RESEARCH PAPER

Lipid Accumulation Product Index and Triglyceride-Glucose Index as Predictors of Metabolic Syndrome in Young Adults: A Cross-Sectional Study

Manmohan Kumar Dumpa[1], Sibi Chakravarthy[1], Josephraj G[3], Suresh K[1]*, Ponnambalam A[1]

[1]Department of General Medicine, Sri Venkateshwaraa Medical College Hospital and Research Centre, Ariyur, Puducherry, India
[2]Cardiothoracic Surgeon, Medical Superintendent, Cardiothoracic Surgeon, Sri Venkateshwaraa Medical College Hospital and Research Centre, Ariyur, Puducherry, India
Corresponding author: Suresh K, sureshsuchu06@yahoo.co.in

ABSTRACT

Background: Metabolic syndrome (MetS) is a cluster of interrelated metabolic abnormalities comprising central obesity, insulin resistance, dyslipidaemia, hypertension, and impaired fasting glucose, collectively increasing the risk of type 2 diabetes mellitus, cardiovascular disease, and cerebrovascular disease. The Lipid Accumulation Product (LAP) index and the Triglyceride-Glucose (TyG) index have been proposed as simple, inexpensive surrogate markers of visceral adiposity and insulin resistance, respectively. However, head-to-head comparative data in Indian young adults are limited.

Objectives: To evaluate and compare the diagnostic accuracy of the LAP index and the TyG index in predicting metabolic syndrome among young adults aged 20-40 years, and to correlate both indices with individual components of metabolic syndrome.

Methods: This cross-sectional study enrolled 189 participants aged 20-40 years at SVMCH & RC, Puducherry from December 2025 to March 2026. Metabolic syndrome was defined per NCEP ATP III criteria with Asian waist circumference cut-offs. The LAP index was calculated as sex-specific formulae using waist circumference and serum triglycerides. The TyG index was calculated as Ln (fasting TG [mg/dL] x fasting glucose [mg/dL] / 2). ROC analysis was performed to derive optimal cut-off values.

Results: The overall prevalence of metabolic syndrome was 27.5% (n=52). Both LAP (56.8 ± 12.5 vs. 28.4 ± 10.2, $p<0.001$) and TyG (9.1 ± 0.6 vs. 8.2 ± 0.5, $p<0.001$) indices were significantly elevated in the MetS group. ROC analysis revealed an AUC of 0.91 for the LAP index (sensitivity 85%, specificity 83%, cut-off 45.5) and 0.88 for the TyG index (sensitivity 82%, specificity 79%, cut-off 8.6). The LAP index showed stronger correlation with waist circumference ($r=0.72$) and triglycerides ($r=0.81$), while the TyG index correlated more strongly with fasting glucose ($r=0.82$).

Conclusion: Both the LAP index and the TyG index are reliable, cost-effective surrogate tools for early identification of metabolic syndrome in young adults. The LAP index demonstrated marginally superior overall diagnostic accuracy. These indices merit integration into routine clinical practice for early metabolic risk stratification.

Keywords: Lipid accumulation product index, triglyceride-glucose index, metabolic syndrome, young adults, insulin resistance, visceral adiposity, ROC analysis

How to cite this article: Dumpa MK, Chakravarthy S, Josephraj G, Suresh K, Ponnambalam A. Lipid accumulation product index and triglyceride-glucose index as predictors of metabolic syndrome in young adults: a cross-sectional study. Int J Drug Deliv Technol. 2026;16(73s): 327-332. DOI: 10.25258/ijddt.16.73s.35

INTRODUCTION

Metabolic syndrome (MetS) is defined as a cluster of interrelated metabolic abnormalities that include central (abdominal) obesity, insulin resistance, dyslipidaemia (elevated triglycerides and/or low HDL cholesterol), hypertension, and impaired glucose regulation, which together markedly increase the risk of type 2 diabetes mellitus, cardiovascular disease, and cerebrovascular disease. Its global prevalence has risen substantially over recent decades, with estimates in the Asia-Pacific region ranging from 12% to over 37% depending on the diagnostic criteria and population studied. [1,2]

Urban young adults in India bear a disproportionately high burden of metabolic risk as a result of fast socioeconomic changes, increasingly sedentary lifestyles, calorie-dense eating habits, and a genetic tendency for central adiposity at a lower BMI. MetS prevalence in specific Indian urban cohorts has been reported to range from 19.5% to over 40% in a number of cross-sectional surveys. [3,4]

The Lipid Accumulation Product (LAP) index, calculated from waist circumference and fasting triglyceride levels, is a validated surrogate marker of visceral lipid accumulation and an effective predictor of metabolic syndrome. [5,6] The Triglyceride-Glucose (TyG) index, calculated from the natural logarithm of the product of fasting triglycerides and fasting glucose, has been proposed as a robust surrogate measure of insulin resistance. Both indices are calculable from routinely available parameters and have demonstrated excellent diagnostic performance in several international studies. [7,8]

Despite accumulating evidence in other ethnic groups, comparative data from Indian young adult populations remain sparse. The present cross-sectional study was therefore designed to evaluate and compare the diagnostic accuracy of the LAP index and the TyG index for the detection of metabolic syndrome

in young Indian adults, and to characterize their correlations with individual components of the metabolic syndrome.

MATERIALS AND METHODS

Study Design and Setting: This was an observational, cross-sectional study conducted in the Department of General Medicine at a tertiary care hospital in Puducherry from December 2025 to March 2026. The study was approved by the Institutional Scientific Review Committee (Ref: SVMC/SRC/2026/01/CTR1322) and the Institutional Ethics Committee.

Participants: A total of 189 adults aged 20-40 years were enrolled after written informed consent. Sample size was calculated based on the TyG index sensitivity of 82% and specificity of 79%, 95% confidence level, and absolute precision of 10%.

Inclusion Criteria: Adults aged 20-40 years attending OPD/IPD/health check-up clinic with complete clinical and biochemical data including waist circumference, serum triglycerides, fasting plasma glucose, HDL cholesterol, and blood pressure.

Exclusion Criteria: Participants with established cardiovascular disease, chronic liver/kidney disease, thyroid disorders, familial hyperlipidaemia, pregnancy, and those on medications significantly altering lipid metabolism were excluded.

Biochemical Analysis: Following an overnight fast, 3 mL of venous blood was collected. Serum triglycerides, fasting blood glucose, and HDL cholesterol were measured using an automated chemistry analyzer (Siemens Dimension EXL 200) with standard commercial kits.

Diagnosis of Metabolic Syndrome: Metabolic syndrome was diagnosed per NCEP ATP III criteria with Asian-specific waist circumference cut-offs (>102 cm men, >88 cm women), triglycerides >= 150 mg/dL, HDL <40/<50 mg/dL (men/women), BP >= 130/85 mmHg, and fasting glucose >= 110 mg/dL. Any three of five criteria constituted a diagnosis.

Index Calculations: LAP index: Men: (WC [cm] - 65) x TG (mmol/L); Women: (WC [cm] - 58) x TG (mmol/L). TyG index: Ln (Fasting TG [mg/dL] x Fasting glucose [mg/dL]/2).

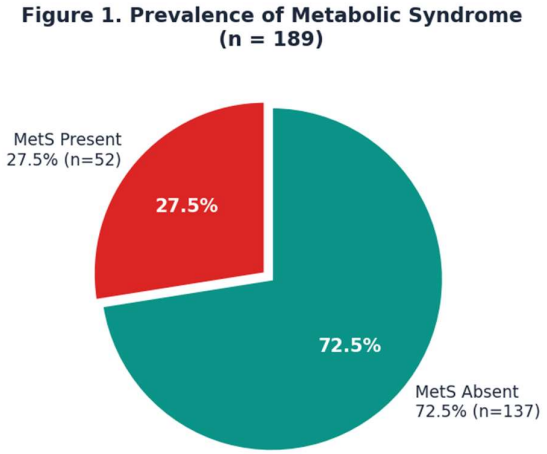
Statistical Analysis: Data were analyzed using SPSS 23.0. Continuous variables were compared using independent-samples t-test. Pearson correlation assessed associations between indices and MetS components. ROC analysis evaluated diagnostic performance. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 189 participants were enrolled. The overall prevalence of metabolic syndrome was 27.5% (n=52), with 137 (72.5%) classified as non-MetS. This prevalence is consistent with previously reported estimates of 19.5%-34.6% in similar young adult Indian populations [3,9]. (Table 1, Figure 1)

Table 1. Distribution of Study Population by Metabolic Syndrome Status

Variable	Number (n=189)	Percentage (%)
Metabolic Syndrome Present	52	27.5%
Metabolic Syndrome Absent	137	72.5%



The mean age was 29.4 ± 5.6 years with near-equal gender distribution: 92 males (48.7%) and 97 females (51.3%) (Table 2).

Table 2. Age and Gender Distribution of Study Participants

Variable	Mean ± SD / n (%)
Age (years)	29.4 ± 5.6
Male	92 (48.7%)
Female	97 (51.3%)

Participants with MetS exhibited significantly higher waist circumference (102 ± 8 vs. 84 ± 7 cm) and blood pressure values compared with the non-MetS group (all p<0.001) (Table 3, Figure 2).

Table 3. Comparison of Clinical Parameters between MetS and Non-MetS Groups

Parameter	MetS (Mean ± SD)	Non-MetS (Mean ± SD)	p-value
Waist Circumference (cm)	102 ± 8	84 ± 7	<0.001
Systolic BP (mmHg)	136 ± 10	118 ± 8	<0.001
Diastolic BP (mmHg)	88 ± 6	76 ± 5	<0.001

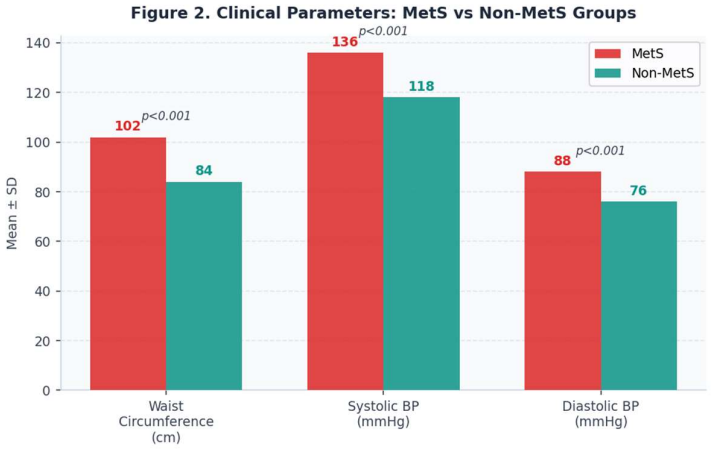


Figure 2: Comparison of clinical parameters between MetS and non-MetS groups (p<0.001 for all)

Statistically significant differences were observed in all biochemical parameters. The MetS group demonstrated elevated fasting glucose, elevated triglycerides, and reduced HDL cholesterol compared with the non-MetS group (all p<0.001) (Table 4, Figure 3).

Table 4. Comparison of Biochemical Parameters between MetS and Non-MetS Groups

Parameter	MetS (Mean ± SD)	Non-MetS (Mean ± SD)	p-value
Fasting Glucose (mg/dL)	122 ± 18	92 ± 12	<0.001
Triglycerides (mg/dL)	182 ± 35	118 ± 28	<0.001
HDL Cholesterol (mg/dL)	38 ± 6	48 ± 7	<0.001

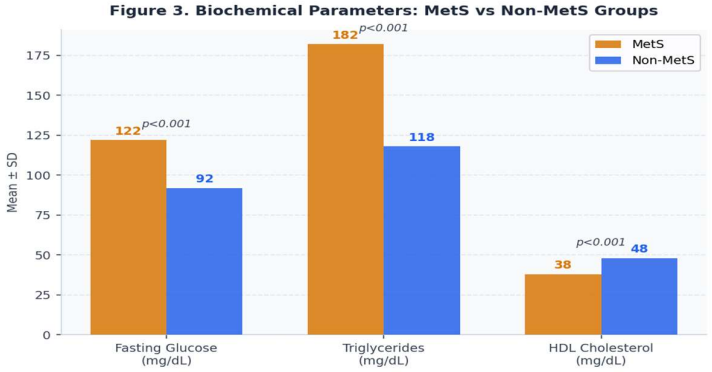


Figure 3: Comparison of biochemical parameters between MetS and non-MetS groups (p<0.001 for all)

The mean LAP index was significantly higher in the MetS group (56.8 ± 12.5 vs.[28].4 ± 10.2, p<0.001), demonstrating the strong association between visceral lipid accumulation and metabolic syndrome (Table 5).

Table 5. Comparison of LAP Index between MetS and Non-MetS Groups

Group	Mean ± SD	p-value
MetS	56.8 ± 12.5	<0.001
Non-MetS	28.4 ± 10.2	—

The TyG index was significantly elevated in the MetS group (9.1 ± 0.6 vs.[8].2 ± 0.5, p<0.001), supporting its utility as a surrogate marker of insulin resistance (Table 6).

Table 6. Comparison of TyG Index between MetS and Non-MetS Groups

Group	Mean ± SD	p-value
MetS	9.1 ± 0.6	<0.001
Non-MetS	8.2 ± 0.5	—

ROC analysis demonstrated excellent diagnostic performance for both indices. The LAP index achieved an AUC of 0.91 (sensitivity 85%, specificity 83%, cut-off 45.5), while the TyG index yielded an AUC of 0.88 (sensitivity 82%, specificity 79%, cut-off 8.6) (Table 7, Figure 4).

Table 7. ROC Analysis: Diagnostic Performance of LAP and TyG Indices

Parameter	LAP Index	TyG Index
AUC	0.91	0.88
Sensitivity (%)	85%	82%
Specificity (%)	83%	79%
Optimal Cut-off	45.5	8.6

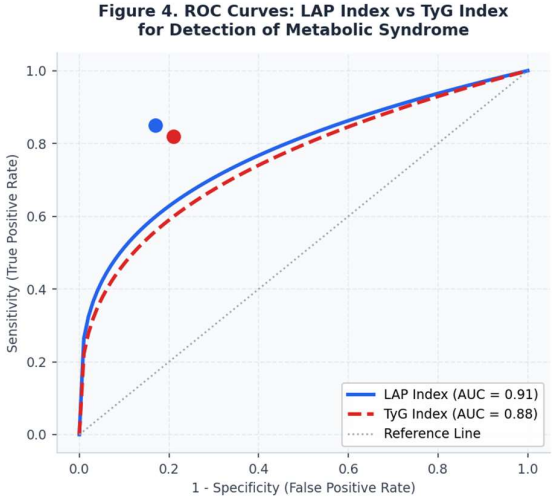


Figure 4: ROC curves for LAP index (AUC=0.91) and TyG index (AUC=0.88) for detection of metabolic syndrome

The LAP index demonstrated stronger correlations with waist circumference (r=0.72) and triglycerides (r=0.81). The TyG index showed a stronger correlation with fasting glucose (r=0.82), underscoring its sensitivity for glycaemic dysregulation (all p<0.001) (Table 8, Figure 5).

Table 8. Pearson Correlation Coefficients of LAP and TyG Indices with Metabolic Syndrome Components

Variable	LAP (r)	TyG (r)	p-value
Waist Circumference	0.72	0.65	<0.001
Triglycerides	0.81	0.78	<0.001
Fasting Glucose	0.68	0.82	<0.001

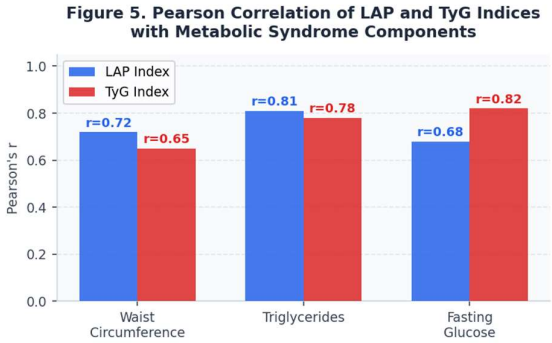


Figure 5: Pearson correlation coefficients of LAP and TyG indices with individual metabolic syndrome components.

The prevalence of metabolic syndrome was marginally higher in females (29%) compared with males (26%), consistent with observations in comparable South Asian populations, (Table 9, Figure 6)

Table 9. Gender-wise Prevalence of Metabolic Syndrome

Gender	MetS (%)	Non-MetS (%)
Male	26%	74%
Female	29%	71%

Figure 6. Gender-wise Prevalence of Metabolic Syndrome

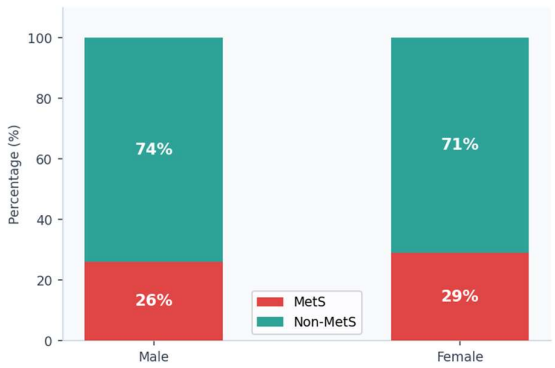


Figure 6: Gender-wise prevalence of metabolic syndrome in the study population

DISCUSSION

The Lipid Accumulation Product Index (LAP) and the Cardiometabolic Index (CMI) are useful for predicting the presence and severity of metabolic syndrome in adult patients [9]. The present cross-sectional study evaluated the utility of the LAP index and the TyG index for identifying metabolic syndrome in 189 young adults aged 20-40 years. The observed prevalence of 27.5% falls within the range of 19.5%-34.6% reported in comparable Indian adult populations. [3-4,10] This substantial burden among young adults underlines the urgency of accessible and affordable screening tools.

The exponential rise in obesity worldwide in recent years has made MetS extremely important.[11] Participants with MetS had considerably higher levels of both indices. In terms of overall diagnostic accuracy, the LAP index (AUC of 0.91) fared better than the TyG index (AUC of 0.88). These findings closely resemble those of Suryapriya Rajendran et al. (2022), who reported LAP AUC values of 0.882 and 0.905 in male and female subjects, respectively; TyG index achieved AUCs of 0.875 and 0.886.[1] In a Bangladeshi cohort of 246 young adults, Alam et al. (2025) reported a MetS prevalence of 34.6%, with TyG AUC of 0.962 and LAP AUC of 0.976, which is slightly higher than the current study, probably due to ethnic differences.[2] In a study of adults from North India, Anju Mittal et al. (2025) found that LAP had the greatest AUC (0.905), supporting the superiority of composite adiposity indices over traditional anthropometric measurements.[8]

The LAP index demonstrated stronger correlations with waist circumference (r=0.72) and triglycerides (r=0.81), which is mechanistically expected given its formula. The TyG index correlated more strongly with fasting glucose (r=0.82), reinforcing its role as a surrogate marker of insulin resistance. Maziar Afshar et al. (2025) similarly demonstrated that TyG-derived indices showed the highest AUC for MetS detection in Western Iranian adults.[7]

Both indices, which simply require waist circumference and basic fasting biochemical data that are frequently available in secondary care, offer significant practical benefits from a therapeutic standpoint. Their use in health camp environments may help detect metabolic syndrome early, allowing for prompt lifestyle and medication management.

Limitations of this study include the cross-sectional design, which precludes causal inference, and the single-centre sampling that may limit generalizability. LAP and TyG were not stratified by sex in ROC analysis. Future multicentric longitudinal studies with larger samples are warranted to validate these cut-offs.

CONCLUSION

In this study of 189 young adults in Puducherry, both the LAP index and the TyG index demonstrated strong and statistically significant associations with metabolic syndrome. The LAP index (AUC 0.91, cut-off 45.5) had marginally superior overall diagnostic accuracy compared with the TyG index (AUC 0.88, cut-off 8.6). The LAP index more effectively captured adiposity-related components while the TyG index was a more sensitive marker of insulin resistance. These simple, cost-efficient composite indices are recommended as adjuncts to routine screening for metabolic syndrome in young adults in resource-limited settings.

Conflict of Interest: The authors declare no conflict of interest.

ETHICAL APPROVAL

Approved by the Institutional Scientific Review Committee and Institutional Ethics Committee, SVMCH & RC (Ref: SVMC/SRC/2026/01/CTR1322). Written informed consent was obtained from all participants.

REFERENCE

1. Suryapriya Rajendran, AnandKumar Kizhakkayil Padikkal, Sasmita Mishra, Manju Madhavanpillai. Association of Lipid Accumulation Product and Triglyceride-Glucose Index with Metabolic Syndrome in Young Adults: A Cross-sectional Study. Department of Biochemistry, Saveetha Medical College and Hospital, 2022.

2. Shamina Alam, Ifat Ara Begum, Rayhan Sharif, Sharmin Chowdhury, Tinni Rani Das, Tanjida Ruba Lita. Performance of Triglyceride-Glucose Index and Lipid Accumulation Product for Prediction of Metabolic Syndrome in Young Adults of Bangladesh. Department of Biochemistry, Eastern Medical College, Cumilla and Dhaka Medical Hospital, Dhaka, 2025.

3. Ray L, Ravichandran K, Nanda SK. Comparison of lipid accumulation product index with body mass index and waist

circumference as a predictor of metabolic syndrome in Indian population. Metab Syndr Relat Disord. 2018;16(5):240-245. doi:10.1089/met.2017.0119.

4. Khan Y, Lalchandani A, Gupta AC, Khadanga S, Kumar S. Prevalence of metabolic syndrome crossing 40% in Northern India. J Family Med Prim Care. 2018;7:118-123. doi:10.4103/jfmpc.jfmpc_10_17.

5. Nascimento-Ferreira MV, Rendo-Urteaga T, Vilanova-Campelo RC, et al. The lipid accumulation product is a powerful tool to predict metabolic syndrome in undiagnosed Brazilian adults. Clin Nutr. 2017;36(6):1693-1700. doi:10.1016/j.clnu.2016.12.020.

6. Chiang JK, Koo M. Lipid accumulation product: a simple and accurate index for predicting metabolic syndrome in Taiwanese people aged 50 and over. BMC Cardiovasc Disord. 2012;12:78. doi:10.1186/1471-2261-12-78.

7. Maziar Afshar, Maryam Afraie, Mobin Azami, Kamran Zamani, Farhad Moradpour, Yousef Moradi. Diagnostic Performance of the TyG Index in Detecting Metabolic Syndrome: A Cross-Sectional Study from Western Iran. Kurdistan University of Medical Sciences, Sanandaj, Iran, 2025.

8. Anju Mittal, Sudeep Kumar, Manisha Arora, Roshan Kumar Mahat, Jyoti Batra. Lipid accumulation products: A better marker for prediction of metabolic syndrome. Muzaffarnagar Medical College and Santosh Medical College, Ghaziabad, Uttar Pradesh, India, 2025.

9. Sofia Tamini, Adele Bondesan, Diana Caroli, Alessandro Sartorio. The Lipid Accumulation Product Index (LAP) and the Cardiometabolic Index (CMI) Are Useful for Predicting the Presence and Severity of Metabolic Syndrome in Adult Patients with Obesity. Istituto Auxologico Italiano, IRCCS, Milan, Italy, 2024.

10. Ranasinghe P, Mathangasinghe Y, Jayawardena R, Hills AP, Misra A. Prevalence and trends of metabolic syndrome among adults in the Asia-Pacific region: a systematic review. BMC Public Health. 2017;17:101. doi:10.1186/s12889-017-4041-1.

11. Rochlani Y, Pothineni NV, Kovelamudi S, Mehta JL. Metabolic syndrome: pathophysiology, management, and modulation by natural compounds. Ther Adv Cardiovasc Dis. 2017;11:215-225. doi:10.1177/1753944717711379.