Diets and Coronary Artery Disease: Clinical Evidence

Mohammed H Moghadasian[1,2]*, Todd C Rideout[3], Francesca Bonomini[4], Gaia Favero[4] and Rita Rezzani[4]

[1]*Department of Food and Human Nutritional Sciences, University of Manitoba, Winnipeg, Canada*

[2]*Canadian Centre for Agri-Food Research in Health and Medicine, St. Boniface Hospital Alberchtsen Research Centre, Winnipeg, Canada*

[3]*Department of Exercise and Nutrition Sciences, State University of New York at Buffalo, Buffalo, USA*

[4]*Anatomy and Physiopathology Division, Department of Clinical and Experimental Sciences, University of Brescia, Brescia, Italy*

*Corresponding Author: Mohammed H Moghadasian, Canadian Centre for Agri-Food Research in Health and Medicine, St. Boniface Hospital Alberchtsen Research Centre, Winnipeg, Canada.

Abstract

In this mini-review, clinical evidence for preventive roles of diets and dietary agents on coronary artery disease has been reviewed and summarized. In particular, the impact of regular consumption of major food groups including, fruits and vegetables, grain products, milk and dairy products, nuts as well as fish, meats and eggs has been discussed. Clinical evidence strongly supports a preventive role for a so called "healthy diet" against coronary artery disease development. A "healthy diet" should contain adequate amounts of fruit and vegetables, whole grain products, fish, tree nuts with minimal amounts of red meats and processed meat, and animal fats. A combination of "healthy diet" and active lifestyle seems to play a crucial role in prevention of coronary artery disease, and thereby, improves quality of life.

Keywords: *Cardiovascular Disease; Coronary Artery Disease; Diets; Lifestyle; Fruits and Vegetables; Fish; Whole Grain Products*

Coronary Artery Disease

Coronary Artery Disease (CAD) or Coronary Heart Disease (CHD) is a form of Atherosclerotic Vascular Disease (AVD) in which advanced atherosclerotic lesions are present in one or more major coronary arteries. Depending on the severity and size of these lesions, patients may experience various clinical events, including sudden death. A number of risk factors have been established for AVD, and accordingly, a variety of approaches has been suggested to reduce the risk. Amongst well-established risk factors, elevated levels of low density lipoprotein (LDL)-cholesterol and/or reduced levels of high density lipoprotein (HDL)-cholesterol are critical. Genetic, dietary and environmental factors contribute to abnormal metabolism of these lipoproteins. For example, familial hypercholesterolemia is a genetic disorder in which patients accumulate circulating LDL-cholesterol due to abnormalities in LDL receptors [1]. Similarly, reduced HDL-cholesterol levels are seen in patients with familial alpha-lipoprotein deficiency or hypoalphalipoproteinemia (Tangier disease) [2]. In addition to these genetic disorders, diets and lifestyle can have a profound effect on the metabolism of LDL and HDL. It has been reported by many large scale clinical trials and/or epidemiological studies that high consumption of saturated or trans-fat can increase LDL-cholesterol levels. On the other hand, active life style and moderate alcohol drinking may increase HDL-cholesterol levels. Hypertriglyceridemia is another risk factor for CAD which can be modified through appropriate diet and lifestyle changes.

Despite widespread promotions and education for healthy dietary behavior and lifestyle, heart-healthy recommendations are not met in many societies. This could be viewed as one of the reasons for the high degree of prevalence of CAD worldwide, making CAD one of the leading preventable causes of mortality and morbidity internationally. In addition, survivors of major coronary events not only will suffer from poor quality of life, but also will experience a significant economic burden. Both poor quality of life and economic burden of the

disease can be significantly improved through an appropriate lifestyle and dietary behavior. Therefore, the purpose of this short review is to summarize the importance of dietary factors in modifying risk factors of CAD.

Fruits and Vegetables

Fruits and vegetables are plant products which traditionally are included in daily diets of humans in various forms. Generally, fruits and vegetables are known to be nutrient rich. In addition, they contain a number of phytochemicals with known biological functions. While they contain high levels of micronutrients and water, most of them may not contain a significant amount of energy-yielding nutrients, particularly saturated fats. This contributes to their potential of providing nutrient requirements for humans without a significant impact on energy intake. Overweight and obesity along with their related co-morbidities are currently a major public health concern internationally [3]. High energy intake and low levels of energy expenditure are thought to be the main determinants of body weight management. One of the principal complications of obesity is ACD. Therefore, regular consumption of fruits and vegetables in recommended amounts may directly and/or indirectly reduce the risk for CAD.

Many clinical studies have reported significant benefits of adequate consumption of fruits and vegetables against CAD. Some of these studies established a dose response relationship for fruit and vegetable consumption and the risk for CAD, by comparing the highest versus the lowest levels of consumption of fruits and vegetables. For example, an analysis of 14 relevant reports showed that consumption of 477g/day of fruits and vegetables was associated with a 12% reduction in CAD risk [4]. Another set of analysis of the pooled data from 22 reports indicated a 16% CAD risk reduction for 300 g/day fruits and vegetables consumption [4]. These analyses suggest that the association between fruit and vegetable consumption and reduced CAD risk may not be linear. Furthermore, such analyses cannot distinguish the effects of fruits versus those of vegetables in reducing CAD risk. However, one may speculate that due to the nature of nutrient and phytochemical composition of fruits and vegetables, additive or synergistic effects may exist. Moreover, such association studies lack the ability to identify the effective compound(s) in fruits and vegetables that contribute to lowering CAD risk. What is known in this regard is that components of fruits and vegetables such as dietary fiber may reduce LDL-cholesterol levels, and the presence of antioxidant vitamins and other phytochemicals may prevent LDL oxidation. Altogether, these biological properties may contribute to CAD risk reduction. Future well designed studies can help further our understanding of the mechanisms by which either fruits or vegetables lower CAD risk.

Grains

A grain is defined as "a small hard particle". In food and agricultural sciences, grains are small hard seeds of plants such as wheat, rice, corn, millet, rye, oat and others. Grains have been a simple and natural constitute of humans diets throughout history. However, current food science and technology has allowed production of various grain products with different texture, tastes, and application. Of the many currently and commonly used terms for grain products, one may point to "whole grain" versus "refined grain" products. Whole grain products contain the outer layer of the grain seeds and therefore contain higher amounts of dietary fiber and certain micronutrients as compared to refined grain products. Alternatively, refined grain products may be enriched with certain micronutrients such as iron and/or some of the B vitamins.

Many epidemiological studies reported an inverse association between whole grain product consumption and CAD risk. In this regard, Gang., *et al.* [5] performed a meta-analysis of data from a total of 400,492 participants of 14 studies. This analysis showed an inverse association between higher intake of whole grain products and CAD risk. Similarly, Jacobs., *et al.* [6] studied the impact of higher versus lower whole grain product consumption in a cohort of 38,740 and found a reduction of CAD risk in subjects who consumed higher number of servings of whole grain products. A similar impact was also observed in another cohort study involving 15,792 participants [7]. The mechanisms by which whole grain products reduce CAD risk are not fully understood. However, the presence of dietary fiber and certain nutrient and/or phytochemicals with antioxidant properties may play a role in reducing LDL cholesterol levels and LDL oxidation.

Nuts, Legumes and other Plant Foods and Beverages

Nuts and legumes are known for their protein contents. In many cases, these plant foods are suggested as an excellent replacement for animal proteins. In addition, nuts and legumes contain a high level of both soluble and insoluble fiber. Regular consumption of adequate dietary fiber is known to reduce LDL cholesterol and thereby reduce CAD risk. Furthermore, most nuts contain a high level of polyunsaturated fatty acids. While legumes may not be a rich source of dietary fats, they contain a number of phytochemicals with antioxidant properties. Although the impact of consumption of nuts and legumes on CAD is not well established, a few studies reported cardiovascular risk reduction for these foods. For example, a clinical trial reported that consumption of nuts with the Mediterranean diet was associated with approximately 30% reduction in cardiovascular risk [8]. Similarly, a review of several clinical trials concluded that consumption of nuts and legumes may reduce overall cardiovascular risk [9]. This meta-analysis included data from ten human studies reporting that consumption of nuts was negatively associated with both fatal and non-fatal CAD events [9]. Another meta-analysis of 29 published studies concluded that an increase in nut consumption was associated with CAD risk reduction [10]. Currently several studies are in progress to further establish such cardiovascular benefits for nuts and legumes and the potential mechanisms by which these foods may reduce cardiovascular risks.

Coffee is among the most common beverages worldwide. Many studies have reported several health-promoting effects associated with regular coffee consumption. Among these benefits, some studies reported reductions in cardiovascular risk. One major potential reason for such benefits could be antioxidant phytochemicals in coffee. Indeed, a comprehensive meta-analysis of 36 studies involving 1,279,804 subjects and 36,352 cardiovascular disease cases reported that long-term consumption of coffee in moderate amounts was significantly and negatively associated with overall cardiovascular disease risk [11].

A review of the literature shows a high number of reports examining the effects of fruit and/or vegetable juices/beverages on cardiovascular health in humans. For example, a review paper concluded that consumption of fruit and vegetable juices may improve cardiovascular heath, which is mediated through the health benefits of components such as polyphenols, vitamins and minerals [12]. Another study reported that beetroot juice supplementation may reduce systolic blood pressure [13]. On the other hand, a systemic review of randomized controlled clinical trials showed no association between the amount of pomegranate juice consumption and LDL-cholesterol reduction [14].

Milk and Dairy Products

Milk is a complete food for the new born of any species. Depending on the species requirements for normal growth and development during early stage of life, milk contains appropriate amounts of macro- and micro-nutrients. Humans have used domesticated animal milk for thousands of years. The dairy industry has used various technologies to produce a number of dairy products with significant differences in taste, texture, shelf life, food application and availability of nutrients and bioactive compounds. The majority of currently sold dairy products are produced from cow's milk. Cow's milk is a very rich source of dietary calcium and some other micronutrients. On the other hand, whole cow's milk may contain up to 5% of fat, including saturated fat. Regular intakes of high amounts of saturated fat are thought to increase LDL-cholesterol levels in adults. Therefore, health authorities recommend consumption of low-fat or fat free milk and dairy products to avoid complications of elevated LDL-cholesterol levels including CAD. Despite this theoretical assumption, no association was found between total dairy product consumption- regardless of the fat contents- and the risk for CAD [15]. This metal analysis of 17 prospective studies involving a total of 2,283 subjects with cardiovascular disease, 4,391 subjects with CHD, 15,554 subjects with stroke and 23,949 mortalities concluded that milk intake may be associated with reduced risk for CVD. Similar findings were reported by another study in which no association was found between dairy product consumption and CAD risk, while a risk reduction was noticed for overall CVD [16].

Other Animal Foods

Red meat, poultry, fish, eggs and processed meat products are among most common animal-based foods in human diets. Among these foods, the benefits of fish- particularly fatty fish- on the cardiovascular system are well established through a number of epidemiological, observational and clinical studies. For example, a meta-analysis of 17 cohort studies of 315,812 participants and an average follow-up of 15.9 years reported that consumption of 1 - 4 servings of fish per week was associated with reductions in CAD mortality [17]. Another meta-analysis of data from 18 randomized clinical trials and 16 prospective cohort studies reported that consumption of two major n-3 fatty acids, namely eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) either from foods or dietary supplement was negatively associated with CAD risk [18]. It has been widely accepted that cardiovascular benefits of fish may be attributed to these fatty acids, particularly DHA. In this regard, analysis of data from Nurses' Health Study, Health Professional Follow-up Study and Cardiovascular Health Study showed an inverse relationship between circulating DHA levels with atherothrombotic stroke incident [19]. Furthermore, it has been shown that DHA may improve cardiovascular function through improvements in vascular endothelial function [20].

Eggs are a rich source of high quality protein and many micronutrients. However, eggs are also a rich source of dietary cholesterol. For many years, high consumption of eggs were thought to increase LDL-cholesterol levels and thereby the risk for CVD. However, recent studies revealed a wide variation of response to dietary cholesterol consumption. Therefore, the American Heart Association recently suggested that the impact of dietary cholesterol on circulating blood cholesterol may not be as detrimental as was once thought. Regardless, "high responders" are still advised to follow dietary cholesterol recommendations to prevent any harm. A meta-analysis of 17 reports from nine CAD and eight stroke studies of 5,847 CAD cases reported that consumption of up to one egg per day was not associated with increased risk for CAD [21]. Omega-3 enriched eggs are also believed to provide more cardiovascular benefits than conventional eggs do.

Red meat and poultry are likely the most widely consumed animal products in many societies globally. Meats may contain higher amounts of saturated fat and cholesterol, and therefore, high consumption of these products may not be cardiovascular friendly. Data from a systemic review of 13 cohort studies with 1,674,272 participants reported that an increase of 100 g/d or 50 g/d of red meat or processed meat, respectively, consumption was positively associated with cardiovascular mortality [22]. This study did not report a cardiovascular adverse effect for white meat consumption. Similarly, no significant association was reported for CAD mortality and any type of meat consumption. The authors suggested that their findings should be interpreted with caution, because of high heterogeneity and possibility of residual confounding.

Conclusions

Despite many achievements in the areas of cardiovascular medicine, dietary and lifestyle recommendations and public health, CAD still remains a major problem worldwide. It is strongly believed that diets and lifestyle can play a crucial role in the pathogenesis of the disease. In this regard, health authorities from almost all countries have made general recommendations to improve dietary habits and lifestyle in the general population and in cardiovascular disease patients in particular. Among these recommendations, higher consumption of fruits and vegetables and whole grain products, along with an appropriate level of physical activity and smoking cessation can be seen on the top of all general public health recommendations. Scientific evidence is very strong to support benefits from such recommendations. In this paper, findings from many large-scale clinical studies have been summarized. All of these findings strongly suggest that adherence to diets rich in fruits and vegetables, whole grain products, fish, nuts and pluses can significantly reduce CAD risk. On the other hand, high consumption of foods rich in saturated fat, industrially-produced trans-fat, and processed meat products may increase the risk for CAD. Thus, several dietary plans rich in these cardiovascular-healthy food types such as the Mediterranean diet and DASH diet have been developed. It should be noted that a healthy cardiovascular system warrants optimal physiological function of other systems, including the endocrine system, nervous system and immune system, endorsing improvements in overall body metabolism and function. Improvements in functions of such body systems directly and/or indirectly lead to prevention of other diseases such as diabetes and cancer. Thus, a cardiovascular-healthy dietary behavior guarantees optimal body function and a better quality of life, particularly in older adults and elderly.

Conflict of Interest

None.

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