

Nutritional Factors Contributing to Coronary Heart Disease

Nalinee Chongviriyaphan, M.D.

Department of Pediatrics, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok 10400, Thailand.

Coronary heart disease (CAD) is a major cardiovascular disease and leading cause of death in both genders worldwide. Generally, it is a preventable disease of coronary arteries that supply blood and oxygen to the heart muscles. When coronary arteries are narrow and hardened because of the accumulation of plaque on the inner walls of coronary arteries (atherosclerosis), the blood flow to the heart is compromised, resulting in reduced oxygen supply to the heart muscles. Since the heart needs a continuous supply of oxygen and nutrients, the heart can be injured by the compromised blood supply. Consequently, patients with CAD develop angina, heart attack, heart failure, arrhythmias and sudden death.

A body of evidence has shown several risk factors of CAD. According to the American Heart Association, the major risk factors that cannot be changed include increasing age, male gender, and heredity. However, there are major risk factors that can be changed or modified such as tobacco smoking, high blood pressure, high blood cholesterol, diabetes mellitus, physical inactivity, obesity, and overweight. There are also some factors contributing to the increased risk of CAD such as stress and alcohol consumption.

Since the modifiable risk factors of CAD involve lifestyle and type of dietary intake. Therefore, healthy lifestyle and food intake can reduce the risk of CAD. This article will focus on some dietary factors that mainly affect the risk of CAD.

Dietary factors contributing to CAD^{1,2}

The quotation "You are what you eat," is originated in the US with the meaning that "to be fit and healthy, you need to eat good (or healthy) food". Nowadays, it has been established that not only eating good food helps us to be healthy but also eating "bad food or unhealthy diet" causes us diseases. For over 40 years, many studies have shown that dietary factors, such as type and amount of fat, are among the factors that increase the risk of CAD.

Saturated fatty acids

Saturated fatty acids (SFAs) potentially increase blood cholesterol in all fractions of lipoproteins. It has been shown that SFAs are associated with low-density lipoprotein cholesterol (LDL-C), the "bad" cholesterol that increases the risk of cardiovascular diseases, in a dose-dependent manner. SFAs increase LDL-C by decreasing LDL receptor synthesis and activity. SFAs that have the most atherogenic effect are myristic, palmitic, and lauric acids, respectively. Myristic acid is found abundantly in

butterfat, coconut, and palm kernel oils. The sources of palmitic acid or palmitate are plants; however, main dietary palmitate comes from animal sources. And lauric acid, which is the medium-chain SFA, is present in palm kernel and coconut oils. The food sources of these fatty acids include cheese, butter, milk, and bakery goods.

Trans-fatty acids

Trans-fatty acids are stereoisomers (*trans* form) of the *cis*-linoleic acid, which is the natural form. *Trans*-fatty acids are produced during hydrogenation process, widely used in the food industry to harden unsaturated oils and soft margarines. *Trans*-fatty acid intake comes from animal foods and hydrogenated vegetable oils. Elaidic acid, the *trans*-isomer of oleic acid, increases blood cholesterol when compared with polyunsaturated fatty acid (PUFA); however, the cholesterol-raising effect is less than myristic and lauric acids. *Trans*-fatty acids not only increase blood cholesterol but decrease high-density lipoprotein cholesterol (HDL-C), which is known as "the good" cholesterol.

The food sources of *trans*-fatty acids are stick margarines, shortening, and high-fat baked goods. However, soft or spray or liquid margarine contains less *trans*-fatty acid than butter. Therefore, eating low-fat dairy products and low fat meats lower the intake of *trans*-fatty acids.

Dietary cholesterol

Dietary cholesterol increases total cholesterol and LDL-C; a 25-mg increase in dietary cholesterol elevate serum cholesterol by 1 mg/dL. However, when cholesterol intake gets to the level of 500 mg/day, the increment in blood cholesterol is small. Therefore, there is possibly a plateau of response for plasma cholesterol to dietary cholesterol. Dietary cholesterol is related to the risk of cardiovascular diseases after adjusting for other risk factors such as age, blood pressure, and cigarette smoking. Nevertheless, dietary cholesterol increases plasma cholesterol and LDL-C in a lesser extent than SFAs.

The response to dietary cholesterol in term of plasma cholesterol varies among individuals. It has been suggested that genetic factors, such as apo-E allele, involve in the discrepancy of cholesterol responsiveness. Dietary cholesterol and SFAs have a synergistic effect on the levels of LDL-C since they decrease LDL receptor synthesis and activity as well as increase all lipoproteins including very-low-density lipoprotein (VLDL) enriched with apo-E.

Polyunsaturated fatty acids

When dietary omega-6 polyunsaturated fatty acid (PUFA) replaces carbohydrate, LDL-C is lower and HDL-C elevated. A 1% increase in omega-6 PUFA decreases total cholesterol by 1.4 mg/dL. However, it has been demonstrated that PUFAs decrease VLDL, apo-B, and HDL-C synthesis. Nevertheless, in a low-fat diet, both LDL-C and HDL-C will be lower when SFAs are replaced with PUFA. Moreover, removing SFAs from the diet is twice as effective in the reduction in plasma cholesterol levels as increasing the amount of PUFA.

The major sources of omega-6 PUFAs are vegetable oils, salad dressings, and margarine made from oils.

Most studies have shown that omega-3 PUFA do not have any effect on total cholesterol. However, they reduce the levels of LDL-C by 5% to 10% and decrease triglyceride levels by 25% to 30%. It has been demonstrated that omega-3 PUFA lower the levels of triglyceride by lowering postprandial lipemia and by inhibiting the production of VLDL and apo B-100. In addition, the lowering effect of omega-3 PUFA on the levels of triglyceride is dose-dependent.

The main sources of omega-3 PUFA are fish oils and marine fish. Consumption of one fatty fish meal/week, providing 5.5 g of omega-3 PUFAs/month, will decrease the risk of cardiac arrest by 50%.

Replacement of carbohydrate with monounsaturated fatty acid (MUFA), found in olive oil, has no effect on blood lipids. Nevertheless, the effects of MUFA on the reduction in levels of cholesterol, LDL-C, and triglyceride are the same as those of PUFA. It has been shown that the effect of MUFA on the levels of HDL-C is related with the total dietary fat intake. If the intake of both MUFA and total fat are high (> 15% and > 35% of total energy, respectively), the levels of HDL-C has not changed.

Although MUFA has a beneficial effect on lowering blood cholesterol, consuming high-fat diets rich in MUFA may cause the development of atherosclerotic lesions similar to those seen in animals fed diets high in SFAs.

Amount of dietary fat

Obesity, among major risk factors for atherosclerosis, is related to total fat intakes. In addition, high-fat

diets postprandially increase lipemia and chylomicron remnants, which are associated with increased risk of cardiovascular diseases. On the other hand, consuming less dietary fat may result in the higher levels of triglyceride and lower levels of HDL-C due to the increase of carbohydrate intake as a replacement source of energy. However, these changes are not associated with increased risk of CAD since LDL-C levels are low in people consuming low-fat diets. In addition, increased triglyceride levels result in the production of large, triglyceride-rich VLDL, which are not associated with the risk of cardiovascular diseases.

The American Heart Association recommends total fat intake at the amount less than 30% of total calories. However, the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III, or ATP III) has increased the range of total fat intake recommendation to 25% to 35% of total calories, with less than 7% from saturated fat.

Fibers

Soluble fibers, found in legumes, oats, fruits, and psyllium, can decrease levels of total cholesterol and LDL-C. When added to a low-fat diet, the average reduction in LDL-C levels is 14% in people with hypercholesterolemia and 10% in those with normocholesterolemia. There are several proposed mechanisms that describe the cholesterol-lowering effect of fibers such as binding bile acids and inhibiting cholesterol synthesis via producing short-chain fatty acids. However, insoluble fibers have no effect on the levels of cholesterol. The American Heart Association does not recommend the use of fiber supplement in the prevention of cardiovascular diseases.

REFERENCES

1. The American Heart Association. Risk factors and coronary heart disease. Available from <http://www.americanheart.org/presenter.jhtml?identifier=235> (Accessed on November 8th, 2005).
2. Krummel DA. Medical nutrition therapy in cardiovascular disease. In: Mahan LK, Escott-Stump S, eds. *Krauses Food, Nutrition, & Diet Therapy*. 11th ed. Philadelphia: Saunders; 2004:860-99.