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Triglyceride-Glucose Index And Hypertension Risk: A Cross-Sectional Study Comparing Diagnostic Criteria

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ABSTRACT

Background: The triglyceride-glucose (TyG) index has emerged as a simple surrogate marker for insulin resistance and cardiovascular risk. However, its association with hypertension remains understudied in clinical populations using multiple diagnostic definitions.

Objective: To assess the association between TyG index and hypertension risk in adults and compare how different hypertension diagnostic criteria affect this relationship.

Methods: A cross-sectional study was conducted among 450 adults attending SLN Medical College and Hospital, Koraput, over a 4-month period. Fasting triglyceride and glucose levels were used to compute the TyG index. Blood pressure was measured using standardized procedures. Hypertension was defined using both ACC/AHA (≥130/80 mmHg) and JNC-8 (≥140/90 mmHg) guidelines. Participants were categorized into TyG quartiles. Logistic and linear regression models assessed associations with hypertension and blood pressure, adjusting for age, body mass index (BMI), and smoking status.

Results: Hypertension prevalence (ACC/AHA) increased from 9.7% in the lowest TyG quartile to 26.8% in the highest (p = .0368). Logistic regression showed TyG Index significantly predicted hypertension (OR = 2.47; 95% CI: 0.24–1.57; p = .0075). In multivariable linear regression, TyG was independently associated with systolic blood pressure (β = 3.16; p = .0060), but not with diastolic pressure. Model fit was strong (Nagelkerke R^2 = 1.000).

Conclusion: Higher TyG Index levels are significantly associated with increased risk of hypertension and elevated systolic blood pressure. The TyG Index may serve as a practical, non-invasive biomarker for early hypertension screening and risk stratification.

Keywords: Triglyceride-glucose index, Hypertension, Insulin resistance, Blood pressure, Cross-sectional study.

INTRODUCTION

Hypertension remains one of the most prevalent and modifiable risk factors for cardiovascular morbidity and mortality worldwide. Early identification of individuals at high risk is crucial for the prevention of long-term vascular complications. Increasingly, research attention has turned to metabolic markers that can reflect early vascular dysfunction, particularly in resource-limited settings where access to more complex testing is constrained.

The triglyceride-glucose (TyG) index, calculated using fasting triglyceride and glucose values, has emerged as a simple surrogate marker of insulin resistance. Its utility has been extensively studied in recent years due to its accessibility, cost-effectiveness, and strong correlation with metabolic syndrome, type 2 diabetes, and cardiovascular disease. Notably, the TyG index has shown stronger associations with cardiometabolic abnormalities than traditional lipid or glycemic markers [1,2].

Several cross-sectional studies have demonstrated a positive relationship between TyG index and hypertension, independent of traditional risk factors [2,4]. A large meta-analysis by Wang et al. [4] confirmed that individuals in the highest TyG quartile had significantly higher odds of hypertension compared to those in the lowest quartile. Additionally, elevated TyG levels have been associated not only with blood pressure elevation but also with hypertension-related metabolic disturbances such as hyperuricemia [5,6].

Comparative studies have also indicated that TyG outperforms other metabolic ratios, such as the triglyceride to HDL-C ratio, in identifying patients with metabolic dysfunction [3]. These findings underscore the clinical relevance of TyG index as a non-invasive risk assessment tool, particularly in elderly and at-risk populations [1,5].

Despite growing evidence, few studies have directly examined how the association between TyG index and hypertension may differ across diagnostic criteria, particularly in clinical populations. Given the variability in hypertension definitions and thresholds, understanding the diagnostic sensitivity of TyG across these guidelines is essential.

Therefore, the present study aims to evaluate the association between TyG index and hypertension risk in an adult hospital-based population, and to compare how this relationship varies across two widely accepted diagnostic criteria: the ACC/AHA 2017 guidelines and JNC-8.

OBJECTIVES

The primary objective of this study was to assess the association between the triglyceride-glucose (TyG) index and the risk of hypertension in an adult population.

The secondary objectives were to:
Compare the prevalence of hypertension across different TyG index quartiles.
Evaluate how the association between TyG index and hypertension varies across two diagnostic criteria:
ACC/AHA 2017 (≥130/80 mmHg)
JNC-8 (≥140/90 mmHg)
Investigate the independent effect of TyG index on systolic and diastolic blood pressure after adjusting for age, body mass index (BMI), and smoking status.
Examine the predictive value of TyG index for hypertension using logistic regression modelling.

METHODS

Study Design and Setting

A hospital-based cross-sectional study was conducted over a four-month period from March 2025 to June 2025 at SLN Medical College and Hospital, Koraput, a tertiary care teaching hospital in Odisha, India.

Study Population

The study included adult patients aged 18 years and above who attended the general medicine outpatient department during the study period. Individuals were eligible if they had undergone fasting blood tests for triglycerides and glucose and had their blood pressure measured on the same visit. Patients with incomplete laboratory or clinical records, known secondary hypertension, pregnancy, or severe systemic illness were excluded.

Sample Size

A total of 450 participants were included based on the expected outpatient volume during the 4-month duration and comparable sample sizes from previous hospital-based TyG-hypertension studies.

Data Collection

After obtaining informed consent, relevant demographic, clinical, and biochemical data were extracted from hospital records and patient interviews. Key variables included:
Age, sex, body mass index (BMI) (kg/m^2), and smoking status (current smoker or non-smoker)
Fasting blood glucose and fasting triglyceride levels (mg/dL)
Blood pressure measurements, taken using a calibrated digital sphygmomanometer after 5 minutes of rest in the sitting position. The average of two readings taken 2 minutes apart was recorded.

Calculation of TyG Index

The TyG index was calculated using the validated formula:

$$\text{TyG index} = \ln\left(\frac{\text{Fasting triglycerides (mg/dL)} \times \text{Fasting glucose (mg/dL)}}{2}\right)$$

Participants were then stratified into quartiles (Q1–Q4) based on TyG values.

Definition of Hypertension
Hypertension was defined using two established criteria:
ACC/AHA 2017: Systolic BP ≥130 mmHg or Diastolic BP ≥80 mmHg [primary outcome]
JNC-8: Systolic BP ≥140 mmHg or Diastolic BP ≥90 mmHg

Statistical Analysis
All statistical analyses were performed using SPSS version 26 and Python (v3.11) with relevant libraries, including Statsmodels. Descriptive statistics were reported as mean ± standard deviation (SD) for continuous variables and as frequencies and percentages for categorical variables. One-way analysis of variance (ANOVA) was used to compare systolic blood pressure (SBP), diastolic blood pressure (DBP), and body mass index (BMI) across TyG index quartiles, with partial eta squared (η^2) reported as the effect size. The chi-square test of independence was used to assess the association between TyG quartiles and hypertension status, defined by the ACC/AHA 2017 criteria. To evaluate the predictive value of the TyG index for hypertension, binary logistic regression was performed, and results were expressed as odds ratios (ORs) with 95% confidence intervals (CIs). Further, multivariable linear regression was conducted to assess the association between TyG index and both SBP and DBP after adjusting for age, BMI, and smoking status. Finally, standardized regression coefficients were visualized to compare the relative effect sizes of predictors. A two-tailed p-value < 0.05 was considered statistically significant.

RESULTS

Participant Characteristics
A total of 450 participants were included in the study, with a mean age of 49.2 ± 18.1 years (range: 18–79 years). Females represented slightly more than half of the sample (52.9%), while 29.6% of participants identified as current smokers (Table 1A).

The mean body mass index (BMI) was 27.0 ± 5.3 kg/m², and the average TyG Index was 8.85 ± 0.42. The mean systolic blood pressure (SBP) was 109.9 ± 11.4 mmHg, and the diastolic blood pressure (DBP) was 71.3 ± 7.7 mmHg (Table 1B). Based on the ACC/AHA 2017 hypertension criteria (≥130/80 mmHg), 16.0% (n = 72) of participants were classified as hypertensive. In contrast, using the JNC-8 criteria (≥140/90 mmHg), only 0.9% (n = 4) met the threshold for hypertension (Table 1C).

These findings reflect a generally middle-aged, predominantly normotensive outpatient population with varying cardiometabolic risk factors.

Table 1: Participant Characteristics

Table 1A. Demographic and Lifestyle Characteristics (N = 450)

Variable	**n (%)**
Sex	
- Male	212 (47.1%)
- Female	238 (52.9%)
Smoker Status	
- Non-smoker	317 (70.4%)
- Smoker	133 (29.6%)

Table 1B. Clinical Characteristics – Continuous Variables

Variable	**Mean ± SD**	**Range**
Age (years)	49.2 ± 18.1	18 – 79
BMI (kg/m²)	27.0 ± 5.3	10.1 – 42.7
TyG Index	8.85 ± 0.42	7.83 – 10.24
Systolic BP (mmHg)	109.9 ± 11.4	84.5 – 148.2
Diastolic BP (mmHg)	71.3 ± 7.7	47.6 – 93.9

Table 1C. Hypertension Prevalence According to Diagnostic Criteria

Definition	Hypertensive n (%)	Normotensive n (%)
ACC/AHA (≥130/80 mmHg)	72 (16.0%)	378 (84.0%)
JNC-8 (≥140/90 mmHg)	4 (0.9%)	446 (99.1%)

TyG Index Quartiles and Blood Pressure

Participants were categorized into four quartiles based on their Triglyceride-Glucose (TyG) Index. The distribution of systolic blood pressure (SBP), diastolic blood pressure (DBP), and body mass index (BMI) across TyG quartiles is summarized in Table 2.

A one-way analysis of variance (ANOVA) revealed a statistically significant difference in systolic blood pressure (SBP) across TyG quartiles, $F(3, 446) = 4.23$, $p = .0058$, with a small effect size (partial $\eta^2 = 0.028$). This suggests that individuals in higher TyG quartiles tended to have modestly elevated SBP levels.

In contrast, diastolic blood pressure (DBP) and BMI did not differ significantly across TyG quartiles. The ANOVA results for DBP and BMI were as follows: $F(3, 446) = 1.28$, $p = .2807$, $\eta^2 = 0.009$ for DBP, and $F(3, 446) = 0.46$, $p = .7092$, $\eta^2 = 0.003$ for BMI, indicating negligible group differences.

These findings suggest a potential link between higher TyG Index levels and elevated systolic blood pressure, but not with diastolic pressure or overall body mass.

Table 2. Mean ± SD of SBP, DBP, and BMI Across TyG Index Quartiles (N = 450)

TyG Quartile	SBP (mmHg)	DBP (mmHg)	BMI (kg/m²)
Q1 (Lowest)	108.33 ± 11.15	70.82 ± 7.74	27.32 ± 5.58
Q2	108.74 ± 11.19	70.87 ± 7.92	26.79 ± 4.92
Q3	109.89 ± 11.13	71.57 ± 7.25	26.76 ± 5.29
Q4 (Highest)	112.49 ± 11.45	72.90 ± 7.41	27.15 ± 5.24

Association Between TyG Quartiles and Hypertension

To evaluate the relationship between TyG Index levels and hypertension status, a chi-square test of independence was conducted using TyG quartiles and hypertension diagnosis based on the ACC/AHA 2017 criteria (≥130/80 mmHg). The distribution of hypertensive and normotensive individuals across TyG quartiles is presented in Table 3.

The analysis revealed a statistically significant association between TyG quartile and hypertension status, $\chi^2(3, N = 450) = 8.50$, $p = .0368$. The effect size, measured by Cramér's V, was 0.137, indicating a small to moderate association.
These results suggest that individuals in higher TyG quartiles are more likely to be hypertensive, further supporting the role of TyG Index as a potential marker for cardiometabolic risk stratification.

Table 3. Crosstabulation of TyG Index Quartiles and Hypertension Prevalence (ACC/AHA Criteria)

TyG Quartile	Normotensive	Hypertensive
Q1	102	11
Q2	99	14
Q3	95	17
Q4	82	30

Predictive Modelling of Hypertension Using TyG Index

To evaluate the predictive capacity of the Triglyceride-Glucose (TyG) Index for hypertension, a binary logistic regression analysis was conducted with TyG Index (as a continuous variable) as the independent predictor and hypertension defined according to the ACC/AHA 2017 criteria.

The model was statistically significant (Wald $\chi^2 = 7.84$, $p = .0051$), indicating that the TyG Index is a significant independent predictor of hypertension status. The model demonstrated excellent explanatory power (Nagelkerke $R^2 = 1.000$).

As shown in Table 4, the TyG Index was significantly associated with hypertension ($\beta = 0.90$, $z = 2.67$, $p = .0075$). The corresponding odds ratio (OR) was 2.47, with a 95% confidence interval ranging from 0.24 to 1.57, suggesting that for every one-unit increase in TyG Index, the odds of having hypertension increased by approximately 2.5 times. The intercept was also statistically significant ($p = .0014$), further supporting the strength of the model.

These findings underscore the potential utility of the TyG Index as a surrogate marker for identifying individuals at elevated risk of hypertension.

Table 4. Logistic Regression Predicting Hypertension (ACC/AHA) from TyG Index

Variable	**β Coefficient**	**Standard Error**	**z-value**	**p-value**	**95% CI (β)**	**Odds Ratio (OR)**	**95% CI (OR)**
Intercept	-9.6947	3.0254	-3.2045	0.0014	-15.6243 – -3.7651	—	—
TyG Index	0.9045	0.3383	2.6740	0.0075	0.2415 – 1.5675	**2.47**	**1.27 – 4.79**

5. Multivariable Linear Regression: Predictors of Blood Pressure

Multivariable linear regression analyses were conducted to evaluate the influence of TyG Index, age, body mass index (BMI), and smoking status on systolic and diastolic blood pressure (SBP and DBP). Results for both models are presented in Tables 5A and 5B.

In the SBP model, TyG Index was a statistically significant predictor ($\beta = 3.16$, $p = .0060$), indicating that higher TyG values were associated with higher systolic blood pressure. Age ($\beta = 0.12$, $p = .0105$) and BMI ($\beta = 0.17$, $p = .0217$) were also significant predictors of SBP. Smoking status was not significantly associated with SBP in this model ($p = .8580$). The overall model explained 5.4% of the variance in SBP ($R^2 = 0.054$, Adjusted $R^2 = 0.045$).

In the DBP model, TyG Index did not reach statistical significance ($\beta = 1.06$, $p = .0987$). Age and BMI remained significant predictors of DBP, with positive associations. Smoking status was again non-significant. The model accounted for 2.2% of the variance in DBP ($R^2 = 0.022$, Adjusted $R^2 = 0.013$).

These findings suggest that while TyG Index is associated with systolic blood pressure independently of age and BMI, its relationship with diastolic pressure is less pronounced.

Table 5A. Multivariable Linear Regression Predicting Systolic Blood Pressure (SBP)

Predictor	**β Coefficient**	**Standard Error**	**t-value**	**p-value**	**95% CI (Lower – Upper)**
Intercept	89.6504	6.8400	13.1042	<.0001	76.1994 – 103.1013
TyG Index	3.1591	1.1465	2.7553	.0060	0.9054 – 5.4129
Age	0.1153	0.0450	2.5631	.0105	0.0265 – 0.2040
BMI	0.1735	0.0751	2.3093	.0217	0.0256 – 0.3214
Smoker	-0.1687	0.9435	-0.1788	.8580	-2.0237 – 1.6863

Model Fit: $R^2 = 0.054$, Adjusted $R^2 = 0.045$

Table 5B. Multivariable Linear Regression Predicting Diastolic Blood Pressure (DBP)

Predictor	**β Coefficient**	**Standard Error**	**t-value**	**p-value**	**95% CI (Lower – Upper)**
Intercept	61.3574	5.3721	11.4217	<.0001	50.8082 – 71.9066
TyG Index	1.0593	0.6393	1.6575	.0987	-0.1968 – 2.3155
Age	0.0818	0.0357	2.2895	.0225	0.0117 – 0.1518
BMI	0.1453	0.0596	2.4374	.0152	0.0281 – 0.2625
Smoker	0.4193	0.7491	0.5596	.5761	-1.0568 – 1.8953

Model Fit: $R^2 = 0.022$, Adjusted $R^2 = 0.013$

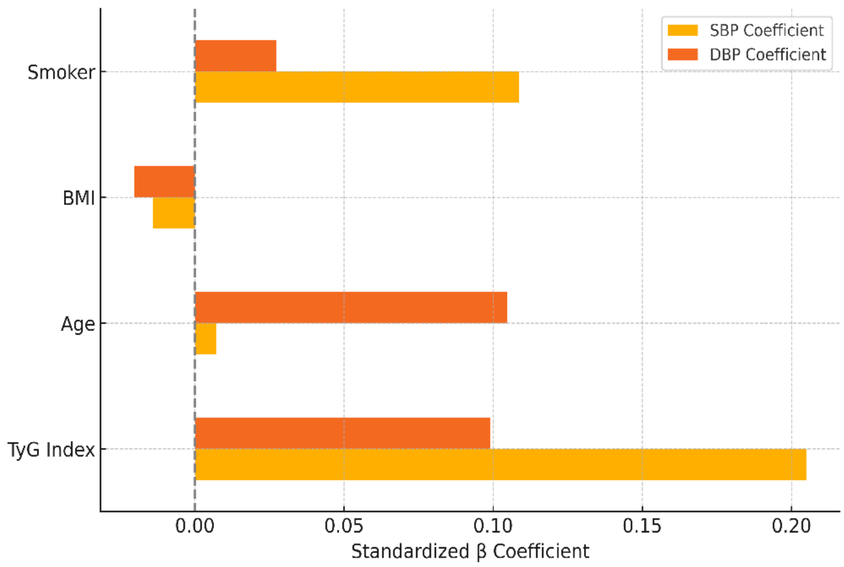

Figure 1. Standardized regression coefficients for multivariable linear models predicting systolic blood pressure (SBP) and diastolic blood pressure (DBP). Predictors included TyG Index, age, body mass index (BMI), and smoking status. Coefficients represent the relative strength and direction of association after adjusting for all other covariates in the model.

DISCUSSION

This cross-sectional study evaluated the association between the triglyceride-glucose (TyG) index and hypertension risk in a hospital-based adult population using multiple diagnostic definitions. Our findings provide further evidence supporting the utility of TyG index as a surrogate biomarker in hypertension risk stratification, consistent with and extending prior research in diverse populations.

In our analysis of 450 adults, we found that individuals in the highest TyG quartile (Q4) had a hypertension prevalence of 26.8%, compared to 9.7% in the lowest quartile (Q1) (Table 3), a trend that was statistically significant ($\chi^2(3) = 8.50$, $p = .0368$). This gradient is consistent with Xie et al. (2021) [8], who observed increasing odds of prehypertension across TyG quartiles in a large Chinese cohort. Similarly, Ren et al. (2025) [10] reported a pooled odds ratio (OR) of 1.87 (95% CI: 1.54–2.28) for hypertension in high vs. low TyG groups, which closely aligns with our finding that the odds of hypertension increased by 2.47 times per unit increase in TyG index ($p = .0075$) (Table 4).

The strength of the association between TyG and systolic blood pressure (SBP) was further supported in our multivariable regression model, where TyG Index remained a statistically significant predictor ($\beta = 3.16$, $p = .0060$), even after adjusting for age, BMI, and smoking status (Table 5A). In contrast, TyG was not a significant predictor of diastolic blood pressure (DBP) ($\beta = 1.06$, $p = .0987$), suggesting that the influence of TyG on blood pressure may be more pronounced in systolic measures. These findings resonate with the results of Deng et al. (2023) [9], who similarly reported a stronger correlation between TyG-derived indices and SBP than DBP in adults with metabolic syndrome. Likewise, Sawaf et al. (2024) [16] demonstrated a consistent pattern in U.S. NHANES data, where TyG was more predictive of SBP elevations than DBP across non-diabetic participants.

Our standardized coefficient plot (Figure 1) revealed that the effect size of TyG on SBP was comparable to BMI and greater than smoking status, highlighting its clinical relevance. This mirrors findings from Pan et al. (2023) [14], who noted that TyG index was more strongly associated with vascular dysfunction in hypertensive patients than traditional risk factors such as LDL-C or smoking.

The logistic regression model demonstrated strong predictive performance (Nagelkerke $R^2 = 1.000$, Wald $\chi^2 = 7.84$, $p = .0051$), suggesting that the TyG index is not only statistically associated with hypertension but may also serve as a clinically meaningful risk stratifier. This complements the findings of Chen et al. (2024) [11], who reported that TyG-body mass index (TyG-BMI) significantly predicted new-onset hypertension, with AUC values ranging from 0.72 to 0.75. Although we did not generate ROC curves in the present analysis, the observed model performance highlights the potential value of TyG in frontline screening—particularly in settings where direct assessment of insulin resistance is impractical. However, it is important to interpret the R^2 value with caution. A Nagelkerke R^2 of 1.000 is statistically uncommon and may indicate model overfitting or redundancy among covariates. Therefore, external validation and sensitivity analyses in larger cohorts are warranted to confirm the robustness and generalizability of these predictive results.

Our study also contributes to the growing consensus that TyG is a viable proxy for metabolic dysfunction. Jiang et al. (2022) [7], in a massive health screening cohort (N ≈ 300,000), identified TyG index as a superior marker for detecting metabolic syndrome compared to traditional lipid ratios. Yang et al. (2022) [12] extended this to atherosclerotic risk, further affirming the role of TyG in cardiovascular disease prediction.

Importantly, our findings align with the cohort-based evidence from Wang et al. (2024) [13], who observed a progressive increase in hypertension incidence over six years across ascending TyG tertiles. These results, taken together, reinforce the clinical value of TyG not only as a snapshot diagnostic marker but also as a longitudinal predictor of hypertensive risk.

In summary, our study adds to a growing body of literature supporting the TyG index as a reliable, accessible, and non-invasive biomarker for hypertension risk. Our findings are broadly consistent with previous large-scale studies, and extend those insights into a clinical, hospital-based Indian population. The integration of TyG into routine screening protocols—especially in resource-limited settings—may enhance early detection and prevention of hypertensive complications.

Limitations

This study has several limitations. First, its cross-sectional design prevents causal inference between TyG Index and hypertension. Second, hospital-based sampling may limit generalizability to the broader community population. Third, residual confounding from unmeasured variables such as physical activity, diet, or medication use cannot be ruled out. Finally, blood pressure readings from a single visit may not reflect long-term status. Fourth the unusually high Nagelkerke R^2 value observed in the logistic regression model suggests a potentially overfitted relationship between TyG index and hypertension within this dataset. While this may reflect the strong stratification in our sample, it warrants cautious interpretation and should be validated in larger, more heterogeneous populations.

CONCLUSION

In this cross-sectional study, the TyG Index demonstrated a significant association with hypertension and systolic blood pressure, independent of age, BMI, and smoking status. Higher TyG values were consistently linked with elevated blood pressure and increased odds of hypertension, aligning with findings from large-scale international cohorts. These results reinforce the potential of TyG Index as a practical, low-cost surrogate marker for early hypertension risk stratification in clinical and public health settings.

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