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Association of the C-Reactive Protein-Triglyceride-Glucose Index with Risk of Stroke Recurrence in Ischemic Stroke with Atrial Fibrillation

Siyu Sun
Jinling Clinical Medical College, Nanjing Medical University
Kejia Deng
Nanjing Jinling Hospital, Affiliated Hospital of Medical School, Nanjing University
Kang Yuan
Nanjing Jinling Hospital, Affiliated Hospital of Medical School, Nanjing University
Mengdi Xie
Nanjing Jinling Hospital, Affiliated Hospital of Medical School, Nanjing University
Shuxian Huo
Nanjing Jinling Hospital, Affiliated Hospital of Medical School, Nanjing University
Rui Liu
Nanjing Jinling Hospital, Affiliated Hospital of Medical School, Nanjing University
Xiaohao Zhang
Nanjing First Hospital, Nanjing Medical University,
Yi Xie
Nanjing First Hospital, Nanjing Medical University,
Xinfeng Liu
xfliu2@vip.163.com

Jinling Clinical Medical College, Nanjing Medical University

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Abstract

Background

C-reactive protein-triglyceride-glucose index (CTI) has emerged as a novel biomarker for insulin resistance and inflammation. However, the association between CTI and stroke recurrence, particularly in ischemic stroke with atrial fibrillation (AF), remains unclear.

Method

This retrospective study included patients diagnosed with ischemic stroke with AF from January 2013 to December 2019 in the Nanjing Stroke Registry Program. The CTI was calculated as follows: 0.412* Ln (CRP [mg/L]) + Ln (TG [mg/dl] × FPG [mg/dl])/2. The primary outcome was the recurrence of stroke. Cox proportional hazards regression models, Kaplan-Meier (KM) curves, and restricted cubic spline (RCS) analysis were used to investigate the association between CTI and stroke recurrence. The receiver operating characteristics curves (ROC) and the area under the ROC curve (AUC) were established to assess the predictive power of CTI for stroke recurrence.

Results

Among 643 ischemic stroke patients with AF, 16.4% experienced recurrence. The CTI was positively associated with stroke recurrence incidence (Hazard ratio (HR), 1.78; 95% confidence interval (CI), 1.28–2.48; $P < 0.001$). High CTI level had a significant association with risk of recurrence with the lowest tertile of CTI as the reference (HR, 2.24; 95% CI, 1.23–4.10; $P = 0.009$). CTI outperformed the Triglyceride-Glucose (TyG) and Neutrophil to Lymphocyte Ratio (NLR) in predicting stroke recurrence at 1, 3 and 6 years (AUC, 0.626; 95%CI, 0.554–0.697 at 3 years). No significant interaction effect was observed in subgroups.

Conclusion

CTI could serve as a practical indicator for predicting stroke recurrence, potentially as a promising tool for risk stratification and personalized decision-making in stroke patients with AF.

Introduction

Atrial fibrillation (AF), as a major risk of stroke, is responsible for roughly 20–30% of all ischemic stroke cases and is projected to increase annually.[1] Strokes attributed to AF are not only severe, with substantial disability and mortality, but also carry a considerable risk for recurrence.[2,3] Previous research has revealed that a 5.1% risk of stroke recurrence in ischemic strokes with AF, with 65.2% of such

recurrences directly linked to AF.[4] Despite being appropriately anticoagulated, 1%-2% of stroke patients with AF still experience recurrence.[5] Nevertheless, the CHADS2, and CHA2DS2-VASc, designed to forecast thromboembolic risk and guide anticoagulation strategies, show poor predictive value for recurrence in stroke with AF.[6] It is crucial to identify high-risk patients for timely evaluation and immediate preventive treatment.

C-reactive protein-triglyceride-glucose index (CTI) is an novel marker offering comprehensive assessment of both inflammatory status and insulin resistance (IR).[7,8] IR and inflammation play decisive roles in the atherosclerosis and stroke development, disrupting the endothelial functions and structures.[9] CTI combines C-reactive protein (CRP) with the Triglyceride-Glucose (TyG) index. It has been reported that TyG, a surrogate marker for IR, was associated with stroke recurrence and mortality,[10,11] and the similar relationship also has been observed between CPR and stroke recurrence.[12,13] Recent studies indicated a correlation between CTI and stroke risk in individuals with cardiovascular-kidney-metabolic (CKM) disease, as well as those with different glycemic statuses.[14,15] However, no research has examined the relationship between CTI and the risk of stroke recurrence in stroke patients with AF.

Therefore, this study aimed to investigate the association between CTI and the risk of stroke recurrence, among ischemic stroke with AF. This study offered a novel perspective and evidence-based strategies to guide preventive care and therapeutic management of stroke.

Methods

Study population

We included patients diagnosed with ischemic stroke with AF from January 2013 to December 2019 in the Nanjing Stroke Registry Program. The diagnosis of AF was based on the history of AF confirmed by 12-lead electrocardiogram (ECG) or dynamic electrocardiogram (DCG), or newly diagnosed AF during hospitalization.[16] The inclusion criteria were 1) age ≥ 18 years; 2) from the onset of stroke to hospitalization within 7 days; 3) sudden focal neurological deficits persisting for over 24 hours, ischemic infarct lesions confirmed by CT or MRI; 4) definite diagnosis of AF. The exclusion criteria were 1) discharge within 24 hours; 2) no available on CTI and follow-up information. Our study was approved by the Medical Ethics Committee of Affiliated Jinling Hospital of Nanjing University School (2010NLY-018) to exempt informed consent, as it was a retrospective analysis using existing medical records, with no risk to participant identities, privacy, or safety. It was performed in adherence to the ethical standards of the 1964 Helsinki Declaration and its later amendments.

Covariates

Demographic details, medical history, laboratory tests were collected in a standard process. Medical history included hypertension, diabetes mellitus, coronary artery disease (CAD), hyperlipidemia, smoking

status, and alcohol use. Laboratory tests included white blood cell (WBC), neutrophil (NEU), lymphocyte (LYM), platelet, fasting plasma glucose (FPG), total cholesterol (TC), triglycerides (TG), and CRP. Laboratory tests for all patients were conducted within 24 hours of hospital admission. Baseline National Institutes of Health Stroke Scale (NIHSS) scores, CHA2DS2-VASc scores, HAS-BLED scores, type of AF, and type of anticoagulant medication were also collected. The CTI was obtained using the following formula: CTI = 0.412 × Ln (CRP [mg/L]) + Ln (TG [mg/ dl] × FPG [mg/dl])/2.

Clinical outcome

The primary outcome was the recurrence of stroke, defined as the sudden onset of new neurological deficits or a sudden worsening of previous deficits, meeting the definition of ischemic stroke. The secondary outcome were all-cause mortality and 90-day modified Rankin Scale (mRS) score, where mRS ≤ 2 indicated favorable prognosis and > 2 indicated unfavorable prognosis. Participants were flowed up by phone or outpatient visits. Outcomes were determined based on clinical presentation, imaging results, medical records, death certificates, and other available data.

Statistical analysis

Data on baseline characteristics were summarized using frequencies and proportions for categorical variables and means (or medians) with standard deviations (or interquartile range) as appropriate for continuous variables. Differences in baseline characteristics were analyzed using the Fisher exact test or $\chi 2$ test for categorical variables and the t-test or Mann-Whitney U test for continuous outcomes.

CTI was stratified into three groups based on the third quartile values (Q1, 3.63–4.76; Q2, 4.76–5.57; Q3, 5.57–7.48). The restricted cubic spline (RCS) analysis was performed to investigate potential nonlinear associations between CTI and stroke recurrence. Kaplan–Meier (KM) curves were employed to evaluate the incidence of stroke recurrence and mortality in three tertiles.

A Cox proportional hazards regression model was used to investigate the association between CTI and stroke recurrence. Three models were developed for comprehensive analysis: Model 1 was unadjusted; Model 2 was adjusted for age, gender, BMI, hypertension, diabetes mellitus, hyperlipidemia, CAD, smoking status, alcohol use, education, resident, anticoagulation type, antithrombotic therapy; Model 3 was adjusted age, gender, BMI, hypertension, diabetes mellitus, hyperlipidemia, CAD, smoking status, alcohol use, education, resident, anticoagulation type, antithrombotic therapy, NIHSS score, CHA2DS2-VASc score, HAS-BLED score, AF type, FPG, WBC, NLR, TyG.

The receiver operating characteristics (ROC) curves and the area under the ROC curve (AUC) were established to assess the predictive value of CTI, NLR and TyG on stroke recurrence at 1, 3, 6 years. Subgroup analyses were conducted to evaluate potential effect modification by age (≤ 60, >60), gender, hypertension, diabetes mellitus, smoking status, drinking status.

All statistical analyses were conducted using R software (version 4.4.1). Statistical significance was set at a two-sided P-value < 0.05.

Results

Baseline characteristics of population

Among 643 ischemic stroke patients with AF, the median age was 72 years, and 60.5% of patients were males. Compared to those without stroke recurrence, participants who experienced stroke recurrence had higher prevalence rates of diabetes mellitus, hyperlipidemia, CAD, higher CHA2DS2-VASc score and HAS-BLED score and elevated CRP、TG、WBC、NEU、CTI、NLR、TyG. They also exhibited a significant difference in anticoagulation type and antithrombotic therapy (Table 1).

Table 1
Baseline characteristics of study population according to stroke recurrence status.

Characteristics	Overall	Without Recurrence	Recurrence	
	(n = 643)	(n = 537)	(n = 106)	P value
Age, year, median (IQR)	72.0 (65.0, 77.0)	71.0 (64.0, 77.0)	72.5 (67.0, 77.8)	0.111
Males, n (%)	389 (60.5)	333 (62.0)	56 (52.8)	0.097
BMI, kg/m^2	24.4 (22.2, 26.3)	24.3 (22.3, 26.2)	24.7 (22.1, 27.3)	0.198
Medical history				
Hypertension, n (%)	428 (66.6)	349 (65.0)	79 (74.5)	0.074
Diabetes mellitus, n (%)	154 (24.0)	118 (22.0)	36 (34.0)	0.012
Hyperlipidemia, n (%)	22 (3.4)	11 (2.0)	11 (10.4)	< 0.001
Coronary Artery Disease, n (%)	115 (17.9)	86 (16.0)	29 (27.4)	0.008
Smoke, n (%)	205 (31.9)	170 (31.7)	35 (33.0)	0.872
Drink, n (%)	121 (18.8)	102 (19.0)	19 (17.9)	0.903
Education				0.325
Illiterate and Primary School, n (%)	247 (38.4)	198 (36.9)	49 (46.2)	
Junior High School, n (%)	290 (45.1)	247 (46.0)	43 (40.6)	
Senior High School, n (%)	56 (8.7)	49 (9.1)	7 (6.6)	
University and above, n (%)	50 (7.8)	43 (8.0)	7 (6.6)	
Urban Resident, n (%)	380 (59.1)	322 (60.0)	58 (54.7)	0.37
Clinical data				
NIHSS score, median (IQR)	8.0 (3.0, 16.0)	8.0 (3.0, 16.0)	8.0 (3.0, 18.0)	0.504

Abbreviations: BMI, Body Mass Index; NIHSS, National Institute Of Health Stroke Scale; CHA2DS2-VASc, Congestive Heart Failure, Hypertension, Age ≥ 75 (Doubled), Diabetes Mellitus, Prior Stroke Or Transient Ischemic Attack (Doubled), Vascular Disease, Age 65–74, Female; HAS-BLED, Hypertension, Abnormal Renal/Liver Function, Stroke, Bleeding History Or Predisposition, Labile INR, Elderly>65, Drugs/Alcohol Concomitantly; AF, Atrial Fibrillation; CRP, C-Reactive Protein; GLU, Glucose; TC, Total Cholesterol; TG, Triglyceride; HDL, High-Density Lipoprotein; LDL, Low-Density Lipoprotein; WBC, While blood cells; NEU, Neutrophil; LYM, Lymphocyte; CTI, C-Reactive Protein-Triglyceride Glucose Index; NLR, Neutrophil To Lymphocyte Ratio; TyG, Triglyceride-Glucose Index; DOAC, Direct Oral Anticoagulants; VKA, Vitamin K Antagonist; LMWH, Low Molecular Weight Heparin.

Characteristics	Overall	Without Recurrence	Recurrence	
	(n = 643)	(n = 537)	(n = 106)	P value
CHA2DS2-VASc score, median (IQR)	5.0 (3.5, 6.0)	5.0 (3.0, 6.0)	5.0 (4.0, 6.0)	< 0.001
HAS-BLED score, median (IQR)	3.0 (2.0, 4.0)	3.0 (2.0, 4.0)	3.0 (3.0, 5.0)	0.046
AF type				
Continuous AF, n (%)	406 (63.1)	339 (63.1)	67 (63.2)	1
Non-valvular AF, n (%)	602 (93.6)	500 (93.1)	102 (96.2)	0.326
Laboratory data				
CRP, mg/L, median (IQR)	3.6 (0.9, 15.2)	2.8 (0.7, 14.2)	7.8 (2.0, 21.9)	< 0.001
GLU, mg/dL, median (IQR)	104.4 (90.0, 133.2)	104.4 (88.2, 131.4)	109.8 (94.0, 147.6)	0.083
TC, mg/dL, median (IQR)	152.9 (37.9)	151.9 (36.3)	157.7 (44.7)	0.216
TG, mg/dL, median (IQR)	93.9 (70.9, 123.1)	92.1 (70.9, 123.1)	102.3 (80.8, 122.4)	0.017
HDL, mg/dL, median (IQR)	42.6 (13.1)	42.8 (13.5)	41.7 (11.3)	0.347
LDL, mg/dL, median (IQR)	90.9 (31.0)	89.9 (29.9)	96.0 (35.8)	0.101
WBC, 10^9/L, median (IQR)	7.6 (6.2, 9.7)	7.5 (6.2, 9.5)	8.5 (6.5, 10.5)	0.013
NEU, %, median (IQR)	63.3 (0.2, 77.6)	61.9 (0.2, 75.9)	74.2 (15.3, 81.2)	0.001
LYM, %, median (IQR)	13.0 (11.6)	12.9 (11.8)	13.4 (10.6)	0.635
CTI, median (IQR)	5.2 (4.6, 5.8)	5.1 (4.6, 5.7)	5.4 (4.8, 6.1)	< 0.001
NLR, median (IQR)	2.4 (0.1, 5.3)	2.2 (0.1, 4.8)	3.8 (1.1, 6.3)	0.002
TyG, mg/dL, median (IQR)	8.6 (0.6)	8.5 (0.5)	8.8 (0.7)	0.003
CTI quartile				0.003

Abbreviations: BMI, Body Mass Index; NIHSS, National Institute Of Health Stroke Scale; CHA2DS2-VASc, Congestive Heart Failure, Hypertension, Age ≥ 75 (Doubled), Diabetes Mellitus, Prior Stroke Or Transient Ischemic Attack (Doubled), Vascular Disease, Age 65–74, Female; HAS-BLED, Hypertension, Abnormal Renal/Liver Function, Stroke, Bleeding History Or Predisposition, Labile INR, Elderly>65, Drugs/Alcohol Concomitantly; AF, Atrial Fibrillation; CRP, C-Reactive Protein; GLU, Glucose; TC, Total Cholesterol; TG, Triglyceride; HDL, High-Density Lipoprotein; LDL, Low-Density Lipoprotein; WBC, While blood cells; NEU, Neutrophil; LYM, Lymphocyte; CTI, C-Reactive Protein-Triglyceride Glucose Index; NLR, Neutrophil To Lymphocyte Ratio; TyG, Triglyceride-Glucose Index; DOAC, Direct Oral Anticoagulants; VKA, Vitamin K Antagonist; LMWH, Low Molecular Weight Heparin.

Characteristics	Overall	Without Recurrence	Recurrence	
	(n = 643)	(n = 537)	(n = 106)	P value
Low Level, n (%)	215 (33.4)	193 (35.9)	22 (20.8)	
Medium Level, n (%)	215 (33.4)	179 (33.3)	36 (34.0)	
High Level, n (%)	213 (33.1)	165 (30.7)	48 (45.3)	
Anticoagulation type				0.019
None, n (%)	177 (27.5)	136 (25.3)	41 (38.7)	
DOAC, n (%)	304 (47.3)	267 (49.7)	37 (34.9)	
VKA, n (%)	124 (19.3)	103 (19.2)	21 (19.8)	
LMWH, n (%)	38 (5.9)	31 (5.8)	7 (6.6)	
Antithrombotic therapy				< 0.001
Anticoagulation, n (%)	299 (46.5)	274 (51.0)	25 (23.6)	
Antiplatelet, n (%)	121 (18.8)	95 (17.7)	26 (24.5)	
Both, n (%)	167 (26.0)	127 (23.6)	40 (37.7)	
None, n (%)	56 (8.7)	41 (7.6)	15 (14.2)	
Outcome				
Death, n (%)	159 (24.7)	127 (23.6)	32 (30.2)	0.193
Death Time, y, median (IQR)	1.7 (0.4, 3.4)	1.7 (0.4, 3.4)	1.5 (0.5, 3.8)	0.571

Abbreviations: BMI, Body Mass Index; NIHSS, National Institute Of Health Stroke Scale; CHA2DS2-VASc, Congestive Heart Failure, Hypertension, Age ≥ 75 (Doubled), Diabetes Mellitus, Prior Stroke Or Transient Ischemic Attack (Doubled), Vascular Disease, Age 65–74, Female; HAS-BLED, Hypertension, Abnormal Renal/Liver Function, Stroke, Bleeding History Or Predisposition, Labile INR, Elderly>65, Drugs/Alcohol Concomitantly; AF, Atrial Fibrillation; CRP, C-Reactive Protein; GLU, Glucose; TC, Total Cholesterol; TG, Triglyceride; HDL, High-Density Lipoprotein; LDL, Low-Density Lipoprotein; WBC, While blood cells; NEU, Neutrophil; LYM, Lymphocyte; CTI, C-Reactive Protein-Triglyceride Glucose Index; NLR, Neutrophil To Lymphocyte Ratio; TyG, Triglyceride-Glucose Index; DOAC, Direct Oral Anticoagulants; VKA, Vitamin K Antagonist; LMWH, Low Molecular Weight Heparin.

Association between CTI and stroke recurrence

During the follow-up period, 16.4% (106/643) of participants experienced stroke recurrence, and 24.7% (159/643) experienced all-cause deaths (**Supplement** Table 1**)**. The RCS analysis demonstrated a significant positive linear relationship between CTI and stroke recurrence in the population (*P* for nonlinearity = 0.205; Fig. 1).

CTI was positively associated with stroke recurrence, with 78% rise for per unit of CTI increase (Modle1 HR, 1.95; 95% CI, 1.52–2.49; P < 0.001; Modle2 HR, 2.01; 95% CI, 1.54–2.61; *P* < 0.001; Modle3 HR, 1.78; 95% CI, 1.28–2.48; *P* < 0.001, Table 2). When categorized into three tertiles, participants in high level had a significant association with increased recurrence risk compared to low level (Modle1 HR, 2.78; 95% CI, 1.68–4.60; *P* < 0.001; Modle2 HR, 2.98; 95% CI, 1.77–5.02; *P* < 0.001; Modle3 HR, 2.24; 95% CI, 1.23–4.10; *P* = 0.009, Table 2).

Table 2
Association between the CTI and stroke recurrence.

Variable	**Modle1**		**Model 2**		**Model 3**	
	HR (95% CI)	***P* value**	**HR (95% CI)**	***P* value**	**HR (95% CI)**	***P* value**
CTI (per 1 unit)	1.95 (1.52–2.49)	< 0.001	2.01 (1.54–2.61)	< 0.001	1.78 (1.28–2.48)	< 0.001
CTI quartile						
Low Level	Ref		Ref		Ref	
Medium Level	1.69 (0.99–2.87)	0.053	1.66 (0.96–2.89)	0.072	1.54 (0.87–2.72)	0.135
High Level	2.78 (1.68–4.60)	< 0.001	2.98 (1.77–5.02)	< 0.001	2.24 (1.23–4.10)	0.009
Model 1: Unadjusted.						
Model 2: Adjusted for Age, Gender, BMI, Hypertension, Diabetes mellitus, Hyperlipidemia, Coronary Artery Disease, Smoke, Drink, Education, Resident, Anticoagulation Type, Antithrombotic therapy.						
Model 3: Adjusted for Age, Gender, BMI, Hypertension, Diabetes mellitus, Hyperlipidemia, Coronary Artery Disease, Smoke, Drink, Education, Resident, Anticoagulation Type, Antithrombotic therapy, NIHSS, CHA2DS2-VASc score, HAS-BLED score, AF type, GLU, WBC, NLR, TyG.						
Abbreviations: BMI, Body Mass Index; NIHSS, National Institute Of Health Stroke Scale; CHA2DS2-VASc, Congestive Heart Failure, Hypertension, Age ≥ 75 (Doubled), Diabetes Mellitus, Prior Stroke Or Transient Ischemic Attack (Doubled), Vascular Disease, Age 65–74, Female; HAS-BLED, Hypertension, Abnormal Renal/Liver Function, Stroke, Bleeding History Or Predisposition, Labile INR, Elderly>65, Drugs/Alcohol Concomitantly; GLU, Glucose; WBC, White Blood Cell; NLR, Neutrophil-to-Lymphocyte Ratio; TyG, Triglyceride-Glucose Index.						

KM curves revealed a reduction of survival probability for both stroke recurrence and mortality with CTI tertiles increased. Survival probabilities for both stroke recurrence and mortality were lowest in the highest CTI tertile (Fig. 2).

Subgroup analyses

The consistent association between CTI and risk of stroke recurrence was maintained across subgroups defined by age, gender, hypertension, diabetes mellitus, smoking status, alcohol use. However, no

significant interaction effect was observed in subgroups (all P > 0.05, Fig. 3).

Predictive performance of CTI for stroke recurrence

Compared to NLR and TyG (**Fig.S1**), CTI had higher AUC values on stroke recurrence at 1 year, 3 years, and 6 years (Fig. 4). The AUC values and corresponding 95%CI of CTI on stroke recurrence were 0.624 (0.546–0.702) at 1year, 0.626 (0.554–0.697) at 3 years, and 0.583 (0.407–0.696) at 6 years, indicating best predictive performance at 3 years.

Discussion

To the best of our knowledge, this study was the first to investigate the association between CTI and stroke recurrence in ischemic stroke with AF patients. Our findings revealed a significant positive linear relationship between CTI and the recurrence of stroke. High level CTI was associated with an increased risk of stroke recurrence compared to the lowest level CTI. This association persisted across all subgroups. Compared to NLR and TyG, CTI demonstrated superior predictive power.

AF-related stroke was associated with a poorer prognosis, driving the development of predictive tools for outcome.[17] Notably, blood markers targeting inflammatory and metabolic pathways have emerged as ideal candidates for convenience, cost-effectiveness and strong predictive power. CTI captured two central and interacting mechanisms of stroke by incorporating both IR and inflammatory component. [18]

CTI was a practical indicator for assessing the risk of stroke recurrence and stroke. A pooled analysis involving 10,443 participants from the China Health and Retirement Longitudinal Study (CHARLS) reported a positive linear association between CTI and stroke recurrence in individuals with different glycemic statuses.[15] Another research from CHARLS revealed CTI had superior predictive accuracy compared to TyG in patients with CKM.[14] Several studies had been conducted on stroke incidence across different populations, including those with hypertension[19], patients undergoing percutaneous coronary intervention[20], and middle-aged and older individuals[21]. However, despite extensive researches on CTI, a powerful predictor for stroke recurrence in AF with stroke remained underexplored. Our study addressed this critical gap.

In our study, CTI showed superior predictive performance to TyG for stroke recurrence; TyG has been recognized as an predictor for recurrence across diverse populations,[11,22] which further validated CTI's optimal predictive value. Previous researches have explored the predictive potential of various biomarkers. Lipoprotein a, Red blood cell distribution width (RDW) has the AUC of 0.685 and 0.695 for incidence of stroke in AF patients.[23] Tumor Necrosis Factor-α (TNF-α), Interleukin-6 (IL-6) and von Willebrand Factor (vWF) showed predictive performance with AUCs of 0.77, 0.74 and 0.81 respectively.[24] A nomogram model integrating NLR, RDW, Lipoprotein a, Systolic pressure, history of stroke, hyperlipidemia, and HDL-C potentially surpassed CHA2DS2-VASc scoring system, achieving a high AUC of 0.915.[25] Our work has expanded upon this foundation, further advancing the field.

Several mechanisms accounted for the correlation between CTI and stroke recurrence. IR significantly contributed to stroke pathogenesis, by impairing endothelium function and promoting platelet adhesion, activation and aggregation.[26,27] IR accelerated progression of atherosclerosis and exacerbated of preexisting atherosclerotic stenosis.[28] Moreover, the inflammatory response triggered by IR also facilitated atherosclerotic progression, due to the bidirectional regulatory crosstalk between inflammation and IR.[29] Notably, inflammation could reinforce atherosclerosis and vascular injury by independently contributing to endothelial dysfunction, cytokine release, and oxidative stress.[30]

Limitation

This study has several limitations. Firstly, this study was an observational study conducted at a single center, potentially introducing biases related to regional characteristics, healthcare context, and patient demographics. Future research should employ multicenter data to enhance generalizability. Secondly, many patients had incomplete clinical and laboratory data. Thirdly, the performance of the predictive model might be compromised due to the influence of unadjusted confounding factors. Furthermore, the absence of tracking changes in TyG and CRP over time prevented us from determining of the association between CTI trajectory and stroke risk.

Conclusion

In summary, CTI was positively associated with stroke recurrence. It outperformed than TyG and NLR in predicting the recurrence of stroke, suggesting that CTI could serve as a predictive biomarker in ischemic stroke with AF.

Abbreviations

Area under the ROC curve (AUC), Atrial fibrillation (AF), Baseline National Institutes of Health Stroke Scale (NIHSS), Cardiovascular-kidney-metabolic (CKM), China Health and Retirement Longitudinal Study (CHARLS), Coronary artery disease (CAD), C-reactive protein (CRP), C-reactive protein-triglyceride-glucose index (CTI), Dynamic electrocardiogram (DCG), Electrocardiogram (ECG), Fasting plasma glucose (FPG), Insulin resistance (IR), Interleukin-6 (IL-6), Kaplan–Meier (KM), Lymphocyte (LYM), Modified Rankin Scale (mRS), Neutrophil (NEU), Receiver operating characteristic (ROC) , Restricted cubic spline (RCS), Total cholesterol (TC), Triglycerides (TG), Triglyceride-glucose (TyG), Tumor necrosis factor-α (TNF-α), von Willebrand factor (vWF), White blood cell (WBC).

Declarations

Ethics approval and consent to participate

Our study was approved by the Medical Ethics Committee of Affiliated Jinling Hospital of Nanjing University School (2010NLY-018) to exempt informed consent, as it was a retrospective analysis using existing medical records, with no risk to participant identities, privacy, or safety.

Consent for publication

All authors have declared no conflicts of interest with respect to the authorship or publication of this article

Availability of data and materials

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

K.Y., S.Y.S, and R. L. were included in the conceptualization and the design of the study; K. Y., S.Y.S., K.J.D acquired and analyzed the data; R. L. and X.F. L. were involved in the supervision of the study; S.Y.S. drafted the manuscript; X.H.Z, M.D.X, S.X.H, Y.X were involved in the modification of the manuscript.

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Figures

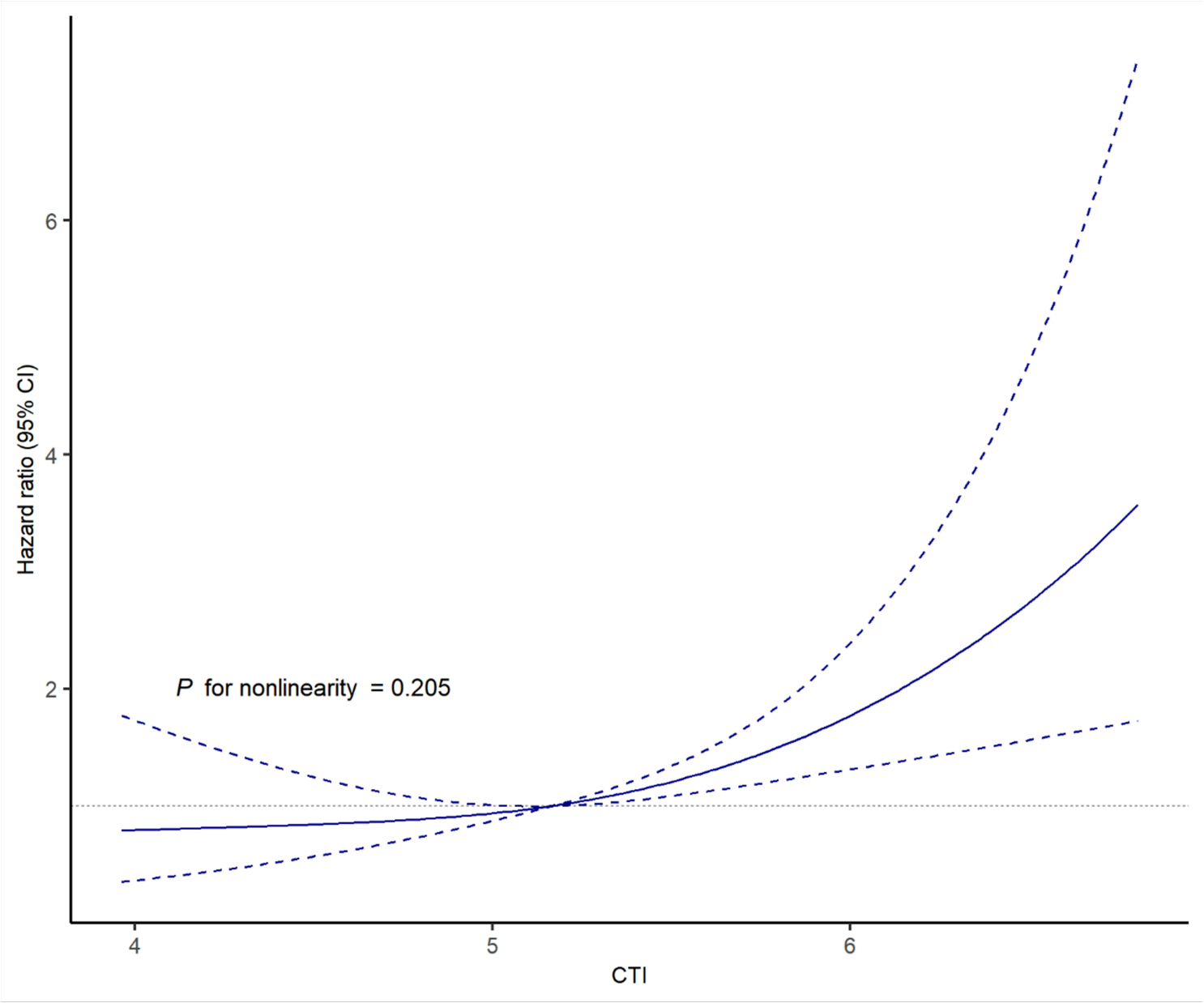


Figure 1

Restricted cubic spline of relationship between CTI and stroke recurrence

Abbreviations: CTI, C-Reactive Protein-Triglyceride-Glucose Index.

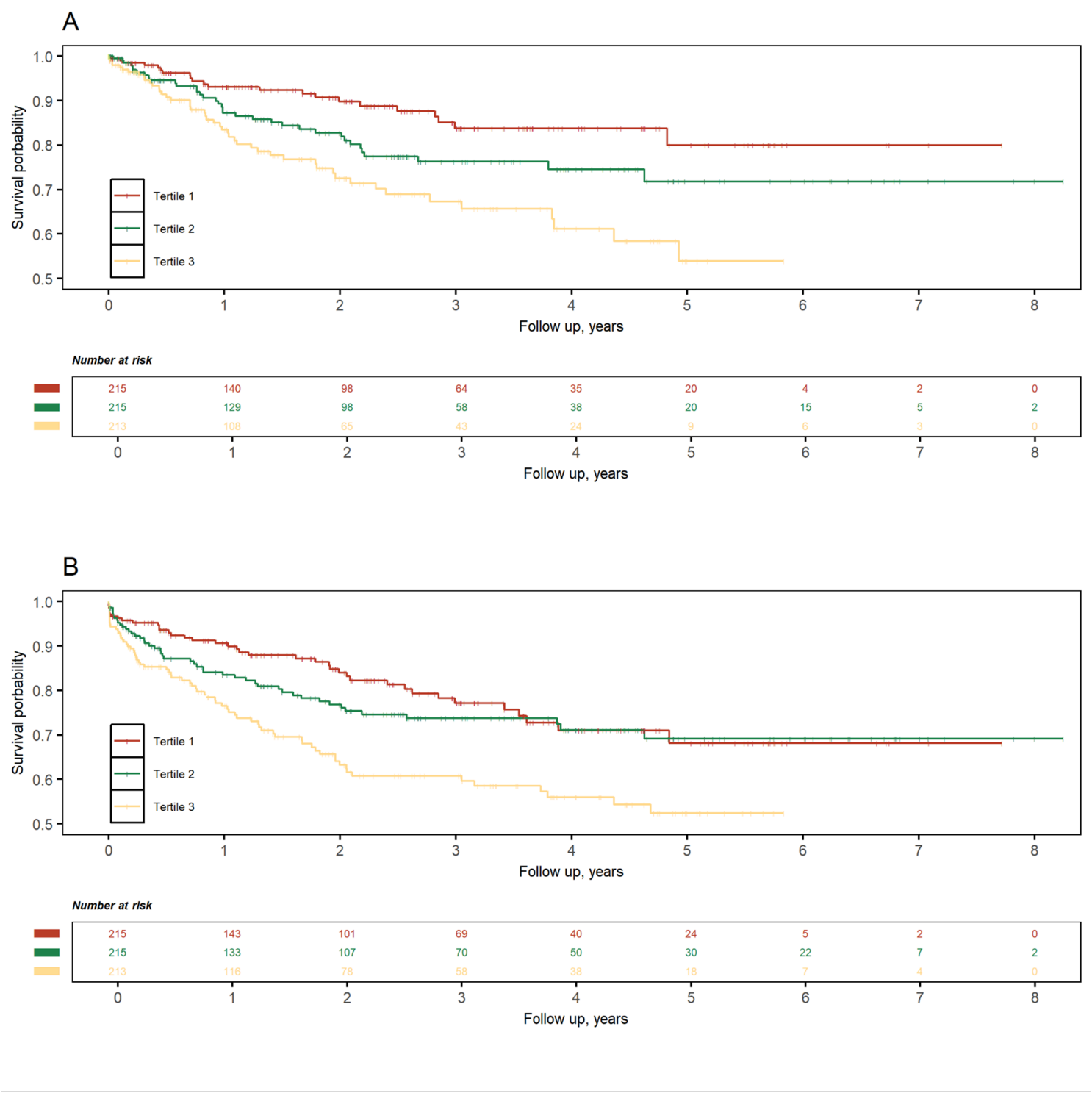


Figure 2

Kaplan–Meier analysis of survival probability across CTI tertiles

Abbreviations: CTI, C-Reactive Protein-Triglyceride-Glucose Index.

A. for stroke recurrence; B. for all-cause death.

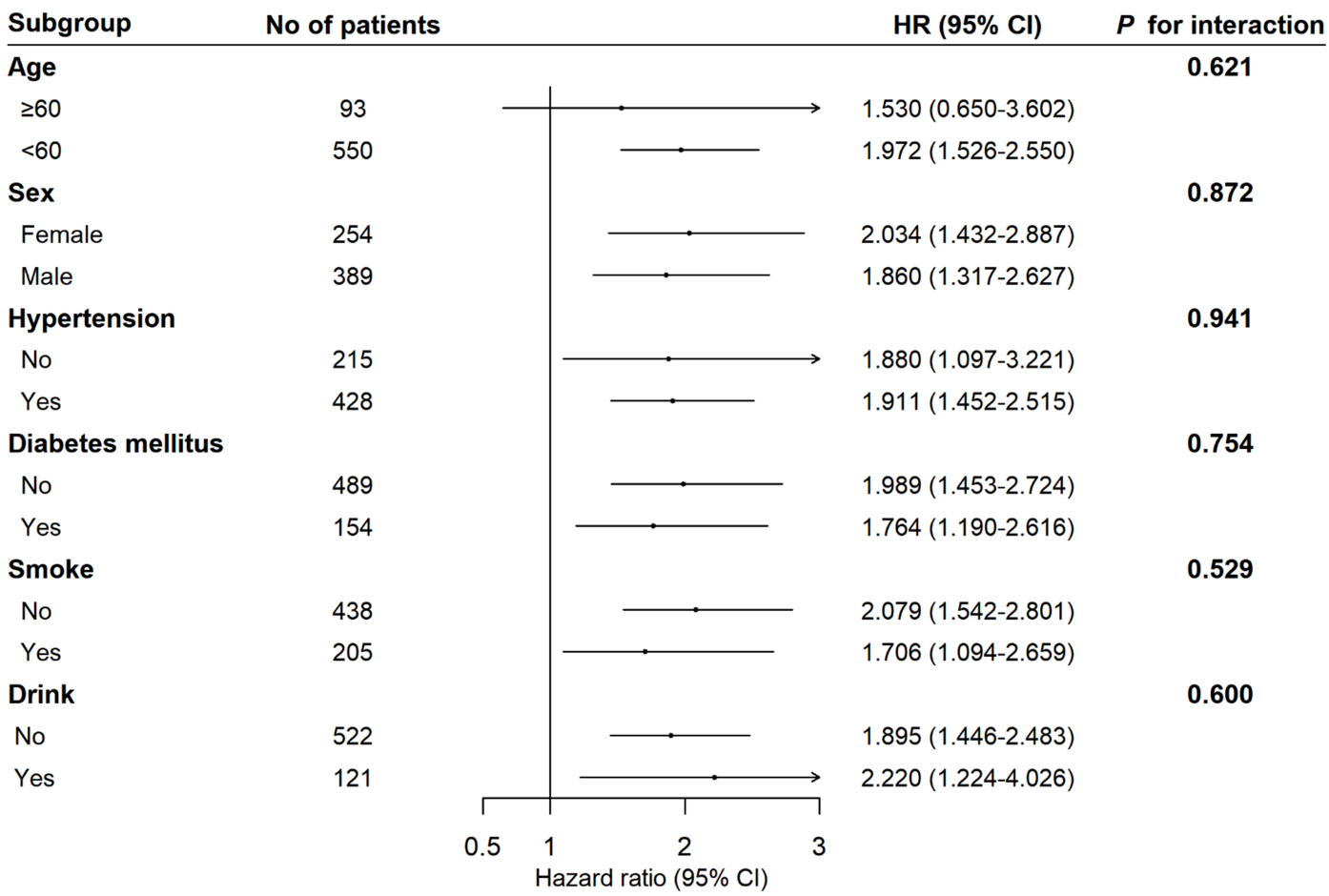


Figure 3

Subgroup analysis for the association between CTI and stroke recurrence

Abbreviations: CTI, C-Reactive Protein-Triglyceride-Glucose Index.

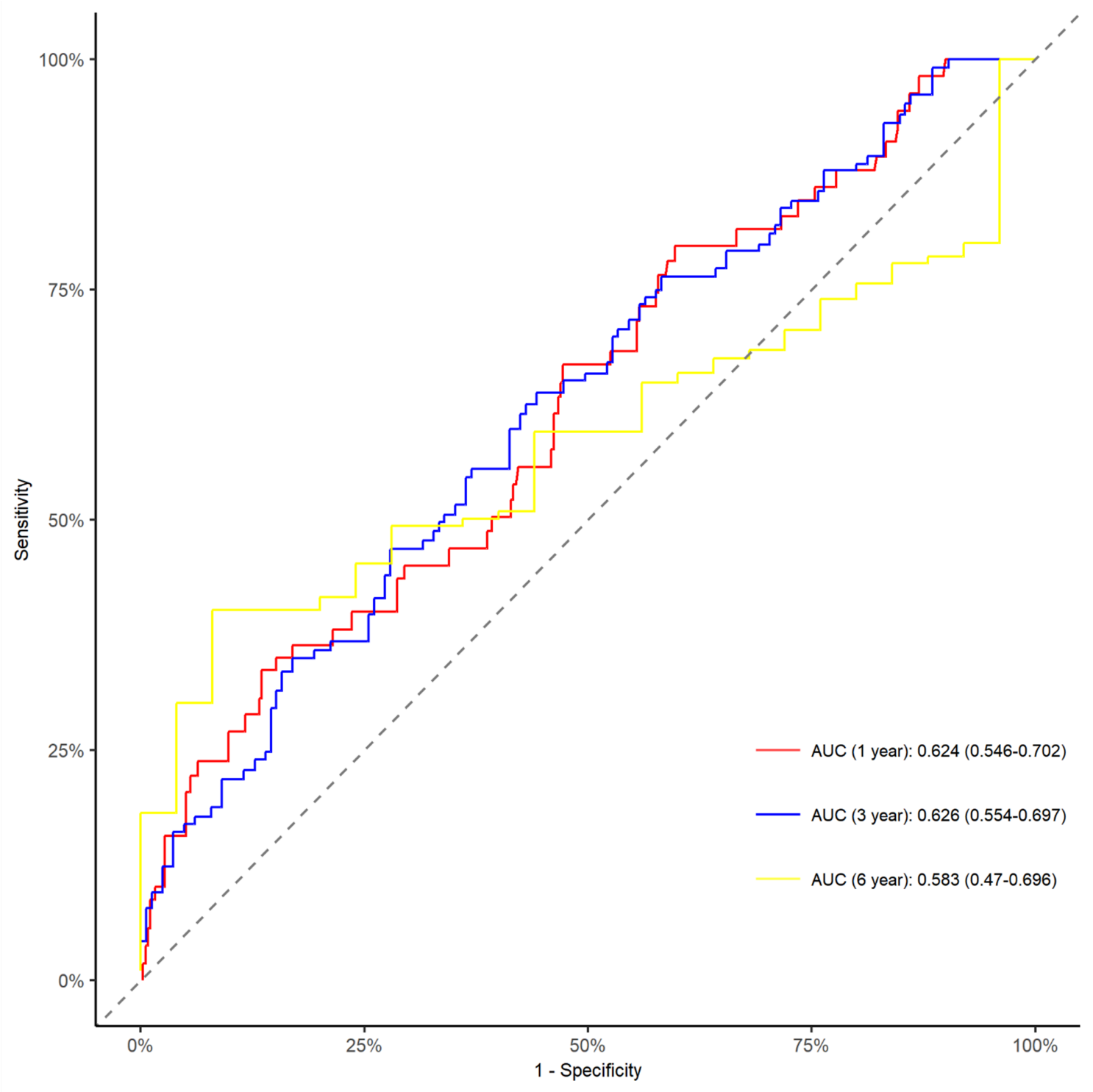


Figure 4

Time-dependent ROC curves for CTI in stroke recurrence prediction

Abbreviations: CTI, C-Reactive Protein-Triglyceride-Glucose Index; ROC,The receiver operating characteristics curves.

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