet quality, anthropometric indices and blood pressure in patients with metabolic syndrome." *Medicine,* vol. 104, 2025, pp. 3.
30. Guan, M. *et al*. "Triglyceride glucose index-body mass index predicts insulin resistance, metabolic syndrome and associates with impaired ovulation in chinese women with polycystic ovary syndrome." *Frontiers in Endocrinology*, vol. 16, 2025, pp. 1653636.
31. Huang, N. *et al*. "The association between triglyceride glucose-body mass index and kidney impairment in patients with type 2 diabetes mellitus." *Diabetes, Metabolic Syndrome and Obesity*, vol. 17, 2024, pp. 3447–3453.
32. Li, W. *et al*. "Association between the triglyceride glucose-body mass index and future cardiovascular disease risk in a population with cardiovascular-kidney-metabolic syndrome stage 0–3: A nationwide prospective cohort study." *Cardiovascular Diabetology,* vol. 23, 2024, pp. 292.
33. Zheng, D. *et al*. "Association between the triglyceride to high-density lipoprotein cholesterol ratio and the risk of type 2 diabetes mellitus among Chinese elderly: The Beijing longitudinal study of aging." *BMJ Open Diabetes Research & Care*, vol. 8, no. 1, 2020, pp. e000811.
34. Kalra, S. and N. Raizada. "Dyslipidemia in diabetes." *Indian Heart Journal*, vol. 76, suppl. 1, 2024, pp. S80–S82.
35. Baez-Duarte, B.G. *et al*. "Triglyceride/high-density lipoprotein cholesterol (TG/HDL-C) index as a reference criterion of risk for metabolic syndrome (MetS) and low insulin sensitivity in apparently healthy subjects." *Gaceta Médica de México*, vol. 153, no. 2, 2017, pp. 152–158.
36. Colantoni, A. *et al*. "Lipid-based insulin-resistance markers predict cardiovascular events in metabolic dysfunction-associated steatotic liver disease." *Cardiovascular Diabetology,* vol. 23, 2024, pp. 175.
37. Baneu, P. *et al*. "The triglyceride/HDL ratio as a surrogate biomarker for insulin resistance." *Biomedicines*, vol. 12, 2024, pp. 1493.
38. Kannel, W.B. *et al*. "Usefulness of the triglyceride-high-density lipoprotein versus the cholesterol-high-density lipoprotein ratio for predicting insulin resistance and cardiometabolic risk (from the framingham offspring cohort)." *American Journal of Cardiology*, vol. 101, no. 4, 2008, pp. 497–501.
39. Ebrahimi, A. *et al*. "The predictive value of the TG/HDL index for metabolic syndrome and its components: A cross-sectional study in the PERSIAN Guilan cohort population." *Endocrine and Metabolic Science*, vol. 19, 2025, p. 100269.
40. Nie, G. *et al*. "High TG/HDL ratio suggests a higher risk of metabolic syndrome among an elderly chinese population: A cross-sectional study." *BMJ Open*, vol. 11, 2021, pp. e041519.