A Comparative Study of Risk Factors and Prognosis in Young and Elderly Patients with Acute ST-Segment Elevation Myocardial Infarction

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Abstract: *Objective:* To investigate the differences in risk factors and prognosis between young and elderly patients with acute ST-segment elevation myocardial infarction (STEMI) so as to provide a basis for the prevention of young patients with acute STEMI. *Methods:* Patients initially diagnosed with STEMI in the 920th Hospital of Joint Logistic Support Force of PLA from January 1, 2018 to December 31, 2022 were retrospectively enrolled in this study. A total of 235 STEMI patients aged ≤ 45 years old and 532 STEMI patients aged ≥ 65 years old were screened. The baseline characteristics, laboratory indicators, clinical characteristics, coronary angiography, SYNTAX score and major adverse cardiovascular events (MACE) during 1-year follow-up were analyzed and compared. *Results:* A total of 767 STEMI patients were enrolled, including 235 in the young group and 532 in the elderly group. Among the STEM patients in the young group, 224 cases were male, and smoking and drinking were common. Compared with the elderly group, the young group had shorter hospital stays and more family history of ischemic heart disease (IHD). The level of low-density lipoprotein in the young group was higher than that in the old group, while the level of high-density lipoprotein in the young group was lower than that in the old group. The level of high uric acid and homocysteine in the young group was significantly higher than that in the old group. The main cause of STEMI in the young group was fatigue, and the most common symptom was angina pectoris. Coronary angiography showed that single vessel disease was more common in the young group than in the elderly group, and the lesion in the young group was the left anterior descending artery. The SYNTAX score was significantly lower in the young group than in the elderly group according to the anatomical characteristics of coronary artery disease. In the forest plot, diabetes mellitus and a family history of IHD showed a trend of major adverse cardiovascular events (MACE) in both groups. *Conclusion:* Males, smokers, alcohol drinkers and family history of ischemic heart disease are more common in young patients. Common risk factors include fatigue, hyperuricemia, hyperlipidemia and so on. In addition, age itself is an independent risk factor. Management of diabetes, hyperuricemia, and homocysteine levels is essential to reduce the incidence of cardiovascular events in young patients. By controlling these factors, the incidence of young patients with acute STEMI can be effectively prevented and the corresponding prevention and treatment basis can be provided.

Keywords: Acute ST-segment elevation myocardial infarction; Young people; Elderly people; Risk factors

1. Introduction

According to surveys, the prevalence of cardiovascular disease (CVD) is increasing year by year, and the annual mortality rate of myocardial infarction (MI) is 17%. MI is still one of the main causes of death in the world, which seriously endangers human physical and mental health [1]. Asia is one of the regions with the highest incidence of cardiovascular diseases in the world [2]. According to the survey, by 2023, the number of people with coronary heart disease in Asia will exceed that in other regions [3]. Developing countries have an increased risk of acute myocardial infarction (AMI) and an earlier onset of AMI than developed countries [4]. The aim of this study is to investigate the risk factors, clinical characteristics, laboratory parameters, coronary angiography and prognostic factors of STEMI in young people aged ≤ 45 years and ≥ 65 years old, and to provide evidence for the prevention of STEMI in young people in China.

2. Research methods

2.1. Study population

Patients admitted to the 920th Hospital of the Joint Logistics Support Force of the People's Liberation Army from January 2018 to January 2022 who were first diagnosed with STEMI according to the new clinical classification of acute myocardial infarction and underwent PCI within 12 hours were retrospectively analyzed. A total of 235 STEMI patients aged ≤ 45 years old and 532 STEMI patients aged ≥ 65 years old were enrolled.

2.2. Inclusion and exclusion indicators

Inclusion criteria: patients with a definite diagnosis of first acute ST-segment elevation myocardial infarction after admission. Exclusion criteria included chronic liver and kidney insufficiency, pulmonary heart disease, malignant tumour, haematological disease, acute inflammatory or infectious disease, immunodeficiency disease, heart valve disease, etc., and patients with incomplete hospitalization data.

2.3. Baseline data and laboratory indicators

Through the database of the cardiology center of our hospital and electronic medical records, the following were measured:

(1) Baseline data (age, gender, MBI, history of hypertension, history of diabetes, history of smoking, history of drinking, family history of ischemic heart disease, length of hospital stays).

(2) Laboratory indicators: triglyceride (TG), total cholesterol (TC), low-density lipoprotein (LDL), high-density lipoprotein (HDL), fasting blood glucose, C-reactive protein (CRP), serum creatinine (CR), uric acid (UA), homocysteine (HCY), creatine kinase isoenzyme (CK-MB).

(3) Angiography: All subjects underwent coronary angiography (CAG) within 12 months after STEMI. This article describes the procedure of CAG and the evaluation criteria for coronary artery lesions, and the results were evaluated by two independent, experienced associate directors and/or attending physicians. Coronary artery stenosis was defined as a greater than 50% reduction in lumen diameter in any of the three coronary arteries or their major branches. Statistical analysis was performed by the number of single-vessel diseased vessels and multivessel diseased vessels on coronary angiography.

(4) The SYNTAX score was calculated using the website (www.syntaxscore.com) based on the coronary angiography data before PCI. The SYNTAX score was calculated by the Cardiovascular interventional Imaging Analysis Core Laboratory of the 920th Hospital of the Joint Logistics Support Force of PLA. The subjects were divided into 3 groups according to SYNTAX score. SYNTAX score ≤ 22 was de-

fined as 'low group, 22 < SYNTAX score ≤ 32 was defined as medium group, and SYNTAX score > 32 was defined as high group.

(5) KiLLip classification: Killip classification was evaluated according to cardiac function damage in acute myocardial infarction: Grade I (no signs of heart failure, but pulmonary capillary wedge pressure can be increased, mortality 0–5%), grade II (mild to moderate heart failure, pulmonary rales appear in less than 50% of both lung fields, third heart sound gallops, persistent sinus tachycardia or other arrhythmias, increased venous pressure, pulmonary congestion X-ray findings, mortality 10–20%). Grade III (moderate heart failure, acute pulmonary oedema, pulmonary rales appear more than 50% of both lungs, fatality rate 35–49%). Grade IV (cardiogenic shock, systolic blood pressure < 90 mmHg, urine < 20 mL/hour, clammy skin, cyanosis, accelerated respiration, pulse rate > 100 beats/min, mortality 85–90%).

(6) Comparative analysis of clinical characteristics: Clinical symptoms such as precordial pain, sweating, and dyspnea were compared and analyzed, and patients with obvious inducements such as fatigue, staying up late, emotional excitement, excessive exercise, and cold stimulation were compared and analyzed.

2.4. Follow-up results

Telephone and clinical follow-ups were conducted at 30 days, 3 months, 6 months and 12 months after discharge, and the median follow-up time was 5.5 months. The main follow-up visit recorded adverse cardiovascular events within 1 year, including death, recurrent myocardial infarction, cardiogenic shock, malignant arrhythmia, stroke, rehospitalization for heart failure and recurrence of angina pectoris. The above adverse cardiovascular events were statistically analyzed.

2.5. Statistical analysis

SPSS 26.0 was used for statistical analysis. Measurement data in accordance with normal distribution were expressed in the form of, and the differences between the two groups were compared using the independent sample t-test. The measurement data that did not meet the normal distribution were expressed in the form of M (Q1, Q3), and the nonparametric rank sum test was used. Count data were expressed in the form of n (%) and analyzed by chi-square test. $P < 0.05$ was considered statistically significant.

3. Results

3.1. Baseline characteristics

The baseline characteristics of the enrolled population are shown in **Table 1**. The mean age of the young group (≤ 45 years old) and the older group (≥ 65 years old) was 38.67 ± 5.45 years old and 72.65 ± 5.53 years old, respectively ($P < 0.001$). Compared with the elderly group, the young group had more males that is, 95.3% and 68% ($P < 0.01$), smokers of 85.5% and 47.2% ($P < 0.01$), and alcohol drinkers of 77.4% 26.9% ($P < 0.01$), family history of ischemic heart disease (IHD) of 23.8% and 7.5%, ($P < 0.01$), respectively. All the differences were statistically significant ($P < 0.05$). The prevalence of hypertension and diabetes was lower in the young group than in the elderly group (16.6% vs 60.9%, 5.1% vs 23.1%, respectively, $P < 0.01$).

Table 1 Comparison of baseline characteristics between the two groups

Variables	Age ≤ 45 (*n* = 235)	Age ≥ 65 (*n* = 532)	*P* value
Age (years)	38.67 ± 5.45	72.65 ± 5.53	< 0.001
Gender (male/female)	224/11	362/170	< 0.001
BMI* (kg/m^2)	24.3 ± 3.8	24.66 ± 3.93	0.236
Smoking history	201 (85.5)	251 (47.2)	< 0.001
Drinking history	182 (77.4)	143 (26.9)	< 0.001
History of hypertension	39 (16.6)	324 (60.9)	< 0.001
History of diabetes	12 (5.1)	123 (23.1)	< 0.001
Family history of IHD†	56 (23.8)	40 (7.5)	< 0.001
Length of stay	10.62 ± 3.75	15.69 ± 4.52	< 0.001

*BMI: Obesity index
†IHD: Ischemic heart disease

3.2. Laboratory indicators

The laboratory indexes of the enrolled population are shown in **Table 2**. The TG (2.41 ± 1.95 vs 1.19 ± 1.16, *P* < 0.01) and LDL-C (3.22 ± 1.46 vs 3.02 ± 1.11, *P* = 0.037) of the young group were higher than those of the elderly group, while HDL-C was lower in the young group than in the elderly group (1.07 ± 0.37 vs 1.18 ± 0.36, *P* < 0.001). In addition, the levels of UA (443.32 ± 188.86 vs 364.53 ± 108.98, *P* < 0.001) and HCY (16.42 ± 6.7 vs 14.37 ± 12.7, *P* = 0.020) in the young group were significantly higher than those in the elderly group. However, there was no significant difference in the levels of CRP, Cr and CK-MB between the two groups.

Table 2 Comparison of laboratory indexes in different age groups

Variables	Age ≤ 45 (*n* = 235)	Age ≥ 65 (*n* = 532)	t	*P*-value
TG (mmol/L)	2.41 ± 1.95	1.19 ± 1.16	10.738	< 0.001
TC (mmol/L)	6.19 ± 2.16	6.28 ± 28.17	0.047	0.962
LDL-C (mmol/L)	3.22 ± 1.46	3.02 ± 1.11	2.089	0.037
HDL-C (mmol/L)	1.07 ± 0.37	1.18 ± 0.36	3.956	< 0.001
Fasting blood glucose (mmol/L)	7.45 ± 1.11	7.84 ± 2.44	2.355	0.019
Serum creatinine (μmmol/L)	83.96 ± 15.12	84.73 ± 48.09	0.241	0.810
Uric acid (μg/L)	443.32 ± 188.86	364.53 ± 108.98	8.355	< 0.001
HCY (μmmol/L)	16.42 ± 6.7	14.37 ± 12.7	2.334	0.020
CRP (mg/L)	15.94 ± 14.79	16.31 ± 9.48	0.426	0.670
BNP (pg/ml)	88.34 ± 37.05	91.70 ± 43.79	0.240	0.811
CK-MB (U/L)	327.51 ± 126.83	339.54 ± 192.5	0.877	0.380
cTnI (U/L)	19.21 ± 5.37	23.28 ± 6.42	8.519	< 0.001

3.3. Coronary angiography characteristics and clinical characteristics of the two groups were analyzed

Table 3 shows that single-vessel disease was more common in young patients (63.8% vs 13.5%, *P* < 0.01), while multi-vessel disease was more common in elderly patients (11.9% vs 36.7%, *P* < 0.01). In the young

group, the left anterior descending coronary artery was the main diseased vessel (85% vs 69%, $P < 0.01$), which might be related to smoking and hyperuricemia (85.5% vs 47.2%, $P < 0.001$; 443.32 ± 188.86 vs 364.53 ± 108.98, $P < 0.001$). In the elderly, the right coronary artery accounted for 71.2% vs 26.4% ($P < 0.001$). SYN-TAX score was used to quantitatively evaluate the complexity of coronary artery lesions based on the location, severity, bifurcation, calcification and other anatomical characteristics of coronary artery lesions. SYNTAX score was (12.57 ± 6.13 vs 27.66 ± 6.8, $P < 0.001$) in the young group and the elderly group. The degree of vascular lesions in the elderly group was higher than that in the young group. It may be related to hypertension and diabetes (60.9% vs 16.6%, $P < 0.001$; 23.1% vs 5.1%, $P < 0.001$). Killip grade IV was significantly lower in the young group than in the elderly group (5.5% vs 24.6%, $P < 0.001$). In terms of inducing factors of acute myocardial infarction, the young group had higher mental stress (anxiety and depression) than the elderly group (63.4% vs 16.4%, $P < 0.001$). Precordial pain was more typical in the young group than in the elderly group (76.2% vs 36.5%, $P < 0.001$).

Table 3 Comparison of angiographic characteristics, SYNTAX score, Killip grade, and clinical characteristics between the two groups

Variables	Age ≤ 45 ($n = 235$)	Age ≥ 65 ($n = 532$)	P value
Vascular disease variables			< 0.001
Single-vessel coronary artery disease	150 (63.8)	72 (13.5)	
Double-vessel coronary artery disease	57 (24.3)	265 (49.8)	
Multivessel coronary artery disease	28 (11.9)	195 (36.7)	
Diseased vessels			
LAD lesions	200 (85.1)	368 (69.2)	< 0.001
LCX lesions	86 (36.6)	440 (82.7)	< 0.001
RCA lesions	62 (26.4)	379 (71.2)	< 0.001
Killip grading			< 0.001
III	26 (11.1)	54 (10.2)	
IV	13 (5.5)	131 (24.6)	
SYNTAX score	12.57 ± 6.13,	27.66 ± 6.8	< 0.001
Triggers			
Staying up late is mentally stressed (depression)	149 (63.4)	87 (16.4)	< 0.001
Emotional	17 (7.2)	76 (14.3)	0.006
Excessive exercise	15 (6.4)	178 (33.5)	< 0.001
Cold stimulation	35 (14.9)	91 (17.1)	0.446
No obvious trigger	34 (14.5)	93 (17.5)	0.301
Symptoms			
Pain in the precordial area	179 (76.2)	194 (36.5)	< 0.001
Dyspnea	126 (53.6)	298 (56.0)	0.538
Big sweat	56 (23.8)	123 (23.1)	0.830

LAD: left anterior descending vessel; LCX: left circumflex vessel; RCA: right coronary artery

3.4. Analysis of predictors of cardiac events

The differences in clinical manifestations between the cardiovascular event group and the non-cardiovascular event group are shown in **Table 4**. **Figure 3** represents the Kaplan-Meier curves for MACE in the two groups at 1 year of follow-up. **Figure 1** and **Figure 2** showing that all MACE events were compared between the younger group and the older group. Hyperuricemia was the most significant predictor in the young group (OR: 1.013, 95% CI: 1.008–1.018, $P < 0.001$). Diabetes mellitus (OR: 6.453, 95% CI:1.037–40.14, $P = 0.046$; OR: 3.861, 95% CI: 2.376–6.275, $P < 0.001$), family history of IHD (OR: 3.336, 95% CI: 1.218–9.136, $P = 0.019$; OR: 2.516, 95% CI: 1.205–5.255, $P = 0.014$) had predictive value for MACE events in both young group and elderly group.
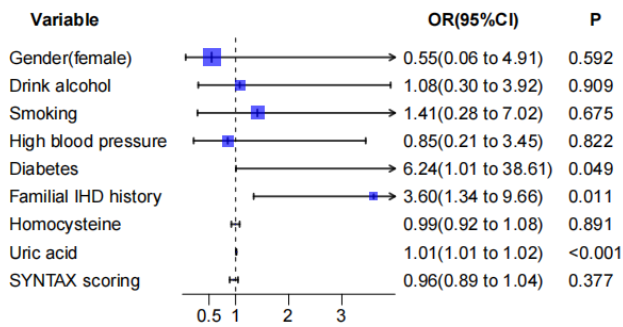
Variable	OR(95%CI)	P
Gender(female)	0.55(0.06 to 4.91)	0.592
Drink alcohol	1.08(0.30 to 3.92)	0.909
Smoking	1.41(0.28 to 7.02)	0.675
High blood pressure	0.85(0.21 to 3.45)	0.822
Diabetes	6.24(1.01 to 38.61)	0.049
Familial IHD history	3.60(1.34 to 9.66)	0.011
Homocysteine	0.99(0.92 to 1.08)	0.891
Uric acid	1.01(1.01 to 1.02)	<0.001
SYNTAX scoring	0.96(0.89 to 1.04)	0.377

Figure 1. Forest plot of influencing factors in the youth group.

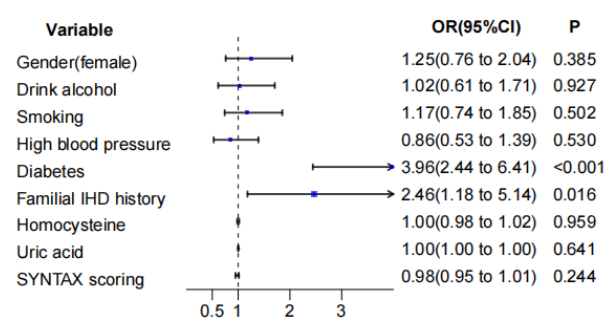| Variable	OR(95%CI)	P
Gender(female)	1.25(0.76 to 2.04)	0.385
Drink alcohol	1.02(0.61 to 1.71)	0.927
Smoking	1.17(0.74 to 1.85)	0.502
High blood pressure	0.86(0.53 to 1.39)	0.530
Diabetes	3.96(2.44 to 6.41)	<0.001
Familial IHD history	2.46(1.18 to 5.14)	0.016
Homocysteine	1.00(0.98 to 1.02)	0.959
Uric acid	1.00(1.00 to 1.00)	0.641
SYNTAX scoring	0.98(0.95 to 1.01)	0.244

Figure 2. Forest map of influencing factors in the elderly group.
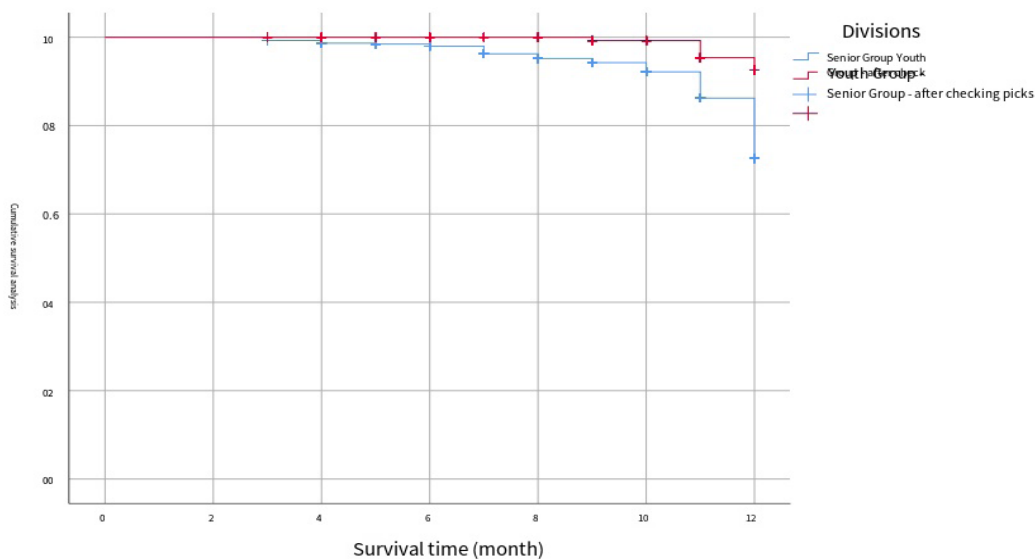

Figure 3. Kaplan-Meier curves of MACE events during 1 year of follow-up between the young and elderly groups.

Table 4 Results of Log Rank test

	χ^2	Degree of freedom, df	P
Log Rank (Mantel-Cox)	13.549	1	< 0.001

4. Discussion

According to the baseline characteristics of the enrolled population (**Table 1**), both young patients and old patients have a history of smoking and drinking. In contrast, young patients have a higher incidence of smoking and drinking than the elderly, which may be related to the changes in the current social environment and the

psychological pressure accompanied by economic development. Young patients mostly have a family history of cardiovascular disease, and older patients mostly have a history of chronic underlying diseases such as hypertension and diabetes, which can obviously be seen to be related to physical conditions. By comparing the laboratory indexes of the enrolled population (see **Table 2**), the TG and LDL-C of the young patients were significantly higher than those of the elderly patients, and the HDL-C was significantly lower than that of the elderly patients. As we all know, hyperlipidemia is one of the necessary conditions for atherosclerosis, and it is also an important factor involved in the occurrence and development of acute myocardial infarction [5]. It is well known that hyperlipidemia is one of the necessary conditions for atherosclerosis and is also an important factor in the occurrence and development of acute myocardial infarction. It can be seen from the chart that the blood lipid of young patients is worse than that of elderly patients, but the metabolism rate of young patients is significantly faster than that of the elderly. At the same time, it can be found that the levels of UA and HCY in young patients are significantly higher than those in the elderly group, which may be one of the reasons for the occurrence of STEMI in young people [6].

Some studies have shown that uric acid and homocysteine are involved in the occurrence and development of STEMI in CV system and its metabolic evolution. It has been shown that the increase of circulating uric acid levels (with the influence of lifestyle and diet) has become a harmful factor for human cardiovascular health [7–8]. A variety of factors can affect serum uric acid levels, some of which lead to hyperuricemia in humans by causing excessive uric acid production or decreased uric acid excretion. Although elevated uric acid concentration has been strongly associated with CAD in several studies, the exact mechanism of the association between uric acid and CAD has not been fully demonstrated. Several studies have shown that elevated uric acid levels play an important role in the development and progression of STEMI, which led the author to speculate that uric acid may be one of the predictors of acute cardiovascular events, and routine screening of uric acid levels may be helpful, which is also consistent with the results of this study [7–12]. However, the level of uric acid should be controlled in order to reduce the incidence of CAD and its related mortality, but there is no clear guideline in China. However, relevant studies have shown that reducing uric acid levels through uric acid excretion drugs can reduce the adverse effects of high uric acid levels on vascular endothelium, blood pressure and inflammation [13–15]. Killip classification is a widely accepted prognostic indicator for heart failure after AMI. A number of studies have shown that there is a correlation between uric acid concentration and Killip classification [16], indicating that uric acid level may be a standard for risk stratification after AMI [17]. This study also evaluated the Killip classification of cardiac function after AMI and found that the mortality rate of grade IV was 85–90%.

Homocysteine, an amino acid derived from methionine, plays a key role in vascular injury and thrombosis, suggesting its potential role in regulating the pathogenesis of AMI [18–20]. Studies have shown that serum HCY levels in patients with AMI are higher than those in patients with stable angina pectoris and healthy people, and increased levels of HCY are associated with increased mortality, suggesting the potential of HCY as a biomarker for predicting angina pectoris occurrence and survival [21]. Similar to previous studies, the results of our current study showed that HCY levels were significantly increased in patients with AMI. Therefore, HCY level was positively correlated with infarct size in patients with AMI. As one of the most fatal cardiovascular diseases, the prognosis of AMI is still not ideal [22,23]. It is necessary to further evaluate the role of HCY level in predicting MACE in AMI patients. A previous study showed that AMI patients with high HCY levels had an increased incidence of MACE compared with AMI patients with low HCY levels [24].

A further comparison of angiographic and clinical features (**Table 3**) showed that young patients with STEMI had more single-vessel disease, whereas older patients had more multivessel disease. This is also consistent with the results of Desai *et al.*(2023) [25-27]. This study showed that the lesion of the left anterior descend-

ing coronary artery was more common in young patients, while the right coronary artery was more common in elderly patients. In order to more accurately understand the number, functional impact, location and severity of coronary artery lesions, this study performed SYNTAX score. The SYNTAX score is a scoring tool that is based on coronary imaging and accurately quantified according to the characteristics of coronary artery lesions. Statistical analysis showed that the degree of vascular lesions in the elderly group was higher than that in the young group. This study also found that in terms of inducing factors, the anxiety and depression of young patients were significantly higher than those of elderly patients, which was also closely related to young people's living habits and social pressure, but the onset of young patients was more significant than that of elderly patients. Therefore, some relevant expert surveys have shown that about one-third of patients with myocardial infarction suffer from severe depression, and about one-fifth of patients suffer from mild depression or depressive symptoms [28]. Depression can induce adverse cardiovascular events and further affect the prognosis of percutaneous coronary intervention (PCI), which also warns us that we need to pay more attention to the mental health problems of young people [29].

Finally, the patients with STEMI were divided into a cardiovascular event group and a non-cardiovascular event group according to the statistics of MACE events in all enrolled patients (**Table 4**). It was found that hyperuricemia was the most significant predictor in the youth group, while diabetes and a family history of IHD were predictive of MACE in both the youth and the elderly groups, which is consistent with the correlation study by Tscharre *et al.*(2018) [30].

In conclusion, in addition to smoking, alcohol, and dyslipidemia, one should not only pay attention to those with a family history of cardiovascular disease but also understand and control blood uric acid levels in young adults. According to the results of this study, the detection and effective treatment of diabetes may also reduce the incidence of acute myocardial infarction in young patients in the future. This study has some limitations. Due to the limited sample size and lack of a validation cohort, further multicenter, large-scale studies are needed.

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Disclosure statement

The authors declare no conflict of interest.

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