

# Hypersensitive C-reactive Protein to HDL-C Ratio Predicts the Severity of Coronary Artery Disease

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## Research article

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# Abstract

**Background:** Lipid and inflammatory molecules play a key role in the development of coronary atherosclerosis. Hypersensitive C-reactive proteins are used as markers of inflammation duration, and HDL-C is used as an anti-atherosclerosis component. However, few studies have combined the two indicators to explore coronary stenosis. We suggested that Hypersensitive C-reactive proteins as a marker of inflammation persistence and HDL-C as an anti-atherosclerosis component should be integrated into a single biomarker, so as to explore the correlation of Hypersensitive C-reactive protein HDL-C ratio with the severity of coronary stenosis and to predict the severity of coronary stenosis in CAD patients.

**Methods:** We examined 360 eligible patients who underwent coronary angiography. Based on the results of coronary angiography, patients with any major coronary arteries (the left anterior descending artery, the left circumflex artery, the left main coronary artery, the right coronary artery) whose lumen diameter reduced by more than 50% were defined as CAD<sup>+</sup> group (n = 139). Patients with luminal stenosis but no more than 50% were defined as CAD<sup>-</sup> group (n = 41), and patients without luminal stenosis (n = 180) were regarded as control group. The relationship between various serum markers and the severity of coronary stenosis was examined by Spearman correlation analysis. Logistic regression analysis was performed to identify the influencing factors of the severity of coronary artery disease.

**Results:** The modified Gensini score was positively correlated with Hypersensitive C-reactive protein HDL-C ratio. Multiple regression analysis showed that Hypersensitive C-reactive protein HDL-C ratio were significantly associated with CAD. Hypersensitive C-reactive protein HDL-C ratio is an independent predictor of CAD. The ROC analysis provided a cut-off value of 1.17 for Hypersensitive C-reactive protein HDL-C ratio to predict CAD with 83.9% specificity and 0.242 Yoden index, and area under the ROC curve of 0.632 (95%CI 0.571-0.694, P <0.001). At the same time, the area under the ROC curve of Neutrophil HDL-C ratio was 0.620, indicating that Hypersensitive C-reactive protein HDL-C ratio as a predictor of CAD has better diagnostic performance than Neutrophil HDL-C ratio.

**Conclusion:** Hypersensitive C-reactive protein HDL-C ratio is not only closely related to coronary artery stenosis, but also an independent predictor of severe coronary stenosis.

## Background

Coronary artery disease (CAD) caused by atherosclerosis is a major cause of death and morbidity worldwide. Its underlying pathogenesis includes maladaptive immune response and unbalanced lipid metabolism, including chronic inflammation of the arterial wall. Lipid accumulation and immune response are formed by homeostasis controlled by leukocyte transport and chemokines and their receptors<sup>1</sup>. Current studies have shown that plasma Hypersensitive C-reactive protein (hs-CRP) is a sensitive and nonspecific biomarker of inflammatory response, reflecting plaque stability and vascular endothelial injury, and a predictor of cardiovascular risk<sup>2</sup>. In addition, High density lipoprotein cholesterol (HDL-C) is considered the so-called 'good cholesterol', largely based on epidemiological

studies showing a negative correlation between lower HDL-C levels and an increased risk of CAD and myocardial infarction<sup>3</sup>. Hs-CRP and HDL-C are both important in the process of atherosclerosis. Recent studies had suggested that the influence of coronary heart disease by 8.27% with dyslipidemia was mediated by the hs - CRP levels<sup>4</sup>.

However, no study has directly combined HDL-C and hs-CRP, two biological indicators, to explore the degree of coronary artery stenosis. Therefore, this study suggested that hs-CRP as a marker of inflammation persistence and HDL-C as an anti-atherosclerosis component should be integrated into a single biomarker CHR, so as to explore the correlation of CHR with CAD degree and to predict the severity of coronary stenosis among CAD patients.

## Methods

### Study design and participants

A retrospective evaluation of 360 subjects (152 males, 42.2%) who underwent coronary angiography at Sichuan Provincial People's Hospital from June 2018 to June 2020 for suspected or known coronary atherosclerosis was performed. The current work was in accordance with the principles of the Declaration of Helsinki. All patients with coronary stent implantation, acute coronary Syndrome (ACS), coronary artery bypass surgery, liver and kidney disease, inflammatory disease, congenital heart disease, severe heart failure, valvular heart disease, blood diseases, rheumatic diseases, malignant tumors, alcohol use and infectious diseases were excluded. Based on the results of coronary angiography, patients with any major coronary arteries (left anterior descending artery, left circumflex artery, left main coronary artery, right coronary artery) whose lumen diameter reduced by more than 50% were classified as CAD<sup>+</sup> group. Patients with luminal stenosis but no more than 50% were classified as CAD<sup>-</sup> group, and patients without luminal stenosis were regarded as control group. Patients with diffuse coronary artery involvement but no stenosis were excluded.

### Clinical data and Definitions

Serological indicators such as creatinine, uric acid, neutrophils, albumin, bilirubin, triglyceride, total cholesterol, high-density lipoprotein cholesterol (HDL-C), albumin, low-density lipoprotein cholesterol (LDL-C), the estimated glomerular filtration rate (eGFR), and Hypersensitive C-reactive protein (hsCRP) were collected. Height and weight were collected to calculate body mass index (BMI), which was counted as weight divided by height squared, weight in kilograms and height in meters. The ratio of hypersensitive C-reactive protein to HDL and the ratio of neutrophils to HDL were calculated. Hypertension was defined as blood pressure  $\geq 140$  mmHg and/or a diastolic blood pressure  $\geq 90$  mmHg taken from at least three-times, or they were being given antihypertensive drugs. Those who had been diagnosed with hypertension in the past were all defined as having a history of hypertension. Patients were considered to have diabetes if their fasting glucose level  $\geq 7.0$  mmol/L or fasting glucose level  $\geq 11.1$  mmol/L or plasma glucose-lowering drugs use. Current smokers were defined as those who smoked at least one cigarette a

day for more than one year in a row; long-term smokers who still quit smoking for less than six months were still considered to have a history of smoking.

## Assessment of the severity of CAD

When measuring the degree of obstruction on lumenogram, a comprehensive judgment was made by two experienced professional doctors blindly. The modified Gensini score (GS) system is a relatively mature evaluation system to measure CAD severity prospectively<sup>5</sup>. This was done by multiplying the sum of the positional scores of each lesion by the obstruction severity score, which reflected the severity of the disease. The detailed calculation of the modified Gensini scoring system is shown in Table 1.

Table 1  
the modified Gensini score system

The degree of stenosis(%)	score	lesion location	score
1–25	1	the second diagonal and other segments	0.5
26–50	2	right coronary artery	1.0
51–75	4	the mid-distal region of the left circumflex artery	1.0
76–90	8	first diagonal branch, the distal left anterior descending artery	1.0
91–99	16	the mid-region of the left anterior descending artery	1.5
100	32	proximal left circumflex artery or the proximal left anterior descending artery	2.5
		the left main coronary artery	5.0

## Statistical analysis

The continuous variable of a normal distribution was represented as mean  $\pm$  standard deviation. Non-normally distributed variables were represented by the median. Categorical variables were expressed in percentage frequency and absolute logarithm. Kolmogorov-Smirnov test was used to verify that the continuous variable was normally distributed. Homogeneity of variance was evaluated by Levene's test. If the data for continuous variables satisfied normal distribution and homogeneity of variance, one-way ANOVA model was used, and the comparison among groups were performed with LSD method; Otherwise, the Kruskal-Wallis test was performed to compare the differences of the non-conforming measurement data. The chi-square test was used when comparing categorical variables. The correlation between Gensini score and serum indexes was analyzed by Pearson or Spearman correlation coefficient, and the Spearman correlation coefficient was calculated. Binary logistic regression analysis was applied to evaluate the independent predictors of the severity of coronary artery disease. Univariate logistic regression models were first performed to assess the crude association between the severity of coronary

stenosis and each index, including the ratio of hsCRP to high-density lipoprotein (CHR), the ratio of neutrophils to high-density lipoprotein (NHR), age, sex, smoking, hypertension, albumin, creatinine, uric acid, HDL cholesterol, LDL cholesterol, neutrophils and hs-CRP individually. Factors that were significant in the univariate model at the  $p < 0.10$  level were enrolled in the multivariate logistic regression model so as to detect factors independently related to the presence of coronary artery stenosis. The backward step-by-step approach was used to build the final prediction model which included all the statistically significant factors ( $P < 0.05$ ). A receiver operating characteristic (ROC) curve was given to compare the diagnostic accuracy of CHR and NHR. Regression coefficients and 95% confidence intervals (CIs) for risk factors significantly associated with CAD were obtained. All statistical analyses were performed on SPSS 25.0 for Mac and all statistical tests were double-sided.  $P$  value  $< 0.05$  was defined as statistically significant.

## Results

A total of 360 patients were included in our research. Baseline demographic and biochemical characteristics of all patients were presented in Table 2. The study included 139 patients with CAD (CAD<sup>+</sup> group, 54.7% males), 41 patients with atherosclerosis (CAD<sup>-</sup> group, 34.1% males), and 180 patients with normal arterial status (control group, 34.4% males). The smoking incidence, diabetes incidence, hypertension incidence, creatinine, neutrophil levels and hsCRP levels in CAD<sup>+</sup> group were clearly higher than that in CAD<sup>-</sup> group and control group ( $P < 0.05$ , respectively). Compared with the CAD<sup>-</sup> group, the Gensini score in the CAD<sup>+</sup> group was significantly higher ( $P < 0.05$ ). However, the levels of HDL-C and albumin in the CAD<sup>+</sup> group were lower than those in the CAD<sup>-</sup> group ( $P < 0.05$ ). The age and gender differences among the three groups were statistically significant, and the average age of patients in the CAD<sup>+</sup> group was higher than that in control group ( $P < 0.001$ ). The proportion of males in the CAD<sup>+</sup> group was apparently higher than that in the CAD<sup>-</sup> group and control group ( $P < 0.05$ , respectively). There were no significant differences in BMI, uric acid, bilirubin, total cholesterol, triglyceride and LDL-C among the three groups ( $P > 0.05$ , respectively).

Table 2  
Clinical and laboratory characteristics of patients

Parameters	CAD <sup>+</sup> group(n = 155)	CAD <sup>-</sup> group(n = 49)	Control Group(n = 200)	P
Age(yr)	64.42 ± 10.66	64.95 ± 10.47	58.88 ± 11.15	< 0.001
Male[n(%)]	76(54.7)	14(34.1)	62(34.4)	0.001
Body mass index(kg/m)	24.46 ± 3.23	23.67 ± 4.98	23.87 ± 4.34	0.394
Smoking[n(%)]	41(29.5)	5(12.2)	29(16.1)	0.005
Hypertension[n(%)]	69(49.6)	18(43.9)	60(33.3)	0.012
Diabetes mellitus[n(%)]	31(22.3)	7(17.1)	19(10.6)	0.017
Creatinine (um/L)	69.69 ± 27.43	63.90 ± 16.43	60.71 ± 13.48	0.001
Albumin(g/L)	41.86 ± 5.17	43.74 ± 4.29	42.96 ± 3.44	0.004
Total bilirubin(um/L)	14.98 ± 6.87	16.29 ± 7.71	14.43 ± 5.97	0.248
hsCRP(mg/L)	4.13 ± 10.30	1.68 ± 5.69	1.24 ± 2.11	< 0.001
eGFR (ml/min)	89.97 ± 19.56	89.84 ± 15.48	98.66 ± 11.44	< 0.001
Total cholesterol(mmol/L)	4.95 ± 1.14	4.64 ± 0.98	4.81 ± 1.05	0.229
Triglyceride(mmol/L)	2.27 ± 1.81	1.95 ± 1.21	2.07 ± 1.48	0.401
Uric acid(um/L)	332.04 ± 82.24	301.07 ± 106.83	316.95 ± 80.01	0.151
LDL-C(mmol/L)	2.83 ± 0.94	2.56 ± 0.84	2.69 ± 0.82	0.224
HDL-C(mmol/L)	1.26 ± 0.35	1.31 ± 0.28	1.38 ± 0.33	0.007
Neutrophils(× 10 <sup>9</sup> /L)	4.67 ± 2.15	3.91 ± 1.71	4.09 ± 1.37	0.032
CHR	3.93 ± 10.82	1.35 ± 4.52	0.98 ± 1.77	< 0.001
Gensini score	18(24.9–35.9)	3(3.3–6.4)	0	< 0.001
NHR	4.01 ± 0.18	3.17 ± 1.78	3.14 ± 1.33	< 0.001

Spearman rank correlation analysis was applied to elucidate the relationship between various risk factors and the modified Gensini score in patients with coronary atherosclerotic heart disease. The correlation

coefficient was shown in Table 3. The results indicated that the Gensini score was positively correlated with CHR,NHR, neutrophils, hsCRP,LDL-C, sex, smoking, and hypertension, while Gensini score was negatively correlated with albumin, eGFR, HDL-C. Gensini score was not correlated with creatinine, uric acid, bilirubin, total cholesterol, triglycerides, or diabetes. The scatter diagram is shown in Fig. 1.

Table 3  
Correlation coefficient between risk factors and Gensini score

Parameters	r	P
CHR and Gensini score	0.418	< 0.001
NHR and Gensini score	0.359	< 0.001
Neutrophils and Gensini score	0.275	< 0.001
hsCRP and Gensini score	0.421	< 0.001
Uric acid and Gensini score	0.091	0.225
Creatinine and Gensini score	0.154	0.07
Albumin and Gensini score	-0.163	0.029
Total bilirubin and Gensini score	0.007	0.926
eGFR and Gensini score	-0.218	< 0.001
total cholesterol and Gensini score	0.045	0.549
triglyceride and Gensini score	0.02	0.79
LDL-C and Gensini score	0.069	0.024
HDL-C and Gensini score	-0.232	0.002
Sex and Gensini score	0.23	0.002
Age and Gensini score	0.014	0.722
Cigarette smoking and Gensini score	0.158	0.034
Hypertension and Gensini score	0.047	0.037
Diabetes mellitus and Gensini score	0.081	0.28

To further explore the possible risk factors for coronary artery stenosis, univariate and multivariate logistic regression analyses were applied (Table 4). Univariate Logistic regression analyses showed that risk factors associated with CAD included CHR,NHR, hsCRP, smoking, hypertension, diabetes mellitus, gender, age, creatinine, albumin, HDL-C, neutrophils, and eGFR ( $p < 0.05$ ). Additionally, after adjusting for all covariates, multiple regression analyses showed that CHR,NHR, age, sex, and diabetes were

significantly correlated with CAD. Consequently, CHR is an independent predictor of CAD, as well as NHR. The ROC analysis displayed that the critical value of NHR was 1.17, 83.9% of specificity and 0.242 of Yoden index could predict CAD, and the area under the ROC curve was 0.632 (95%CI 0.571–0.694,  $P < 0.001$ ). At the same time, the area under the ROC curve of NHR was 0.620, indicating that CHR as a predictor of CAD has better diagnostic performance than NHR, as shown in Fig. 2.

Table 4  
Logistic regression analysis of factors associated with the presence of CAD

Variables	Univariate		Multivariate	
	OR(95% CI)	P	OR(95% CI)	P
Creatinine	0.974(0.960–0.989)	< 0.001	1.020(0.985–1.056)	0.273
Albumin	1.064(1.007–1.124)	0.027	0.997(0.935–1.062)	0.920
CHR	0.848(0.762–0.945)	< 0.001	0.904(0.819–0.998)	0.046
NHR	0.739(0.640–0.854)	< 0.001	0.841(0.716–0.989)	0.036
Age	0.954(0.934–0.975)	< 0.001	0.943(0.920–0.966)	< 0.001
HDL	2.872(1.440–5.726)	0.003	0.926(0.189–4.534)	0.924
Neutrophils	0.826(0.724–0.943)	0.005	1.090(0.667–1.781)	0.732
Cigarette smoking	2.178(1.270–3.735)	0.005	0.654(0.319–1.338)	0.245
Hypertension	0.507(0.322–0.799)	0.003	0.746(0.441–1.261)	0.274
diabetes	0.411(0.221–0.765)	0.005	0.465(0.232–0.932)	0.031
hsCRP	0.881(0.808–0.960)	0.004	0.899(0.651–1.241)	0.516
eGFR	1.039(1.022–1.056)	< 0.001	1.043(0.988–1.100)	0.124
Sex	0.425(0.270–0.670)	< 0.001	2.732(1.588–4.699)	< 0.001

## Discussion

In our study, the results showed that increased CHR levels were closely related to the degree of coronary artery stenosis. And we also found that CHR was an independent predictor of CAD. As far as we know, our study is the first research to investigate whether CHR is associated with CAD severity of coronary artery disease. A total of 360 patients were included in our work, and the results showed that CHR (OR: 0.904, 95%CI: 0.819–0.998), NHR, age, male, and history of diabetes were independent risk factors for CAD. We also demonstrate that elevated CHR levels are a predictor of severity of coronary artery disease and perform better than NHR in terms of diagnostic efficacy.

In recent years, with the rapid economic development, the change of lifestyle and the adoption of unhealthy diet cardiovascular disease has been the "first killer" of human health<sup>6</sup>, seriously threatening the life expectancy and quality of life of people all over the world<sup>7</sup>. In Europe, more than 4 million people die each year from cardiovascular disease (CVD)<sup>8</sup>. The incidence of cardiovascular disease (CVD) in China is also on the rise. At present, there are about 290 million people with cardiovascular diseases in China, including 11 million patients with coronary heart disease<sup>9</sup>. Therefore, for patients with chest pain, assessing the severity of coronary artery stenosis is a necessary prerequisite for preventing and controlling cardiovascular disease progression, and helps clinicians develop individualized, comprehensive treatment strategies to improve patients' quality of life<sup>10</sup>.

In fact, the pathophysiological process of CAD is mainly atherosclerosis, in which dyslipidemia and chronic inflammation of the arteries as well as various inflammatory factors play a central role<sup>11</sup>. Studies have shown that hs-CRP levels and dyslipidemia have a synergistic effect in the pathogenesis of CAD, and the association between dyslipidemia and CAD seems to be strengthened by the increased hs-CRP levels. Mediation analysis showed that the effect of dyslipidemia on CHD is 8.27% mediated by hs-CRP levels, and the direct effect is 0.621<sup>4</sup>. To our knowledge, however, no study has directly combined HDL-C and hs-CRP, two biological indicators, to explore the degree of coronary artery stenosis. In our work, we assumed that CHR is a biomarker composed of inflammation marker and lipid cholesterol marker. through univariate and multivariate analysis, we explored many factors related to CAD. the results show that CHR is positively correlated with Gensini score. after adjusting for confounding factors, we find that CHR is an independent predictor of CAD disease. In addition, our study also found that THE specificity of CHR cut-1.17 for predicting CAD was 83.9%.

Based on our analysis, we attempted to interpret the results associated with increased CHR and severity of coronary artery stenosis. hs-CRP is a blood biomarker produced by the liver, representing acute systemic inflammation, and is considered a perfect marker for assessing systemic inflammation because its serum level does not change with circadian rhythm within 24 hours and does not change with food intake<sup>12</sup>. hs-CRP is widely used in clinical practice, especially in cerebrovascular and cardiovascular diseases<sup>13</sup>. hs-CRP is considered as a risk factor of cardiovascular diseases and can increase the mortality of cardiovascular diseases<sup>14,15</sup>. CRP is involved in the pathogenesis and development of vascular inflammation and coronary atherosclerosis<sup>16</sup>. It directly affects complement activation, apoptosis, vascular cell activation, monocyte recruitment, lipid accumulation, and thrombosis and other atherosclerotic processes<sup>17,18</sup>. Epidemiological meta-analysis showed that hs-CRP > 3.0 mg/dL compared to < 1.0 mg/dL increased the risk of CAD by 1.6 times, and the hs-CRP levels were positively associated with the severity of coronary heart disease, which increase with the increase of lesion count<sup>19</sup>. Therefore, plasma hs-CRP has become a sensitive biomarker of inflammation<sup>2</sup>, which is of great significance to predict the stability of coronary plaque in coronary heart disease, the severity of vascular disease, restenosis of coronary arteries after coronary angioplasty, and the incidence of cardiovascular events<sup>9</sup>. Our results showed that the levels of hs-CRP in the CAD<sup>+</sup> group were significantly higher than those of the

CAD<sup>-</sup> group and control group, and Gensini score was positively related to hs-CRP, which was also consistent with previous studies<sup>20</sup>.

Dyslipidemia is viewed as a necessary condition for atherosclerosis, and studies have shown that dyslipidemia may account for 50% of the attributable risk in patients with CAD. Therefore, recent studies on the correlation between lipid biomarkers and coronary heart disease have become the focus<sup>21</sup>. HDL-C, as a typical lipid related biomarker, plays an important protective role in the process of atherosclerosis and inflammation due to its anti-oxidant, anti-inflammatory, anti-apoptotic and anti-thrombotic properties<sup>22-24</sup>. HDL-C has been shown to regulate cholesterol efflux, protect vascular endothelium, stabilize plaque, and prevent rupture<sup>25-27</sup>. In addition, HDL reduces inflammation by inhibiting the expression of adhesion molecules in endothelial cells and reduces coronary atherosclerosis by inhibiting the oxidation of low-density lipoprotein<sup>28,29</sup>. Therefore, HDL-C, on the one hand, inhibits the progression of atherosclerosis and on the other hand promotes plaque regression<sup>30</sup>. It had been estimated that for each increment of 1 mg/dL in HDL-C, the CAD risk was reduced by 2% in males and by 3% in females<sup>31,32</sup>. Current evidence suggested an inverse correlation between HDL-C levels and CAD, myocardial infarction, carotid atherosclerosis, and stroke. Increased HDL levels can prevent coronary heart disease<sup>24,33</sup>.

In conclusion, due to the interaction between decreased HDL-C and increased CRP in CAD, increased CHR may be associated with inflammatory activity and dyslipidemia. In addition, a comprehensive CHR indicator may be more effective and reliable than a single indicator in explaining the complex interactions between CRP and HDL-C. As far as we know, there was no study to discuss the relationship between CHR and the degree of coronary artery disease. In our work, we directly explored the correlation between the severity of coronary artery disease and conducted regression analysis on the predictors of multiple indicators, which was our advantage. Studies have shown that NHR was correlated with the degree of coronary artery disease<sup>34</sup>. In our work, CHR, as a new predictor for patients with coronary heart disease, has more diagnostic advantages than NHR in evaluating the severity of coronary artery stenosis. This may be because hs-CRP is more sensitive than neutrophils in detecting low-grade inflammation.

The modified Gensini score is a reliable marker for assessing the severity of coronary artery disease. Some experts found that patients with severe CAD were grouped according to the modified Gensini score, and the results indicated that there were significant differences between the highly rated groups and other groups<sup>35,36</sup>. In our work, CHR was positively correlated with the modified Gensini score, suggesting that patients with relatively high CHR may have more severe coronary stenosis, and that CHR may be useful in predicting the severity of the lesion.

In conclusion, we believe that CHR may preliminarily reflect the severity of coronary artery, so as to better guide clinical practice. However, our work had some limitations. First, this was a single-center retrospective design, and the type of study had determined its limitations; In addition, we did not apply a

China-PAR(prediction for ASCVD risk in China) model to explore the correlation between CHR and MACE events. In future work, we will expand the sample size for multi-center discussion.

## Conclusion

We found that CHR was not only closely related to the degree of coronary artery stenosis, but also an independent predictor of severe coronary artery stenosis. Different from many other biological indicators, CHR can be calculated from the complete blood count at admission, which is fast and convenient. It can be used as a simple and effective auxiliary indicator for the prediction and assessment of coronary artery stenosis, and may have certain clinical application value.

## Abbreviations

CHR : Hypersensitive C-reactive protein to High density lipoprotein cholesterol ratio

NHR : neutrophils to High density lipoprotein cholesterol ratio

hsCRP: Hypersensitive C-reactive protein

CAD: Coronary artery disease

HDL-C: High density lipoprotein cholesterol

LDL-C: Low density lipoprotein cholesterol

ACS: acute coronary Syndrome

BMI: body mass index

GS: Gensini score system

ROC: A receiver operating characteristic

CI: confidence intervals

AMI: acute myocardial infarction

LSD: Least Significant Difference

eGFR: estimated glomerular filtration rate

China-PAR: prediction for ASCVD risk in China

## Declarations

**Ethics approval and consent to participate:**

This retrospective database analysis did not involve the collection, use, or transmittal of individual identifiable data. As such, Institutional Review Board (IRB) approval to conduct this study was not required and considered exempt according to 45CFR46.101(b)(4): Existing Data & Specimens - No Identifiers. Both the data set itself and the security of the offices where the data are housed meet the requirements of the Health Insurance Portability and Accountability Act (HIPAA) of 1996. Administrative permissions were required to access the raw data from Sichuan Provincial People's Hospital. With the permission of Sichuan Provincial People's Hospital and the department of Cardiovascular Medicine, we were allowed to access the raw data of Sichuan Provincial People's Hospital.

**Consent for publication:**

Not applicable.

**Availability of data and materials:**

All data are freely available for scientific purpose. The data can be found from all listed authors.

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**Competing interests:**

The authors declare that they have no competing interests

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**Authors' contributions:**

HL and TK meet the International Committee of Medical Journal Editors (ICMJE) criteria for authorship of this article, take responsibility for the integrity of the work as a whole, and have given their approval for this version to be published. HL and TK conceptualized and designed the study. HL and TK verified, analyzed, and interpreted the data. HL and TK wrote the manuscript and substantially contributed to critical revision of the intellectual content. HL and TK contributed equally to this work. They should be considered co-first authors.

LY, the corresponding author of this paper, interpreted the data and substantially contributed to critical revision of the intellectual content.

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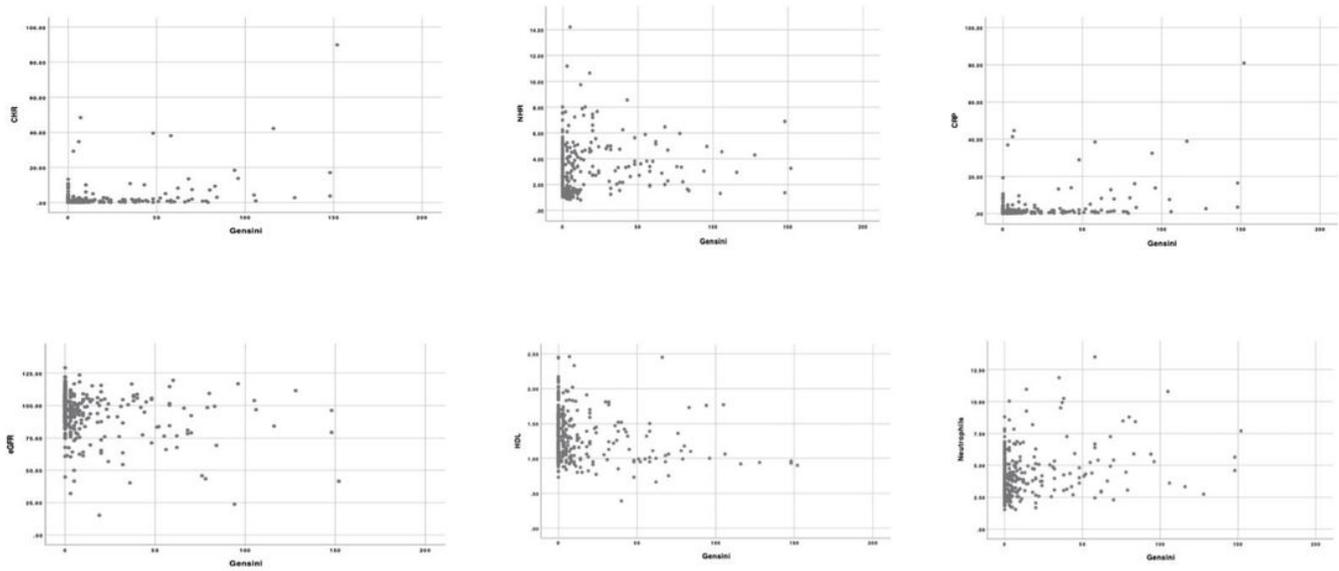
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## Figures



**Figure 1**

Relationship between serological indicators and Gensini score. (A) Relationship between Gensini score and CHR. (B) Relationship between Gensini score and NHR. (C) Relationship between Gensini score and hsCRP. (D) Relationship between Gensini score and eGFR. (E) Relationship between Gensini score and HDL-C. (F) Relationship between Gensini score and Neutrophil. CHR: the ratio of Hypersensitive C-reactive protein to high-density lipoprotein; NHR: the ratio of Neutrophil to high-density lipoprotein ; HDL-C: high-density lipoprotein cholesterol;

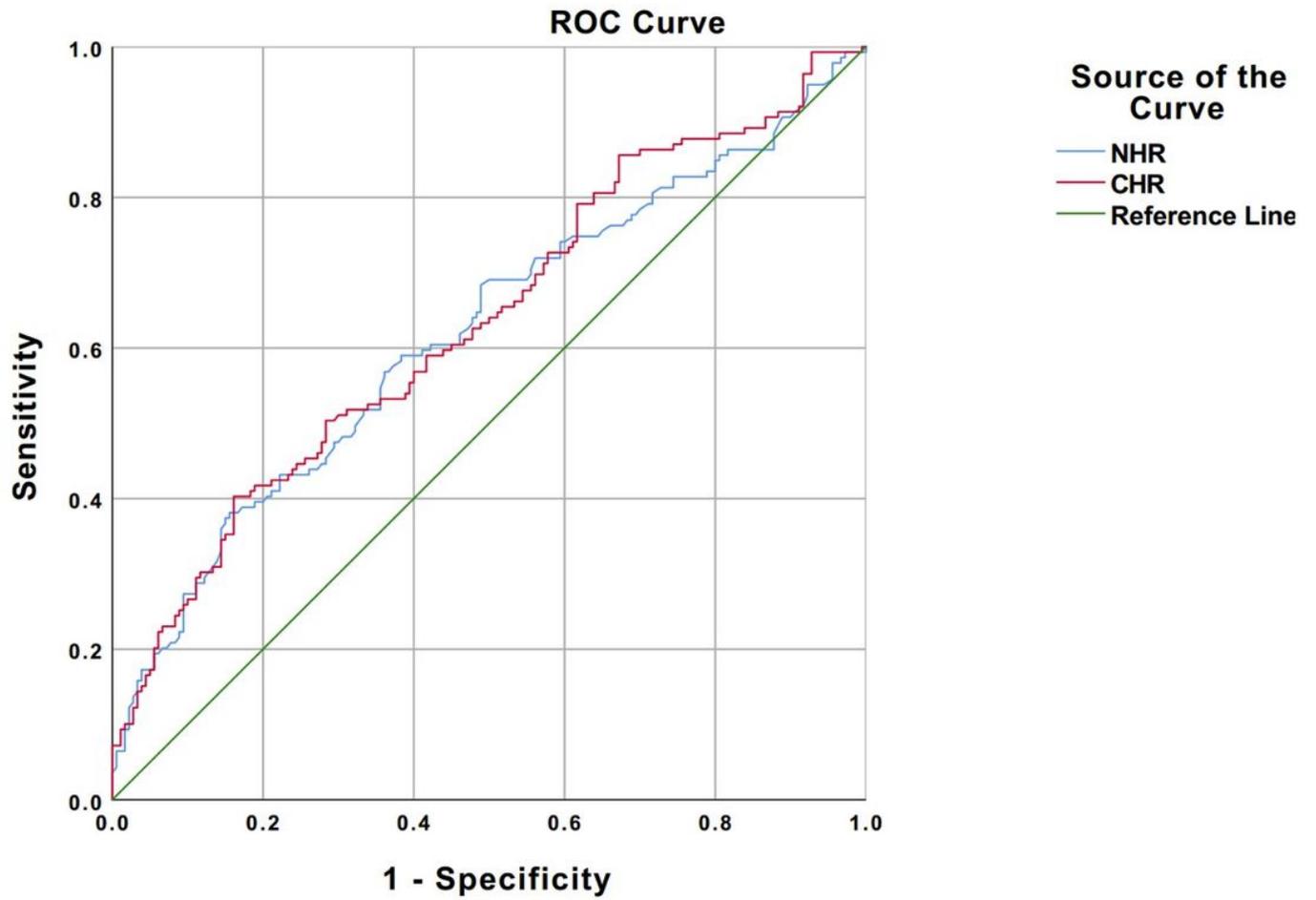


Figure 2

Receiver-operating characteristic curve analysis for CHR and NHR for prediction of CAD

## Supplementary Files

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