

Dietary Pattern, Lifestyle Factors, and Cardiovascular Diseases

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Abstract Primary prevention of cardiovascular disease (CVD) is considered the most effective strategy for controlling CVD and its consequences. Modification of risk factors is an effective way to reduce CVD risk, and most risk factors can be altered with lifestyle changes and medications. Prospective studies have demonstrated that individually modified lifestyle factors (including physical activity, smoking, alcohol consumption, body mass index, and dietary factors) are associated with lower risks of coronary heart disease (CHD), heart failure (HF), and stroke, but the results are inconsistent. The association between diet and the risk of CVD is varying. Furthermore, there are not enough studies to demonstrate the joint effects of multiple modifiable lifestyle factors on the risks of CHD, HF, and stroke. This review focuses on the dietary pattern, other lifestyle factors, and the joint associations of multiple modifiable lifestyle factors with the risks of CHD, HF, and stroke and has found that healthy lifestyle factors, including healthy diet, were significantly associated with decreased risks of CHD, HF, and stroke in men and women, and the risks progressively decreased as the number of healthy lifestyle factors increased. These results also suggest that in the general population, most cases of CHD, HF, and stroke could be avoided by practicing a healthy lifestyle.

Keywords Lifestyle factors · Lifestyle changes · Dietary pattern · Risks · Coronary heart disease · Heart failure · Stroke · Cardiovascular disease · Diet · Physical activity · Body mass index · Smoking · Alcohol

Introduction

Cardiovascular disease (CVD) is one of the leading causes of death worldwide. Many previous studies focused on the pharmacologic management of and improved therapies for CVD. Although these treatments have been proven beneficial, they are costly, require medical intervention, and may have side effects. Moreover, functional recovery is often incomplete [1]. CVD is in large part preventable. The potential for preventing morbidity and mortality from CVD is enormous. It is estimated that each year, 565,000 people have a first myocardial infarction and 500,000 have a first stroke in the United States [2]. Therefore, primary prevention of CVD is considered the most effective strategy in controlling CVD and its consequences [3].

Modification of risk factors is an effective way to reduce CVD risk, and most cardiovascular risk factors can be altered with lifestyle changes and medications [4]. The American Heart Association and American Stroke Association released the revised guidelines for primary prevention of stroke emphasizing lifestyle modification to reduce stroke risk [5••]. Guidelines for the prevention of CVD in women also recommended lifestyle interventions [6]. Increasing evidence has indicated that individually modified lifestyle factors (including physical activity [7–9], smoking [10, 11], alcohol consumption [12, 13], body mass index [BMI] [14, 15], and dietary factors [16, 17]) are associated with lower risks of coronary heart disease (CHD), heart failure (HF), and stroke, but the results are inconsistent. Diet is a key

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modifiable risk factor in the prevention and risk reduction of CVD. Although cigarette smoking, obesity, and physical inactivity are well-established causes of CHD, HF, and stroke, the role of specific dietary factors had not been clearly defined until more recently, and a few studies have examined the relationship between overall dietary patterns and the risks of CHD, HF, and stroke [18, 19]. Furthermore, several studies have estimated the joint effects of multiple healthy lifestyle factors on lowering the risks of the above diseases [20–23, 24, 25]. This review focuses on dietary patterns and the joint associations of multiple modifiable lifestyle factors with the risks of CHD, HF, and stroke.

Diet, Healthy Lifestyle, and Coronary Heart Disease

Individual Lifestyle Factors and Coronary Heart Disease

Cigarette smoking is a major risk factor for CHD [10]. The CHD risk declines after the cessation of smoking and approximates the level of those who have never smoked after 10 to 14 years [26, 27]. An average of at least 30 min/d of moderate or vigorous activity is associated with a substantial reduction in the risk of CHD [28]. Prospective epidemiologic studies have shown that cardiovascular and total mortality increase throughout the range of overweight and obesity. Overweight and obesity predict cardiovascular mortality in men [29–33] and women [30–35]. The associations of overweight and obesity with CHD may even be stronger in healthy, nonsmoking individuals [31, 34, 35]. The relationship between alcohol consumption and the risk of CHD is controversial [36, 37]. Some studies showed moderate alcohol consumption is associated with a lower risk of CHD [38, 39], but others showed a J-shaped association of alcohol consumption with CHD risk [37].

Dietary Patterns and Coronary Heart Disease

Studies in the early-1970s spurred an interest in the role of single nutrients such as dietary total fat in CHD risk. With accumulating evidence, focus has been shifted from total fat to quality of fat. Recent meta-analyses of intervention studies confirm the beneficial effects of replacing saturated fat with polyunsaturated fatty acids on CHD risk [19]. Some studies have shown that dietary factors, including low intake of trans fat and glycemic load (which reflects the extent to which diet raises blood glucose levels); high intake of cereal fiber, marine n-3 fatty acids, and foliate; and a high ratio of polyunsaturated to saturated fat are associated with a reduced risk of CHD [40–42]. Recent studies have also found a link between dietary intake of fruit, vegetables, and whole grains and protection against CHD. This has been ascribed to their fiber, vitamin, mineral, and phytochemical content. In particular,

accumulating evidence showed protective effects of folate, vitamin B6, vitamin B12, vitamin E, vitamin C, flavonoids, and phytoestrogens on CHD risk [43].

The Nurses' Health Study estimated the role of overall eating pattern by using a food frequency questionnaire (FFQ) on the risk of CHD, and found that a diet with a high intake of fruits, vegetables, whole grains, legumes, poultry, and fish and low intakes of refined grains, potatoes, and red and processed meats (the prudent pattern) was associated with a lower risk of CHD [44]. Another large cohort from a Mediterranean country indicated that Mediterranean diet (the frequent intake of plant-based foods and olive oil) was associated with a lower risk of CHD [45]. One recent review strongly supported valid associations (four criteria satisfied) of protective factors, including intake of vegetables, nuts, and "Mediterranean" and high-quality dietary patterns, with CHD [46]. The Dietary Approaches to Stop Hypertension (DASH) trial study investigated the potential benefits of DASH on CHD by using the Framingham risk equations to calculate 10-year risk of developing CHD. Compared with a control group and a fruits and vegetables diet, the DASH diet (rich in fruits, vegetables, low-fat dairy, and reduced in fats and cholesterol) reduced estimated 10-year CHD risk by 18% and 11%, respectively [47].

Dietary patterns have frequently been classified as two patterns: "healthy or prudent" and "Western." In general, the "healthy" pattern has been associated with more favorable biological profiles, slower progression of atherosclerosis, and a reduced CHD incidence compared with the "Western" pattern. Evidence on changes in dietary patterns with changes in CHD risk is still lacking. With the emergence of the concept of personalized nutrition, studies focus increasingly on the role of genetic factors in the modulation of the association between nutrients and CHD [19].

Joint Effect of Healthy Lifestyle Factors and Coronary Heart Disease

Because each individual modifiable lifestyle is associated with the risk of CHD, a few studies took into account the joint effect of healthy lifestyle factors on the reduced risk of CHD. The Nurses' Health Study [48] and the Health Professionals' Follow-Up Study [49] demonstrated that a combination of healthy lifestyle factors was associated with a substantially reduced risk of CHD, and the CHD risk progressively decreased as the number of healthy lifestyle factors increased. These results also suggest that in these populations, the majority of cases of CHD could be avoided by practicing a healthy lifestyle. The healthy lifestyle factors in these two studies were characterized in the same way, including maintaining normal BMI (<25 kg/m²), eating a healthy diet (diet score, top 40%), exercising at least 30 min/d, not currently smoking, and moderate alcohol consumption (5–

30 g/d). In the Nurses' Health Study, 84,129 women 30 to 55 years of age were followed up over 14 years, and 1,128 women were identified as having a coronary event. Those who adhered to five healthy lifestyle factors had a relatively lower risk of developing CHD (hazard ratio [HR], 0.17 [95% CI, 0.07–0.41]) compared with all other women [48]. In the Health Professionals' Follow-Up Study, 42,847 men aged 40 to 75 years were followed up over 16 years, and 2,183 men developed a coronary event. Those who adhered to five healthy lifestyle factors had a larger reduction in the risk of developing CHD (HR, 0.13 [95% CI, 0.09–0.19]) compared with men without healthy lifestyle factors. The majority of CHD events among US men could be preventable through adherence to healthy lifestyle practices, even among those taking medications for hypertension or hypercholesterolemia [49].

In the EPIC-Potsdam study, participants with all four healthy lifestyle factors at baseline (never smoking, BMI < 30 kg/m², performing ≥3.5 h/week of physical activity, and adhering to healthy dietary principles [diet index > median]) had a lower risk of developing myocardial infarction than participants without a healthy lifestyle factor (HR, 0.81 [95% CI, 0.47–0.93]), and 45% of myocardial infarctions could be prevented [50]. It also has been found that each factor contributes to risk reduction independently of other factors in the estimated magnitude. The only exception was the combination of diet index above the median and physical exercise, which showed a larger risk reduction as estimated from the relative risk of the single factor. Moderate use of alcohol was not included as a potentially beneficial behavior in the EPIC-Potsdam study, with the explanation that because of the well-documented harms caused by alcohol abuse [51], a great deal of reluctance exists in the public health community to recommend drinking moderately for fear that the message will be misinterpreted and viewed as endorsing unfettered alcohol use [50].

Diet, Healthy Lifestyle, and Heart Failure

Individual Lifestyle Factors and Heart Failure

In addition to the medical treatments of HF, modifiable lifestyle factors can also affect the incidence. Modifiable lifestyle factors such as smoking [20, 52–55], physical activity [9, 15, 20, 56], BMI [15, 20, 56], alcohol consumption [13, 20, 57–59], and dietary intake [20] have been shown to influence the risk of HF in many studies. As increasing evidence revealed the positive association between smoking and HF risk, the European Society of Cardiology, American College of Cardiology, and American Heart Association defined smoking as one of the risk factors as well as one of the targets of prevention and management of HF in their

guidelines [60–62]. The results from prospective studies consistently indicate that regular physical activity reduces the risk of HF in men and women [9], [25]. Both general obesity and abdominal obesity increase the risk of HF. Overweight (BMI 25–29.9 kg/m²) has been found to be a strong risk factor for HF in some [3, 15, 63], but not all studies [64, 65]. Furthermore, research related to the joint effect of obesity and physical activity on HF risk indicates that lean and active individuals had the lowest risk of HF [15, 56]. The studies on alcohol consumption with the risk of HF yielded inconsistent results [13, 20, 57–59, 66]. Mukamal et al. [66] did not find a significant association between alcohol consumption and the risk of HF. In contrast, several other studies [20, 57–59] showed that moderate alcohol consumption was associated with a reduced risk of HF, whereas alcohol abuse was associated with a higher risk of HF [52].

Dietary Patterns and Heart Failure

Healthy diet is associated with a decreased risk of HF. Djoussé et al. [20, 67, 68] evaluated the associations between dietary factors and the risk of HF by using the data from the Physicians' Health Study and found that dietary intakes of fruits and vegetables [20] and whole-grain breakfast cereals [67] were associated with a reduced risk of HF, while dietary intake of eggs more than twice daily was associated with an increased risk of HF [68]. In the first National Health and Nutrition Examination Survey Epidemiologic Follow-Up Study, He et al. [69] found that consumption of 100 mmol/d or more of sodium was associated with an increased risk of HF. The Swedish Mammography Cohort showed that the DASH diet or a diet with a high intake of fruits, vegetables, low-fat dairy products, and whole grains was associated with a decreased risk of HF [70].

Joint Effect of Healthy Lifestyle Factors and Heart Failure

Two cohort studies estimated the joint effect of the above modifiable lifestyle factors on the risk of HF. In the Physicians' Health Study I [20], investigators found that adherence to healthy lifestyle factors was associated with the remaining lifetime risk of HF in men. However, it is unclear if this observed finding of a null association is generalizable to other populations and to both sexes. The FINRISK study involving 38,075 Finnish men and women observed that maintaining a BMI of 25 kg/m² or lower, consuming vegetables three or more times per week, abstaining from smoking, and engaging in a moderate or high level of physical activity were individually associated with a decreased risk of HF in men and women; it also found the dose–response relationship between the number of healthy lifestyle factors and the risk of HF [25].

Diet, Healthy Lifestyle, and Stroke

Individual Lifestyle Factors and Stroke

Each modifiable lifestyle factor (including physical activity, smoking, alcohol consumption, BMI, and diet) has been found to be associated with a lower risk of stroke in most studies, although some conflicting results exist. Overweight and obesity have been found to increase the risk of stroke in various observational studies [14, 71, 72]. For example, obese women (BMI ≥ 30.0 kg/m²) had a 1.5-fold higher risk of total stroke and a 1.7-fold higher risk of ischemic stroke compared with healthy weight women (BMI < 25 kg/m²) in a large cohort of US women [71]. Physical activity is associated inconsistently with a decreased risk of stroke [7, 8, 23, 73]. A meta-analysis of observational studies showed that moderately intense physical activity had a protective effect for total, ischemic, and hemorrhagic stroke [73]. In the Women's Health Study, vigorous physical activity was not strongly associated with a lower stroke risk [23]. In our previous study, a single type or combination of occupational and leisure time physical activity was associated with a decreased risk of stroke [7]. Previous reports from us and others have indicated that smoking is an independent risk factor for ischemic [11, 23], [24•] and hemorrhagic stroke [24•, 74, 75]. Two meta-analyses of cohort studies suggest that fruit and vegetable consumption decreases stroke risk [76, 77]. Our results support that vegetable consumption decreases stroke risk, but we did not find an association between fruit consumption and stroke risk [24•]. The inconsistency might be partly due to the different questionnaires used to assess fruit consumption and the differences in dietary habits between different populations. The association between alcohol consumption and stroke risk has been described as J-shaped in most studies, with the lowest risk among those consuming light to moderate amounts of alcohol [12, 78]. In the Health Professionals' Follow-Up Study and the Nurses' Health Study, Chiuve et al. [22] found a J-shaped association with a lower risk of ischemic and hemorrhagic stroke among light drinkers. In our previous study, we merged people with light to moderate alcohol intake as healthy lifestyle for alcohol consumption because we found that alcohol consumption had a J-shaped association with ischemic stroke risk [24•].

Dietary Patterns and Stroke

Several foods and nutrients have been linked to stroke. The EPICOR study investigated the association between stroke and adherence to four prior-defined dietary patterns: Healthy Eating Index 2005, DASH, Greek Mediterranean Index, and Italian Mediterranean Index. The investigators observed 40,681 volunteers for 7.9 years, and 178 stroke cases were diagnosed (100 ischemic, 47 hemorrhagic). The

study found that all patterns were significantly and inversely associated with ischemic stroke except for the Greek Index, suggesting that adherence to any one dietary pattern investigated would protect against at least one type of stroke [79]. The Nurses' Health Study found that the "Western" dietary pattern (characterized by higher intakes of red and processed meats, refined grains, and sweets and desserts) may increase stroke risk, whereas the "prudent" diet pattern (characterized by higher intakes of fruits, vegetables, legumes, fish, and whole grains) may protect against stroke [80]. In the 2002 China National Nutrition and Health Survey, the traditional Southern dietary pattern (characterized by high intakes of rice and vegetables and moderate intakes of animal foods) was related to low prevalence of stroke and the traditional Northern dietary pattern (characterized by high intakes of refined cereal products, potatoes, and salted vegetables) was associated with an increased stroke risk [81]. A review suggested that a diet low in sodium, high in potassium, and rich in fruits, vegetables, whole grains, cereal fiber, and fatty fish will likely reduce the incidence of stroke [82]. Evidence is limited or inconsistent regarding optimal levels of dietary magnesium, calcium, antioxidants, total fat, other fat subtypes, cholesterol, carbohydrate quality, and animal protein for stroke prevention [82].

Joint Effect of Healthy Lifestyle Factors and Stroke

Thus far, only a few studies have assessed the association of combined lifestyle factors and stroke risk. In the Women's Health Study, a healthy lifestyle consisting of never smoking, low BMI, moderate alcohol consumption, regular physical activity, and healthy diet score was associated with a significantly reduced risk of total and ischemic stroke, but not of hemorrhagic stroke [23]. In the Health Professionals' Follow-Up Study and the Nurses' Health Study, a low-risk lifestyle, including no smoking, a healthy weight (BMI < 25 kg/m²), moderate alcohol consumption, 30 min or more of moderate physical activity daily, and a healthy diet score resulted in substantial reductions in the risk of ischemic stroke among men and women, but not of hemorrhagic stroke [22]. In the EPIC-Potsdam study, participants with all four factors at baseline, including never smoking, BMI less than 30 kg/m², performing 3.5 h/wk or more of physical activity, and adhering to healthy dietary principles (diet index $>$ median), had a lower risk of developing stroke than participants without a healthy factor (HR, 0.50 [95% CI, -0.18–0.79]) [50•]. In the FINRISK study, five healthy lifestyle factors—healthy BMI, eating regularly vegetables (≥ 3 times/wk), practicing a moderate or high level of physical activity, never smoking, and light to moderate alcohol consumption—were all associated with a substantially reduced risk of stroke. These five healthy lifestyle factors were significantly associated with a decreased risk of total, ischemic, and hemorrhagic stroke, and the stroke

Table 1 Characteristics of studies of healthy lifestyle and the risks of cardiovascular diseases (CHD, heart failure, and stroke)

Study	Participants, <i>n</i>	Age, <i>y</i>	Sex	Follow-up, <i>y</i>	HLFs/health index points, <i>n</i>	Definition of HLFs	Major findings of HRs (95% CI)	Confounding factors
CHD								
The Nurses' Health Study [48]	84,129	30–55	Women	14	3	Diet score in upper 2 quintiles, nonsmoking, moderate-vigorous exercise ≥ 30 min/d	Men – Women 0.43 (0.33–0.55)	Age, parental history of MI before age 60, menopausal status and use or nonuse of postmenopausal hormones, history of hypertension, history of high cholesterol
					4	Diet score in upper 2 quintiles, nonsmoking, moderate-vigorous exercise ≥ 30 min/d, BMI < 25 kg/m ²	0.34 (0.23–0.52)	
					5	Diet score in upper 2 quintiles, nonsmoking, moderate-vigorous exercise ≥ 30 min/d, BMI < 25 kg/m ² , alcohol use ≥ 5 g/d	0.17 (0.07–0.41)	
The Health Professionals' Follow-Up Study [49]	42,847	40–75	Men	16	5	Not currently smoking, diet score top 40%, exercise ≥ 30 min/d, BMI < 25 kg/m ² , moderate alcohol use (5–30 g/d)	0.13 (0.09–0.19)	Age, family history of MI before age 60, aspirin use, use of antihypertensive medication, baseline hypercholesterolemia, baseline hypertension
EPIC-Potsdam study [50]	23,153	35–65	Men and women	7.8	4	Never smoking, BMI < 30 kg/m ² , PA ≥ 5 h/wk, diet index $>$ median	Men and women combined, 0.81 (0.47–0.93)	Age, sex, educational status, occupational status
Heart failure								
Physicians' Health Study I [20]	20,900	53.6	Men	22.4	≥ 4	BMI < 25 kg/m ² , never smoking, regular exercise (≥ 5 times/wk), moderate alcohol consumption (≥ 5 drinks/wk), consumption of breakfast cereals (≥ 1 serving/wk), consumption of fruits and vegetables (≥ 4 /d)	10.1% (7.9%–12.3%) (lifetime risk of HF)	–
Finnish study [25]	38,075	–	Men and women	14.5	0 1 (any 1) 2 (any 2) 3 (any 3) 4 (any 4) 5 (any 5)	Never smoking, BMI < 25 kg/m ² , moderate/high levels of PA, consumption of vegetables ≥ 3 times/wk, consumption of alcohol ≤ 70 g/wk	Men and women combined, 1.00 0.61 (0.44–0.85) 0.42 (0.31–0.58) 0.31 (0.22–0.43) 0.22 (0.15–0.31) 0.16 (0.09–0.27); <i>P</i> for trend < 0.001	Age, education, alcohol consumption, history of MI, history of valvular heart disease, history of diabetes, systolic blood pressure, and total cholesterol
Stroke								
The Women's Health Study [23]	37,636	45	Women	10	0–4 5–8 9–12 13–16 17–20	Never smoking, consumption of 4 to < 10.5 alcoholic drinks/wk, exercise ≥ 4 times/wk, BMI < 22 kg/m ² , healthy diet	Total stroke Ischemic stroke Hemorrhagic stroke	Age, postmenopausal hormone use, oral contraceptive use, family history of MI, income, geographic location of home, level of education, ethnicity, marital status, randomized treatment assignments, history of hypertension, antihypertensive treatment, diabetes mellitus, and elevated cholesterol (≥ 240 mg/dL)
					0–4 5–8 9–12 13–16 17–20		1.00 0.65 (0.44–0.97) 0.65 (0.44–0.95) 0.51 (0.33–0.78) 0.56 (0.30–1.05); <i>P</i> for trend = 0.01 1.00 0.62 (0.40–0.96) 0.63 (0.41–0.96) 0.43 (0.27–0.70) 0.38 (0.18–0.82); <i>P</i> for trend = 0.001	
					0–4 5–8 9–12 13–16 17–20		1.00 0.79 (0.30–2.08) 0.73 (0.28–1.91) 0.92 (0.34–2.49) 1.38 (0.41–4.71); <i>P</i> for trend = 0.49	

Table 1 (continued)

Study	Participants, <i>n</i>	Age, <i>y</i>	Sex	Follow-up, <i>y</i>	HLFs/health index points, <i>n</i>	Definition of HLFs	Major findings of HRs (95% CI)	Confounding factors
The Nurses' Health Study and the Health Professionals' Follow-Up Study [22]	43,685 (men), 71,243 (women)	54 (men), 50 (women)	Men and women	14–16	3	Nonsmoking, top 40% of AHEI diet score	0.62 (0.61–0.75)	Age, calendar year, parental history of MI before age 60, regular aspirin use, and vitamin E supplementation, plus use of hormone therapy in women
					4	Exercise ≥30 min/d, nonsmoking, top 40% of AHEI diet score	0.53 (0.41–0.68)	
					5	Exercise ≥30 min/d, BMI <25 kg/m ² , nonsmoking, top 40% of AHEI diet score	0.52 (0.32–0.85)	
					3	Exercise ≥30 min/d	0.82 (0.64–1.06)	
					4	BMI <25 kg/m ²	0.56 (0.39–0.81)	
					5	Alcohol intake of 5–15 g/d	0.47 (0.26–0.86)	
					0–1	Moderate or high level of PA, vegetable consumption ≥3 times/wk, never smoking, healthy BMI (<25 kg/m ²), light–moderate alcohol consumption	Total stroke, 1.00	
					2 (any 2)		0.62 (0.50–0.78)	
					3 (any 3)		0.52 (0.42–0.65)	
					4 (any 4)		0.40 (0.31–0.52)	
Finnish study [24•]	36,686	–	Men and women	–	0–1		0.28 (0.16–0.46); <i>P</i> for trend <0.001	Age, study year, education, family history of stroke, history of diabetes, systolic blood pressure, and total cholesterol
					2		Ischemic stroke, 1.00	
					3		0.73 (0.60–0.90)	
					4		0.65 (0.52–0.80)	
					5		0.64 (0.48–0.86)	
					0–1		0.24 (0.13–0.46); <i>P</i> for trend <0.001	
					2		Hemorrhagic stroke, 1.00	
					3		0.57 (0.37–0.87)	
					4		0.54 (0.35–0.84)	
					5		0.61 (0.36–1.04)	
EPIC-Poisdam study [50•]	23,153	35–65	Men and women	Men, 7.8; women, 8.2	4	Never smoking, BMI <30 kg/m ² , PA ≥3.5 h/wk, diet index >median	0.47 (0.16–1.34); <i>P</i> for trend =0.041	Age, sex, educational status, occupational status
					5		0.50 (–0.18–0.79)	

AHEI alternative healthy eating index; BMI body mass index; CHD coronary heart disease; HF heart failure; HLF healthy lifestyle factor; HR hazard ratio; MI myocardial infarction; PA physical activity

risk progressively decreased as the number of healthy lifestyle factors increased. These results also suggest that in this population, the majority of cases of stroke could be avoided by practicing a healthy lifestyle [24]. Fewer hemorrhagic stroke cases and a lower incident rate of hemorrhagic stroke might partly explain the inconsistency in the above studies.

Mechanisms of Cardioprotective Effects of Healthy Lifestyle

Hypertension, diabetes, and hyperlipidemia have been found to be important vascular risk factors for CVD, including CHD, heart failure, and stroke [83–86]. The EPIC-Potsdam study indicated almost 60% of ischemic stroke risk could be attributed to hypertension, diabetes, hypercholesterolemia, smoking, and heavy alcohol consumption [87]. It could be hypothesized that the protective effects of healthy lifestyle on CVD may have a direct biological basis and also partly mediate through their effect on those vascular risk factors of CVD. For example, an individual healthy lifestyle factor such as physical activity has a favorable effect on blood pressure, lipid profile, insulin sensitivity, body weight, improved regulation of endothelial function, reduced inflammation, and improved autonomic balance, and also reduces the risk of incident hypertension and diabetes [7, 88–91]. A healthy diet has a favorable effect on reduced oxidative stress and inflammation, improved endothelial function, decreased insulin resistance, and decreased thrombotic tendency [92–94]. A combination of several lifestyle factors decreases the risks of incident hypertension and type 2 diabetes [95, 96].

Conclusions

Each of these modifiable lifestyle factors, such as maintaining a healthy BMI, healthy diet, performing a moderate or high level of physical activity, never smoking, and light to moderate alcohol consumption, has been shown to be independently associated with the risks of CHD, HF, and stroke, and a graded inverse association between the number of these healthy lifestyle traits and the risks of CHD, HF, and stroke was found in various studies, suggesting the important role of promoting healthy lifestyle in the primary prevention of CVDs (Table 1). However, the general public does not have enough awareness of these associations, and the prevalence of unhealthy lifestyles continues to be high. To prevent and manage CHD, HF, and stroke risk through behavior modification, greater efforts at education are needed.

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- Of importance
- Of major importance

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