Review

A review: Serum Lipid Profile Status in Cardiovascular Disease

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Abstract: Dyslipidemia is one of the modifiable risk factors for cardiovascular diseases (CVD). Lipids and lipoproteins, their metabolism, and their transport are essential contributing factors of cardiovascular disease (CVD) as they regulate plasma cholesterol concentration, enhancing cholesterol uptake by macrophages, leading to foam cell formation and ultimately resulting in plaque formation and inflammation. In a population with cardiovascular risk factors, HDL-cholesterol, Total/HDL-cholesterol and triglycerides/HDL-cholesterol ratios were associated with a higher population attributable risk for cardiovascular disease compared to other common biomarkers.

Keywords: CVD, Lipid profile, NCD, Dyslipidemia.

1. Introduction

Once communicable disease was the most threatening disease for human population. Nowadays the non-communicable diseases are the number one cause for morbidity and mortality worldwide[1]. According to World Health Organization (WHO) data cardiovascular disease (CVD) killed the most number of people worldwide[2]. Cardiovascular disease is a broad term which used to describe all conditions affecting the heart and circulatory system, including coronary heart disease, stroke, heart attack and aortic disease. Heart disease is a general term for conditions affecting the structure of the heart and the way it functions. All heart diseases are cardiovascular diseases. But, all cardiovascular diseases are not heart diseases. Example: stroke. This affects blood vessels in the brain, but not the heart itself[3].

An estimated 17.9 million people died from cardiovascular disease (CVDs) in 2016, representing 31% of total global deaths. Of these deaths, 85% was caused by heart attack and stroke[2]. Over three quarters of CVD deaths take place in low-income and middle-income countries. Out of the 17 million premature deaths (under the age of 70) due to noncommunicable diseases, 82% are in low-income and middle-income countries, and 37% are caused by CVDs in 2015[2,4]. In recent years, rapid urbanization, increased life expectancy, unhealthy diet, and lifestyle changes have led to an increased rate of CVD in Southeast Asia, including Bangladesh[5]. In 1986, noncommunicable diseases (NCDs) represented only 8% of total deaths compared to 52% of deaths due to communicable diseases [1], whereas in 2014, NCDs are estimated to account for 59% of total deaths in which CVD is the single-most important contributor, and is responsible for 17% of total mortality[6].

Cardiovascular disease risk factors can be split into two categories:

- Non-modifiable cardiovascular disease risk factors are those which cannot be changed. Examples: Person's age, ethnicity and family history, etc.
- Modifiable cardiovascular disease risk factors are those which can be reduced or controlled with altered

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behavior. By changing lifestyle, people are able to reduce their chances of developing cardiovascular disease. Examples: Smoking, diet and exercise[7–9].

- Risk factors of CVD.
- Family history
- Dyslipidemia
- Cholesterol
- High blood pressure (hypertension)
- Diabetes
- Being overweight (obesity)
- Age
- Ethnicity
- Sex
- Socioeconomic status
- Smoking
- Physical inactivity
- Diet

Dyslipidemia is one of the major risk factors for CVD. And it is also identified as one of the first cause of death in the developed and developing countries[10]. The abnormal level of lipid profile causes dyslipidemia. It is characterized by high levels triglycerides (TG), borderline high levels of low-density lipoprotein (LDL) and low levels of high-density lipoprotein (HDL)[11]. A lipid profile is a blood test that measures the amount of cholesterol and fats called triglycerides in the blood. The increased level of TC, TG and LDL is found to be associated with the higher risk of cardiovascular disease (CVD)[12–16]. According to WHO global estimates, dyslipidemia cause one third of ischemic heart disease and one fifth of global cerebrovascular disease, and equates to nearly 2.6 million deaths every year worldwide[17].

2. Methods

Table 1 Comparison of different studies on CVD & lipid profile.

Study no.	Investigator	Study design	Country	Population	Assessment
1	Kumar L and Das AL[21]	Case-control study 2018	India	90 patients with acute or severe coronary heart diseases.	Lipid profile (TC, TG, LDL-C, HDL-C)
2	Akanda MAK et al.[22]	Cross-sectional study 2017	Bangladesh	Among adults age over 18 years residing in an urban and a rural community. A total of 768 participants were screened.	Lipid profile (TG, LDL, TC)
3	Haque AE et al.[23]	Cross-sectional study 2016	Malaysia	160 patients aged between 30 to 79 years were included in this study. Out of 160 patients with CHD, 69% were male and 31% female.	Lipid profile (TC, TG, HD L-C, LDL-C)
4	Choudhury KN et al.[24]	Case-control study 2014	Bangladesh	234 participants, including 159 hypertensive patients and 75 normotensive controls.	Lipid profile (TC, TG, HDL, LDL)
5	Ferduos BA et al.[25]	cross-sectional analytical study 2014	Bangladesh	Fifty diagnosed Ischemic Heart Disease (IHD) patients of both sexes with age range of 30–65 years were taken as cases and 50 age and sex matched healthy volunteers were taken as controls.	Lipid profile (TC, TG, LDL-C, HDL-C)
6	Kondreddy R et al.[26]	Case-control study 2014	Libya	93 patients 40–80 years were diagnosed with CHD (history of angina or surviving myocardial infarction) with or without diabetes mellitus and hypertension.	Lipid profile (TC, LDL-C, HDL-C, Triglycerols, VLDL-C)

3. Results

3.1. Study 1

The serum total cholesterol to HDL-Cholesterol and low density lipoprotein-cholesterol to HDL-Cholesterol ratios also were significantly higher in cases than in controls, whereas the rise in triglycerides to HDL-Cholesterol ratio was not found to be significant.

3.2. Study 2

Between the urban and rural participants, the mean total cholesterol level was 175.2 ± 37.5 vs. 149.6 ± 23.8 mg/dL, mean triglyceride was 132.5 ± 35.3 vs. 154.7 ± 34 mg/dL and mean LDL was 104.0 ± 34.6 vs.79.7 ± 25.5 (mg/dL), respectively (p-value < 0.05). There was an increase in total cholesterol with increasing age (Odds Ratio (*OR*) = 4.53, 95% Confidence Interval (*CI*) = 3.55–9.52) and economic status between the areas ($p < 0.05$, *OR* = 1.88, 95% *CI* = 0.89–2.37). Total cholesterol was found to be high among urban participants and triglyceride level was found to be high among rural population ($p < 0.05$). Factors significantly associated with dyslipidemia were blood pressure, fasting blood sugar and food habits ($p < 0.05$).

3.3. Study 3

Most of the CHD patients had the total cholesterol level high, and among them 25.6% were Malay. Malays were the highest in the optimal range (<3.0 mmol/L) with 20.9% and HDL level within the normal range (1.2–1.8 mmol/L) by 22.2% (34). Most of the CHD patients had the TG level within normal range (<1.5 mmol/L) but among them 19.9% were Malays.

3.4. Study 4

The mean (± standard deviation) systolic blood pressure and diastolic blood pressure of the participants were 137.94 ± 9.58 and 94.42 ± 8.81, respectively, which were higher in the hypertensive patients (P<0.001). The serum levels of TC, TG, and LDL were higher while HDL levels were lower in hypertensive subjects compared to normotensives, which was statistically significant (P<0.001). Age, waist circumference, and body mass index showed significant association with hypertensive patients (P<0.001) but not with normotensives. The logistic regression analysis showed that hypertensive patients had 1.1 times higher TC and TG, 1.2 times higher LDL, and 1.1 times lower HDL than normotensives, which was statistically significant (P<0.05).

3.5. Study 5

The mean ± SD of serum TC, TG, HDL-C and LDL-C concentration in cases were 314.54 ± 73.72 mg/dL, 288.04 ± 60.45 mg/dL, 36.02 ± 4.12 mg/dL, and 178.62 ± 22.7 mg/dL respectively and in controls were 174.64 ± 18.97 mg/dL, 119.42 ± 12.47 mg/dL, 43.04 ± 2.58 mg/dL and 126.28 ± 11.45 mg/dL respectively.

3.6. Study 6

Lipid profile of patients with coronary heart disease showed significant variation from that of the control group. The TC ($p < 0.05$) and LDL-C ($p < 0.05$) were significantly higher in the cases, whereas the HDL-C had significantly lowered ($p < 0.05$) from that of the controls. Serum triacylglycerol was raised among cases than that of the controls but was not significant statistically. The total cholesterol to HDL-C and LDL-C to HDL-C ratios also were significantly higher in cases than in controls, whereas the rise in triacylglycerol to HDL-C ratio was not found to be significant.

4. Discussion

Studies exclusively related to dyslipidemia are very rare in Bangladesh. A study on 51,353 predominantly urban populations during 2005–2011 demonstrated significantly higher mean serum levels of total cholesterol

(TC), LDL-C, TG, LDL to HDL cholesterol ratio and TC to HDL-C ratio among younger adults aged 30–39 years compared to other age groups, regardless of sex, which may lead to microvascular complications[18]. Another study on 3201 individuals found rising trend of dyslipidemia in sub-urban population. Prevalence of dyslipidemia was 16.6% in general and 22.2% in males and 15.9% in females. TC was high (>240 mg/dL) in 16.9%, LDL-C was high (>160 mg/dL) in 15.7%, HDL-C was low (<40 mg/dL) in 8.8%, and TG was high (>200 mg/dL) in 17.8% and very high (>350 mg/dL) in 2.0% population[19].

Women had significantly higher TC and LDL-C in comparison to men above 40 years. Contrary to the popular belief, dyslipidemia is common in rural people as well[20]. Studies are needed to determine the lipoprotein profile of the population for better understanding of the contribution of dyslipidemia in CVD. Dyslipidemia is one of the major risk factors of cardiovascular disease, which can be modified either by proper life style changes or medical management or by the combination of both. Lipoprotein abnormalities play an important role in the causation of atherosclerosis. Dyslipidemia causes morbidity and mortality in patients with elevated triglyceride and LDL, and decreased HDL cholesterol concentrations. The modifications of LDL lipoprotein increase atherogenicity and available data suggest that LDL is more atherogenic. CVD have been generally described as having high levels of oxidative stress. Oxidative stress generally causes damage to the membrane polyunsaturated fatty acids leading to the generation of MDA, a thiobarbituric acid reacting substance (TBARS). Increased lipid peroxidation products in with vascular complications, have been reported. In one study, triglycerides, VLDL-C, LDL-C, and total cholesterol in all three groups are significantly higher as compared to those in controls ($p < 0.001$). HDL-C in all three groups is lower as compared to that in controls ($p < 0.001$). Elevated TG has been found to be significant and independent risk factor for major coronary events even after adjustment for LDL-C and HDL-C levels and other risk factors. Similar results have been reported by some other authors. Decreased HDL-C in patients indicate decreased rate of reverse cholesterol transport and therefore accumulation of TG rich lipoproteins leading to increased risk of atherosclerosis and CVD in all groups [27]. High levels of oxidative stress have been generally associated with CVD. Damage to the membrane's polyunsaturated fatty acids from oxidative stress typically results in the production of MDA, a chemical that reacts with thiobarbituric acid (TBARS). There have been reports of increased lipid peroxidation products along with vascular problems. Free radicals can destroy any biomolecule, including lipids, proteins, and nucleic acids, but lipids are likely the most vulnerable. Malonyldialdehyde (MDA) is the byproduct of the oxidative breakdown of lipids (lipid peroxidation), which is a destructive, self-replicating chain reaction. When compared to normal, a significant increase in MDA serum levels is observed in all groups. The primary oxidation targets are cellular proteins, which lead to the creation of aldehyde and ketone residues. The carbonyl content of proteins is a measure of this post-translational process and a sign of oxidative stress[27]. The development of carbonyl groups is regarded as an early, reliable indicator of protein oxidation. When compared to normal, a significant rise in the carbonyl content of red cell extract is observed in all groups. Contrary to lipid peroxidation, protein oxidation lacks the characteristics of chain reactions. The plasma proteins that are peroxidatively damaged have a fairly lengthy lifespan. As a result, measuring POX (Protein Oxidation) in plasma is regarded as a reliable indicator of the level of free radical activity. Protein side chains including arginine, lysine, threonine, and proline residues are modified by reactive oxygen species to create protein carbonyls. Elevated protein carbonyl levels are found in CVD and are thought to be an early and stable sign for POX. This shows the production of carbonyl groups, which is proof that proteins have been altered by free radicals [28,29].

From study 1 they found that the total cholesterol, HDL cholesterol, LDL cholesterol and triglycerides concentrations were significantly higher ($p < 0.05$) in coronary heart disease patients. The major risk factors are elevated LDL-C, reduced HDL-C, smoking, hypertension, insulin resistance with or without overt diabetes mellitus, age, and family history of premature CHD. Modifiable risk factors account for 85% of the elevated CHD risk, of which the most important is plasma cholesterol. TC levels of <160 mg/dL is able to decrease CHD risk. From the study 2 they found that the mean TC and LDL levels were significantly higher among participants

of urban areas compared to the participants of rural areas ($p = 0.001$). On the other hand, the mean TG level was found to be significantly higher among participants of rural areas compared to the participants of urban areas ($p = 0.001$). Mean high density lipoprotein was similar between urban and rural adults. Study 3 they found that demonstrated that Malays were mostly affected by heart disease (HD) followed by Chinese and Indians, and the incidence was twice as high as in men compared to women. Indians have a CHD mortality risk which twice that for Chinese and 3.6 times higher than that for Malays.

In study 4, the relationship between serum lipid profile and hypertension was investigated among an urban population in Bangladesh. Results of this study revealed that the mean values of serum TC, TG, and LDL were significantly higher and statistically significant among the hypertensive patients compared to normotensives. The mean HDL level was lower in the hypertensive compared to normotensives and was statistically significant. In study 5, they reveal that the patients with chronic ischemic heart disease is associated with significantly higher levels of serum TC, TG and LDL-C whereas HDL-C was found to be lower in IHD patients. And study 6, the findings of the present study indicated high serum cholesterol as an important single risk factor for coronary heart disease and an increase in the levels of LDL-Cholesterol and a decrease in HDL-Cholesterol add further value to the association observed.

5. Conclusion

From the above studies, it can be concluded that total cholesterol, LDL-C and TG are elevated and HDL-C is decreased in most cases of CVD. It is also observed that urban people are more susceptible to CVD than the rural people. Another finding is that the Malaysian populations are affected by heart disease compared to Chinese and Indians. It is also noted that people with hypertension and IHD are more likely to have raised TC, TG, LDL and reduced HDL level which leads to CVD. Therefore, it can be decided that abnormal lipid profile is a vital risk factor for CVD. These findings can be used for lifestyle intervention program to maintain the normal level of lipid profile and to achieve primary prevention of coronary artery disease and associated non communicable diseases in the entire human population.

Conflict of Interest

The authors declare no conflict of interest.

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