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Plasma lipoprotein(a) levels are associated with the severity of coronary heart disease in Han Chinese people

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Background/aim: The aim of this study was to investigate the association of lipoprotein(a) [Lp(a)] with the severity of coronary heart disease (CHD) in Han Chinese people.

Materials and methods: Six hundred and seventy-nine patients with angiographically defined CHD were enrolled in this cross-sectional study. Fasting lipids were measured, and the severity of CHD was quantitatively assessed for each patient according to the number of stenotic coronary branches and the Gensini scoring system.

Results: The levels of Lp(a), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), very low-density lipoprotein cholesterol (VLDL-C), and apolipoprotein (apo) B100 increased, while high-density lipoprotein cholesterol (HDL-C) and apoAI decreased significantly with the number of stenotic vessels. The levels of Lp(a) increased and HDL-C and apoAI decreased significantly with the Gensini scores. The logistic regression analyses showed that Lp(a) and HDL-C were independently associated with the number of stenotic coronary vessels after adjusting for age, weight, body mass index, sex, smoking, alcohol consumption, hypertension, diabetes, triglycerides, TC, LDL-C, VLDL-C, apoAI, and apoB100. However, only Lp(a) was independently associated with the Gensini scores after adjustment.

Conclusion: Our data indicate that Lp(a) might be a useful marker in predicting the severity of coronary heart disease.

Key words: Lipoprotein(a), coronary heart disease, severity, Gensini score, lipid

1. Introduction

At the beginning of the twentieth century, coronary heart disease (CHD) and cerebrovascular disease were only responsible for less than 10% of all deaths worldwide. Over the past few decades, the epidemic of cardiovascular disease has become the leading cause of morbidity and mortality in developed countries and in some developing countries, including China (1–3). The risk factors for CHD include dyslipidemia, metabolic syndrome, atherogenic diet, unhealthy lifestyle, and gene mutations or polymorphisms (4–6). Of these risk factors, dyslipidemia is considered to be the most important determinant and accounts for at least 50% of the population-attributable risk for CHD (7). Conventionally, increases in low-density lipoprotein cholesterol (LDL-C), total cholesterol (TC), and triglycerides (TG) and/or decreases in high-density lipoprotein cholesterol (HDL-C) were considered as the major causal factors for CHD (8). Clinical guidelines recommended that the primary therapy be targeted to LDL-C and non-HDL-C reduction, and that the other lipid indices be used as secondary or supplementary targets (8,9). However, lipoprotein(a) [Lp(a)], as an emerging risk factor for CHD, is getting more and more attention among epidemiologists and cardiologists.

Lp(a) was originally discovered by Kåre Berg in 1963 (10). It has received intensive investigation in the last few decades regarding its important role in the occurrence of CHD (11–14). This LDL-like particle is of particular interest because a large hydrophilic glycoprotein [apolipoprotein(a), apo(a)], which has

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highly homologous regions as plasminogen, is covalently linked to apolipoprotein (apo) B100 via a disulfide bond. Lp(a) has long been considered as an atherogenic and prothrombotic lipoprotein due to its unique structure (15), which was also supported by experimental proof that Lp(a) can inhibit the key positive feedback step of the plasmin-mediated conversion from Glu-plasminogen to Lys-plasminogen (16) and the activation of pericellular plasminogen in human umbilical vein endothelial cells, THP-1 monocytes, and macrophages (17).

A series of studies have suggested a causal link between circulating Lp(a) and CHD (11–14). The plasma levels of Lp(a) have also been associated with the severity of CHD (18–20). Both Lp(a) levels and percentage of hyper-Lp(a) increased linearly with the number of significantly diseased vessels in elderly men and women (18). Among the recognized risk factors of atherosclerosis, Budde et al. (19) found that only Lp(a) plasma levels correlated significantly with the vessel score, stenosis score, and extent score. Habib et al. (20) demonstrated that Lp(a) levels were associated with more severe and diffuse blockage of the coronary vessels in a Saudi population. However, other studies failed to demonstrate a positive correlation between the increasing Lp(a) concentrations and the severity of CHD (21,22). Although Labeur et al. (21) found a significant association between Lp(a) and the severity of coronary stenosis in Belgian patients, it was attenuated after adjusting for other confounding factors, and Imhof et al. (22) did not find an appreciable association between Lp(a) and the severity of coronary atherosclerosis in a European population. Hence, the association between plasma Lp(a) levels and the severity of CHD is still obscure and needs to be further explored.

The plasma levels of Lp(a) vary widely across populations and ethnicities. Data on the association between Lp(a) and CHD were largely derived from Caucasians, and few studies were conducted in low- and middle-income countries like China, where more than 80% of the global burden of cardiovascular disease occurs (1,2). In this study, we sought to investigate the relationship between Lp(a) levels and the severity of CHD in a cohort of Chinese patients.

2. Materials and methods

2.1. CHD patients

This study was designed as a hospital-based investigation at the Affiliated Hospital of North Sichuan Medical College (Nanchong, China). A total of 679 consecutive patients diagnosed with CHD by coronary angiography were enrolled in this study between May 2011 and April 2014. Patients taking lipid-lowering drugs were excluded from the study. Patients with valvular disease, cardiomyopathy, renal or hepatic dysfunction, active inflammatory disease, myocarditis, and malignant disease were also excluded. Written consent was provided by all the participants or their guardians prior to their participation in the study. Our study was approved by the ethics committee of North Sichuan Medical College.

2.2. Coronary angiography

Standard coronary angiography was performed using the Judkins technique with an Allura Xper FD20 (Philips Medical Systems Nederland B.V., the Netherlands). Two experienced cardiologists who were unaware of the patients' biochemical statuses were employed to evaluate the severity of CHD. There were at least four views of the left coronary system and two views of the right coronary artery. CHD was diagnosed in patients who had coronary stenosis greater than 50% in at least one major coronary artery. Those with stenosis less than 50% in any of the major coronary arteries were excluded from this study.

2.3. Definition

Body mass index (BMI) was calculated by dividing weight by height squared (kg/m^2). Smokers were patients with regular cigarette smoking. Drinkers were patients with regular alcohol consumption. Patients with systolic/diastolic blood pressure higher than 140/90 mmHg or active use of antihypertensive drugs were diagnosed with hypertension. Patients with fasting glucose levels above 126 mg/dL or active use of antidiabetic drugs or insulin were diagnosed with diabetes.

2.4. Biochemical measurement

Fasting blood samples were taken on the first morning of the hospitalization day when patients did not take any lipid-lowering drugs. Blood samples were immediately transported to the Department of Clinical Laboratory of the Affiliated Hospital of North Sichuan Medical College for measurements of Lp(a), TC, LDL-C, HDL-C, very low-density lipoprotein cholesterol (VLDL-C), TG, apoB100, and apoAI. The measurements were carried out using an automatic clinical chemistry analyzer (Beckman Coulter UniCel DxC 800 Synchron, USA).

2.5. Statistical analysis

Data were expressed as mean ± standard deviation (SD) unless otherwise stated. Continuous variables were tested for normality and log transformation was carried out for those data with nonnormal distribution. All statistical analyses were carried out using SPSS 13.0 (SPSS Inc., Chicago, IL, USA). The differences among the groups divided by the number of stenotic vessels or the tertile of the Gensini scores were analyzed by one-way analysis of variance (ANOVA). The associations between the variables and the severity of CHD were analyzed by univariate and multivariate ordinal logistic regression analysis. The results of logistic regression analysis were expressed as the odds ratio (OR) with 95% confidence interval (95% CI). $P < 0.05$ was considered to be significant in all the analyses.

3. Results

3.1. Clinical characteristics of the study population

The study population consisted of 679 CHD patients with a mean age of 63.28 ± 10.40 years, a mean BMI of 24.37 ± 2.95, and a mean Lp(a) level of 325.24 ± 354.77 mg/L. The majority of the patients were males (71.13%) and nondiabetic (85.13%). Around half of the patients were smokers (47.28%) or hypertensive (48.16%) (Table 1).

To evaluate the effects of Lp(a) and other variables on the severity of CHD, the patients were divided into three groups according to the number of stenotic vessels (group 1: single-vessel stenosis; group 2: double-vessel stenosis; group 3: multivessel stenosis) or the tertile of the Gensini scores [group 1: ≤33rd percentile (scores 1–12); group 2: 33rd to 66th percentile (scores 13–32); group 3: ≥66th percentile (scores ≥33)]. The mean age, Lp(a), TC, LDL-C, VLDL-C, and apoB100 and the percentages of males and hypertensive and diabetic patients increased while HDL-C and apoAI levels decreased significantly with the number of stenotic vessels. When comparisons of the variables were conducted among the tertile of the Gensini scores, the mean age, Lp(a) levels, and percentages of males and diabetic patients increased while HDL-C and apoAI levels decreased significantly with the tertile of the Gensini scores.

Of all the variables, age, Lp(a), HDL-C, and apoAI had consistently significant associations with the severity of CHD evaluated by either the number of stenotic vessels or the Gensini scores.

3.2. Ordinal logistic regression analysis for the associations between lipid parameters and the number of stenotic vessels

Univariate logistic regression analyses showed that the number of stenotic vessels was significantly associated with age, male sex, diabetes mellitus, higher levels of TC, LDL-C, Lp(a), and apoB100 and lower levels of HDL-C and apoAI ($P < 0.05$ for all) (Table 2). Subsequent multiple logistic regression analyses revealed that the number of stenotic vessels was independently associated with age, male sex, diabetes mellitus, Lp(a), and HDL-C concentrations after adjusting for the possible confounding variables including TC, LDL-C, apoAI, and apoB100 ($P < 0.05$ for all) (Table 2).

3.3. Ordinal logistic regression analyses for the associations between lipid parameters and the tertile of the Gensini scores

Univariate logistic regression analyses showed that the tertiles of the Gensini scores were significantly associated with age, male sex, diabetes mellitus, smoking, Lp(a), HDL-C, and apoAI levels ($P < 0.05$ for all) (Table 3). Subsequent multiple logistic regression analyses revealed that the tertiles of the Gensini scores were independently associated with age, diabetes mellitus, and Lp(a) after controlling for other possible confounding variables including sex, smoking, HDL-C, and apoAI ($P < 0.05$ for all) (Table 3).

4. Discussion

In the present study, we found that Lp(a) increased proportionally with the number of stenotic coronary branches and the tertile of the Gensini scores; patients with higher Lp(a) concentrations were more likely to have multiple stenotic vessels and high Gensini scores. In the multivariate logistic regression, Lp(a) and HDL-C were significantly associated with the risk of multibranch coronary artery stenosis after adjusting for age, sex, diabetes, TC, LDL-C, apoAI, and apoB100, but only Lp(a) remained significant when the tertile of the Gensini scores was used as the dependent variable after adjustment. Our results indicate that Lp(a) may be a stronger predictor for the severity of CHD than HDL-C and other conventional lipid parameters.

Some previous studies also demonstrated a positive association between Lp(a) and the severity of CHD (18,19). Of the conventional lipid parameters, Budde et al. (19) found that only the plasma levels of Lp(a) correlated significantly with the coronary vessel score, stenosis score, and extent score. Furthermore, both Lp(a) levels and the percentage of high Lp(a) were found to be linearly and significantly related to the number of stenotic vessels in elderly men and women (18). However, the association between plasma Lp(a) levels and the severity of CHD has not been fully clarified. Although the fully adjusted OR for CHD was 3.3 for the patients in the upper quartile of the Lp(a) distribution compared to the bottom quartile, Imhof et al. (17) did not find an appreciable association between Lp(a) and the severity of CHD. This controversy can partly be explained by the differences in the experimental design, stenosis evaluation, and characteristics and ethnicities of patients. In addition, the different medical treatments among studies may also account for these inconsistent results. Our results suggest that Lp(a) could be a good predictor for the severity of CHD and that Lp(a) may play an important role in the development of coronary plaques in Han Chinese people.

The association between Lp(a) and the severity of coronary stenosis is probably linked to its proatherogenic and prothrombotic properties (23). Lp(a) is a unique lipoprotein particle that consists of a LDL-like particle and an apo(a) molecule, which is covalently linked to apoB100 by a disulfide bond. According to the Adult Treatment Panel III Guidelines (8) and the 2013 ACC/AHA blood cholesterol guidelines (9) of the United States, LDL is the most atherogenic lipoprotein in blood and is considered as the major cause of CHD. Lp(a) is supposed to be as atherogenic as LDL since it contains a LDL-like particle

Table 1. Clinical characteristics of the CHD patients by the number of stenotic vessels or the tertile of the Gensini scores.

Variables	Total patients (n = 679)	Number of stenotic vessels				Tertile of the Gensini scores			
		Single-vessel stenosis (n = 268)	Double-vessel stenosis (n = 189)	Multivessel stenosis (n = 222)	P-value	≤33rd percentile (n = 230)	33rd to 66th percentile (n = 224)	≥66th percentile (n = 225)	P-value
Demographic parameters									
Age, years	63.28 ± 10.40	61.89 ± 10.67	62.81 ± 9.84	65.36 ± 10.25	0.001*	61.94 ± 10.51	63.09 ± 10.72	64.84 ± 9.78	0.011*
Weight, kg	64.46 ± 9.68	65.16 ± 9.91	64.13 ± 9.14	63.84 ± 9.85	0.429	65.36 ± 9.78	63.93 ± 9.68	63.95 ± 9.53	0.321
BMI, kg/m^2	24.37 ± 2.95	24.58 ± 2.76	24.37 ± 3.12	24.10 ± 3.04	0.343	24.72 ± 2.83	24.25 ± 3.02	24.08 ± 3.01	0.144
Men, n (%)	483 (71.13)	169 (63.06)	144 (76.19)	170 (76.58)	0.001*	154 (66.96)	154 (68.75)	175 (77.78)	0.025*
Smokers, n (%)	321 (47.28)	113 (42.16)	97 (51.32)	111 (50.00)	0.095	94 (40.87)	111 (49.55)	116 (51.56)	0.052
Drinkers, n (%)	202 (29.75)	77 (28.73)	61 (32.28)	64 (28.83)	0.670	72 (31.30)	64 (28.57)	66 (29.33)	0.805
Hypertension, n (%)	327 (48.16)	135 (50.37)	76 (40.21)	116 (52.25)	0.033*	106 (46.09)	113 (50.45)	108 (48.00)	0.648
Diabetes, n (%)	101 (14.87)	25 (9.33)	28 (14.81)	48 (21.62)	0.001*	25 (10.87)	29 (12.95)	47 (20.89)	0.007*
Lipid parameters									
Lp(a), mg/L	325.24 ± 354.77	271.74 ± 303.55	320.79 ± 352.69	393.63 ± 400.99	0.001*	272.72 ± 311.06	316.20 ± 348.04	387.94 ± 393.17	0.002*
TG, mmol/L	1.58 ± 1.10	1.47 ± 0.86	1.66 ± 1.14	1.66 ± 1.30	0.099	1.54 ± 0.93	1.53 ± 1.19	1.69 ± 1.17	0.255
TC, mmol/L	4.17 ± 1.06	4.01 ± 0.85	4.34 ± 1.10	4.23 ± 1.21	0.002*	4.13 ± 0.94	4.19 ± 1.00	4.20 ± 1.22	0.744
LDL-C, mmol/L	2.36 ± 0.81	2.22 ± 0.69	2.44 ± 0.81	2.45 ± 0.93	0.002*	2.31 ± 0.72	2.35 ± 0.77	2.41 ± 0.93	0.462
HDL-C, mmol/L	0.99 ± 0.33	1.02 ± 0.32	1.01 ± 0.35	0.94 ± 0.31	0.01*	1.01 ± 0.31	1.04 ± 0.36	0.93 ± 0.30	0.002*
VLDL-C, mmol/L	0.83 ± 0.56	0.76 ± 0.42	0.91 ± 0.67	0.84 ± 0.59	0.014*	0.81 ± 0.50	0.80 ± 0.55	0.88 ± 0.62	0.236
ApoAI, g/L	1.00 ± 0.21	1.01 ± 0.20	1.02 ± 0.21	0.97 ± 0.21	0.017*	1.02 ± 0.19	1.02 ± 0.21	0.96 ± 0.20	0.001*
ApoB100, g/L	0.75 ± 0.25	0.71 ± 0.23	0.78 ± 0.25	0.77 ± 0.27	0.008*	0.73 ± 0.23	0.75 ± 0.24	0.77 ± 0.28	0.223

CHD, Coronary heart disease; BMI, body mass index; Lp(a), lipoprotein(a); TG, triglycerides; TC, total cholesterol; LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; VLDL-C, very low-density lipoprotein cholesterol; apoAI, apolipoprotein AI; apoB100, apolipoprotein B100. *: Significant difference ($P < 0.05$).

Table 2. Ordinal logistic regression analysis of the number of stenotic vessels (dependent variable) and other independent variables.

Variables	Univariate logistic regression			Multivariate logistic regression		
	OR	95% CI	P-value	OR	95% CI	P-value
Anthropometric parameters						
Age, years	1.03	1.01–1.04	0.000*	1.04	1.03–1.06	0.000*
Weight, kg	0.99	0.97–1.01	0.196			
BMI, kg/m^2	0.96	0.90–1.02	0.155			
Sex, n (%)						
Female	1.00 (ref)			1.00 (ref)		
Male	1.73	1.27–2.37	0.001*	1.95	1.39–2.72	0.000*
Smokers, n (%)						
No	1.00 (ref)					
Yes	1.29	0.98–1.71	0.070			
Drinkers, n (%)						
No	1.00 (ref)					
Yes	1.03	0.76–1.39	0.871			
Hypertension, n (%)						
No	1.00 (ref)					
Yes	1.03	0.78–1.36	0.830			
Diabetes, n (%)						
No	1.00 (ref)			1.00 (ref)		
Yes	2.12	1.43–3.15	0.000*	2.31	1.54–3.49	0.000*
Lipid parameters						
TG, mmol/L	1.13	0.99–1.28	0.063			
TC, mmol/L	1.18	1.04–1.35	0.013*	1.24	0.89–1.73	0.206
LDL-C, mmol/L	1.33	1.12–1.59	0.001*	1.33	0.86–2.06	0.199
HDL-C, mmol/L	0.55	0.36–0.85	0.007*	0.51	0.26–0.99	0.046*
VLDL-C, mmol/L	1.23	0.95–1.57	0.111			
ApoAI, g/L	0.44	0.22–0.87	0.019*	0.66	0.23–1.90	0.437
ApoB100, g/L	2.09	1.19–3.65	0.010*	1.86	0.60–5.77	0.284
Lp(a), mg/L	1.26	1.11–1.43	0.000*	1.23	1.08–1.41	0.002*

ApoAI: Apolipoprotein AI; ApoB100: apolipoprotein B100; BMI: body mass index; 95% CI: 95% confidence interval; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol; Lp(a): lipoprotein(a); OR: odds ratio; TC: total cholesterol; TG: triglycerides; VLDL-C: very low-density lipoprotein cholesterol. *: Significant association ($P < 0.05$).

(24). In addition, Lp(a) is also thought to be prothrombotic (25). The molecular structure of plasminogen includes a signal peptide, Kringles 1–5, a protease domain, and a tail, whereas apo(a) has the homologous signal peptide, Kringle 4, Kringle 5, and a protease-like domain and does not contain Kringles 1–3 and the tail. The structural homology between apo(a) and plasminogen suggests that Lp(a) can promote thrombosis. Several studies have shown that Lp(a) can inhibit the activation of plasminogen by competing for the binding of activators to plasminogen, and can consequently attenuate fibrinolysis (17,26). Lp(a) may also promote thrombosis by a mechanism independently of plasminogen (27). The number of Kringle 4 type 2 (KIV-2) repeats and the molecular size of apo(a) are also associated with CHD (28). The molecular size of apo(a) varies from 300 kDa to 800 kDa across populations. A metaanalysis demonstrated that individuals with small apo(a) isoforms (≤22 repeats) had 2-fold higher CHD risk compared to those with larger apo(a) isoforms (>22 repeats) (28).

It is worth mentioning that age, sex, and diabetes had a significant relationship with the severity of CHD after adjusting for other possible confounding factors in

Table 3. Ordinal logistic regression analysis of the tertile of the Gensini scores (dependent variable) and other independent variables.

Variables	Univariate logistic regression			Multivariate logistic regression		
	OR	95% CI	P-value	OR	95% CI	P-value
Anthropometric parameters						
Age, years	1.02	1.01–1.03	0.004*	1.03	1.01–1.04	0.000*
Weight, kg	0.99	0.97–1.01	0.185			
BMI, kg/m^2	0.95	0.89–1.00	0.058			
Sex, n (%)						
Female	1.00 (ref)			1.00 (ref)		
Male	1.48	1.09–2.01	0.012*	1.30	0.89–1.91	0.175
Smokers, n (%)						
No	1.00 (ref)			1.00 (ref)		
Yes	1.37	1.04–1.81	0.025*	1.25	0.88–1.77	0.216
Drinkers, n (%)						
No	1.00 (ref)					
Yes	0.95	0.70–1.29	0.738			
Hypertension, n (%)						
No	1.00 (ref)					
Yes	1.06	0.08–1.40	0.677			
Diabetes, n (%)						
No	1.00 (ref)			1.00 (ref)		
Yes	1.80	1.21–2.68	0.004*	1.90	1.27–2.84	0.002*
Lipid parameters						
TG, mmol/L	1.18	0.90–1.54	0.243			
TC, mmol/L	1.05	0.92–6.05	0.464			
LDL-C, mmol/L	1.12	0.94–1.32	0.210			
HDL-C, mmol/L	0.63	0.42–0.93	0.021*	0.77	0.46–1.31	0.343
VLDL-C, mmol/L	1.19	0.93–1.52	0.177			
ApoAI, g/L	0.34	0.17–0.68	0.002*	0.45	0.18–1.13	0.090
ApoB100, g/L	1.65	0.95–2.87	0.078			
Lp(a), mg/L	1.25	1.11–1.42	0.000*	1.27	1.11–1.44	0.000*

ApoAI: Apolipoprotein AI; ApoB100: apolipoprotein B100; BMI: body mass index; 95% CI: 95% confidence interval; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol; Lp(a): lipoprotein(a); OR: odds ratio; TC: total cholesterol; TG: triglycerides; VLDL-C: very low-density lipoprotein cholesterol. *: Significant association ($P < 0.05$).

the present study and that these indices are classical risk factors for the development of CHD. The severity of CHD increases steeply with age in Indonesian males and females (29). The reason why the severity of stenosis increases with age is that age reflects the progressive accumulation of coronary atherosclerosis (8). At any given age, males are at a greater risk for coronary disease compared to females (30). Risk in females lags approximately 10 to 15 years behind that of males (8). The reasons for sex difference in CHD risk are not fully understood. One possible mechanism could be the earlier onset of risk factors in males: for example, elevations of LDL-C, triglycerides, and blood pressure, and/or reduction of HDL-C (8). However, the Framingham Heart Study showed that the differences in absolute risk between males and females cannot be explained entirely by the differences of the conventional

risk factors (8). A growing body of literature revealed that the risk for CHD increases substantially with type 2 diabetes mellitus (31,32). Furthermore, the mortality rate in diabetic subjects who have experienced CHD is much higher than that in nondiabetic subjects (33). In our study, the patients with diabetes mellitus had more severe narrowing of the three major coronary arteries than did the nondiabetic patients, which indicates that diabetes is not only associated with the onset of CHD but also with the development of CHD.

Although LDL-C is considered as the major cause of CHD in both the Adult Treatment Panel III Guidelines (8) and the 2013 ACC/AHA blood cholesterol guidelines (9) of the United States, our study shows that LDL-C is a poor predictor for the increased number of stenotic vessels (Table 2) and the Gensini score (Table 3). On the other hand, HDL-C levels decreased with increasing Gensini scores after adjusting for other possible confounding factors (Table 3). Epidemiological evidence links low levels of HDL-C to increased CHD morbidity and mortality, whereas high HDL-C levels conversely convey reduced risk (34). Taken together with our findings, it can be safely concluded that HDL-C is negatively associated with the severity of CHD. Furthermore, decreased HDL-C was found to be an independent predictor for enhanced inflammation and endothelial activation, which are both critical in the pathogenesis of atherosclerosis and atherosclerosis-related complications (35). The mechanistic relationship between low HDL-C levels and the severity of CHD has not been fully elucidated. One theory could be that HDL promotes efflux of cholesterol from foam cells in reverse cholesterol transport (36), and, on the other hand, has antioxidant and antiinflammatory properties that inhibit atherogenesis (37).

It should be pointed out that our study has several limitations. First, the Syntax scoring system was not employed to assess the severity of CHD in the present study for the reason that our angiographic data were more suitable to calculate the Gensini scores. The clinical risk factors are included in the calculation of Syntax scores and hence it can objectively evaluate the severity of CHD. In addition, the Syntax scores can also accurately distinguish patients with or without a clinical outcome and could accurately predict the cardiovascular risk without under- or overestimating risk (38). Second, we did not carry out a clinical follow-up of the studying population. Well-designed long-term prospective trials are needed to determine the exact role of Lp(a) in the development of CHD. Third, the patients included in this study are exclusively Han Chinese people, and therefore our findings may not apply to other ethnic groups. However, one advantage of our study is that the severity of CHD was assessed by both the number of stenotic vessels and the Gensini scores. Our results could be more accurate since most of previous studies only used one method to evaluate the severity of CHD (39,40).

In conclusion, we observed an orderly increase in Lp(a) levels with the increasing number of stenotic vessels and Gensini scores, and an independent association between Lp(a) and the severity of CHD after adjusting for other possible confounding factors. Lp(a) may be a useful predictor for the severity of CHD in the Han Chinese population.

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