

5.4 Recommendations for preventing cardiovascular diseases

5.4.1 *Background*

The second half of the 20th century has witnessed major shifts in the pattern of disease, in addition to marked improvements in life expectancy, this period is characterized by profound changes in diet and lifestyles which in turn have contributed to an epidemic of noncommunicable diseases. This epidemic is now emerging, and even accelerating, in most developing countries, while infections and nutritional deficiencies are receding as leading contributors to death and disability (1).

In developing countries, the effect of the nutrition transition and the concomitant rise in the prevalence of cardiovascular diseases will be to widen the mismatch between health care needs and resources, and already scarce resources will be stretched ever more thinly. Because unbalanced diets, obesity and physical inactivity all contribute to heart disease, addressing these, along with tobacco use, can help to stem the epidemic. A large measure of success in this area has already been demonstrated in many industrialized countries.

5.4.2 *Trends*

Cardiovascular diseases are the major contributor to the global burden of disease among the noncommunicable diseases. WHO currently attributes one-third of all global deaths (15.3 million) to CVD, with developing countries, low-income and middle-income countries accounting for 86% of the DALYs lost to CVD worldwide in 1998. In the next two decades the increasing burden of CVD will be borne mostly by developing countries.

5.4.3 *Diet, physical activity and cardiovascular disease*

The “lag-time” effect of risk factors for CVD means that present mortality rates are the consequence of previous exposure to behavioural risk factors such as inappropriate nutrition, insufficient physical activity and increased tobacco consumption. Overweight, central obesity, high blood pressure, dyslipidaemia, diabetes and low cardio-respiratory fitness are among the biological factors contributing principally to increased risk. Unhealthy dietary practices include the high consumption of saturated fats, salt and refined carbohydrates, as well as low consumption of fruits and vegetables, and these tend to cluster together.

5.4.4 *Strength of evidence*

Convincing associations for reduced risk of CVD include consumption of fruits (including berries) and vegetables, fish and fish oils (eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA)), foods high in linoleic acid and potassium, as well as physical activity and low to moderate

alcohol intake. While vitamin E intake appears to have no relationship to risk of CVD, there is convincing evidence that myristic and palmitic acids, trans fatty acids, high sodium intake, overweight and high alcohol intake contribute to an increase in risk. A “probable” level of evidence demonstrates a decreased risk for α -linolenic acid, oleic acid, NSP, wholegrain cereals, nuts (unsalted), folate, plant sterols and stanols, and no relationship for stearic acid. There is a probable increase in risk from dietary cholesterol and unfiltered boiled coffee. Possible associations for reduced risk include intake of flavonoids and consumption of soy products, while possible associations for increased risk include fats rich in lauric acid, β -carotene supplements and impaired fetal nutrition. The evidence supporting these conclusions is summarized below.

Fatty acids and dietary cholesterol

The relationship between dietary fats and CVD, especially coronary heart disease, has been extensively investigated, with strong and consistent associations emerging from a wide body of evidence accrued from animal experiments, as well as observational studies, clinical trials and metabolic studies conducted in diverse human populations (2).

Saturated fatty acids raise total and low-density lipoprotein (LDL) cholesterol, but individual fatty acids within this group, have different effects (3–5). Myristic and palmitic acids have the greatest effect and are abundant in diets rich in dairy products and meat. Stearic acid has not been shown to elevate blood cholesterol and is rapidly converted to oleic acid in vivo. The most effective replacement for saturated fatty acids in terms of coronary heart disease outcome are polyunsaturated fatty acids, especially linoleic acid. This finding is supported by the results of several large randomized clinical trials, in which replacement of saturated and trans fatty acids by polyunsaturated vegetable oils lowered coronary heart disease risk (6).

Trans fatty acids are geometrical isomers of cis-unsaturated fatty acids that adopt a saturated fatty acid-like configuration. Partial hydrogenation, the process used to increase shelf-life of polyunsaturated fatty acids (PUFAs) creates trans fatty acids and also removes the critical double bonds in essential fatty acids necessary for the action. Metabolic studies have demonstrated that trans fatty acids render the plasma lipid profile even more atherogenic than saturated fatty acids, by not only elevating LDL cholesterol to similar levels but also by decreasing high-density lipoprotein (HDL) cholesterol (7). Several large cohort studies have found that intake of trans fatty acids increases the risk of coronary heart disease (8, 9). Most trans fatty acids are contributed by industrially hardened oils. Even though trans fatty acids have been reduced or eliminated from retail fats and spreads in many parts of the

world, deep-fried fast foods and baked goods are a major and increasing source (7).

When substituted for saturated fatty acids in metabolic studies, both monounsaturated fatty acids and n-6 polyunsaturated fatty acids lower plasma total and LDL cholesterol concentrations (10); PUFAs are somewhat more effective than monounsaturates in this respect. The only nutritionally important monounsaturated fatty acid is oleic acid, which is abundant in olive and canola oils and also in nuts. The most important polyunsaturated fatty acid is linoleic acid, which is abundant especially in soybean and sunflower oils. The most important n-3 PUFAs are eicosapentaenoic acid and docosahexaenoic acid found in fatty fish, and α -linolenic acid found in plant foods. The biological effects of n-3 PUFAs are wide ranging, involving lipids and lipoproteins, blood pressure, cardiac function, arterial compliance, endothelial function, vascular reactivity and cardiac electrophysiology, as well as potent anti-platelet and anti-inflammatory effects (11). The very long chain n-3 PUFAs (eicosapentaenoic acid and docosahexaenoic acid) powerfully lower serum triglycerides but they raise serum LDL cholesterol. Therefore, their effect on coronary heart disease is probably mediated through pathways other than serum cholesterol.

Most of the epidemiological evidence related to n-3 PUFAs is derived from studies of fish consumption in populations or interventions involving fish diets in clinical trials (evidence on fish consumption is discussed further below). Fish oils have been used in the Gruppo Italiano per lo Studio della Sopravvivenza nell'Infarto Miocardico (GISSI) trial involving survivors of myocardial infarction (12). After 3.5 years of follow-up, the group that received fish oil had a 20% reduction in total mortality, a 30% reduction in cardiovascular death and a 45% decrease in sudden death. Several prospective studies have found an inverse association between the intake of α -linolenic acid, (high in flaxseed, canola and soybean oils), and risk of fatal coronary heart disease (13, 14).

Cholesterol in the blood and tissues is derived from two sources: diet and endogenous synthesis. Dairy fat and meat are major dietary sources. Egg yolk is particularly rich in cholesterol but unlike dairy products and meat does not provide saturated fatty acids. Although dietary cholesterol raises plasma cholesterol levels (15), observational evidence for an association of dietary cholesterol intake with CVD is contradictory (16). There is no requirement for dietary cholesterol and it is advisable to keep the intake as low as possible (2). If intake of dairy fat and meat are controlled, there is no need to severely restrict egg yolk intake, although some limitation remains prudent.

Dietary plant sterols, especially sitostanol, reduce serum cholesterol by inhibiting cholesterol absorption (17). The cholesterol-lowering effects of plant sterols has also been well documented (18) and commercial products made of these compounds are widely available, but their long-term effects remain to be seen.

NSP (dietary fibre)

Dietary fibre is a heterogeneous mixture of polysaccharides and lignin that cannot be degraded by the endogenous enzymes of vertebrate animals. Water-soluble fibres include pectins, gums, mucilages and some hemicelluloses. Insoluble fibres include cellulose and other hemicelluloses. Most fibres reduce plasma total and LDL cholesterol, as reported by several trials (19). Several large cohort studies carried out in different countries have reported that a high fibre diet as well as a diet high in wholegrain cereals lowers the risk of coronary heart disease (20–23).

Antioxidants, folate, and flavonoids

Even though antioxidants could, in theory, be protective against CVD and there is observational data supporting this theory, controlled trials employing supplements have been disappointing. The Heart Outcomes Prevention Evaluation trial (HOPE), a definitive clinical trial relating vitamin E supplementation to CVD outcomes, revealed no effect of vitamin E supplementation on myocardial infarction, stroke or death from cardiovascular causes in men or women (24). Also, the results of the Heart Protection Study indicated that no significant benefits of daily supplementation of vitamin E, vitamin C and β -carotene were observed among the high-risk individuals that were the subject of the study (25). In several studies where dietary vitamin C reduced the risk of coronary heart disease, supplemental vitamin C had little effect. Clinical trial evidence is lacking at present. Observational cohort studies have suggested a protective role for carotenoids but a meta-analysis of four randomized trials, in contrast, reported an increased risk of cardiovascular death (26).

The relationship of folate to CVD has been mostly explored through its effect on homocysteine, which may itself be an independent risk factor for coronary heart disease and probably also for stroke. Folic acid is required for the methylation of homocysteine to methionine. Reduced plasma folate has been strongly associated with elevated plasma homocysteine levels and folate supplementation has been demonstrated to decrease those levels (27). However, the role of homocysteine as an independent risk factor for CVD has been subject to much debate, since several prospective studies have not found this association to be independent of other risk factors (28, 29). It has also been suggested that elevation of plasma homocysteine is a consequence and not a cause of atherosclerosis, wherein impaired renal function resulting from atherosclerosis raises

plasma homocysteine levels (30, 31). Data from the Nurses' Health Study showed that folate and vitamin B6, from diet and supplements, conferred protection against coronary heart disease (32). A recently published meta-analysis concluded that a higher intake of folate (0.8 mg folic acid) would reduce the risk of ischaemic heart disease by 16% and stroke by 24% (33).

Flavonoids are polyphenolic compounds that occur in a variety of foods of vegetable origin, such as tea, onions and apples. Data from several prospective studies indicate an inverse association of dietary flavonoids with coronary heart disease (34, 35). However, confounding may be a major problem and may explain the conflicting results of observational studies.

Sodium and potassium

High blood pressure is a major risk factor for coronary heart disease and both forms of stroke (ischaemic and haemorrhagic). Of the many risk factors associated with high blood pressure, the dietary exposure that has been most investigated is daily sodium intake. It has been studied extensively in animal experimental models, in epidemiological studies, controlled clinical trials and in population studies on restricted sodium intake (36, 37).

All these data show convincingly that sodium intake is directly associated with blood pressure. An overview of observational data obtained from population studies suggested that a difference in sodium intake of 100 mmol per day was associated with average differences in systolic blood pressure of 5 mmHg at age 15–19 years and 10 mmHg at age 60–69 years (37). Diastolic blood pressures are reduced by about half as much, but the association increases with age and magnitude of the initial blood pressure. It was estimated that a universal reduction in dietary intake of sodium by 50 mmol per day would lead to a 50% reduction in the number of people requiring antihypertensive therapy, a 22% reduction in the number of deaths resulting from strokes and a 16% reduction in the number of deaths from coronary heart disease. The first prospective study using 24-hour urine collections for measuring sodium intake, which is the only reliable measure, demonstrated a positive relationship between an increased risk of acute coronary events, but not stroke events, and increased sodium excretion (38). The association was strongest among overweight men.

Several clinical intervention trials, conducted to evaluate the effects of dietary salt reduction on blood pressure levels, have been systematically reviewed (39, 40). Based on an overview of 32 methodologically adequate trials, Cutler, Follmann & Allender (39) concluded that a daily reduction of sodium intake by 70–80 mmol was associated with a lowering of blood pressure both in hypertensive and normotensive individuals, with systolic and diastolic blood pressure reductions of 4.8/1.9 mmHg in the former and 2.5/1.1 mmHg in the latter. Clinical trials have also demonstrated the

sustainable blood pressure lowering effects of sodium restriction in infancy (41, 42), as well as in the elderly in whom it provides a useful non-pharmacological therapy (43). The results of a low-sodium diet trial (44) showed that low-sodium diets, with 24-hour sodium excretion levels around 70 mmol, are effective and safe. Two population studies, in China and in Portugal, have also revealed significant reductions in blood pressure in the intervention groups (45, 46).

A meta-analysis of randomized controlled trials showed that potassium supplements reduced mean blood pressures (systolic/diastolic) by 1.8/1.0 mmHg in normotensive subjects and 4.4/2.5 mmHg in hypertensive subjects (47). Several large cohort studies have found an inverse association between potassium intake and risk of stroke (48, 49). While potassium supplements have been shown to have protective effects on blood pressure and cardiovascular diseases, there is no evidence to suggest that long-term potassium supplements should be administered to reduce the risk for CVD. The recommended levels of fruit and vegetable consumption assure an adequate intake of potassium.

Food items and food groups

While the consumption of fruits and vegetables has been widely believed to promote good health, evidence related to their protective effect against CVD has only been presented in recent years (50). Numerous ecological and prospective studies have reported a significant protective association for coronary heart disease and stroke with consumption of fruits and vegetables (50–53). The effects of increased fruit and vegetable consumption on blood pressure alone and in combination with a low-fat diet, were assessed in the Dietary Approaches to Stop Hypertension (DASH) trial (54). While the combination diet was more effective in lowering blood pressure, the fruit and vegetable diet also lowered blood pressure (by 2.8 mmHg systolic and 1.1 mmHg diastolic) in comparison to the control diet. Such reductions, while seeming modest at the individual level, would result in a substantial reduction in population-wide risk of CVD by shifting the blood pressure distribution.

Most, but not all, population studies have shown that fish consumption is associated with a reduced risk of coronary heart disease. A systematic review concluded that the discrepancy in the findings may be a result of differences in the populations studied, with only high-risk individuals benefiting from increasing their fish consumption (55). It was estimated that in high-risk populations, an optimum fish consumption of 40–60 g per day would lead to approximately a 50% reduction in death from coronary heart disease. In a diet and reinfarction trial, 2-year mortality was reduced by 29% in survivors of a first myocardial infarction in persons receiving advice to consume fatty fish at least twice a week (56). A recent study based

on data from 36 countries, reported that fish consumption is associated with a reduced risk of death from all causes as well as CVD mortality (57). Several large epidemiological studies have demonstrated that frequent consumption of nuts was associated with decreased risk of coronary heart disease (58, 59). Most of these studies considered nuts as a group, combining many different types of nuts. Nuts are high in unsaturated fatty acids and low in saturated fats, and contribute to cholesterol lowering by altering the fatty acid profile of the diet as a whole. However, because of the high energy content of nuts, advice to include them in the diet must be tempered in accordance with the desired energy balance.

Several trials indicate that soy has a beneficial effect on plasma lipids (60, 61). A composite analysis of 38 clinical trials found that an average consumption of 47 g of soy protein a day led to a 9% decline in total cholesterol and a 13% decline in LDL cholesterol in subjects free of coronary heart disease (62). Soy is rich in isoflavones, compounds that are structurally and functionally similar to estrogen. Several animal experiments suggest that the intake of these isoflavones may provide protection against coronary heart disease, but human data on efficacy and safety are still awaited.

There is convincing evidence that low to moderate alcohol consumption lowers the risk of coronary heart disease. In a systematic review of ecological, case-control and cohort studies in which specific associations were available between risk of coronary heart-disease and consumption of beer, wine and spirits, it was found that all alcoholic drinks are linked with lower risk (63). However, other cardiovascular and health risks associated with alcohol do not favour a general recommendation for its use.

Boiled, unfiltered coffee raises total and LDL cholesterol because coffee beans contain a terpenoid lipid called cafestol. The amount of cafestol in the cup depends on the brewing method: it is zero for paper-filtered drip coffee, and high in the unfiltered coffee still widely drunk in, for example, in Greece, the Middle East and Turkey. Intake of large amounts of unfiltered coffee markedly raises serum cholesterol and has been associated with coronary heart disease in Norway (64). A shift from unfiltered, boiled coffee to filtered coffee has contributed significantly to the decline in serum cholesterol in Finland (65).

5.4.5 ***Disease-specific recommendations***

Measures aimed at reducing the risk of CVD are outlined below. The strength of evidence on lifestyle factors is summarized in Table 10.

Fats

Dietary intake of fats strongly influences the risk of cardiovascular diseases such as coronary heart disease and stroke, through effects on

blood lipids, thrombosis, blood pressure, arterial (endothelial) function, arrhythmogenesis and inflammation. However, the qualitative composition of fats in the diet has a significant role to play in modifying this risk.

Table 10
Summary of strength of evidence on lifestyle factors and risk of developing cardiovascular diseases

Evidence	Decreased risk	No relationship	Increased risk
Convincing	Regular physical activity	Vitamin E supplements	Myristic and palmitic acids
	Linoleic acid		Trans fatty acids
	Fish and fish oils (EHA and DHA)		High sodium intake
	Vegetables and fruits (including berries)		Overweight
	Potassium		High alcohol intake (for stroke)
	Low to moderate alcohol intake (for coronary heart disease)		
Probable	α -Linolenic acid	Stearic acid	Dietary cholesterol
	Oleic acid		Unfiltered boiled coffee
	NSP		
	Wholegrain cereals		
	Nuts (unsalted)		
	Plant sterols/stanols		
	Folate		
Possible	Flavonoids		Fats rich in lauric acid
	Soy products		Impaired fetal nutrition
Inufficient	Calcium		Beta-carotene supplements
	Magnesium		Carbohydrates
	Vitamin C		Iron

EPA, eicosapentaenoic acid; DHA, docosahexaenoic acid; NSP, non-starch polysaccharides.

The evidence shows that intake of saturated fatty acids is directly related to cardiovascular risk. The traditional target is to restrict the intake of saturated fatty acids to less than 10%, of daily energy intake and less than 7% for high-risk groups. If populations are consuming less than 10%, they should not increase that level of intake. Within these limits, intake of foods rich in myristic and palmitic acids should be replaced by fats with a lower content of these particular fatty acids. In developing countries, however, where energy intake for some population groups may be inadequate, energy expenditure is high and body fat stores are low (BMI < 18.5 kg/m²). The amount and quality of fat supply has to be considered keeping in mind the need to meet energy requirements. Specific sources of saturated fat, such as coconut and palm oil, provide low-cost energy and may be an important source of energy for the poor.

Not all saturated fats have similar metabolic effects; those with 12–16 carbons in the fatty acid chain have a greater effect on raising LDL cholesterol. This implies that the fatty acid composition of the fat source

should be examined. As populations progress in the nutrition transition and energy excess becomes a potential problem, restricting certain fatty acids becomes progressively more relevant to ensuring cardiovascular health.

To promote cardiovascular health, diets should provide a very low intake of trans fatty acids (hydrogenated oils and fats). In practice, this implies an intake of less than 1% of daily energy intake. This recommendation is especially relevant in developing countries where low-cost hydrogenated fat is frequently consumed. The potential effect of human consumption of hydrogenated oils of unknown physiological effects (e.g. marine oils) is of great concern.

Diets should provide an adequate intake of PUFAs, i.e. in the range 6–10% of daily energy intake. There should also be an optimal balance between intake of n-6 PUFAs and n-3 PUFAs, i.e. 5–8% and 1–2% of daily energy intake, respectively.

Intake of oleic acid, a monounsaturated fatty acid, should make up the rest of the daily energy intake from fats, to give a daily total fat intake ranging from 15% up to 30% of daily energy intake. Recommendations for total fat intake may be based on current levels of population consumption in different regions and modified to take account of age, activity and ideal body weight. Where obesity is prevalent, for example, an intake in the lower part of the range is preferable in order to achieve a lower energy intake. While there is no evidence to directly link the quantity of daily fat intake to an increased risk of CVD, total fat consumption should be limited to enable the goals of reduced intake of saturated and trans fatty acids to be met easily in most populations and to avoid the potential problems of undesirable weight gain that may arise from unrestricted fat intake. It should be noted that highly active groups with diets rich in vegetables, legumes, fruits and wholegrain cereals will limit the risk of unhealthy weight gain on a diet comprising a total fat intake of up to 35%.

These dietary goals can be met by limiting the intake of fat from dairy and meat sources, avoiding the use of hydrogenated oils and fats in cooking and manufacture of food products, using appropriate edible vegetable oils in small amounts, and ensuring a regular intake of fish (one to two times per week) or plant sources of α -linolenic acid. Preference should be given to food preparation practices that employ non-frying methods.

Fruits and vegetables

Fruits and vegetables contribute to cardiovascular health through the variety of phytonutrients, potassium and fibre that they contain. Daily intake of fresh fruit and vegetables (including berries, green leafy and cruciferous vegetables and legumes), in an adequate quantity (400–500 g per day), is recommended to reduce the risk of coronary heart disease, stroke and high blood pressure.

Sodium

Dietary intake of sodium, from all sources, influences blood pressure levels in populations and should be limited so as to reduce the risk of coronary heart disease and both forms of stroke. Current evidence suggests that an intake of no more than 70 mmol or 1.7 g of sodium per day is beneficial in reducing blood pressure. The special situation of individuals (i.e. pregnant women and non-acclimated people who perform strenuous physical activity in hot environments) who may be adversely affected by sodium reduction needs to be kept in mind.

Limitation of dietary sodium intake to meet these goals should be achieved by restricting daily salt (sodium chloride) intake to less than 5 g per day. This should take into account total sodium intake from all dietary sources, for example additives such as monosodium glutamate and preservatives. Use of potassium-enriched low-sodium substitutes is one way to reduce sodium intake. The need to adjust salt iodization, depending on observed sodium intake and surveillance of iodine status of the population, should be recognized.

Potassium

Adequate dietary intake of potassium lowers blood pressure and is protective against stroke and cardiac arrhythmias. Potassium intake should be at a level which will keep the sodium to potassium ratio close to 1.0, i.e. a daily potassium intake level of 70–80 mmol per day. This may be achieved through adequate daily consumption of fruits and vegetables.

NSP (dietary fibre)¹

Fibre is protective against coronary heart disease and has also been used in diets to lower blood pressure. Adequate intake may be achieved through fruits, vegetables and wholegrain cereals.

Fish

Regular fish consumption (1–2 servings per week) is protective against coronary heart disease and ischaemic stroke and is recommended. The serving should provide an equivalent of 200–500 mg of eicosapentaenoic and docosahexaenoic acid. People who are vegetarians are recommended to ensure adequate intake of plant sources of α -linolenic acid.

Alcohol

Although regular low to moderate consumption of alcohol is protective against coronary heart disease, other cardiovascular and health risks associated with alcohol do not favour a general recommendation for its use.

¹ Specific amounts will depend on the analytical methodologies used to measure fibre.

Physical activity

Physical activity is related to the risk of cardiovascular diseases, especially coronary heart disease, in a consistent inverse dose–response fashion when either volume or intensity are used for assessment. These relationships apply to both incidence and mortality rates from all cardiovascular diseases and from coronary heart disease. At present, no consistent dose–response relationship can be found between risk of stroke and physical activity. The lower limits of volume or intensity of the protective dose of physical activity have not been defined with certainty, but the current recommendation of at least 30 minutes of at least moderate-intensity physical activity on most days of the week is considered sufficient. A higher volume or intensity of activity would confer a greater protective effect. The recommended amount of physical activity is sufficient to raise cardio-respiratory fitness to the level that has been shown to be related to decreased risk of cardiovascular disease. Individuals who are unaccustomed to regular exercise or have a high-risk profile for CVD should avoid sudden and high-intensity bursts of physical activity.

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