Healthy Foods Choices for Cardiovascular Disease

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Cardiovascular disease (CVD) remains the first cause of mortality globally. Diet plays a fundamental role in cardiovascular health and is closely linked to the development of CVD. Numerous human studies have provided evidence on the relationship between diet and CVD.

cardiovascular disease | risk factors | macronutrients | food products

1. Sugar-Sweetened Beverages (SSBs)

SSBs, which include carbonated and noncarbonated soft drinks, fruit drinks, and sports drinks that contain added caloric sweeteners, are the largest source of added sugar in the diet in high-income countries. Given the emerging association of added sugars with cardiometabolic risk factors, health authorities including WHO and Dietary Guidelines for Americans have suggested that the consumption of SSBs should be reduced to <10% of total energy intake. SSBs consumption may increase CVD risk factors among American populations, especially among US children [1][2]. The data from the Coronary Artery Risk Development in Young Adults (CARDIA) study show that higher SSB consumption is associated with a range of cardiometabolic outcomes such as high low-density lipoprotein cholesterol, high triglycerides, and hypertension [3]. Consumption of SSBs has also been reported to be associated with increased risk of CHD and adverse changes in blood pressure, inflammatory factors, and leptin [4][5]. Moreover, the findings from cross-sectional studies and prospective analysis of two large US cohorts (Nurses' Health Study and Health Professionals Follow-up Study) have shown that habitual intake of SSBs is positively associated with a greater risk of CVD mortality and adverse levels of multiple cardiometabolic biomarkers [6][7][8]. Of note, the intake of SSBs is rising in low- and middle-income countries due to urbanization and beverage marketing [9]. Although no significant association between CVD mortality and SSB intake is found in a Chinese adult cohort in Singapore [10], a positive association of SSB intake (≥2 servings/day) with CVD mortality is observed in a Chinese younger adult cohort [11]. Thus, reducing intake of SSBs is important to improve overall diet quality and cardiometabolic health. The public nutrition policies and regulatory strategies should continue to call for reduction in intake of SSBs on a global scale.

Artificially sweetened beverages (ASBs) have been suggested as an alternative to SSBs because they provide few calories but retain a sweet flavor. Although a high level of ASB intake is reported to have a slight positive association with CVD mortality, replacing SSBs with ASBs may be recommended to improve health and longevity [8]. A recent network meta-analysis of 17 RCTs suggests that using ASBs as a substitute for SSBs is associated with reduced body weight and cardiometabolic risk factors such as body mass index (BMI), body fat, and lipid percentage [12]. These findings provide evidence on the benefits of using ASBs as a replacement strategy for SSBs. However, controversial results are also reported in some studies. For instance, a direct association between high artificial sweetener intake and increased CVD risk has been established, suggesting that ASBs may not be a healthy substitute for SSBs [13]. A previous meta-analysis of seven prospective cohort studies with 308,420 participants showed that there is an association between consumption of ASBs and cardiovascular risk [14]. Consistently, results from a cohort of French NutriNet-Santé study including 104,760 participants show that a higher intake of sugary drinks and ASBs is associated with a higher risk of CVD [15]. Moreover, another meta-analysis of prospective cohort studies provides evidence that the habitual consumption of both SSBs and low-calorie sweetened beverages is associated with a high risk of CVD incidence and CVD mortality [16].

Accordingly, the debate on whether ASBs can be used as an alternative to SSBs is still ongoing. Future studies are needed to better understand the underlying mechanisms of the potential metabolic impact of ASBs on health. For policymakers to make recommendations about SSBs and cardiometabolic health, new evidence alongside existing the literature needs to be considered. Moreover, the interest in suitable alternative beverages for SSBs such as 100% fruit juice, water, tea, and coffee is growing, and their health effects over the life-course and CVD prevention need to be examined in future studies.

2. Red Meat and Processed Meat

Meat consumption is considered a risk factor for cardiovascular and metabolic diseases. Unprocessed red meat and processed meat are important components of the US diet, and their consumption has been linked to the risk of CVD mortality in the US population [17][18]. According to WHO, red meat consumption is “probably carcinogenic” to humans, whereas processed meat is considered “carcinogenic” to humans [19]. The dietary patterns that are low in red and processed meat intake have been recommended by WHO and US Dietary Guidelines for Americans.

Accumulating evidence from observational studies has shown that red and processed meat intake is positively associated with the risk of developing CVD. For instance, a meta-analysis of 17 prospective cohort studies provides evidence showing that high consumption of total red meat and processed meat is associated with an increased risk of CVD mortality [17]. The data from the Isfahan Cohort Study show that red meat and red plus processed meat intake are positively linked with CVD mortality, but inversely associated with stroke risk [20]. In a large prospective Health Professionals Follow-up Study cohort, a greater intake of total, processed, and unprocessed red meat is found to be associated with a higher risk of CHD [21]. Notably, substituting high-quality plant-based protein foods for red meat is associated with a lower risk of CHD [21].

The evidence supporting the association of reduced intake of red meat and processed meat with decreased CVD risk is insufficient. A meta-analysis with 6,035,051 participants showed that there is very-low-certainty evidence supporting that dietary patterns with less red and processed meat intake may result in decreased risk for CVD [22]. In another meta-analysis of prospective cohort studies, a small reduced risk for CVD mortality, stroke, and myocardial infarction was found to be associated with a reduced intake of processed meat and unprocessed red meat [23]. Consistently, a systematic review of randomized trials showed that diets lower in red meat may have little or no effect on all-cause mortality and nonfatal CVD [24].

Another point that should be emphasized is that red meat and processed meat may influence CVD risk differently. For example, in a meta-analysis including 17 prospective cohorts and 3 case-control studies with 1,218,380 individuals from 10 countries, intake of processed meat was found to be associated with high incidence of CHD, but no significant association was observed between the consumption of unprocessed red meat and total meat and the risk of CHD [25]. A recent large multinational prospective study showed that a higher intake of processed meat is associated with a higher risk of mortality and major CVD, but no significant association between unprocessed red meat and major CVD was observed [26]. These findings suggest that the effect of processed meat consumption on adverse cardiometabolic outcomes is somewhat greater than that observed for unprocessed red meat. Further studies focusing on revealing the mechanisms of how unprocessed red and processed meat consumption influence risk of cardiometabolic diseases are urgently needed for dietary and policy recommendations.

3. Poultry and Fish

Although the positive associations between consumption of processed meat or unprocessed red meat and CVD risk have been established, the association of white meat intake with CVD-related incidents is still uncertain. White meat intake is considered to show healthier advantages compared to processed meat or unprocessed red meat. In the National Institutes of Health (NIH)-AARP Diet and Health Study, substituting white meat, particularly unprocessed white meat, is found to be associated with reduced risk of all-cause mortality [27]. A meta-analysis of prospective cohort studies reports that high intake of white meat is associated with reduced risk of stroke and stroke-related death [28]. Another meta-analysis of 13 cohort studies comprising 1,674,272 individuals show no significant association between intake of white meat and CVD mortality [29]. Moreover, a robust and inverse association between white meat consumption and all-cause mortality was observed in a recent meta-analysis of prospective cohort studies [30]. Collectively, these findings suggest that white meat may be a healthier and more sustainable alternative to red and processed meat consumption.

Poultry and fish are the major proportions of white meat consumption. Poultry meat is generally considered a healthy food because it provides high-quality protein and is often lower in fat than other animal meat. Moreover, poultry meat is reasonably affordable and accessible, with high rates of consumption globally. Fish has always been a main ingredient in the diet of populations living close to the sea. The diversity of the fish family provides quality protein, vitamins, essential fatty acids and micronutrients. Although evidence from RCTs is limited, several observational studies have been conducted to study the associations of poultry and fish consumption with the incidence of CVD. In a prospective cohort study of 29,682 US adults, consumption of poultry or fish was found to be not significantly associated with all-cause mortality, whereas intake of poultry but not fish is significantly associated with incidence of CHD, stroke, heart failure, and CVD [18]. The data from another UK Biobank prospective study show that eating fish rather than poultry is associated with a lower risk of adverse cardiovascular outcomes, including stroke, myocardial infarction, and heart failure [31]. These findings suggest that replacement of red and processed meats with fish but not poultry may be a better choice among patients at high risk for CVD.

Prospective cohort studies and RCTs have provided robust evidence showing a dose-dependent inverse relationship between fish consumption and heart failure incidence, cerebrovascular risk, and IHD risk as well as CHD death [32][33][34][35]. A large prospective study with 409,885 participants from nine European countries (European Prospective Investigation Into Cancer and Nutrition) reports that although there is no clear association between the consumption of white fish or fatty fish and IHD risk, a borderline significant inverse association is observed in the substitution analyses [36]. A pooled analysis of four prospective cohort studies including 191,558 people from 58 countries shows that a fish intake of 175 g (two servings of fish) weekly is reported to be associated with lower risk of major CVD events and total mortality among high-risk individuals or patients with existing vascular disease [37]. Consistent with these findings, the consumption of two servings of fish per week has been recommended by the American Heart Association and European Society of Cardiology (ESC). The beneficial effect of fish consumption on cardiovascular incidents is attributed mainly to omega-3 polyunsaturated fatty acids, such as eicosapentaenoic and docosahexaenoic acids [38][39]. Further studies are required to determine whether other nutrient ingredients in fish may also contribute to its cardioprotective effect on cardiovascular risk. Upcoming clinical trials are required to take more details into consideration.

4. Nuts

Nuts, including tree nuts and peanuts, are unique plant food products that are rich in unsaturated fatty acids, protein, fiber, vitamins, minerals, and other bioactive compounds, such as phenolic antioxidants and phytosterols [40]. Due to their unique nutrient composition, nuts are thought to be beneficial for improving health.

There is compelling evidence showing that nut intake confers protection against CVD. The early prospective cohort investigation of the Adventist Health Study and the Physicians' Health Study has reported that consumption of nuts is associated with a reduced risk of both fatal CHD, nonfatal myocardial infarction, and sudden cardiac death [41][42][43]. Soon thereafter, the inverse association of nut intake with death from heart disease such as IHD and CVD was observed in other large prospective cohort studies such as the Nurses' Health Study and the Health Professionals Follow-up Study [44][45][46][47][48]. Supporting this, the prospective evaluation from three large cohorts including 71,764 US residents of African and European descent and 134,265 Chinese participants shows that nut consumption is associated with a reduced risk of CVD mortality in subjects with low socioeconomic status [49], highlighting that intake of nuts appears to be a cost-effective measure to improve cardiovascular health.

Studies have shown that a one-serving (28 g) increase in nut intake per day is associated with a 29% and 21% reduction in the relative risk of CHD and CVD, respectively, when compared with not eating nuts [50][51]. Moreover, frequent intake of nuts including tree nuts, peanuts, and walnuts has been associated with low CVD incidence and mortality [52][53]. Of note, the evidence regarding the association between nut intake and stroke is limited and still uncertain. Prospective cohort studies have provided evidence showing that high intake of dietary nuts is inversely associated with stroke risk [54][55]. However, no significant association between nut consumption and the risk of total or ischemic stroke is reported in the prospective cohort of 21,078 participants of the Physicians' Health Study [56] and the prospective cohort of 26,285 participants of the European Prospective Investigation into the Cancer and Nutrition Potsdam Study [57].

Overall, these studies suggest that increasing nut consumption should be encouraged as a crucial part of a healthy dietary pattern to reduce the risk of CVD. Further research focusing on the role of specific nut types in influencing CVD outcomes particularly for stroke subtypes is needed.

5. Fruits and Vegetables

Increased consumption of fruit and vegetables is known as the cornerstone of a healthy diet for CVD prevention. Over the past few decades, several epidemiological studies, including the first National Health and Nutrition Examination Survey Epidemiologic Follow-up Study [58] and the Atherosclerosis Risk in Communities study [59], have suggested that intake of fruit and vegetables may reduce CVD risk and may have beneficial effects on the total mortality and incidence of CHD [60]. However, there is still some inconsistency among people from different ethnic backgrounds. For instance, an inverse association between fruit and vegetable intake and CHD risk is found in Western populations, but not in Asian populations [61]. In a prospective cohort study (Prospective Urban Rural Epidemiology) including 135,335 participants from 18 low-income, middle-income, and high-income countries, higher fruit and vegetable consumption was found to be associated with a low risk of CVD, myocardial infarction, cardiovascular mortality, non-cardiovascular mortality, and total mortality in non-Western countries [62]. Moreover, a greater fruit rather than vegetable consumption has been found to be associated with a lower risk of CVD mortality in Chinese cohort studies [63][64]. In summary, these studies generally support a favorable relation between high amounts of fruit and vegetable consumption and reduced risk of CVD.

The dose–response relationship between fruit and vegetable consumption and CVD has been studied. A minimum of 400 g/day of fruits and vegetables has been recommended by many dietary guidelines. A fruit and vegetable intake over five servings/day has been reported to be associated with lower risk of CHD [65]. An intake of 800 g/day of combined apples/pears, citrus fruits, green leafy vegetables/salads, and cruciferous vegetables is able to reduce the risk of CVD [66]. The results from 2 prospective cohort studies (Nurses' Health Study and Health Professionals Follow-up Study) and a meta-analysis of 26 prospective cohort studies show that consumption of approximately five servings of fruits and vegetables per day is associated with the lowest mortality, but higher intake does not reduce the additional risk [67]. However, an intake of three to four servings per day (equivalent to 375–500 g/day) of fruits and vegetables, which is affordable in low-income and lower-middle-income countries, is found to be as beneficial as higher amounts of intake in reducing total mortality [62]. Therefore, fruit and vegetable consumption is likely to be a cost-effective approach to prevent CVD in low-income countries.

Stroke is the third leading cause of death and a common cause of disability in developed countries. Early cohort studies have provided evidence supporting the inverse relation between fruit and vegetable intake and stroke [68]. For instance, the intake of cruciferous and green leafy vegetables and citrus fruit and juice displays protective effects on reducing ischemic stroke risk [69]. Similarly, a prospective cohort study of 54,506 Danish people showed that an increased intake of fruit reduces the risk of ischemic stroke [70]. A prospective cohort study of 40,349 Japanese showed that daily intake of green-yellow vegetables and fruits is associated with a lower risk of total stroke, intracerebral hemorrhage, and cerebral infarction mortality [71]. Individuals with more than five servings of fruit and vegetables per day are found to be associated with a lower risk of stroke when compared to those with fewer than three fruit and vegetable servings per day [72]. The data from a recent large cohort comprising 418,329 participants from nine European countries show that higher consumption of fruit and vegetables is inversely associated with the risk of total and ischemic stroke [73]. Thus, adherence to an increased intake of fruit and vegetables is recommended for the prevention of stroke.

6. Salt and Sodium

Salt is an important nutrient component of a healthy diet, and the human body needs a certain amount of salt to maintain cellular homeostasis. A systematic analysis of 24 h urinary sodium excretion and a dietary survey worldwide reports that sodium intake has exceeded the recommended levels in almost all countries [74]. It is estimated that 1.65 million deaths from cardiovascular causes in 2010 are attributable to the consumption of more than 2.0 g of sodium per day [75]. Therefore, sodium reduction has been recommended by American and European guidelines for the prevention of hypertension and CVD occurrence [76][77]. The WHO has set a global target of reducing salt intake to an eventual target of <5 g daily in adults.

The role of sodium in cardiovascular health is to maintain intravascular volume. Accumulating evidence has shown that increased sodium intake is closely related to elevated blood pressure, an essential risk factor for CVD. In the INTERSALT study with 10,079 adults from 32 countries, a direct association between salt intake and blood pressure was observed [78]. Reduced salt intake has been reported to control blood pressure effectively [79]. A trial examining the effect of dietary sodium on blood pressure reported that a reduction in sodium intake to levels below the current recommendation of 2.3 g per day is able to lower blood pressure [80]. Consistently, a systematic review and meta-analysis of randomized trials shows that a longer-term modest reduction of salt intake from 9–12 to 5–6 g/day leads to falls in blood pressure and may reduce CVD [81]. Another meta-analysis of 14 cohort studies and 5 RCTs also shows a clear benefit of lower sodium intake on reduction in blood pressure [82].

Accumulating evidence has suggested that sodium intake is associated with an increased CVD risk. For instance, an early prospective study of 1173 Finnish people has reported that increased urinary sodium excretion can predict mortality and risk of CHD, suggesting that high sodium intake is a key risk factor for CVD [83]. A meta-analysis of 13 prospective studies comprising 170,000 people has reported that high salt intake is associated with a greater incidence of stroke and cardiovascular events [84]. Another meta-analysis of prospective studies also showed that higher sodium intake is associated with higher CVD mortality [85]. The results from long-term follow-up of two completed lifestyle intervention trials show that people with a sodium reduction have a lower risk of cardiovascular outcomes in 10 to 15 years after the trial [86]. A pooled analysis of data from four international prospective studies with 133,118 people from 49 countries shows that high sodium intake (greater than 6 g/day) is associated with an increased risk of CVD events and death in individuals with hypertension. Notably, low sodium intake (less than 3 g/day) is also associated with an increased risk of cardiovascular outcomes in individuals with or without hypertension, implying a J- or U-shaped association between salt intake and CVD risk [87]. In line with these findings, the data from clinical trials and observational studies have shown that reducing sodium intake to less than 5 g/day is effective in reducing blood pressure and CVD [88].

However, a few recent cohort studies show controversial results. For instance, a prospective cohort study reports that although the relationship between sodium intake and blood pressure is linear, no strong association of dietary salt intake with increased CVD risk is observed [89]. In a recent prospective cohort of 176,570 participants from the UK biobank, lower frequency of adding salt to foods was found to be associated with lower risk of CVD, particularly heart failure and IHD [90]. Collectively, although both low and high salt intakes are reported to be associated with increased risk of CVD, reducing salt intake at a modest level may be an effective and affordable strategy to prevent CVD. Future large and long-term trials are needed to confirm the effectiveness and safety of salt reduction for CVD events and mortality.

7. Dairy Products

Dairy food products, which include butter, milk, cheese, and yogurt, are widely consumed worldwide and represent a major source of dietary saturated fatty acids. As stated above, a high intake of saturated fatty acids has been associated with an increased risk of CVD. This may imply that a reduction in dairy food consumption may cause decreased low-density lipoprotein cholesterol level in plasm and contribute to improved cardiovascular health. Circulating biomarkers of dairy fat provide objective measures of dairy fat intake. A systematic review and meta-analysis of prospective studies reports that no significant effects of circulating biomarkers of dairy fat on total CVD, CHD, or stroke, suggesting that higher dairy fat exposure is not associated with an increased risk of CVD [91]. Another systematic review and meta-analysis showed that higher levels of both odd-chain dairy fat biomarkers are associated with lower CVD risk [92]. Moreover, a large, multinational, prospective cohort study involving participants from 21 countries in five continents provided evidence showing higher dairy consumption is associated with lower risks of mortality and CVD, particularly stroke [93]. In fact, dairy foods are a heterogeneous group of products with different biochemical properties and nutritional composition. This means that the effect of dairy foods on cardiovascular health may depend on the specific food type. Indeed, the available evidence about the association of dairy foods consumption with CVD-related health outcomes is still controversial.

A previous meta-analysis of prospective cohort studies reported that there is an inverse association between dairy consumption and overall risk of CVD [94]. In line with these findings, dairy consumption was also found to be inversely associated with CVD, CHD, and stroke [95]. However, another meta-analysis of 29 prospective cohort studies with 938,465 participants showed that there is no association between dairy products and cardiovascular mortality [96]. The heterogeneity of individual dairy products was also observed in a systematic review and meta-analysis of cohort studies examining the association of dairy product intake with the risk of major atherosclerotic CVDs in the general adult population. The results show a positive association of high-fat milk and an inverse association of cheese with CHD risk [97]. Consistently, fermented dairy food intake is found to be associated with decreased CVD risk [98]. In the Kuopio Ischaemic Heart Disease Risk Factor Study, high intake of fermented dairy products showed an inverse association with the risk of CHD, whereas high intake of non-fermented dairy products was associated with increased risk of CHD [99]. Moreover, non-fermented milk intake was associated with an increased risk for developing cardiometabolic diseases [100]. In a recent meta-analysis of cohort studies with 896,871 participants, an inverse association between yogurt consumption and risk of all-cause and CVD mortality was found, whereas there was no significant association between yogurt consumption and risk of cancer mortality [101].

Overall, these findings suggest that fermented and non-fermented dairy products can have opposite associations with the risk of CVD. The effect of dairy food consumption on cardiovascular health may depend more on the food type relative to the fat content within the products. Further study is required to elucidate the mechanisms by which fermented dairy products improve cardiovascular health.

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