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RESEARCH PAPER

Performance of Triglyceride-Glucose Index and Lipid Accumulation Product for Prediction of Metabolic Syndrome in Young Adults of Bangladesh

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Abstract

Background: Insulin resistance, central adiposity, and aging are key contributors to rise of prevalence of metabolic syndrome (MetS) worldwide, including in Bangladesh. Early detection of individuals at risk of MetS is crucial for prevention. The Triglyceride-Glucose (TyG) index, calculated from fasting plasma glucose (FPG) and triglyceride (TG) levels, serves as a surrogate marker for insulin resistance. Lipid Accumulation Product (LAP), calculated from waist circumference (WC) and TG levels, reflects central obesity. Therefore, TyG index & LAP may predict MetS more effectively.

Objective: To evaluate the association of TyG index and LAP with MetS in young adults of Bangladesh

Methods: This cross-sectional study was conducted at Sir Salimullah Medical College from March 2024 to February 2025. Using purposive sampling, 246 apparently healthy urban adults (18-40 years) were recruited. MetS was defined per modified NCEP-ATP III guidelines. Demographic, clinical, and biochemical data were collected. TyG index and LAP were calculated, and their associations with MetS were analyzed by unpaired t-test. Youden index was done to determine the optimal cut-off values for the TyG index and LAP in predicting MetS. Using these cut off values their diagnostic performance for prediction of MetS was determined by receiver operating characteristic (ROC) curve analysis and sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) was calculated. A *p-value* ≤ 0.05 was considered statistically significant.

Results: Among 246 young adults, the prevalence of metabolic syndrome (MetS) was 34.6%. Both TyG index and LAP were significantly higher in participants with MetS ($p < 0.001$). The optimal cut-off values were 8.69 for TyG and 39.93 for LAP. Individuals with TyG >8.69 and LAP >39.93 had increased risk of MetS. ROC analysis showed excellent diagnostic performance of TyG (sensitivity 97.6%, specificity 85.7%, PPV 78.3%, NPV 98.5%, AUC 0.962, accuracy 90.2%) and LAP (sensitivity 98.8%, specificity 77.0%, PPV 69.2%, NPV 98.6%, AUC 0.976, accuracy 84.2%) for detection of MetS.

Conclusion: High Triglyceride-Glucose (TyG) Index and raised Lipid Accumulation Product (LAP) are associated with metabolic syndrome (MetS) in young adults in Bangladesh. Both indices demonstrate high diagnostic efficacy for MetS with cutoff point 8.69 for TyG index & 39.93 for LAP, making them valuable non-invasive and cost-effective surrogate markers for identifying individuals at risk of MetS. Given their simplicity and reliability, TyG index and LAP can be utilized for early detection and screening of MetS.

Keywords: Triglyceride-Glucose Index (TyG), Lipid Accumulation Product (LAP), Metabolic Syndrome (MetS)

Introduction

Metabolic syndrome (MetS) is a multifaceted condition characterized by a combination of metabolic abnormalities.[1] Rapid urbanization, sedentary lifestyles, and excessive caloric intake have contributed to its rise as a significant global health challenge. Individuals with MetS face a twofold increased risk of cardiovascular disease (CVD) and a fivefold risk of developing diabetes mellitus (DM) within five to ten years. Additionally, they have a two to fourfold higher likelihood of experiencing a stroke, a

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three to fourfold increased risk of myocardial infarction, and a doubled mortality rate from such events.[2] The worldwide prevalence of MetS in adults has been estimated to be 20-25%.[3] It is increasingly prevalent in both developed and developing nations.[4] An increasing trend is also evident in countries in the Asia-Pacific region.[5] In Bangladesh, the prevalence varies depending on the criteria used, standing at 37% based on modified NCEP ATP III guidelines and 20% using WHO criteria.[6]

Insulin resistance is a key feature of MetS and serves as a critical predictor of cardiovascular disease.[7] The Triglyceride-Glucose (TyG) Index, calculated from fasting blood glucose and triglyceride levels, is a cost-effective and reliable marker for assessing insulin resistance.[8] Research suggests that a higher TyG index is linked to an increased risk of atherosclerotic cardiovascular disease (ASCVD), type 2 diabetes, and hypertension.[9] Elevated TyG levels have also been observed in patients with subclinical atherosclerosis.[10]

Waist circumference and triglyceride levels are key components of MetS according to NCEP-ATP III and IDF criteria.[11,12] However, waist circumference alone does not differentiate between visceral and subcutaneous abdominal fat.[13] To address this, Kahn introduced the Lipid Accumulation Product (LAP), a novel index for evaluating visceral adiposity, which has been shown to predict diabetes and cardiovascular risk more effectively than body mass index (BMI).[14] LAP calculation requires only waist circumference and plasma triglyceride levels, making it a practical tool for clinical assessment.[15]

Given these considerations, the present study was conducted to examine the association between the Triglyceride-Glucose (TyG) Index, Lipid Accumulation Product (LAP), and MetS in a representative sample of young adults in Bangladesh.

Materials and Methods

This cross-sectional study was conducted at the Department of Biochemistry, Sir Salimullah Medical College, Dhaka, Bangladesh, from March 2024 to February 2025. The study population comprised apparently healthy young adults aged 18 to 40 years residing in urban communities of Dhaka. A purposive sampling technique was used to select the study subjects. The sample size was determined using a statistical formula based on the expected prevalence of metabolic syndrome (MetS) in Bangladesh, resulting in a total of 246 participants. Inclusion criteria required participants to be apparently healthy young adults, while exclusion criteria included individuals with a BMI below 18.5 kg/m² or above 40 kg/m², pregnant or lactating women, and individuals with a history of acute illness, diabetes mellitus, liver disease, renal disease, pulmonary disease, cardiovascular disease, malignancy, HIV, or alcoholism. Participants were categorized into two groups based on the modified National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria: those with MetS and those without.

The study analyzed both independent and dependent variables. Independent variables included age, gender, body mass index (BMI), waist circumference (WC), systolic blood pressure (SBP), diastolic blood pressure (DBP), fasting plasma glucose (FPG), fasting serum triglycerides (TG), fasting serum high-density lipoprotein cholesterol (HDL-C), triglyceride-glucose index [Ln {(fasting triglycerides in mg/dL) × (fasting glucose in mg/dL)}/2], and lipid accumulation product [(waist circumference in cm - 65) × triglyceride in mmol/L] for men and [(waist circumference in cm - 58) × triglyceride in mmol/L] for women.

The dependent variable was the presence of MetS, defined according to the modified NCEP ATP III criteria, requiring at least three of the following conditions: elevated waist circumference (≥90 cm for men and ≥80 cm for women), triglycerides ≥150 mg/dL, reduced HDL-C levels (<40 mg/dL for men and <50 mg/dL for women), elevated blood pressure (SBP ≥130 mmHg or DBP ≥85 mmHg), or fasting blood glucose ≥100 mg/dL.

Ethical clearance was obtained from the Institutional Ethics Committee of Sir Salimullah Medical College. Participants were informed about the study's purpose, risks, and procedures, and only those who provided written consent were included. Socio-demographic and clinical data were collected using a structured questionnaire. Anthropometric measurements, including waist circumference, height, and weight, were taken following standardized WHO guidelines. BMI was calculated using the formula: weight in kg / (height in meters).[2] Blood pressure was measured on the left arm in a seated position using a manual sphygmomanometer after five minutes of rest.

Fasting blood samples were collected after an overnight fast of 10-12 hours. A total of 5 mL of venous blood was drawn, with 2 mL collected in sodium fluoride tubes for fasting plasma glucose measurement and 3 mL in plain tubes for fasting serum triglycerides and HDL-C assessment. Samples were processed in the Biochemistry Laboratory of Sir Salimullah Medical College using standard biochemical methods. Fasting plasma glucose was estimated using the glucose oxidase method, fasting serum triglycerides using the

enzymatic GPO-PAP method, and fasting HDL-C using the enzymatic CHOD-PAD method.[16-18]

Data were collected, checked, and processed systematically. Statistical analysis was performed using SPSS version 27. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as percentages. Unpaired student's t-test was used for comparison between groups. Youden index was done to determine the optimal cut-off values for the TyG index and LAP in predicting MetS. Using these cut off values their diagnostic performance for prediction of MetS was determined by receiver operating characteristic (ROC) curve analysis and performance tests e.g. sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV). A *p-value* ≤*0.05* was considered statistically significant.

Results

A total of 246 healthy young adults from urban communities in Dhaka city were included in this study. Among the 246 study subjects, a total of 85 individuals were identified as having metabolic syndrome. This corresponds to a prevalence of 34.6% in the study population (table I).

Table I: Frequency of metabolic syndrome among the study subjects (N = 246)

Total	Metabolic syndrome	Frequency (95% CI)
246	85	34.6%

The mean TyG index in the metabolic syndrome group was 9.04 ± 0.28, whereas in the non-metabolic syndrome group it was 8.34 ± 0.33, and this difference was statistically highly significant (*p < 0.001*). Similarly, the mean LAP was markedly elevated in subjects with metabolic syndrome (62.89 ± 15.53) compared to those without (30.82 ± 11.20), with the difference again reaching high statistical significance (*p < 0.001*). These findings indicate that both TyG index and LAP are strongly associated with the presence of metabolic syndrome, and may serve as reliable surrogate markers for identifying individuals at increased risk (table II).

Table II: Association of TyG index & LAP with metabolic syndrome

Parameter	Metabolic syndrome	No metabolic syndrome	p value
TyG index	9.04 ± 0.28	8.34 ± 0.33	< 0.001
LAP	62.89 ± 15.53	30.82 ± 11.20	< 0.001

The optimum cut-off value for predicting metabolic syndrome was determined by Youden's index and the optimum cut off point for the TyG index and for LAP found to be 8.69 and 39.93 respectively. Therefore, individuals with TyG index > 8.69 and/or LAP> 39.93 are at high risk of MetS (table II).

Table III: Optimum cut-off points of TyG index & LAP determined by Youden's index for detection of MetS (N=246)

Parameter	Cut-off points	Risk of MetS
TyG index	8.69	>8.69
LAP	39.93	> 39.93

ROC curve analysis for TyG and LAP, revealed that at the optimum cut-off value of 8.69, the TyG index demonstrated sensitivity 97.6%, specificity 85.7%, PPV 78.3%, NPV 98.5%, accuracy 90.2% and AUC 0.962 for detecting metabolic syndrome. Similarly, at the cut-off value 39.93, LAP showed sensitivity 98.8%, specificity 77.0%, PPV 69.2%, NPV 98.6%, accuracy 84.2% and AUC 0.976 for detection of metabolic syndrome (figure -1, figure-2 and table-IV). With respect to diagnostic performance study and AUC; both TyG index & LAP are found to be strong predictor of MetS with nearly identical efficacy.

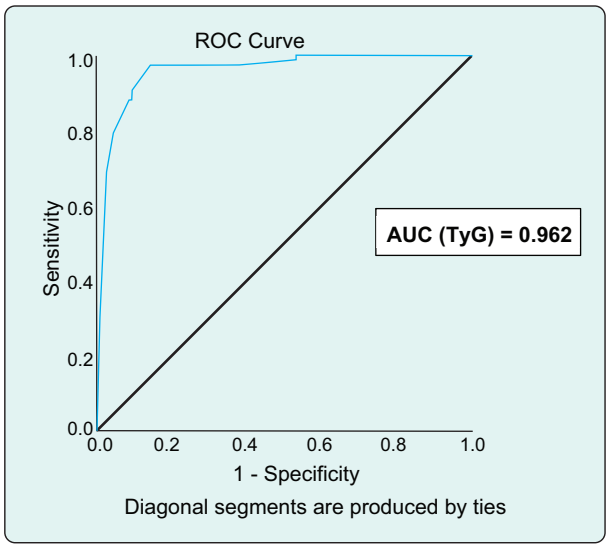

Figure 1: Receiver operating characteristic (ROC) curve analysis of TyG in all subjects

Table IV: Performance of TyG index & LAP for detection of Metabolic syndrome using for optimum cutoff point

TyG index	Cut off value	Sensitivity	Specificity	PPV	NPV	Accuracy
	8.69	97.6%	85.7%	78.3%	98.5%	90.2%
LAP	39.93	98.8%	77.0%	69.2%	98.6%	84.2%

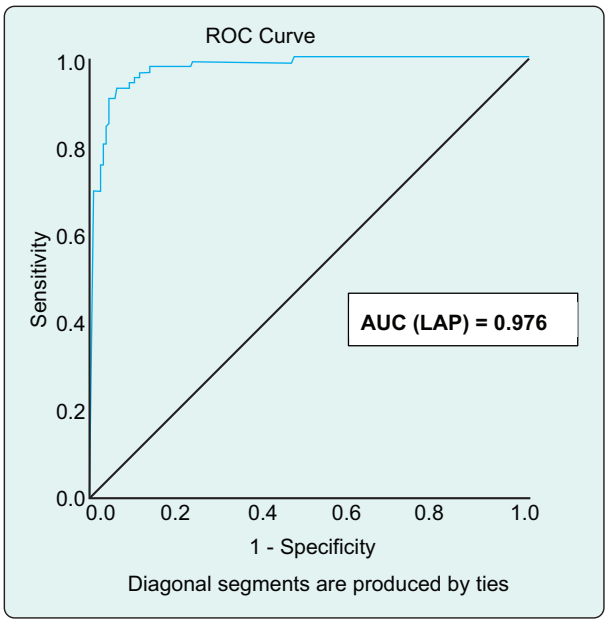

Figure 2: Receiver operating characteristic (ROC) curve analysis of LAP in all subjects

Discussion

In this study of 246 healthy young adults from urban Dhaka, the prevalence of metabolic syndrome (MetS) was 34.6%, highlighting a substantial metabolic burden in this population. This is higher than reported in some South Asian cohorts, reflecting urban lifestyle factors such as sedentary behavior, dietary changes, and increasing obesity rate. Both the triglyceride-glucose (TyG) index and lipid accumulation product (LAP) were significantly elevated in subjects with MetS. The mean TyG index was 9.04 ± 0.28 in the MetS group versus 8.34 ± 0.33 in non-MetS subjects, while the mean LAP was 62.89 ± 15.53 versus 30.82 ± 11.20, respectively ($P < 0.001$). These findings support previous evidence that TyG and LAP reflect insulin resistance and central adiposity—key components of MetS.[19,20] The reason for the high prevalence of metabolic syndrome in females is probably due to women in urban areas frequently facing higher levels of obesity and abdominal fat accumulation, key risk factors for metabolic syndrome, driven by urbanization-induced lifestyle changes such as decreased physical activity and greater consumption of high-calorie foods.

Our findings confirmed that the TyG index and LAP are significantly correlated with key MetS components, including fasting plasma glucose (FPG) and triglycerides (TG), as observed in previous studies.[21,22]

The present study demonstrates that both TyG index and LAP are strongly associated with metabolic syndrome. Individuals with higher TyG index (>8.69) and LAP (>39.93) exhibited very high risk of having MetS. These findings highlight the strong predictive capacity of these indices and support their use as simple, cost-effective tools for early identification of individuals at risk of MetS.

ROC curve analysis demonstrated excellent diagnostic performance for both indices. The TyG index cut-off of 8.69 yielded a sensitivity of 97.6%, a specificity of 85.7%, and an overall accuracy of 90.2%, while LAP at 39.93 showed a sensitivity of 98.8%, a specificity of 77.0%, and an accuracy of 84.2%. Notably, both indices exhibited high negative predictive values (>98%), suggesting strong utility in ruling out MetS among low-risk individuals. These results are consistent with studies from diverse populations, confirming the reliability of TyG and LAP as practical, cost-effective surrogate markers for metabolic risk. These findings are consistent with previous studies, which reported similar diagnostic accuracy for TyG and LAP.[23,24]

Conclusion

The Triglyceride-Glucose (TyG) Index and Lipid Accumulation Product (LAP) are significantly associated with metabolic syndrome (MetS) in young adults in Bangladesh. Both indices demonstrate high diagnostic efficacy with cutoff point 8.69 for TyG index & 39.93 for LAP, making them valuable non-invasive and cost-effective surrogate markers for identifying individuals at risk of MetS. Given their simplicity and reliability, TyG and LAP can be effectively utilized for early detection and screening of MetS.

Conflict of Interest: There are no conflicts of interest.

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Ethical Clearence: Ethical clearance was received by Institutional Ethics Committee of Sir Salimullah Medical College, Dhaka.

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