



## Original Research Article

## Correlation of serum cholesteryl ester transfer protein (CETP) level with lipid profile in young myocardial infarction patients

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## ABSTRACT

**Introduction:** Heart Disease is number one cause of mortality and a silent epidemic among Indians. The risk of coronary artery disease is found to increase with increase in serum Cholesteryl ester transfer protein (CETP) levels. CETP mediates the exchange of lipids between the lipoproteins. Serum CETP levels of young myocardial infarction (MI) patients are measured to see its correlation with lipid profile.

**Materials and Methods:** This prospective observational case-control study was done on 50 young MI patients and 30 age-matched controls for measuring serum CETP and lipid profile in the biochemistry laboratory of Christian medical college, Ludhiana. The study started from 1<sup>st</sup> November 2014 till full enrolment. Serum CETP were quantified by Enzyme Linked Immunosorbent Assay (ELISA) method.

**Results:** The mean serum CETP value observed among cases was  $1168.7 \pm 738.3 \mu\text{g/L}$  and that among cases was  $978.4 \pm 337.2 \mu\text{g/L}$  with a p-value was 0.18. The correlation coefficients of serum CETP with total cholesterol, triglyceride, Low density lipoprotein and high density lipoprotein are -0.083, -0.037, -0.020 and 0.050 and similarly among controls were -0.292, 0.086, 0.282, 0.337 respectively.

**Conclusion:** The serum CETP concentrations were found to be higher in cases as compared to the controls but were not found to be statistically significant, while no correlation was found between serum CETP concentration and lipid profile in young MI cases.

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### 1. Introduction

Myocardial infarction is an acute and catastrophic event with serious consequences in terms of mortality, morbidity and cost to the society with an estimated burden of 3.6 million young individuals being affected each year.<sup>1</sup> (1). MI is an acute coronary syndrome that occurs during natural course of coronary atherosclerosis. MI remains to pose a major burden on the society despite the major improvements made in its management. Public health estimates show that coronary artery disease (CAD) would rise in the developing nations by 120% and 137% in women and men, respectively by 2020. Of all the developing nations, India is undergoing the most rapid epidemiologic transition from communicable to non-communicable diseases characterized by high burden of atherothrombotic dominated non-

communicable diseases. In India CAD is the leading cause of death accounting for 1.46 million deaths which represented 14% of all-cause mortality in 2004. It is projected that by 2020 ischemic heart disease will result in 2.5 million deaths. Coronary atherosclerosis i.e. formation of waxy plaque in coronaries is the most important cause of myocardial infarct, which is attributed to derangement in lipid profile.<sup>2</sup>

Cholesteryl Ester Transfer Protein (CETP) is a plasma protein secreted from the liver that has an established role in lipoprotein metabolism. It transports cholesterol from peripheral tissues to liver in a process called as reverse cholesterol transport (RCT). It also transfers cholesteryl esters from High-density lipoprotein (HDL) to Low-density lipoprotein (LDL) & Very low density lipoprotein (VLDL) and transferring triglycerides from VLDL to HDL & LDL.<sup>3,4</sup>

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Cholesterol when combines with a free fatty acid forms cholesteryl ester (CE). This esterification takes place either in the cell or in the plasma. In cells of liver, intestine and adrenal cortex- the cholesterol reacts with Acyl CoA (fatty acid) to form cholesteryl esters in a reaction catalysed by ACAT, [Acyl- CoA Cholesterol Acyl Transferase] an enzyme found in endoplasmic reticulum of the cells. Whereas, in plasma, cholesteryl ester (CE) synthesis is catalysed by LCAT [Lecithin Cholesterol Acyl Transferase] an enzyme secreted by liver. This esterified cholesterol is transported in blood as integral part of lipoprotein. The fact that CETP redistributes Cholesteryl Esters (CE) from non-atherogenic lipoprotein HDL to potentially atherogenic lipoprotein i.e. LDL and VLDL fraction implies that it may be pro-atherogenic. But, by the virtue of its ability to increase the rate of reverse cholesterol transport in which cholesterol from peripheral tissues is transported to the liver for its elimination in bile, CETP may be considered to be antiatherogenic. A third view shows evidence of concentration dependent anti-inflammatory function of HDL, which adds on to its antiatherogenic property. As CETP is found to reduce the concentration of HDL it may reduce the anti-inflammatory impact of HDL in a process that is ultimately pro-atherogenic. Theoretically CETP may be either pro-atherogenic or antiatherogenic. Hence, the net impact of CETP is uncertain.<sup>3,4</sup>

Animal studies with the evidence supporting both a pro-atherogenic and an antiatherogenic role of CETP have been reported depending on the metabolic settings and on the species being investigated.<sup>3-6</sup> The ILLUSTRATE Trial (Investigation of lipid level management using coronary ultrasound to assess reduction of atherosclerosis by CETP inhibition and HDL raising) done on humans has shown that inhibition of CETP has favourable effects on lipid profile, by raising HDL (high density lipoprotein) by 72% and lowering LDL (low density lipoprotein) by 25%. A hypothesis was formed that pharmacological inhibition of CETP retards the development of atherosclerosis.<sup>7-9</sup> Most of the studies of CETP on human subjects have revealed that the incidence of cardiovascular disease (CVD) is directly related to plasma CETP levels and hence it is atherogenic, even though the evidence of antiatherogenic role of CETP has also been reported under different lipid environment.<sup>10-12</sup>

The human CETP gene has been mapped to chromosome. 16. It was found that a subset of Japanese population with genetic deficiency of CETP had markedly elevated HDL cholesterol.<sup>13</sup> There is paucity of studies correlating serum CETP & lipid profile in myocardial Infarction patients. Hence, this study strives to know if there is a correlation of raised CETP levels with changes in lipid profile in myocardial infarction patients.

## 2. Materials and Methods

A prospective observational case-control study was conducted in the Department of Biochemistry on the diagnosed young myocardial infarction patients admitted to Department of Cardiology at Christian Medical College and Hospital, Ludhiana. After due approval from IEC (Institutional Ethics Committee), a total of 80 individuals were enrolled for the study, of which 50 were cases and 30 were healthy matched controls. The study period started in November 2014 and ended in August 2015. Young patients (age  $\leq 45$  years) with diagnosed myocardial infarction, according to WHO criteria,<sup>14</sup> admitted to Coronary C are U nit (CCU) were included in the study. Consent in written form was taken from patients fulfilling the criteria, then findings in terms of history, biochemical test parameters (blood sugar, CK, CKMB, troponin T) ECG, ECHO, angiography were noted. Blood samples were collected within 24 hours of the infarct event, but after an informed & written consent.

Blood sample were brought to the Department of Biochemistry, where the serum was separated from it after proper clot formation and centrifugation. Lipid profile was performed as routine on these serum samples from the patients and controls on the HITACHI modular p-800 auto-analyser (Roche Diagnostics, Germany). Serum samples were then stored in the deep freezer ( $-4^{\circ}\text{C}$ ) until further processing for serum CETP level s which were determined using commercially available CETP ELISA assay kit of BIOSPES, obtained from INFOBIO, New Delhi.

### 2.1. Statistical analysis

For comparison of means of biochemical values student's t-test was used whereas, the proportions was compared using  $\chi^2$  (Chi-Square) test. Linear and logistic regression analysis was used to determine the correlation of lipid profile parameters with serum CETP levels and to study the association of Acute Coronary Syndrome (ACS) with serum CETP concentrations. The data was analysed using Statistical package for social sciences (SPSS) statistics for windows version 21.0.

## 3. Results

The lipid profile and serum CETP concentrations of cases and controls were obtained and compared. The Table 1 depicts the mean and median of the lipid profile parameters- Total Cholesterol (TC), Low density lipoprotein (LDL), Triglyceride (TG) and High density lipoprotein (HDL) among cases and controls. The corresponding p-Value is also shown.

The mean serum CETP observed among cases was  $1168.7 \pm 738.3 \mu\text{g/L}$  and that among controls was  $978.4 \pm 337.2 \mu\text{g/L}$  along with p-value of 0.18.

The correlation coefficients of serum CETP with total cholesterol (TC), triglycerides (TG), Low density lipoprotein (LDL) and High density lipoprotein (HDL) is depicted in Tables 2, 3, 4 and 5 respectively.

#### 4. Discussion

The consequences of the myocardial infarction when affecting the young individuals are usually tragic and devastating for the family. This subgroup of young patients with MI, represent those who come to medical attention owing to symptomatic disease and may just represent the “tip of iceberg” when considering the symptomatic and subclinical disease together.<sup>15</sup> The strong inverse relation of CAD with HDL- cholesterol suggests that increments in HDL makes an independent contribution to reduction in CAD risk.<sup>16</sup> Kurasawa et al. (1985) suggested that the rate of cholesteryl ester transfer is proportional to HDL concentration in the serum within the ranges of physiological concentration but under the conditions of low cholesteryl transfer rate, cholesteryl ester generated by the action of LCAT enzyme may accumulate in HDL if free cholesterol is continuously provided.<sup>17</sup> Koizumi et al. in the same year (1985) were the first to show that it was the genetic deficiency of CETP that is the most important and frequent cause of hyperalphalipoproteinemia (elevated HDL levels) in the Japanese.<sup>18</sup> In 1990, Yamashita et al. investigated the molecular mechanism of CETP deficiency in 4 unrelated families who were CETP deficient, with HDL levels exceeding 150 mg/dl.<sup>19</sup>

Studies on association of common variants in human CETP gene and the cardiovascular diseases have yielded contradictory results despite consistent association with HDL-c levels.<sup>20,21</sup> Similarly, only few studies have been published on association of plasma CETP levels and CHD outcomes, and they also do not provide a consistent result.<sup>22–30</sup> The question of whether CETP is pro- or antiatherogenic, is still open to debate.

Serum CETP levels in present study group among cases (n=50) was  $1168.73 \pm 738.3 \mu\text{g/L}$  but comparatively higher levels are noted in most of the other studies by Zhuang et al. (2001), Boekholdt et al. (2004), Cho et al. (2009) and Ritsch et al. (2010) as shown in Table 6. Among the normal healthy control group (n=30) serum CETP concentration in our study group was  $978.42 \pm 337.19 \mu\text{g/L}$ , for Zhuang et al. was  $1400.0 \pm 1370.0 \mu\text{g/L}$ , for Boekholdt et al. was  $3800.0 \pm 2100.0 \mu\text{g/L}$  and for Cho et al. was  $2300.0 \pm 300.0 \mu\text{g/L}$  in.<sup>23–26</sup> The reason for low levels among present study group could be that this particular group of population has lower endogenous levels of serum CETP, lower levels are noted in the control group as well compared with other study population groups.

The finding of no correlation between serum CETP levels and lipid profile parameters in young MI patients and healthy controls in present study (Chart 1 / Tables 3,

4, 5 and 6) are consistent with that of Zhuang et al.<sup>23</sup> The highest levels of serum CETP in cases were noted among three patients – levels being 4364, 3397.5 and 3050  $\mu\text{g/L}$  and their total cholesterol levels and triglycerides were noted to be in the lowest quartiles – the levels of total cholesterol being 124, 169 and 123 mg/dl and that for triglycerides being 107, 121 and 113 mg/dl respectively. In line with this, the patient having highest levels of total cholesterol (328 mg/dl) and highest levels of triglyceride (461 mg/dl) was found to have normal levels of serum CETP. Similarly among controls, the individual with highest level of serum CETP 1762.5  $\mu\text{g/L}$  also had total cholesterol level in the lowest quartile – the level being 135 mg/dl. Among the cases, LDL levels as well as HDL levels were also found to be in the lower quartile among the same patients with highest levels of serum CETP and their corresponding LDL levels were 87, 114 and 63 mg/dl and HDL levels were 20, 30 and 37 mg/dl respectively. Similarly among controls, the individual with highest levels of LDL (173 mg/dl) and highest levels of HDL (71 mg/dl) was found to have normal levels of serum CETP.

In similar studies like the nested case-control study by Boekholdt et al. elevated CETP levels were associated with increased risk of future CAD but only in individuals with raised triglycerides.<sup>24</sup> Borggreve et al. suggests high plasma CETP may favour reduced risk of CVD in patients with low triglycerides.<sup>27</sup> On the other hand, study by Cho et al. shows greatly elevated CETP levels in MI patients.<sup>25</sup> Contrary to this, Ritsch et al. suggested that low endogenous CETP levels are associated with increased cardiovascular mortality.<sup>26</sup> The relationship of serum CETP with CAD has ever been a question since the discovery of CETP deficiency as a cause of elevated HDL levels, and surprisingly, it remains unanswered.

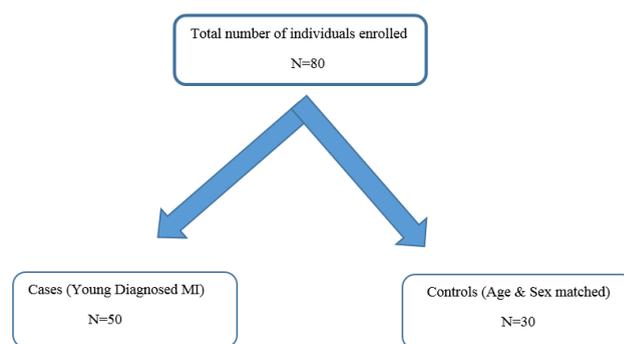


Chart 1: Study Population

#### 5. Conclusion

Myocardial infarction has been recognized among younger age group more frequently in recent years. Considering the social responsibilities that a young individual has towards

**Table 1:** Comparative lipid profile of cases and controls

Lipid Profile ( mg/dl)	TC	LDL	TG	HDL
Cases				
Mean	179.1 ± 48.8	112.1 ± 40.2	143.2 ± 76.9	41.7 ± 10.2
Median	174.5	108	125	40
Controls				
Mean	173.7 ± 35.6	107.4 ± 28.5	149.3 ± 67.5	42.9 ± 11.1
Median	165	105.5	155	40.5
p- Value	0.599	0.582	0.719	0.593

Values represent Mean ± SD (Standard deviation)

p-value <0.05 is considered to be statistically significant

**Table 2:** Correlation of serum CETP with total cholesterol

Category	Total Cholesterol	Serum CETP levels in µg/L	p-value	Correlation coefficient
Cases (n=50)	< 199 mg/dl (n=38)	1232.27 ± 810.13	0.568	-0.083
	200-300 mg/dl (n=11)	901.96 ± 349.18		
	>300 mg/dl (n=1)	1685 ± 0		
Controls (n=30)	< 199 mg/dl (n=22)	914.96 ± 316.34	0.117	-0.292
	200-300 mg/dl (n=8)	1152.94 ± 351.24		
	>300 mg/dl (n=0)	0 ± 0		

Values represent Mean ± SD (Standard deviation)

p-value <0.05 is considered to be statistically significant

**Table 3:** Correlation of serum CETP with triglyceride

Category	Triglyceride levels	Serum CETP levels in µg/L	p-value	Correlation coefficient
Cases (n=50)	< 150 mg/dl (n=31)	1258.31 ± 893.44	0.796	-0.037
	150-300 mg/dl (n=17)	999.5 ± 356.3		
	>300 mg/dl (n=2)	1218.75 ± 171.47		
Controls (n=30)	< 150 mg/dl (n=14)	946.79 ± 366.17	0.651	0.086
	150-300 mg/dl (n=15)	981.3 ± 314		
	>300 mg/dl (n=1)	1378 ± 0		

Values represent Mean ± SD (Standard deviation)

p-value <0.05 is considered to be statistically significant

**Table 4:** Correlation of serum CETP with low density lipoprotein

Category	LDL levels	Serum CETP levels in µg/L	p-value	Correlation coefficient
Cases (n=50)	< 130 mg/dl (n=35)	1209.33 ± 842.58	0.893	-0.020
	> 130 mg/dl (n=15)	1074 ± 415.57		
Controls (n=30)	< 130 mg/dl (n=23)	918.76 ± 326.43	0.131	0.282
	> 130 mg/dl (n=7)	1174.43 ± 316.82		

Values represent Mean ± SD (Standard deviation)

p-value <0.05 is considered to be statistically significant

**Table 5:** Correlation of serum CETP with high density lipoprotein

Category	HDL levels	Serum CETP levels in µg/L	p-value	Correlation coefficient
Cases (n=50)	< 40 mg/dl (n=24)	1287.96 ± 979.18	0.732	0.050
	40-60 mg/dl (n=24)	1046.69 ± 408.04		
	>60 mg/dl (n=2)	1202.5 ± 406.59		
Controls (n=30)	< 40 mg/dl (n=14)	851.11 ± 302.8	0.068	0.337
	40-60 mg/dl (n=13)	1105.5 ± 368.38		
	>60 mg/dl (n=3)	1021.83 ± 131.18		

Values represent Mean ± SD (Standard deviation)

p-value <0.05 is considered to be statistically significant

**Table 6:** Serum CETP levels among cases in various studies

CETP levels in cases ( $\mu\text{g/L}$ )	Present study (n=50)	Zhuang et al. (n=117)	Boekholdt et al. (n=735)	Kyung-Hyun et al. (n=10)	Ritsch et al. (n=2560)
	1168.73 $\pm$ 738.3	1980.0 $\pm$ 1680.0	4000.0 $\pm$ 2200.0	4400.0 $\pm$ 400.0	1115.0 $\pm$ 295.0

Values represent Mean  $\pm$  SD (Standard deviation)

the society at large and the associated long term disability of the premature CAD, there is a need to find more potential risk factors associated with heart diseases in the young that in turn may help in designing preventive programs. Experimental evidence have suggested athero-protective as well as pro-atherogenic role of CETP. The findings of this study can be summarized as:

1. The lipid profile parameters were not found to be deranged in majority of the young myocardial infarction cases.
2. The average serum CETP level among young patients of myocardial infarction was 1168.73  $\mu\text{g/L}$ , whereas that among age & sex matched healthy controls was 978.4  $\mu\text{g/L}$  in this population sub-group (statistically insignificant).
3. The serum CETP levels were not significantly different between the young myocardial infarction patients and the control group.
4. The levels of serum CETP were not found to be significantly correlating with changes in total cholesterol and HDL concentration among the young myocardial infarction patients.

Thus, based on the findings obtained in the present study it can be concluded that the serum CETP levels are not significantly raised among young myocardial infarction patients of age  $\leq 45$  years in our population as compared to healthy controls and that the levels of CETP cannot be significantly correlated with changes in lipid profile in this young age group. But this being a very controlled study with a small sample size more studies are needed to find correlation with other factors for actually correlating CETP with MI or to find any drugs for its inhibition to raise the HDL and other cardio protective factors in the young population.

## 6. Source of funding

None.

## 7. Conflicts of interest

None

## References

1. Putaala J. Ischemic stroke in the young: current perspectives on incidence, risk factors, and cardiovascular prognosis. *Eur Stroke J.* 2016;1(1):28–40.
2. Isezuo S, Subban V, Krishnamoorthy J, Pandurangi UM, Janakiraman E, Kalidoss L. Characteristics, treatment and one-year outcomes of patients with acute coronary syndrome in a tertiary hospital in India. *Indian Heart J.* 2014;66(2):156–63.
3. Barter PJ, Brewer HB, Chapman MJ, Hennekens CH, Rader DJ, Tall AR. Cholesteryl ester transfer protein a novel target for raising HDL and inhibiting atherosclerosis. *Arterioscler Thromb Vasc Biol.* 2003;23(2):160–167.
4. CETP and atherosclerosis. *Arterioscler Thromb Vasc Biol.* 2000;20(9):2029–2031.
5. Zeller M, Masson D, Farnier M, Lorgis L, Deckert V, Barros JPD. High serum Cholesteryl ester transfer rates and small high-density lipoproteins are associated with young age in patients with acute myocardial infarction. *J Am Coll Cardiol.* 2007;50(20):1948–55.
6. Vries RD, Perton FG, Dallinga-Thie GM, Roon AV, Wolffenbuttel B, Tol AV. Plasma cholesteryl ester transfer is a determinant of intima-media thickness in type 2 diabetic and non-diabetic subjects: Role of CETP and triglycerides. *Diabetes.* 2005;54(12):3554–3559.
7. Nissen SE, Tardiff JC, Nichollas SJ, Revkin JH, Shear CL, et al. Effect of torcetrapib on the progression of coronary atherosclerosis. *N Engl J Med.* 2007;356(13):1304–1316.
8. Cholesteryl ester transfer-protein modulator and inhibitors and their potential for the treatment of cardiovascular diseases. *Vasc Health Risk Manag.* 2012;8:323–3531.
9. Miller NE. CETP inhibitors and cardiovascular disease: Time to think again. *F1000Res.* 2014;3:124–124.
10. Wang J, Wang LJ, Zhong Y, Gu P, Shao JQ, et al. CETP gene polymorphisms and risk of coronary atherosclerosis in a Chinese population. *Lipids Health Dis.* 2013;12(1):1–1.
11. Forrester JS, Makkar R, Shah PK. Increasing high-density lipoprotein cholesterol in dyslipidemia by cholesteryl ester transfer protein inhibition: an update for clinicians. *Circ.* 2005;111(14):1847–1854.
12. Nicholls SJ, Tuzcu EM, Brennan DM, Tardiff JC, Nissen SE. Cholesteryl ester transfer protein inhibition, high-density lipoprotein raising, and progression of coronary atherosclerosis insights from ILLUSTRATE (Investigation of Lipid Level Management Using Coronary Ultrasound to Assess Reduction of Atherosclerosis by CETP Inhibition and HDL Elevation). *Circ.* 2008;118(24):2506–2514.
13. Armitage J, Holmes MV, Preiss D. Cholesteryl Ester Transfer Protein Inhibition for Preventing Cardiovascular Events: JACC Review Topic of the Week. *J Am Coll Cardiol.* 2019;73(4):477–487.
14. Ferreira R. New diagnostic criteria of acute myocardial infarction. *Rev Port Cardiol.* 2003;22:735–740.
15. Klein LW, Nathan S. Coronary artery disease in young adults. *J Am Coll Cardiol.* 2003;41(4):529–531.
16. Rifkind BM. High-density lipoprotein cholesterol and coronary artery disease: survey of the evidence. *Am J Cardiol.* 1990;66(6):3–6.
17. Kurasawa T, Yokoyama S, Miyake Y, Yamamura T, Yamamoto A. Rate of cholesteryl ester transfer between high and low density lipoproteins in human serum and a case with decreased transfer rate in association with hyperalphalipoproteinemia. *J Biochem.* 1985;98(6):1499–1508.
18. Koizumi J, Mabuchi H, Yoshimura A, Michishita I, Takeda M, et al. Deficiency of serum cholesteryl-ester transfer activity in patients with familial hyperalphalipoproteinemia. *Atheroscler.* 1985;58(1):175–186.
19. Yamashita S, Hui DY, Sprecher DL, Matsuzawa Y, Sakai N, et al. Total deficiency of plasma cholesteryl ester transfer protein in subjects

- homozygous and heterozygous for the intron 14 splicing defect. *Biochem Biophys Res Commun*. 1990;170(3):1346–1351.
20. Cuchel M, Rader DJ. Is the cholesteryl ester transfer protein proatherogenic or antiatherogenic in humans. *J Am Coll Cardiol*. 2007;50(20):1956–1964.
  21. Lancet T. Cholesterol: the good, the bad, and the stopped trials. *The Lancet*. 2006;368(9552):2034–2034.
  22. Wolfe ML, Rader DJ. Cholesteryl ester transfer protein and coronary artery disease: an observation with therapeutic implications. *Circ*. 2004;110(11):1338–1340.
  23. Zhuang Y, Wang J, Qiang H, Li Y, Lui X, et al. Serum cholesteryl ester transfer protein concentrations in healthy Chinese subjects and cardio-cerebrovascular disease patients. *Clin Chim Acta*. 2001;305(1-2):19–25.
  24. Boekholdt SM, Kuivenhoven JA, Wareham NJ, Peters RJ, Jukema JW, et al. Plasma levels of cholesteryl ester transfer protein and the risk of future coronary artery disease in apparently healthy men and women: the prospective EPIC (European Prospective Investigation into Cancer and nutrition)-Norfolk population study. *Circ*. 2004;110(11):1418–1423.
  25. Cho KH, Shin DG, Baek SH, Kim JR. Myocardial infarction patients show altered lipoprotein properties and functions when compared with stable angina pectoris patients. *Exp Mol Med*. 2009;41(2):67–76.
  26. Ritsch A, Scharnagl H, Eller P, Tancevski I, Duwensee K, Demetz E. Cholesteryl ester transfer protein and mortality in patients undergoing coronary angiography: the Ludwigshafen risk and cardiovascular health study. *Circ*. 2010;121(3):366–374.
  27. Borggreve SE, Hillege HL, Dallinga-Thie GM, Jong PED, Wolfenbittel BH, et al. High plasma cholesteryl ester transfer protein levels may favour reduced incidence of cardiovascular events in men with low triglycerides. *Eur Heart J*. 2007;28(8):1012–1018.
  28. Niu W, Qi Y. Circulating cholesteryl ester transfer protein and coronary heart disease: mendelian randomization meta-analysis. *Circ: Cardiovascular Genetics*. 2015;8(1):114–121.
  29. Millwood, Bennett DA, Holmes MV, Boxall R, Guo Y, et al. Association of CETP gene variants with risk for vascular and nonvascular diseases among Chinese adults. *JAMA cardiology*. 2018;3(1):34–43.
  30. Guerin M, J S, Gall J, Berthet M, Frisdal M, et al. Association of serum cholesterol efflux capacity with mortality in patients with ST-segment elevation myocardial infarction. *J Am Coll Cardiol*. 2018;72(25):3259–3269.

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