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ORIGINAL RESEARCH

TyG Index is Associated with Major Adverse Cardiovascular Events in HIV-Infected Individuals with Cardiovascular Disease: A Single-Center Retrospective Cohort Study

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Objective: To explore the correlation between triglyceride-to-glucose (TyG) ratio and major adverse cardiovascular events (MACE) risk in coronary artery disease complicated with human immunodeficiency virus (CAD-HIV) patients, and assess its predictive value.

Methods: A single-center retrospective cohort study was conducted. A total of 103 CAD-HIV patients admitted to the First Affiliated Hospital of Xinjiang Medical University from January 2020 to June 2025 were enrolled, with a follow-up of 5–49 months (median 22.00 months). Patients were grouped by MACE occurrence. Baseline data and TyG index were collected, with MACE as the primary endpoint. Cox regression, restricted cubic spline (RCS), ROC curve and subgroup analysis were performed.

Results: Forty-one patients (39.81%) developed MACE, with significantly higher TyG index in the MACE group ($P < 0.001$). Multivariate Cox analysis showed each 0.1-unit elevation in TyG index increased MACE risk by 42% (HR = 1.42, 95% CI: 1.16–1.74, $P < 0.001$). Compared with Q1, Q3 and Q4 had 4.42-fold (95% CI: 1.17–16.68, $P = 0.028$) and 6.17-fold (95% CI: 1.77–21.54, $P = 0.004$) higher risk. RCS verified linear positive correlation (P for overall = 0.006, P for nonlinear = 0.387). AUC for 1-year and 3-year MACE prediction was 0.745 and 0.805, respectively. The association was stronger in non-smokers (P for interaction = 0.006).

Conclusion: TyG index is linearly associated with MACE risk in CAD-HIV patients and shows favorable predictive performance for 1-year and 3-year MACE, which can be used as a simple biomarker for cardiovascular risk stratification.

Keywords: TyG index, HIV, CAD, MACE, association study

Background

With the widespread application and continuous optimization of antiretroviral therapy (ART), the survival duration of patients infected with human immunodeficiency virus (HIV) has been significantly prolonged,[1] and the disease spectrum has gradually shifted from opportunistic infections to chronic non-communicable diseases.[2] Cardiovascular disease (CAD) is one of the most predominant cardiovascular complications in HIV-infected individuals,[3] with a markedly higher incidence risk than that in the general population, and has become a major cause of late death among HIV-infected patients.The elevated cardiovascular risk in this population is closely associated with the synergistic and superimposed effects of chronic inflammation and persistent immune activation mediated by HIV infection,[4] long-term ART-related metabolic toxicity, as well as traditional cardiovascular risk factors.

For HIV-infected patients with confirmed CAD (CAD-HIV), the risk of major adverse cardiovascular events (MACE) is significantly increased. At present, cardiovascular risk scores for the general population are still used as the main assessment tools in clinical practice. Such scores do not fully account for HIV-specific factors including immune

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dysfunction, viral load, ART regimens and duration of exposure, leading to reduced predictive accuracy and inadequate stratification performance in the CAD-HIV population. These limitations fail to meet the requirements for precise risk early warning, highlighting an urgent need for simple, economical and highly accessible biological indicators to optimize cardiovascular risk management in this population.

The triglyceride-glucose (TyG) index is calculated from fasting triglyceride and fasting blood glucose levels and is a well-recognized surrogate marker of insulin resistance,[5] with the advantages of convenient detection, low cost and ease of dynamic monitoring. Insulin resistance can directly promote the occurrence and progression of MACE by inducing lipid metabolism disorders, vascular endothelial injury, accelerated atherosclerosis and plaque instability, representing a key pathophysiological link between metabolic abnormalities and adverse cardiovascular events.[6] Existing studies have confirmed that the TyG index is significantly correlated with the incidence and prognosis of CAD in the general population, patients with diabetes mellitus and hypertension, and can effectively predict adverse cardiovascular events.[7,8] However, studies on the association between the TyG index and MACE in the specific high-risk CAD-HIV population remain limited. There is no conclusive evidence clarifying whether a stable dose–response relationship exists between them, and its predictive value for MACE and applicability in subgroup analyses in this population have not been systematically validated, representing an obvious research gap.

Based on the above research status, this study enrolled CAD-HIV patients as research subjects and retrospectively analyzed their clinical data with MACE as the endpoint. This study aims to determine the independent association and linear dose–response characteristics between the TyG index and the occurrence of MACE, systematically evaluate its predictive efficacy for short- and medium-term MACE, and explore the modifying effects of clinical characteristics on the strength of the association through subgroup analyses, so as to provide a scientific basis for cardiovascular risk stratification, early identification and individualized intervention in this population.

Materials and Methods

Study Design and Participants

This study was a single-center, retrospective cohort study. Consecutive HIV-infected patients with confirmed cardiovascular disease (CAD-HIV) who were admitted to the First Affiliated Hospital of Xinjiang Medical University from January 2020 to June 2025 were enrolled.

Inclusion Criteria

①Meeting the diagnostic criteria for HIV infection as outlined in the Chinese Guidelines for HIV/AIDS Diagnosis and Treatment (2021 Edition);[9] ②Confirmed diagnosis of CAD (eg., coronary artery disease, heart failure, arrhythmia, valvular heart disease) via electrocardiogram, echocardiogram, or coronary angiography; ③Age ≥ 18 years; ④Complete clinical data, including baseline demographic characteristics, laboratory test indicators, and ART treatment information; ⑤Traceable follow-up data.

Exclusion Criteria

①Concurrent severe underlying conditions such as malignant tumors, severe hepatic or renal insufficiency, or autoimmune diseases; ②Loss to follow-up or study withdrawal during the follow-up period; ③Missing indicators required for baseline TyG index calculation; ④History of MACE.

A total of 103 patients were finally included in this study. The study protocol was approved by the Ethics Committee of the First Affiliated Hospital of Xinjiang Medical University (ethics approval number: 2021–005), and the requirement for informed consent from patients was waived. The study was conducted in strict accordance with the ethical principles of the Declaration of Helsinki. All patient information was used solely for the analysis of this study; a strict patient data confidentiality system was implemented, and personal privacy information was anonymized to prevent disclosure and non-research use.

Data Collection

Baseline patient information was extracted from the hospital electronic medical record system, including: ① Demographic characteristics: age, gender, body mass index (BMI), marital status; ② Lifestyle habits: smoking history, alcohol consumption history; ③ Comorbidities: hypertension, diabetes, hypercholesterolemia, hepatitis B virus (HBV) co-infection, hepatitis C virus (HCV) co-infection; ④ Laboratory indicators: triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), total cholesterol, fasting blood glucose, high-sensitivity C-reactive protein (hsCRP), CD4+ T-cell count, HIV viral load, aspartate aminotransferase (AST), alanine aminotransferase (ALT), platelet count; ⑤ ART regimen: 2 NRTIs + INSTI, 2 NRTIs + INSTI + NNRTI, 2 NRTIs + PI, BIC/FTC/TAF, EVG/c/FTC/TAF, cumulative ART exposure time (months); ⑥ HIV transmission route.

Calculation of Core Indicator

The TyG index was calculated using the widely accepted formula:TyG = ln[TG (mg/dL) × fasting glucose (mg/dL) / 2], where TG and fasting glucose were baseline measured values.[10]

Follow-Up and Study Endpoints

The follow-up duration ranged from 5 to 49 months, with a median follow-up time of 22.00 months.

The primary endpoint of this study was the occurrence of MACE during follow-up, including acute myocardial infarction, unstable angina pectoris, ischemic stroke, heart failure, and cardiovascular death. The diagnosis of MACE was based on internationally accepted clinical diagnostic criteria[11] and confirmed by imaging examinations (eg., coronary angiography, cranial CT or MRI) or laboratory tests. All MACE diagnoses were independently verified in an unblinded manner by two senior clinicians. The start time of follow-up was the date of enrollment, and the end time was the date of MACE occurrence, loss to follow-up, or study completion.

Quality Control

Data were double-checked by two independent researchers; laboratory tests performed by accredited hospital department.

Statistical Analysis

All statistical analyses were performed using R software, with a two-sided P value < 0.05 considered statistically significant. For missing data handling, multiple imputation was applied to impute data with a missing rate of less than 20%. For descriptive statistics, measurement data with a normal distribution were presented as mean ± standard deviation (), and between-group comparisons were conducted using the independent-sample *t*-test; in contrast, measurement data without a normal distribution were expressed as median (interquartile range) [M (Q1, Q3)], and the Mann–Whitney *U*-test was applied for between-group comparisons. Enumeration data were presented as number (percentage) [n (%)], with the χ^2-test or Fisher's exact test used for between-group comparisons as appropriate. Cox regression analysis was employed to investigate the association between the TyG index and the occurrence of major adverse cardiovascular events (MACE) in patients with coronary artery disease and human immunodeficiency virus (CAD-HIV), and three regression models were constructed: Model 1 was an unadjusted crude model; Model 2 was adjusted for gender, age, and body mass index (BMI); and Model 3 was fully adjusted for confounding factors, including demographic characteristics, living habits, comorbidities, HIV-related indicators, antiretroviral therapy (ART) regimens, and laboratory indicators. To clarify the dose-response trend, the TyG index was transformed into a categorical variable based on quartiles for analysis. Additionally, on the basis of the fully adjusted Model 3, restricted cubic spline (RCS) was used to fit the association curve between the TyG index and MACE, and the likelihood ratio test was performed to evaluate the statistical significance of the nonlinear association; the optimal number of knots for RCS was determined by the Akaike information criterion (AIC), where the fitting effects of RCS models with 3–5 knots were compared, and 4 knots corresponding to the model with the smallest AIC value were selected for the final analysis (reference value: 87.8). To assess the predictive performance of the TyG index for 1-year and 3-year MACE occurrence, receiver operating characteristic (ROC) curves were plotted, and the area under the curve (AUC) with 95% confidence interval (95% CI)

was calculated; the confidence interval of AUC was further verified using the Bootstrap resampling method with 1000 replications. Finally, subgroup analysis was conducted based on Model 3, with stratification factors including gender, smoking status, drinking status, hypertension, diabetes mellitus, and hypercholesterolemia. The differences in the association between the TyG index and MACE across different subgroups were evaluated, and an interaction test was used to determine the modifying effect of stratification factors on the association of the TyG index with MACE.

Results

Patient Characteristics

A total of 103 CAD-HIV patients were enrolled in this study and divided into the Non-MACE group (n=62) and the MACE group (n=41) according to the occurrence of MACE. Comparison of baseline characteristics between the two groups (Table 1) revealed statistically significant differences in age, diabetes, hepatitis B virus coinfection, TyG index, total cholesterol, hsCRP,

Table 1 Baseline Data for HIV Patients

Variables	Total (n = 103)	Non-MACE (n = 62)	MACE (n = 41)	*P*
Age	39.00 (35.00, 43.00)	37.50 (33.00, 42.75)	41.00 (38.00, 43.00)	0.014
BMI	23.90 (22.65, 24.30)	23.85 (22.30, 24.30)	24.10 (23.90, 24.30)	0.187
Sex				0.460
Female	24 (23.30)	16 (25.81)	8 (19.51)	
Male	79 (76.70)	46 (74.19)	33 (80.49)	
Married or cohabiting				0.769
Divorced/widowed	37 (35.92)	24 (38.71)	13 (31.71)	
Married or cohabiting	33 (32.04)	19 (30.65)	14 (34.15)	
Never married	33 (32.04)	19 (30.65)	14 (34.15)	
Smoking				0.212
No	53 (51.46)	35 (56.45)	18 (43.90)	
Yes	50 (48.54)	27 (43.55)	23 (56.10)	
Drinking				0.340
No	62 (60.19)	35 (56.45)	27 (65.85)	
Yes	41 (39.81)	27 (43.55)	14 (34.15)	
Hypertension				0.468
No	66 (64.08)	38 (61.29)	28 (68.29)	
Yes	37 (35.92)	24 (38.71)	13 (31.71)	
Diabetes				0.018
No	78 (75.73)	52 (83.87)	26 (63.41)	
Yes	25 (24.27)	10 (16.13)	15 (36.59)	
Hypercholesterolemia				0.276
No	46 (44.66)	25 (40.32)	21 (51.22)	
Yes	57 (55.34)	37 (59.68)	20 (48.78)	
HIV transmission route				0.374
Heterosexual contact	32 (31.07)	16 (25.81)	16 (39.02)	
Male-to-male sex contact	63 (61.17)	41 (66.13)	22 (53.66)	
Others	8 (7.77)	5 (8.06)	3 (7.32)	
Hepatitis B virus coinfection				0.010
No	86 (83.50)	47 (75.81)	39 (95.12)	
Yes	17 (16.50)	15 (24.19)	2 (4.88)	
Hepatitis C virus coinfection				0.171
No	96 (93.20)	60 (96.77)	36 (87.80)	
Yes	7 (6.80)	2 (3.23)	5 (12.20)	
TyG	8.78 (8.65, 8.90)	8.71 (8.62, 8.82)	8.93 (8.82, 9.02)	<0.001
HDL-C,mg/dL	45.60 (43.20, 47.50)	45.55 (43.20, 47.10)	46.80 (43.10, 48.10)	0.582
LDL-C,mg/dL	98.40 (98.20, 98.60)	98.40 (98.20, 98.60)	98.30 (98.20, 98.70)	0.718
Total cholesterol,mg/dL	162.00 (153.80, 165.65)	155.15 (152.83, 162.05)	165.30 (163.00, 173.70)	<0.001
Hscrp,Mg/L	1.72 (0.80, 2.73)	0.89 (0.72, 1.71)	2.68 (1.87, 2.95)	<0.001
CD4+ T-cell count,cells/μL	340.90 (224.30, 417.35)	401.80 (319.20, 446.35)	224.90 (176.90, 340.90)	<0.001

(*Continued*)

Table 1 (Continued).

Variables	Total (n = 103)	Non-MACE (n = 62)	MACE (n = 41)	*P*
HIV RNA load,copies/mL	356,789.00 (277,722.00, 417,221.50)	299,999.50 (278,901.00, 397,376.25)	401,234.00 (234,567.00, 456,789.00)	0.032
Cumulative Antiretroviral Therapy Exposure Duration,months	62.00 (37.50, 74.00)	41.50 (34.25, 67.75)	71.00 (52.00, 88.00)	<0.001
AST (U/L)	31.00 (27.50, 33.00)	30.00 (27.00, 33.00)	31.00 (28.00, 34.00)	0.065
ALT (U/L)	33.00 (29.00, 38.00)	31.00 (28.00, 35.75)	36.00 (31.00, 39.00)	0.002
Platelet count,10/L	216.00 (207.50, 220.00)	216.00 (209.00, 220.00)	211.00 (207.00, 221.00)	0.282
Creatinine,mg/dL	0.72 (0.70, 0.73)	0.72 (0.70, 0.73)	0.70 (0.69, 0.73)	0.283
Antiretroviral therapy regimen type				<0.001
2NRTIs+INSTI	19 (18.45)	5 (8.06)	14 (34.15)	
2NRTIs+INSTINRTIs+NNRTI	25 (24.27)	18 (29.03)	7 (17.07)	
2NRTIs+PI	22 (21.36)	5 (8.06)	17 (41.46)	
BIC/FTC/TAF	16 (15.53)	16 (25.81)	0 (0.00)	
EVG/c/FTC/TAF	21 (20.39)	18 (29.03)	3 (7.32)	
White blood cell count,10/L				0.002
<4 or >10	20 (19.42)	6 (9.68)	14 (34.15)	
4-10	83 (80.58)	56 (90.32)	27 (65.85)	

CD4+ T-cell count, HIV RNA load, cumulative ART exposure duration, ALT, ART regimen type, and white blood cell count (all P<0.05). Specifically, the median values of age, TyG index, total cholesterol, hsCRP, HIV RNA load, cumulative ART exposure duration, and ALT were higher in the MACE group than in the Non-MACE group, whereas the median CD4+ T-cell count was lower. The MACE group also had a higher prevalence of diabetes, a higher proportion of abnormal white blood cell count (<4 or >10×10^9/L), and a lower incidence of hepatitis B virus coinfection. Additionally, the distribution of ART regimen types differed significantly between the two groups. No significant between-group differences were observed for BMI, sex, married or cohabiting status, smoking, drinking, hypertension, hypercholesterolemia, HIV transmission route, hepatitis C virus coinfection, HDL-C, LDL-C, AST, platelet count, or creatinine (all P>0.05).

Cox Regression Analysis of the TyG Index and MACE in CAD-HIV Patients

The results of Cox proportional hazards regression analysis (Table 2) demonstrated that each 0.1-unit increase in the continuous adjusted TyG index was associated with a significantly elevated risk of MACE in CAD-HIV patients. In the crude model (Model 1), the hazard ratio (HR) was 1.51 (95% confidence interval [CI]: 1.24–1.84, P<0.001), indicating a 51% increased risk of MACE per 0.1-unit increment in the TyG index. After adjustment for sex, age, and BMI (Model 2), the HR was 1.50 (95% CI: 1.23–1.83, P<0.001), corresponding to a 50% higher MACE risk. In Model 3, which was fully adjusted for confounding factors including demographic characteristics, clinical history, laboratory parameters, and ART-related variables, the HR was 1.42 (95% CI: 1.16–1.74, P<0.001), representing a 42% increased

Table 2 Relationship Between TyG Index and CAD in HIV Patients

Variables	Model1		Model2		Model3	
	HR (95% CI)	*P*	HR (95% CI)	*P*	HR (95% CI)	*P*
Adjusted TyG (continuous)	1.51 (1.24–1.84)	<0.001	1.50 (1.23–1.83)	<0.001	1.42 (1.16–1.74)	<0.001
Adjusted TyG (categorical)						
Q1	1.00 (reference)		1.00 (reference)		1.00 (reference)	
Q2	1.65 (0.39–6.91)	0.495	1.70 (0.40–7.25)	0.475	1.72 (0.40–7.39)	0.468
Q3	4.46 (1.26–15.82)	0.021	4.58 (1.21–17.32)	0.025	4.42 (1.17–16.68)	0.028
Q4	6.96 (2.07–23.37)	0.002	7.06 (2.05–24.31)	0.002	6.17 (1.77–21.54)	0.004

Notes: Model1: Crude. Model2: Adjust: Sex, Age, BMI. Model3: Adjust: Sex, Age, Married or cohabiting, BMI, Smoking, Drinking, Hypertension, Diabetes, Hypercholesterolemia, HIV transmission route, Hepatitis B virus coinfection, Hepatitis C virus coinfection, Antiretroviral therapy regimen type, HDL-C, LDL-C, Total cholesterol, Creatinine, hsCRP, CD4+ T-cell count, HIV RNA load, Cumulative Antiretroviral Therapy Exposure Duration, AST, ALT, White blood cell count, Platelet count.
Abbreviations: HR, Hazard Ratio; CI, Confidence Interval.

MACE risk per 0.1-unit rise in the TyG index. All these results were statistically significant, suggesting that the adjusted TyG index was an independent risk factor for MACE in CAD-HIV patients.

In quartile-based subgroup analysis using the TyG index as a categorical variable with Q1 as the reference, no significant differences in MACE risk were found for Q2 across Models 1, 2, and 3 (all P>0.05). For Q3, the HRs were 4.46 (95% CI: 1.26–15.82, P=0.021), 4.58 (95% CI: 1.21–17.32, P=0.025), and 4.42 (95% CI: 1.17–16.68, P=0.028) in Models 1, 2, and 3, respectively. For Q4, the corresponding HRs were 6.96 (95% CI: 2.07–23.37, P=0.002), 7.06 (95% CI: 2.05–24.31, P=0.002), and 6.17 (95% CI: 1.77–21.54, P=0.004). These findings indicated that patients in the third and fourth TyG index quartiles exhibited a significantly higher risk of MACE, with a dose-dependent increase in MACE risk as the TyG index quartile rose.

Dose–Response Relationship Between the TyG Index and MACE in CAD-HIV Patients

Based on the fully adjusted Model 3, restricted cubic spline (RCS) analysis was performed to further explore the dose–response relationship between the TyG index and MACE in CAD-HIV patients. The optimal number of knots was determined using the Akaike Information Criterion (AIC): the fitting effects of RCS models with 3–5 knots were compared, and 4 knots corresponding to the model with the smallest AIC value were selected for the final analysis, with a reference value of 87.8. As shown in Figure 1, the overall association between the TyG index and MACE risk was statistically significant (P for overall = 0.006), and the nonlinearity test revealed no significant nonlinear relationship (P for nonlinear = 0.387). These results supported a linear positive correlation between the TyG index and MACE risk, with a progressive linear increase in MACE risk per 0.1-unit increment in the TyG index.

Predictive Performance of the TyG Index for MACE in CAD-HIV Patients

Receiver operating characteristic (ROC) curve analysis was performed to evaluate the predictive value of the TyG index for 1-year and 3-year major adverse cardiovascular events (MACE). The area under the ROC curve (AUC) for predicting 1-year MACE was 0.745 (95% CI: 0.640–0.850), and the AUC for predicting 3-year MACE was 0.805 (95% CI: 0.706–0.888). The 95% confidence intervals of the AUC values were estimated using the bootstrap resampling method with 1000 replications. These results demonstrated that the TyG index exhibited moderate-to-high predictive performance for 1-year and 3-year MACE in this patient population (Figure 2).

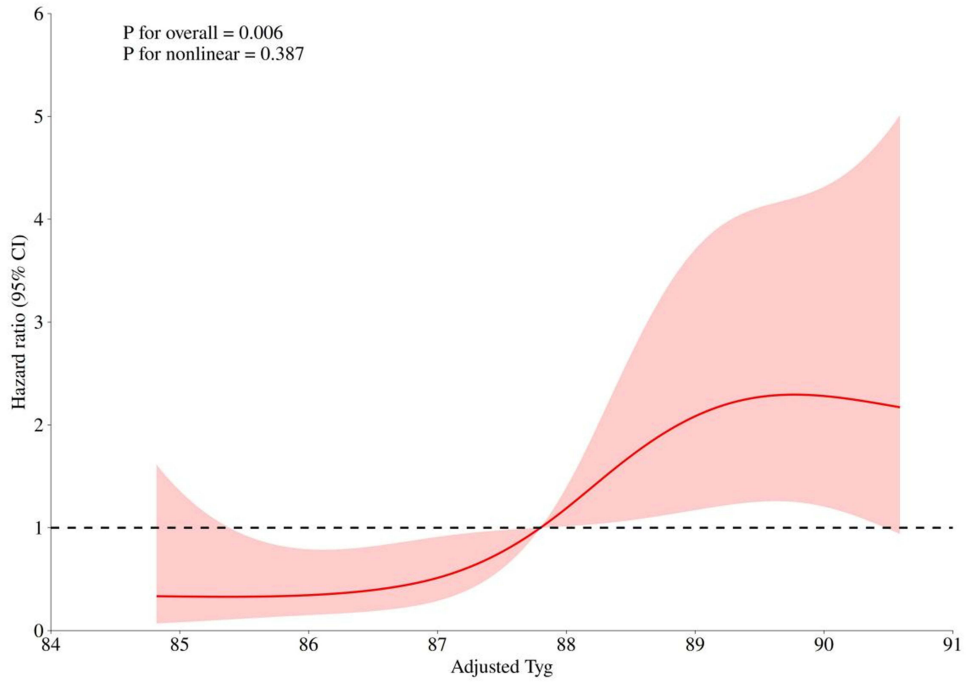

Figure 1 RCS curve of the TyG index.

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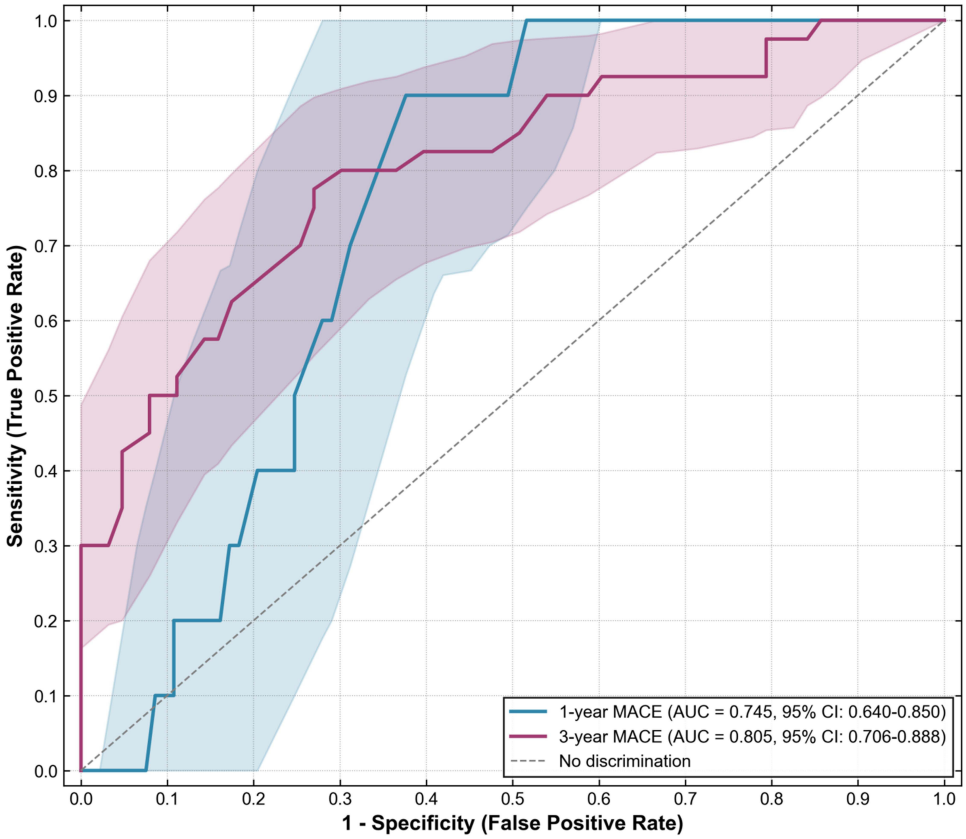

Figure 2 ROC curves for predicting major adverse cardiovascular events at 1 and 3 years in patients with coronary heart disease and HIV.

Subgroup Analysis

Subgroup analyses stratified by sex, smoking status, drinking status, hypertension, diabetes, and hypercholesterolemia were conducted based on Model 3 to further investigate the association between the TyG index and MACE. As illustrated in Figure 3, the overall HR was 1.43 (95% CI: 1.17–1.75, P<0.001). In subgroup analyses, elevated TyG index was significantly associated with increased MACE risk among non-smokers, non-drinkers, and patients without hypertension, diabetes, or hypercholesterolemia, whereas the significance of the association was attenuated in smokers, drinkers, and those with comorbid metabolic diseases. A significant interaction was detected only between smoking status and the TyG index (P for interaction=0.006), while no significant interactions were observed for other stratifying variables (all P>0.05). These results suggested that the predictive effect of the TyG index on MACE risk was consistent across most clinical subgroups, and smoking status could strengthen the magnitude of this association.

Discussion

This retrospective cohort study of 103 CAD-HIV patients systematically investigated the association between the TyG index and the occurrence of MACE in this population. The results demonstrated that the TyG index was associated with MACE in CAD-HIV patients, pending external validation, and exhibited a linear dose–response relationship. Receiver operating characteristic curve analysis indicated that the TyG index had moderate to high predictive performance for short-term and medium-term adverse cardiovascular events in CAD-HIV patients, supporting its use as a simple indicator for clinical risk assessment.

Previous studies have shown that the TyG index is significantly associated with the risks of coronary heart disease[12] and stroke[13] in the general population, independent of traditional cardiovascular risk factors. Among the 103 CAD-HIV patients enrolled in this study, 41 experienced MACE. The baseline TyG index in the MACE group was 8.93 (8.82, 9.02), which was higher than 8.71 (8.62, 8.82) in the Non-MACE group (P<0.001). This finding suggests that a higher TyG index is associated

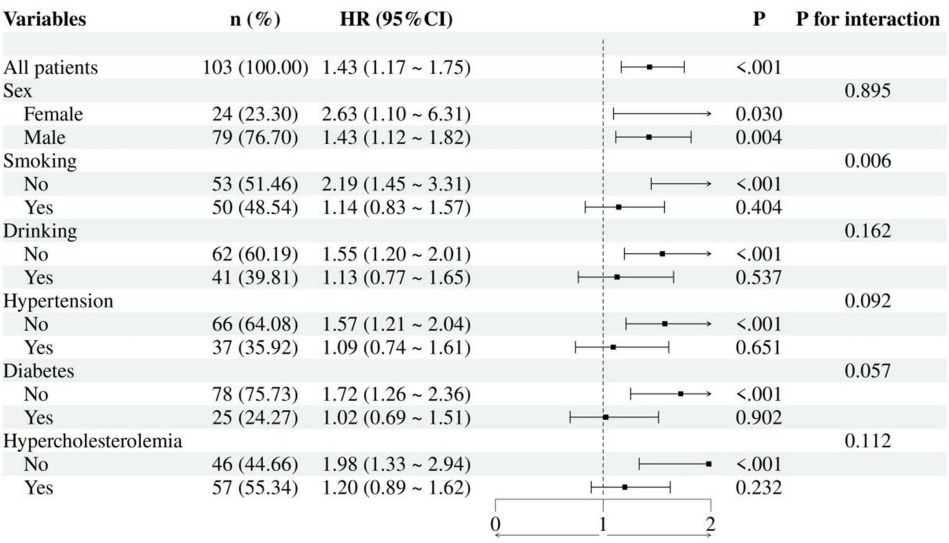

Figure 3 Forest plot of subgroup analysis.

with a greater likelihood of adverse cardiovascular events in these patients, consistent with previous findings in the general population.[14,15] A hypothetical explanation can be derived from HIV-related metabolic pathways. Chronic immune activation, elevated inflammatory responses induced by HIV infection,[4] and long-term ART-related metabolic toxicity[16] can jointly trigger insulin resistance and elevated triglycerides.[17] As the TyG index is an integrated marker composed of lipid-related and glucose-related components, it can sensitively reflect changes in cardiovascular risk in this population.

Multivariate Cox regression analysis showed that after full adjustment for confounding factors, each 0.1-unit increase in the TyG index was associated with a 42% higher risk of MACE (HR=1.42, 95% CI: 1.16–1.74, P<0.001). Using the lowest quartile as the reference, the risk of MACE was 4.42-fold higher in the third quartile (95% CI: 1.17–16.68, P=0.028) and 6.17-fold higher in the fourth quartile (95% CI: 1.77–21.54, P=0.004). This dose–response trend indicated a progressively strengthening association between the TyG index and MACE. With increasing TyG index, the severity of insulin resistance and lipid disorders worsens, accompanied by vascular endothelial injury and increased instability of atherosclerotic plaques. HIV infection itself can further amplify these abnormalities by reducing CD4+ T-cell count, elevating HIV viral load and high-sensitivity C-reactive protein (hsCRP). In the present study, the MACE group had lower CD4+ T-cell counts, higher HIV viral loads, higher hsCRP levels, longer cumulative ART exposure, and a different distribution of ART regimens compared with the Non-MACE group, all of which support this hypothesis. However, the above mechanisms have not been directly verified experimentally and cannot be regarded as definitive conclusions.

Restricted cubic spline analysis indicated a linear positive correlation between the TyG index and MACE risk (P for overall=0.006, P for nonlinear=0.387) with no evidence of deviation from linearity. This suggests that within the observed range of this study, a higher TyG index was associated with a higher risk without an obvious threshold effect, facilitating direct clinical risk stratification by numerical value without the need for complex cutoff definitions. Receiver operating characteristic curve analysis showed that the area under the curve of the TyG index for predicting 1-year MACE was 0.745 (95% CI: 0.640–0.850) and 0.805 (95% CI: 0.706–0.888) for 3-year MACE, indicating moderate to high predictive performance for both short-term and medium-term MACE. This may be because MACE in CAD-HIV patients results from multiple interacting factors, limiting the predictive power of any single marker. Nevertheless, since the TyG index can be calculated using only fasting triglycerides and glucose, with convenient detection and low cost, it can be directly integrated into the clinical decision-making pathway for CAD-HIV patients, including routine admission screening and baseline risk stratification. Repeated measurements during follow-up can allow dynamic monitoring of risk changes, and the stratification results can guide adjustments in hypoglycemic, lipid-lowering intensity and ART regimens to maximize its clinical utility.

Subgroup analysis showed an overall HR of 1.43 (95% CI: 1.17–1.75, P<0.001). A significant interaction was only observed between smoking status and the TyG index (P for interaction=0.006). The association between the TyG index

and MACE was stronger in non-smokers, non-drinkers, and individuals without hypertension, diabetes, or hypercholesterolemia. This may be because smoking and comorbid metabolic diseases are themselves major risk factors for CAD, and their cardiovascular damage may mask or attenuate the effect of the TyG index. These subgroup findings are observational, limited by sample size, and require external cohort validation before widespread application.

Although this study identified an association between the TyG index and MACE in CAD-HIV patients that requires external validation, as well as a certain predictive value for MACE risk, several limitations exist:①This was a single-center retrospective design with a sample size of only 103 patients, which may introduce selection and information biases and affect the stability and generalizability of the results.②The TyG index was calculated only using baseline measurements, without monitoring dynamic changes during follow-up, thus failing to reflect fluctuations after therapeutic interventions.③Although the multivariate adjustment model included a wide range of variables, residual confounding from unmeasured factors such as diet, physical activity, family history of cardiovascular disease, and ART adherence may remain. Meanwhile, high-dimensional models carry a risk of overfitting, which may overestimate the predictive effect of the TyG index.④As an observational study, this research only confirmed a statistical correlation between the TyG index and MACE and cannot infer causality. Further external cohort studies are needed to verify whether the TyG index is an independent risk factor for MACE in CAD-HIV patients.⑤The limited sample size in subgroup analyses reduced the stability of interaction results, requiring cautious interpretation.

Based on the findings of this study, future multicenter prospective cohort studies with larger sample sizes and dynamic monitoring of the TyG index are warranted to further validate its predictive value in CAD-HIV patients. Meanwhile, basic research should be conducted to clarify the direct links between the TyG index and HIV-related immune, inflammatory, and metabolic pathways, providing higher-level evidence for clinical risk stratification and precision management to improve the long-term cardiovascular prognosis of this high-risk population.

Conclusion

This single-center retrospective cohort study demonstrates that an elevated TyG index is associated with an increased risk of MACE in CAD-HIV patients, pending external validation, with a linear dose–response relationship. After multivariate adjustment, the TyG index remains an independent correlate of MACE and shows moderate to good predictive performance for 1-year and 3-year MACE in this population. Subgroup analysis indicates that smoking status modifies the strength of the association between the TyG index and MACE. Therefore, the TyG index can serve as a simple and effective biomarker for cardiovascular risk stratification and early identification in CAD-HIV patients, providing a reference for individualized clinical management.

Data Sharing Statement

The datasets generated and/or analyzed during the current study are not publicly available due to patient privacy and ethical restrictions but are available from the corresponding author upon reasonable request. Data sharing may require approval from the ethics committee of The First Affiliated Hospital of Xinjiang Medical University.

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Author Contributions

Lina Chen (first author): responsible for study conception, writing the original draft, and funding acquisition. Jie Zhou (corresponding author): responsible for patient data collection and participated in manuscript revision. Gang Guo (corresponding author): provided partial funding and oversaw project supervision. Guofeng Fan (second author): participated in data analysis and interpretation, and participated in manuscript revision. Qianru Yuan (third author): assisted in study execution and was responsible for data acquisition. All authors have made substantial contributions to the work, including the conception, design, and implementation of the study; acquisition, analysis, and interpretation of data; participation in manuscript writing, revision, or critical review; final approval of the version to be published;

confirmation of the target journal for submission; and accountability for all aspects of the research work. Additionally, all authors have read and approved the final manuscript.

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Disclosure

The authors affirm that the research was carried out without any commercial or financial affiliations that could be perceived as a potential conflict of interest.

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