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Dietary Patterns that Decrease Cardiovascular Disease and Increase Longevity

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Abstract

Coronary heart disease progression and its toll on health and longevity are inextricably linked to diet and lifestyle practices. Aging results in a progressive worsening of vascular function, and accompanying CHD risk factors, that are caused by unhealthy diet and lifestyle practices. Implementing healthy dietary patterns alone or in conjunction with pharmacotherapy favorably affects cardiovascular health, quality of life and longevity. Among the most consistent findings from nutrition epidemiology research is that certain dietary patterns are associated with lower chronic disease risk over long periods of time. These patterns are typically plant-based and are abundant in fruits, vegetables, grains, legumes, nuts and seeds. The dietary patterns that increase risk are low in a variety of plant foods and higher in fatty meats, solid fats and added sugars. Research shows that the Mediterranean diet, Dietary Approaches to Stop Hypertension (DASH) diet, and certain vegetarian diets (e.g., Portfolio Diet and Ornish diet), reduce multiple risk factors associated with CVD. All of these dietary patterns are low in saturated fat, trans fat and dietary cholesterol and achieve nutrient adequacy. A healthy dietary pattern also promotes a healthy body weight. The purpose of this paper is to inform clinicians about the evidence base in support of cardioprotective dietary patterns for CVD prevention and treatment. Furthermore, adoption of healthy dietary pattern in individuals with hypertension and elevated cholesterol levels may prevent the need for drug therapy or the need to increase drug doses to meet blood pressure and lipid/lipoprotein targets.

Keywords: Longevity; Dietary patterns; Healthy aging; Mediterranean diet; DASH diet

Introduction

Aging is the result of biological changes that occur in multiple organ systems. The rate of aging is determined by a combination of genetic and environmental factors [1]. Chronic disease contributes to the aging process by hastening the rate and accumulation of damaging cellular alterations [2]. Coronary heart disease (CHD) is a multi-factorial chronic disease that begins in childhood and progresses with age. CHD remains the leading cause of death and disability globally, with approximately 3.4 million deaths in women and 3.8 million deaths in men each year [3]. It is estimated that 60% of these deaths occur within low- and middle-income countries [3]. Many factors, particularly diet and lifestyle practices, can slow the progression of age-related diseases (Table 1). The study of dietary patterns is increasingly used in investigations of longevity to define those that are useful for predicting mortality and longevity. It has been postulated that a dietary pattern followed over a lifetime contributes importantly to the development of age-related diseases [4]. The purpose of this paper is to describe major dietary patterns that are associated with increased longevity and lower rates of age-related diseases such as CHD.

Populations with decreased CHD risk and increased longevity

The diets of five populations with atypical longevity have been described recently and labeled the “Blue Zones” [5]. The Blue Zones are regions where the proportion of individuals who reach age 100 is up to 10 times greater than in the United States. The populations include the Okinawans in Japan, the Sicilians and Sardinians in Italy, the Seventh Day Adventists in Loma Linda California, and populations inhabiting the areas of the Nicoya Peninsula region in Costa Rica, and Ikaria Greece. These populations have an unusually high proportion of individuals living beyond a hundred years of age. Several studies have characterized the lifestyle practices of these populations and found that they all tend to be very physically active, small in stature, and non-obese, [6,7]. In general, the dietary patterns have similar characteristics, i.e., they are higher in plant foods and lower in animal products.

The Mediterranean diet is characterized by a high intake of monounsaturated fat, plant proteins, whole grain breads, cereals, pasta, moderate alcohol and low intake of red meat, refined grains and sweets. The benefits of a traditional Mediterranean diet are well established and in the Mediterranean Island, Sardinia, the specific region is characterized by its exceptional male longevity. Interestingly, an evaluation of the 377 Sardinian municipalities found that diet was not related with their unique longevity, but rather factors that affected energy expenditure were more important [8]. In contrast, a study of the centenarians living in the Sicani Mountains, located in western Sicily, found that close adherence to Mediterranean diet played a key role in age-related disease prevention and increased longevity. The oldest individuals living in these villages had anthropometric measures within normal limits and without any sign of age-related diseases, including cognitive deterioration and dementia. Likewise, the people of Ikaria Island, Greece, have one of the highest life expectancies in the world. Scientific evidence shows protective health benefits from long-term adherence to the Mediterranean diet including cardioprotective effects [9]. Inhabitants of the Nicoya Peninsula region in Costa Rica also enjoy exceptional longevity. While the diet in this region has

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Factor	Recommendation	Approximate SBP reduction	Approximate LDL-C reduction
Sodium intake	Reduce to no more than 2, 300 mg or 6 g of sodium chloride daily.	2 – 8 mm Hg	-
Saturated fat intake	Reduce to no more than 7% of calories	-	8 – 10%
Dietary cholesterol	Reduce to no more than 200 mg per day	-	3 – 5%
Adopt DASH eating plan	Consume a diet rich in fruits, vegetables, and low-fat dairy products with a reduced content of total and saturated fat.	8 – 14 mm Hg	-
Viscous fiber	Increase intake to 5 – 10 g per day	-	3 – 5%
Plant sterols/stanols	Increase intake to 2 g per day	-	6 – 15%
Soy protein*	Increase intake to 20- 50 g per day	-	3 – 5% (7-10%)†
Weight reduction	Achieve and maintain a normal body weight (BMI: 18.5 – 24.9 kg/m^2)	5 – 20 mm Hg/10 kg weight loss	5 – 8% / 4.5 kg weight loss
Physical activity	Achieve regular aerobic physical activity for at least 30 min each day, for 5 days each week.	4 – 9 mm Hg	-
Alcohol consumption	Limit consumption to no more than 2 drinks per day for men, and no more than 1 drink per day for women.	2 – 4 mm Hg	-
Cumulative estimate		Suggestive evidence for a cumulative response	24 – 37%

Adapted and reproduced from the Third Report of the National Cholesterol Education Program Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults - Adult Treatment Panel III [60]
Modified and adapted with permission from The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure [63]
*Sacks et al, 2006 [64]. †Jenkins et al, 2010 [65]

Table 1: Approximate Systolic Blood Pressure (SBP) and LDL Cholesterol (LDL-C) Reductions Achievable by Diet and Lifestyle Modifications.

not been studied in-depth, it includes an abundance of fruits, garden vegetables, beans, rice and corn [5]. Noteworthy, is the mineral content of their water supply, which is high in magnesium and calcium.

In addition to the increased longevity of certain populations globally, there also is evidence of decreased CHD prevalence. In particular, there has been extensive research of the Okinawan group in Japan, and the Seventh Day Adventists in Loma Linda, California. These two populations demonstrate the benefits of adhering to cardioprotective dietary patterns, which positively affect morbidity and mortality. Key attributes of the dietary and lifestyle practices of these groups include increased intakes of vegetables, fruits, legumes, nuts and grains, as well as lower meat and alcohol intake and smoking avoidance.

The Okinawans

The Okinawans have an average life expectancy of approximately 82 years, and are some of the longest living people in the world [10,11]. Their quality of life with increased age is greater than most other developed countries; in 1995, CHD mortality was 33 per 100, 000 individuals, versus 193 per 100,000 Americans [6]. In addition, mortality rates of breast (6 per 100, 000 versus 33 per 100, 000) and prostate cancer (4 per 100,000 versus 28 per 100,000) were significantly lower, along with colon cancer mortality rates for both men (10 per 100,000 versus 19 per 100, 000) and women (6 per 100,000 versus 19 per 100, 000) than rates in the United States. The decreased morbidity and increased longevity have been ascribed to their traditional diet that is low in energy, often referred to as calorie restricted, yet nutritionally dense, particularly in antioxidants and flavonoids [6]. Many of characteristics of the traditional Okinawan diet are comparable to the DASH and Mediterranean dietary patterns [7]. However, the traditional Okinawan diet is lowest in fat (<10%) and highest in carbohydrate (~85%). Antioxidant rich yellow-orange root vegetables, such as sweet potatoes, and green leafy vegetables are major food sources [6]. This traditional dietary pattern is low in calories, emphasizes vegetables, legumes and low glycemic carbohydrates; fish/fish products and alcohol are consumed in moderation and consumption of meat and dairy products is low [7]. Sodium intake has been estimated to be 1,113 mg/ day, with a potassium intake of 5,199 mg/ day [6]. The daily use of traditional herbs and spices rich in bioactive compounds also may be cardioprotective. Interestingly, since World War II changes in the food environment to a more Western dietary pattern have resulted in younger Okinawans having the highest rates of obesity [12,13]. These findings demonstrate the health benefits of the traditional Okinawan diet that is thought to explain the long life expectancy of this population.

The Seventh-Day Adventists

The Seventh-Day Adventists (Adventists) are a population that has a proportionally lower incidence of ischemic heart disease than aged-matched non-Adventist individuals in the surrounding community [14]; Adventists also have relatively lower rates of mortality due to heart disease and type 2 diabetes [15]. The diet and lifestyle practices followed by this faith-based community include higher intakes of grains, fruits, nuts and vegetables [15], while prohibiting smoking and alcohol consumption. This dietary pattern is low in saturated fat and higher in fiber compared to a typical Western dietary pattern [15]. One longitudinal study investigating the effects of vegetarian diets on longevity followed a cohort of Adventists for 21 years [16,17]. The investigators found that individuals with predominately vegetarian eating patterns had lower age-related mortality rates and lower rates of CHD.

Tonstad and colleagues [18] evaluated the effects of a similar vegetarian dietary pattern on BMI and the prevalence of type 2 diabetes using 22,434 men and 38,469 women from the Adventist Health Study-2. Average BMI in vegans was 23.6 kg/m^2 versus 28.8 kg/m^2 for non-vegetarians; lacto-vegetarians had a BMI of 25.7 kg/m^2. Prevalence of type 2 diabetes was 2.9% for vegans versus 7.6% for non-vegetarians. In addition, vegans had a significantly lower risk of type 2 diabetes (OR 0.51, 95% CI 0.40 – 0.66) versus non-vegetarians; this model accounted for BMI, age, sex, ethnicity, physical activity, education level, income, television viewing, alcohol use, and sleep habits. Reduction of BMI, and subsequent reductions in risk of fatal and non-fatal IHD events and associated co-morbidities such as type 2 diabetes and lifestyle-related cancers that are related to adherence to a plant-based dietary pattern

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may explain the lower prevalence of CVD (and other chronic diseases) along with the increased longevity in this population group.

Animal studies of caloric restriction

While there currently are no interventions that can prevent, stop or reverse the aging process, there are interventions in humans that have been shown to delay aging and, in animal models, prolong lifespan by as much as 60% (19). One intervention shown to prevent age-related disorders and increase lifespan is calorie restriction, defined as a reduction in calorie intake below usual intake, without malnutrition [19,20]. In 1935, McCay et al. [21] published the first paper showing that calorie restriction with adequate nutrition extends maximal lifespan in rats. Since then hundreds of studies have consistently shown that calorie restriction by 10-30% can extend the longevity of various species from yeast to rodents.

More recently, the effects of caloric restriction on non-human primates longevity was reported in two independent 20-year longitudinal studies in rhesus monkeys [22,23]. Colman et al. [22] was the first to show a significant benefit in reducing age-related mortality and disease with caloric restriction [22]. Similar to rodents, Colman et al. [22] demonstrated that calorie restriction in monkeys resulted in lower adiposity, improved lipid and lipoprotein profiles, improved insulin sensitivity, and reduced inflammation. While Mattison et al. [23] also demonstrated beneficial effects of caloric restriction on age-related diseases they did not find improved survival outcomes. The contrasting results have been attributed to several differences in diet composition, study design and genetic variation of the experimental animals. Of note, is that there is evidence that energy restriction (ER) in mice has adverse effects on the immune response to influenza infection. This is associated with an increased susceptibility and mortality to influenza infection, which is associated with impaired natural killer cell function and altered inflammation [24].

These studies, in combination with the extensive literature on dieting (i.e. caloric restriction) in humans, suggest that in nonhuman and human primates, moderate calorie restriction evokes very similar metabolic, hormonal and physiological changes that, in calorie restricted rodents have increased longevity [25] as long as they are not exposed to pathogens. However, because of experimental limitations, studying the beneficial effects on aging and longevity in humans is difficult. Most recently, the Comprehensive Assessment of the Long-term Effects of Reducing Intake of Energy (CALERIE) research program has been designed to systematically investigate sustained calorie restriction in humans on markers of aging and cardiovascular disease [26]. Specifically, the CALERIE Phase 2 study is evaluating the long term effects of a 25% reduction of ad libitum energy intake in a middle aged non-obese population [27]. However, given that long term compliance to calorie restricted diets is poor, evaluating the benefits of sustained caloric restriction in humans is limited primarily to epidemiologic evidence.

As previously discussed, the Okinawans in Japan were known to consume a very nutrient dense diet with fewer calories (≈1785 kcal/day) than residents of the main Japanese islands (≈2068 kcal/day) [6]. The Okinawans are known for their longevity and markedly low mortality rates from coronary heart disease and cancer. Despite these healthful biological changes, the majority of individuals are not able to engage in prolonged caloric restriction. Thus, alternative behavioral approaches that include diet and lifestyle change may hold promise in delivering benefits similar to those achieved through caloric restriction.

Dietary patterns associated with decreased CHD risk and increased longevity

The above examples illustrate that there is variation in healthy dietary patterns linked to increased longevity. They vary in macronutrients, with the Mediterranean Dietary Pattern being higher in total fat whereas the Okinawan diet is very high in dietary carbohydrate (Table 2). All healthful dietary patterns are nutrient dense and incorporate high quality carbohydrates, mainly from vegetables, fruits and legumes. The nutrients and bioactives including phytonutrients in these diets may benefit CVD risk status. To evaluate the contribution of these food components in the diet for reducing cardiovascular disease risk factors Jenkins et al. [28,29] conducted a controlled feeding trial using a diet similar in nutrient content to the Okiniawan diet and referred to it as the "Portfolio Diet". The Portfolio Diet is a vegetarian diet designed to achieve maximal LDL-C lowering effects. The diet includes plant sterols, viscous fibers primarily from oat, barley, and psyllium, soy protein (21 g/1,000 kcal), and almonds (14 g/1,000 kcal) [28,29]. The investigators found that when these phytonutrient-rich foods, which are high in fiber, healthier fats, and soy were incorporated into the diet for four weeks, total and LDL-cholesterol were reduced by 22.4% and 29.0%, respectively with no significant effect on HDL-C or TG [28]. A follow-up study demonstrated a greater cholesterol-lowering effect of a Portfolio Diet than a Step II diet [29]. TC and LDL-C decreased by 9.9% and 12.1% respectively, on the Step II diet (a diet containing < %7 of calories as SFA), whereas on a Portfolio Diet TC and LDL-C decreased by 26.6% and 35.0%, respectively. These findings demonstrated that a heart healthy diet that included a combination of dietary strategies (i.e. increased fiber, flavonoids, stanols, and vegetable protein) had additive effects on major CVD lipid/lipoprotein risk factors. This food first approach proved to be as efficacious as a first generation statin drug.

Similar reductions in LDL-C, angina, and stenosis also have been demonstrated with a very low fat vegetarian diet, termed the Ornish Plan, which also includes comprehensive lifestyle changes [30-33]. In the Lifestyle Heart Trial, 48 patients with moderate to severe CVD were randomized to an intensive lifestyle intervention, including a vegetarian diet with only 10% fat, or a usual care control group. The foods emphasized in this diet included beans and legumes, fruits, grains, and vegetables; however, all sources of fat were restricted including plant sources such as avocados, seeds, and oils. The additional lifestyle interventions implemented were aerobic exercise, stress management training, smoking cessation, and group psychological support. Thirty-five participants completed the 5-year evaluation with similar compliance between groups (71% of intervention patients versus 75% for the control patients.) The intervention group experienced significant reductions in arterial stenosis, a 91% reduction in angina, less than half the number of cardiac events, and a 40% reduction in LDL-C. While the feasibility of such extreme dietary changes may be challenging for

	Traditional Okinawan **	Mediterranean §	DASH Diet ‡
Carbohydrate (% kcal)	85%	43%	55%
Protein (% kcal)	9%	13%	18%
Fat (% kcal)	6%	42%	27%
Saturated fat (% kcal)	2%	9%	6%
Cholesterol (mg)	__	75 mg	72 mg
Sodium (mg/d)	1113 mg	__	1150 mg
Potassium (mg/d)	5199 mg	__	4700 mg

*Adapted from Willcox et al, 2009 [7]
** Willcox et al, 2007 [6]; §Kromhout et al, 1989 [66]; ‡ Sacks et al, 2001 [52]

Table 2: Estimated Nutrient Composition by Dietary Pattern*.

many individuals, this trial demonstrated the efficacy of an intensive lifestyle intervention in high risk patients, and Medicare has begun covering the Ornish Plan. A criticism of the dietary intervention has been raised about the lack of distinction between different types of fats. However, in a very low fat, vegetarian diet, an unfavorable fatty acid profile is unlikely. This low fat, vegetarian diet combined with lifestyle strategies is the first dietary pattern to reverse arterial stenosis.

Prevention of CHD is crucial for promoting longevity. In the US, the Dietary Guidelines for America [34], American Heart Association, and other health organizations recommend healthy dietary patterns for the prevention of CVD and other chronic diseases. Included in these guidelines are two diets that demonstrate health promoting effects, the Mediterranean diet and the Dietary Approaches to Stop Hypertension diet (DASH).

Mediterranean dietary pattern

A Mediterranean dietary pattern includes different cuisines characteristic of the countries that surround the Mediterranean Sea. However, the shared characteristics of the dietary patterns are that they are high in fruits and vegetables, legumes, nuts, seeds, olive oil and whole grains; there is also increased consumption of fish, poultry, dairy products, and decreased red meat intake, in addition to low to moderate intakes of wine (for non-Islamic countries) [35].

Epidemiologic and clinical studies have reported benefits of a Mediterranean diet on CVD risk factors. A review by Dontas et al. [36] highlights the importance of the Mediterranean dietary pattern in the prevention of coronary heart disease. The Seven Countries Study was the first to create great interest in the Mediterranean diet in the 1980s when it reported that the 15-year mortality rate from CVD in Southern Europe was 50% lower than that of Northern Europe or the United States [37]. Several years later the Lyon Diet Heart Study was designed to test the effects of a Mediterranean diet versus a Western diet on the secondary prevention of MI. Subjects were randomized to a control diet or a Mediterranean-style diet containing higher amounts of α-linolenic acid for 104 weeks. Despite no changes in blood lipids and having similar BMI and blood pressure as the control group, subjects following the Mediterranean-style diet had a markedly lower prevalence of cardiac death, nonfatal MI, fewer major secondary events, and decreased hospitalizations. Subjects consuming the Mediterranean-style diet had a 50-70% lower risk of recurrent events [38].

Additional studies have supported the findings of the Lyon Diet Heart Study. A systematic review of 12 prospective cohort studies concluded that greater adherence to a Mediterranean diet was associated with a significant reduction in mortality from CVD and total mortality [39]. In addition, a meta-analysis of cohort studies found that greater adherence to a Mediterranean dietary pattern was protective against CVD [40]. More recently, an analysis of 81,722 women in the Nurses' Health Study found that women in the highest quintile for the Mediterranean diet score (high intake of vegetables, fruits, nuts, whole grains, legumes, fish; ratio of monounsaturated fatty acids to saturated fatty acids; moderate intake of alcohol; and low intake of red and processed meat), experienced a 40% reduction in sudden cardiac death relative to the women consuming diets least reflective of this dietary pattern [41].

The Prevención con Dieta Mediterránea (PREDIMED) Study was a multicenter clinical trial that evaluated the efficacy of a Mediterranean diet on primary prevention of CVD [42,43]. In 2003, the PREDIMED trial began randomizing participants 55-80 years of age with diabetes or ≥3 major CVD risk factors (hypertension, hypercholesterolemia, family history of heart disease, tobacco use, or overweight/obesity) to consume either: 1) a low(er)-fat diet, 2) a Mediterranean diet with virgin olive oil (1 L/wk), or 3) a Mediterranean diet with tree nuts (hazelnuts, almonds, and walnuts; 30 g/d). After 3 months, subjects in both Mediterranean diet groups containing olive oil or nuts had lower TC/HDL-C ratios compared to the low-fat group, -0.38 and -0.26, respectively. Additionally, the Mediterranean diet with nuts reduced fasting glucose (-5.4 mg/dL), systolic BP (-7.1 mmHg), diastolic BP (-2.6 mmHg), and TG concentrations (-13 mg/dL) relative to the low(er)-fat diet [42]. The Mediterranean diet with olive oil also reduced fasting glucose (-7.0 mg/dL), systolic and diastolic BP (-5.9 and -1.6 mmHg), but did not reduce triglyceride concentrations compared to the low(er)-fat diet. After 4 years of follow-up, both Mediterranean diets reduced the incidence of diabetes by 52% compared to a low(er)-fat diet in individuals with high CVD risk [44]. The trial was discontinued early when significant benefits were discovered for the combined CVD outcomes endpoint of stroke, myocardial infarction, or death from cardiovascular outcomes [43]. Both the higher nut and higher extra virgin olive oil diets reduced incidence of the combined endpoint by approximately 30% relative to the low(er) fat diet that limited intake of these foods [43]. Moreover, Martinez-Gonzalez et al. [45] reported a strong inverse relationship between a 14-item Mediterranean diet assessment tool and various indices of obesity (i.e. BMI, waist circumference, and waist-to-height ratio). These findings suggest that better adherence to a Mediterranean dietary pattern may affect adiposity and obesity to a greater extent than caloric intake or macronutrient quantity [45]. Therefore, it is important to note that even though all three diets were quite similar in overall macronutrient composition, differing by only 4% total fat between the "low fat" and Mediterranean diets, the Mediterranean dietary pattern was associated with greater cardiovascular benefits. Thus, small dietary changes can contribute greatly to CVD outcomes. Results of the PREDIMED Study have provided further evidence that the Mediterranean diet is effective for significantly lowering CVD morbidity and mortality.

The Dietary Approaches to Stop Hypertension (DASH) Eating Plan

The DASH eating pattern decreases CHD risk by lowering systolic (-5.5 mm Hg) and diastolic blood pressure (-3.0 mm Hg), as well as total cholesterol (-13 mg/ dl), and LDL-C (- 10.7 mg/dl) [46,47]. This dietary pattern promotes fruits, vegetables and use of low-fat dairy products; preferential use of whole grains, fish, poultry and nuts, with reduced intakes of sweets, sugar-sweetened beverages and red meat [46]. These food-based recommendations translate to higher intakes of potassium (4,700 mg/ day), magnesium (500 mg/day), and calcium (1, 240 mg/ day), and lower intakes of total fat (27% calories), saturated fat (6% calories) and cholesterol (150 mg/ day) (based on a 2,100 kcal/ day diet) [46]. Recommended intakes of carbohydrate and protein are 55% and 18% of calories, respectively. Clinical investigation of this DASH dietary pattern (N = 459) showed a significant systolic blood pressure lowering effect in the treatment groups ($P < 0.008$), with a greater effect demonstrated in persons with hypertension (-11.4 mm Hg) versus those with pre-hypertension (-3.5 mm Hg), a greater effect in women (-6.4 mm Hg) versus men (-4.8 mm Hg), and a greater effect in African-Americans (-6.9 mm Hg) versus Caucasian-Americans (-3.3 mm Hg); participants were on dietary treatment for 8 weeks and were weight stable throughout the study [48]. The DASH diet also significantly lowered ($P < 0.0001$) TC (-13.7 mg/dL), LDL-C (-10.7 mg/ dL), and HDL-C (-3.7 mg/dL), with greater lowering of TC and LDL-C in men (-19.2 mg/dL and -16.5 mg/dL, respectively) versus women (-8.9 mg/dL and -5.4 mg/dL, respectively) after accounting for race and baseline lipid concentration [47,48]. This dietary pattern reduced risk of CHD by -18% versus a typical American diet [49].

The DASH dietary pattern also has been shown to reduce overall mortality. In a prospective cohort study of hypertensive individuals (N = 5, 532) in the Third National Health and Nutrition Examination Survey (NHANES III), Parikh and colleagues [50] investigated the association between adherence to the DASH dietary pattern and overall mortality. Average follow-up time was 8.2 years and hypertension was determined by either blood pressure measurement, medication use, or self-reporting; diet adherence was determined by 24-hour dietary recall. Results indicated significant decreases in all-cause mortality (HR 0.69, 95% CI: 0.52 – 0.92, P = 0.01), and death due to stroke (HR 0.11, 95% CI: 0.03 – 0.47, P = 0.003). No significant associations were reported for CVD mortality (HR 0.92, 95% CI 0.63 – 1.35, P = 0.67), or mortality due to ischemic heart disease (HR 0.77, 95% CI 0.47 – 1.14, P = 0.28).

Reducing dietary sodium in combination with the DASH dietary pattern has been shown to additively lower blood pressure. A new report from the Institute of Medicine supports previous findings that reducing sodium from very high intake levels (>3,400 mg/day, current average American intake) to moderate levels (2,300 mg/day) improves health [51]. Sacks and colleagues [52] compared the DASH diet with three levels of sodium for 30 days; a low (1,150 mg/ day), intermediate (2,300 mg/day), or a high sodium (3,450 mg/day) intake, with the high sodium intake representative of an average American diet. The low-sodium DASH diet reduced systolic (-3.0 mm Hg) and diastolic (-1.6 mm Hg) blood pressure versus the high-sodium DASH diet, and demonstrated that compared to a high-sodium average American diet, the low-sodium DASH diet significantly decreased systolic blood pressure by -7.1 mm Hg and -11.5 mm Hg in pre-hypertensive and hypertensive individuals, respectively. Thus, these findings demonstrate a significant blood pressure lowering effect of a DASH dietary pattern that is high in fruits, vegetables and low-fat dairy products, and reduced in sodium.

The Report of the Dietary Guidelines Advisory Committee [53] classified the Prudent diet as a "DASH derivative." A Prudent dietary pattern is characterized by higher intake of vegetables, fruits, legumes, whole grains, fish, and poultry with decreased intake of foods characteristic of a Western dietary pattern: i.e., high in red meat, processed meat, refined grains, sweets and dessert, French fries, and full-fat dairy products [54]. In prospective cohort studies examining 5,872 to 72,113 subjects, higher prudent diet scores were associated with lower risk of CVD [54-57] and all cause mortality [54,56,57]. Individuals in the highest quintile for adherence to the Prudent pattern had up to a 50% lower risk of CVD mortality compared to those consuming the most Western dietary pattern [54,57]. Thus, a large body of evidence supports implementation of DASH, Prudent, and other DASH-derivative dietary patterns to reduce CVD risk and total mortality.

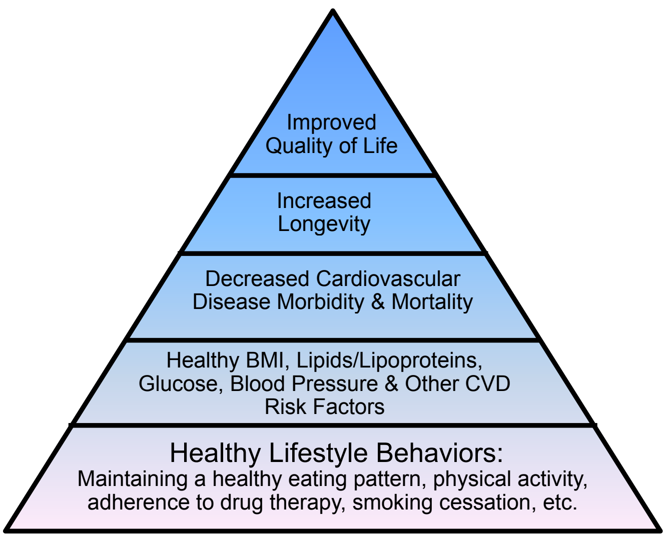

Figure 1: Healthy eating patterns and lifestyle behaviours are the foundation for increasing longevity and improving quality of life (adapted from Mozaffarian et al. [67]).

The elderly are among the fastest growing segment of the population. As the population ages, understanding the influence of dietary patterns as they affect the aging process will become ever more important. Although it seems unlikely that there is one specific dietary pattern that promotes atypical longevity, many similarities exist among dietary patterns associated with increased longevity and decreased incidence of age-related chronic disease. Such patterns promote plant-based foods, rich in phytonutrients, and low in saturated fat. Over the last 200 years, the "Western" diet has changed from being high in fiber, complex carbohydrates and lean meats to being high in, added sugars, solid fats, fatty meats, refined grains with an accompanying low nutrient density. This dietary shift contributes to the development of age-related chronic disease. Despite our knowledge about what foods comprise a healthy diet, there continues to be a huge gap between current eating patterns of the American public versus those that are recommended. Importantly, even minor shifts from the current diet to ones recommended will provide additional cardioprotective benefits when used in combination with drug therapy.

Complementary effects with drug therapy

There is impressive evidence that a healthy dietary pattern benefits individuals on drug therapy for CVD risk reduction. Importantly, in the Lyon Diet Heart Study and in the PREDIMED Study, participants on drug therapy who consumed a healthy Mediterranean-style diet achieved greater benefits than those on the control diet. Thus, on the basis of a primary prevention trial and a secondary prevention intervention, there is strong rationale for recommending a healthful dietary pattern for individuals who need drug therapy.

For individuals on statin therapy, dietary modifications for lowering LDL-C compliment statin therapy effectiveness. In the CARDIO2000 Study, Pitsavos et al. [58] studied 534 hypercholesterolemic participants and found that the combination of a Mediterranean diet and statin treatment was associated with a 43% reduction in coronary risk, independent of cholesterol levels and other cardiovascular risk factors. In addition, the adoption of the Mediterranean diet by hypercholesterolemic participants on drug therapy was associated with a 17% reduction in risk compared to hypercholesterolemic participants on drug therapy who did not adopt a Mediterranean diet. Investigation of diet modifications (SFA < 7%; cholesterol < 200 mg/ day) in combination with lovastatin (20 mg/ day) showed a further -5% reduction in LDL-C levels [59] an effect often gained by doubling the statin dose [60]. A meta-analysis of 8 randomized clinical trials in hypercholesterolemic participants (N = 306) found that use of plant sterols/stanols (1.8 – 6.0 g/day) in combination with statin therapy significantly lowered total cholesterol (-14 mg/dL, P < 0.0001), and LDL-C (-13.3 mg/dL, P < 0.0001) versus no sterol/stanol supplement, thus demonstrating the additional benefits in persons on statin therapy

[61]. Healthy diet (such as the DASH dietary pattern) and lifestyle practices (i.e., physical activity) also decrease blood pressure, thereby decreasing the need for pharmacotherapy, or lowering the medication dose. Thus, a healthy diet has direct and beneficial effects on important CVD risk factors in combination with pharmacotherapy to achieve CVD risk factor targets.

Conclusion

A healthy dietary pattern lowers CHD risk and is complementary to drug therapies by targeting well-established risk factors such as elevated BMI, high blood pressure, and an atherogenic lipid profile. Several dietary patterns have been associated with low CHD risk in both epidemiological studies and randomized controlled trials. For persons on drug therapy for hypertension or hypercholesterolemia, or both, dietary modifications significantly improve drug effectiveness. Of note, is the importance of other lifestyle factors, such as physical activity and smoking cessation that also benefit total and cardiac mortality and morbidity. In a thorough systematic review of randomized control trials, Cole et al. [62] found that lifestyle interventions promoting regular physical activity, a healthy diet, and adherence to medication have beneficial effects in patients with CHD. Thus, establishing healthy lifestyle behaviors would be expected to decrease CVD morbidity and mortality, increase longevity and improve the quality of life (Figure 1). As such, every effort should be made to incorporate diet and other healthy lifestyle practices into treatment regimens for all patients.

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