

Functional Food Security and the Heart

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ABSTRACT

Increased demand for food security has made the world blind about the utility and necessity of functional food security characterized with food diversity and adequacy of nutrients. Food diversity may

have been the major factor causing adequacy of nutrients in the Paleolithic diet 40,000 years ago. The increased prevalence of cardiovascular diseases (CVDs) and type 2 diabetes throughout the world, are closely linked to food security via westernized dietary patterns, physical inactivity, and rapid increase in the rate of obesity. The World Heart Federation and the World Health Organization are working hard to bring down the death rates due to CVDs, at least 25% by 2025. There is substantial evidence that increased intake of functional foods can bring about a significant decline in the epidemic of CVDs and type 2 diabetes, resulting in health promotion. It is possible that functional food security in conjunction with regular physical activity, can maintain the normal physiology and metabolism of our bodies, resulting into decline in CVDs and type 2 diabetes.

Key words: Foods; Dietary patterns; Western diet; Prudent diet

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INTRODUCTION

High technology cardiac care and highly effective drug therapy have been responsible for causing a significant decline in deaths from cardiovascular diseases (CVDs), which could also be partly due to improved diet and lifestyle^[1-3]. Reduction in the intake of saturated fat, salt and sugar, and increased consumption of functional foods; fruits, vegetables and whole grains, as well as some increase in physical activity and decrease in tobacco intake may have contributed to decline in CVDs in high income countries^[1-6]. However, this decreasing trend in CVDs is partly offset by rising obesity and type 2 diabetes, and poor adherence to lifestyle changes^[6-8]. Increased availability of statins for treatment of coronary artery disease (CAD) at affordable cost is the greatest single discovery which has improved the outcome among patients with CAD. The prevalence of high cholesterol, blood pressure and smoking have decreased in developed

countries, with some impact in some middle-income countries^[1-5].

The European Union agenda; “from farm to fork” approach involving organic farming initiatives, sustainable agriculture, and community-supported agriculture that is also promoted by some in the agriculture, food service, and restaurant communities, appears to be important to provide functional food security in European union countries. The global burden of diseases study has also emphasized on the role of diet and lifestyle factors to explain the causes of deaths due to CVDs and other chronic disease in 10 countries^[7] (Figure 1). However, we are still ignorant about functional food security characterized by diversity and adequacy of nutrients that may have been beneficial and abundant in the Paleolithic diet 40,000 years ago because of food diversity^[1-3]. The increased prevalence of CVDs and type 2 diabetes throughout the world has been closely linked to food security via westernized dietary patterns, physical inactivity, and rapid increase in the rate of obesity. In this mini review, we emphasize on the evidence for the role of functional foods security in the prevention of CVDs and type 2 diabetes^[1-4].

THE EPIDEMIC OF HEART ATTACKS

The World Heart Federation pointed out on the heart of 25 by 25 for achieving the goal of reducing global and regional premature deaths from CVDs and published a modeling study in association with the American Heart Association^[8]. The challenges of prevention of CVDs have also been addressed by a scientific statement of the International College of Cardiology who give greater emphasis on functional food

security^[9]. In South-West Asia, where undernutrition was common about 50 years ago, metabolic syndrome has become quite common, due to rapid economic development and food security^[4]. In a cross-sectional survey from various corners of India among 6,940 subjects (3,433 women and 3,507 men) aged 25 years and above, the overall prevalence of obesity (BMI 25 kg/m² and above) was 6.8% (7.8 vs 6.2%, *p* < 0.05) and overweight (BMI 23.0-24.9 kg/m²) 33.5% (35.0 vs 32.0%, *p* < 0.05) among women and men, respectively^[10]. In South Asia, central obesity and insulin resistance develops rapidly after the body mass index goes beyond 23 Kg/M², which is considered a paradox because these populations turn highly susceptible to develop CAD and type 2 diabetes^[4,11-13]. In a recent cohort study of 2.3 million adolescents, during 42,297,007 person-years of follow-up, 2,918 of 32,127 deaths (9.1%) were from CVDs, including 1,497 from heart attack, 528 from stroke, and 893 from sudden death. A BMI in the 50th to 74th percentiles, which is within the accepted normal range during adolescence, was associated with increased CVD and all-cause mortality after 40 years of follow-up^[14]. Overweight and obesity among parents and offspring may be also associated with increased cardiovascular mortality via epigenetic inheritance in adulthood^[15].

In the United Nations High Level Meeting (UN HLM), key targets were proposed to reach by 2025 to reduce the risk of premature death due to CVDs and other chronic diseases by 25% by 2025^[8]. This proposal requires that CVDs and its risk factors be aggressively addressed because it is the largest contributor to global mortality, accounting for nearly half of the 36 million annual deaths^[7]. Both

	China	India	US	Indonesia	Brazil	Pakistan	Nigeria	Bangladesh	Russia	Japan
High blood pressure	1	1	1	1	1	1	1	1	1	1
High sodium	2	2	6	12	4	3	7	4	6	2
Low fruit	3	4	7	3	5	4	5	2	5	4
Smoking	4	5	9	2	7	6	13	6	4	5
Ambient particulate matter	5	7	16	10	13	9	6	7	14	10
High body-mass index	6	11	2	7	2	2	2	14	2	7
Low whole grains	7	13	11	5	10	15	12	8	7	9
High fasting plasma glucose	8	8	4	11	8	10	11	10	9	11
Household air pollution	9	6		8	20	8	3	3		
Lead	10	18	19	18	19	17	17	13	21	19
Low physical activity	11	9	5	9	6	13	8	9	11	6
High total cholesterol	12	3	3	6	3	5	9	12	3	3
Low omega-3	13	12	12	22	14	14	14	16	17	21
Low fiber	14	15	15	15	16	18	19	18	16	14
Low nuts and seeds	15	16	10	13	12	16	16	17	12	12
Alcohol use	16	20	20	19	21	22	15	21	8	16
Low vegetables	17	10	8	4	9	7	10	5	10	8
Low glomerular filtration	18	14	14	14	11	12	4	11	15	13
Low PUFA	19	17	18	16	18	19	18	19	18	15
Secondhand smoke	20	22	22	17	22	21	22	22	19	18
High trans fat	21	19	17	21	15	11	20	15	20	17
High processed meat	22	21	13	20	17	20	21	20	13	20
High sweetened beverages	23	23	21	23	23	23	23	23	22	22

Figure 1 Dietary factors and other risk factors in relation to mortality in the global burden of disease study (Reference 7).

et al., reported estimates to indicate how reduction of selected risk factors would affect CVD mortality for different regions in 188 countries up to the year of 2025^[16]. Risk factors were projected to 2025 assuming that current trends continue. If United Nations risk factor targets are achieved in the year 2025, counterfactual scenarios would be then constructed indicating CVD premature mortality, adjusting for joint effects of risk factors. It has been estimated that 7.8 million premature CVD deaths would occur in 2025 if current risk factor trends continue^[16]. Premature CVD deaths would be reduced to 5.7 million if these risk factors targets are achieved as a result of a 26% reduction for men and a 23% reduction for women in the global risk of premature CVD death. The largest risk reduction would be achieved if the prevalence of hypertension is declined, followed by a reduction in tobacco smoking for men and obesity for women. Gender and region were important factors for meeting all risk factor targets on CVD mortality.

It is possible that United Nations target of a 25% reduction in premature CVD mortality by the year 2025 appears achievable for some countries. However, more aggressive risk factor targets may be required if all regions are to reach this goal. Many countries will see no change or even an increase in premature CVD mortality if there is no decrease in CVD risk factors. The Global Cardiovascular Disease Taskforce with the help from Institute for Health Metrics developed region specific estimates, showing that > 5 million premature CVD deaths among men and 2.8 million among women are projected worldwide by 2025^[16]. These deaths may be decreased to 3.5 million and 2.2 million, respectively, if risk factor targets for blood pressure, diabetes mellitus, obesity and tobacco use, are achieved by various countries and regions because global risk factor targets have variable effects, depending on region. It is known that, United Nations targets for reducing systolic blood pressure and tobacco use have more substantial effects on future occurrence of CVDs, compared with maintaining current levels of body mass index and fasting plasma glucose. It seems that reductions in multiple risk factors has the largest impact for almost all regions and these goals can be accomplished only if all the health professionals and governments in each country set priorities, implement cost-effective population wide strategies, and collaborate in public-private partnerships across multiple sectors; including Ministry of health, Agriculture, Food and Nutrition, Sports and Housing.

FOOD SECURITY AND EMERGENCE OF CHRONIC DISEASES

The world population is currently (2016) growing at a rate of around 1.13% per year and the current average population change is estimated at around 80 million per year. The United Nations estimated that the world's population will increase from 7.4 billion in 2016 to 8.1 billion in 2025, with most growth in developing countries and more than half in Africa. By 2050, the world population will reach 9.6 billion. There is marked reduction in death rates due to undernutrition and an emergence of morbidity and mortality due to CVDs and other chronic diseases^[7]. Nutrition in transition from poverty to affluence indicate that there is increased availability of Western foods resulting in food security for most populations of the world^[1-4,7]. (Figure 1). However, as per IHME News, USA, Oct 2015, "The biggest cause of early death in the world is not smoking or alcohol - it's what you eat." (Staufenberg J, Oct 2015). This observation is supported by intensive research because both undernutrition due to food scarcity and over-nutrition due to food security are associated with a significant increase in metabolic syndrome which is a risk factor of death due to

Pathway for Health Promotion.& Disease Prevention.? Singh,2014-16

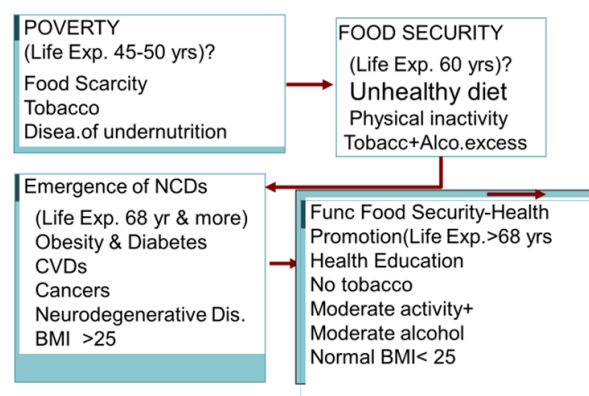


Figure 2 Transition from poverty to Food Security and Functional Food Security leading to health promotion and prevention of obesity.

CVDs, diabetes and cancer^[6-9].

The world's population suffering from under-nourishment is around 12.5%, lower from almost half of the world's population in 1947 as per records of FAO. However, 868 million people remain hungry, an estimated 2 billion people suffer from one or more micronutrient deficiencies and an estimated 1.4 billion people are overweight, of whom 500 million are obese, which predisposes to type 2 diabetes and CVDs. Therefore, food security has been the priority of most of the governments and health agencies, without much consideration for functional foods. The FAO and WHO were short of hard evidence that providing western type foods can enhance life expectancy for hardly 60 years or more. It may be associated with unhealthy diet, physical inactivity, tobacco use and alcohol consumption, which may cause emergence of obesity, metabolic syndrome, diabetes, hypertension, atherosclerosis, carcinogenesis, degenerative diseases of brain and osteoporosis^[1,7-16]. The Western-type foods are: all refined, high-energy, salty, sugary and low-nutrient foods; red meat, preserved and processed meats, bread, biscuits, candies, cookies, white chocolate, high-sugar foods and syrups may have adverse effects on health, resulting in to hypertension, heart attack and stroke. All rapidly absorbed foods, deep fried foods, red meat, preserved, salted meats and snacks, plastic-containing foods, Chinese rice, trans-fat and too much of -6 and saturated fat and trans-fat-rich foods are also known to predispose to CVDs and other chronic diseases (Figure 2).

FUNCTIONAL FOOD SECURITY AND THE HEART

Functional food security means increased availability of foods that are rich in protective nutrients and low in energy and nutrients having beneficial effects^[17-20]. These foods can enhance life expectancy, to 68 years and more. The functional food security may be associated with other health behaviors; health education, no tobacco, moderate activity, moderation in alcohol intake and normal waist/hip ratio or normal waist circumference, they can lead to a reduction in chronic diseases mentioned above^[4,7,17-20]. Functional foods and Functional Farming (4 F) may be defined as foods which contain certain nutrients that can address some physiological mechanisms in our bodies, thereby providing benefits^[18-20]. Functional farming (FF) produces functional foods either by appropriate soil, or by genetic engineering or plant breeding^[20]. Functional foods security in conjunction with increased physical activity are effective measures, and weight loss is the main predictor of the success in the prevention of diabetes and CVDs including heart attacks^[1-4,17-20].

legumes, whole grains, fruits, nuts, and olive oil), moderate consumption of fish and wine, and low consumption of red and processed meat and whole-fat dairy products, is widely recognized as a healthy dietary pattern, rich in functional foods, which is similar to Paleolithic diet (Figure 3)^[1,17,18-24]. Further cohort studies from Southern Europe also suggested a lower incidence of CVDs and diabetes with increasing adherence to the Mediterranean-style diet in previously healthy individuals^[23] or myocardial infarction survivors^[24].

In a case control study among 287 women, aged 22-69 years and 649 controls, the risk of acute myocardial infarction (AMI) was directly associated with frequency of consumption of meat (odds ratio 1.5 for upper v lower thirds of consumption), ham and salami (1.4), butter (2.3), total fat added to food (1.6), and coffee (2.8)^[25]. Assessment of risk with functional food revealed significant inverse association for fish (0.6), carrots (0.4), green vegetables (0.6), and fresh fruit (0.4). The risk was below one for moderate alcohol consumption (0.7) and above one for heavier intake (1.2) indicating that alcoholism could be a risk factor of AMI. It is possible that frequency of consumption of functional foods and western type foods may provide useful indicators of the risk of AMI. It is likely that certain foods; fish, moderate alcohol, or vegetables and fruits may have an independent protective role against risk of AMI^[25].

In another case study involving 342 subjects (171 patients with AMI and 171 matched controls) six food items were assessed that were considered protective; olive oil, fiber, fruits, vegetables, fish and alcohol^[26]. The findings showed that the higher the score of food intakes, the lower the odds ratio of myocardial infarction. A significant linear trend was apparent after adjustment for the main cardiovascular risk factors. For each additional point in the a priori Mediterranean pattern (observed range: 9-38) the odds ratio (95 % confidence intervals) was 0.92 (0.86-0.98). This estimate was 0.55 (0.42-0.73) when we used the post hoc pattern (range: 0-8). The result indicated that a Mediterranean diet (that emphasizes olive oil, fiber, fruits, vegetables, fish and alcohol and reduces meat/meat products) can be an effective measure for reducing the risk of myocardial infarction. Our results support the exclusion of refined cereals with a high glycemic load as healthy elements of this pattern. In the further case study involving 760 patients, below age 79 years, have non-fatal AMI, and 682 patients have acute conditions unrelated to diet^[27]. Increasing intake of anthocyanidins (OR = 0.45, 95% CI 0.26-0.78 for the highest vs the lowest quintile, (Ptrend = 0.003) and flavonols (OR = 0.65, 95% CI 0.41-1.02, (Ptrend = 0.02)) were significant protective factors against AMI^[27]. It is possible that increased intake of anthocyanidins reduced the risk of AMI even after allowance for alcohol, fruit and vegetables, supporting a real inverse association between this class of flavonoids and AMI risk.

In a case study among 54 patients with AMI and 85 matched controls, the incidence of lipoprotein (a) excess (> 30 mg/dL; 42.6 vs 24.7%; $p < 0.05$) and mean concentration of lipoprotein (a) (Lp[a], 6.4 mg/dl, 95% confidence interval: 2.8-10.5; $p < 0.05$) was significantly greater in the AMI group compared with control subjects. Mean total cholesterol and triglycerides were significantly higher and mean nitrite level lower in the study group as compared with the control group. There was a significant greater incidence of cardiac events in the second quarter of the day compared with the fourth quarter. Lp (a), triglycerides, blood glucose, plasma insulin, malondialdehyde, diene conjugates, TBARS and TNF-alpha and IL-6 levels, which were significantly greater during the acute phase, showed a significant decline and serum nitrite and coenzyme Q demonstrated an increase at 4 weeks of follow-up when the acute reactions evoked by MI had been controlled. Large breakfasts were

a predisposing factor for cardiac events in the second quarter of the day and it was significantly associated with metabolic reactions. The findings indicate that acute reactions as a result or as circadian rhythms appear to be important in the pathogenesis of AMI-associated complications and that a large breakfast in association with nitrite deficiency may further trigger the circadian rhythms^[29].

In another case-control study involving 202 patients with AMI, there was a significant ($p < 0.02$) increase in cardiac events in the second quarter of the day compared to other quarters, respectively (16.8%, 41.0%, 13.8%, 28.2% per quarter) which was mostly after a heavy breakfast or dinner^[30]. Neuropsychological mechanisms were observed as follows: emotional stress (45.5%), sleep deprivation (27.7%), cold climate (29.2%), hot climate (24.7%), large meals (47.5%) and physical exertion (31.2%). These triggering factors are known to enhance sympathetic activity and decrease vagal tone, resulting in an increased secretion of plasma cortisol, noradrenaline, aldosterone, angiotension-converting enzyme (ACE), interleukin (IL)-1, -2, -6, -18, and tumor necrosis factor-alpha (TNF-alpha), all of which are pro-inflammatory agents. There is also a deficiency in the serum levels of vitamin A, E, and C and magnesium, potassium, melatonin, and IL-10 (an anti-inflammatory agent). In our study, we found a decrease in magnesium, potassium, vitamin A, E, C and beta carotene combined with an increase in thiobarbituric acid-reactive substances (TBARS), MDA and diene conjugates, TNF-alpha and IL-6, all of which are indicators of oxidative damage and pro-inflammatory activity, respectively^[29,30].

The relationship between dietary patterns and risk of acute coronary syndrome (ACS) was examined in a standardized case-control study INTERHEART, involving participants from 52 countries^[31]. Using the principle-component analysis technique, the authors identified 3 major dietary patterns; Oriental (high intake of tofu and soy and other sauces), Western (high in fried foods, salty snacks, eggs, and meat), and prudent (high in fruit and vegetables). Consistent with previous studies in single within-population cohort studies, the authors found an inverse association between the prudent pattern score and risk of ACS and a significant positive association between the Western pattern score and increased risk of ACS. The Oriental pattern was not significantly associated with risk. The investigators constructed a dietary risk score based on 7 food items on the food-frequency questionnaire (meat, salty snacks, fried foods, fruits, green leafy vegetables, cooked vegetables, and other raw vegetables) and found that a higher score (indicating a poor diet) was strongly associated with ACS risk: Those in the highest quartile of the score had nearly 2-fold increased risk, even after adjustment for established coronary risk factors. In sensitivity analyses, the investigators found a consistent association for the composite diet score between men and women and across different regions of the world (North America, western Europe, Australia, central Europe, Middle East, Africa, south Asia, southeast Asia, China, and South America). On the basis of an arbitrary cut point of the score (top 3 quartiles versus the bottom quartile), the investigators estimated that 30% of MI could be explained by unhealthy diets worldwide. Although Western-style changes in food patterns are widely believed to adversely influence risk of chronic diseases, few epidemiological studies have directly linked dietary patterns and mortality from coronary heart disease. The INTERHEART study is the first large study to quantify eating patterns in all geographic regions of the world. It provides evidence that despite different food habits in various populations, reproducible patterns can be found in diverse regions of the world. These findings are important because there has been a concern that dietary patterns derived through a data-

driven approach such as principle-component analysis may be highly unstable and non-reproducible because of very different eating habits in different populations.

In recent years, dietary-patterning analysis has been increasingly used as an alternative method to traditional single-nutrient analysis because it can assess cumulative effects of the overall nutrients in the diet. Habitual intake patterns are typically quantified by statistical methods such as factor or cluster analysis or diet-quality indexes based on prevailing dietary recommendations or healthful traditional diets eg, the Mediterranean diet, and Indo-Mediterranean diet. Principle-component analysis is commonly used to define dietary patterns using food consumption information to identify common underlying dimensions (factors or patterns) of food intake. The method aggregates specific food items based on the degree to which these food items are correlated with each other. A summary score for each pattern is then derived and can be used to examine relationships between various eating patterns and outcomes of interest such as coronary heart disease and other chronic diseases. Previous validation studies found that 2 major patterns (the prudent and Western patterns) identified through principle-component analysis of food consumption data assessed by food frequency questionnaires were reproducible over time and correlated reasonably well with the patterns identified from diet records. The consistent association observed between the Western or unhealthy dietary pattern (high in animal products, salty snacks, refined starches and sugar and fried foods and low in fruits and vegetables) and ACS risk in different regions of the world from the INTERHEART study and other studies^[28-31] provides reliable evidence of the adverse effects of globalization on human nutrition and chronic disease risk, but the evidence is indirect because these studies did not specifically assess the impact of global trade and marketing on food consumption patterns, and their effects on inflammation, endothelial dysfunction, across different countries^[28-31]. Despite this weakness, most recent studies suggest that the current trend of dietary convergence toward a typical Western diet is likely to play a role in the globalization of risk factors of CVDs including myocardial infarction^[28-31].

INTERVENTION TRIALS WITH FUNCTIONAL FOODS AND HEART ATTACK

Most trials with functional foods are conducted using Mediterranean-style diets in subjects with heart attack or those with high risk of CVDs^[32-39]. Heart attack or AMI or acute coronary syndrome (ACS) is highly dynamic state associated with pro-inflammatory, severe neuro-endocrinological dysfunction, apart from myocardial damage^[40-43]. There is marked increase in sympathetic activity, oxidative stress and inflammation, free fatty acids, dyslipidemia and deficiency of magnesium, potassium, coenzyme Q10 as well as in vitamin A, C, E and beta-carotene during the ACS event. These adverse effects are more common during second quarter of 24 hours. There is endothelial dysfunction due to rise in free fatty acids and endothelin 1 and reduction in bradykinin and nitric oxide which enhances the susceptibility for recurrent cardiovascular events after ACS but it could be prevented by Mediterranean style diet^[40-43].

These syndromes usually occur when an acute thrombus forms in an atherosclerotic coronary artery. Atheromatous plaque sometimes becomes unstable or inflamed, causing it to rupture or split, exposing thrombogenic material, which activates platelets and the coagulation cascade and produces an acute thrombus. Platelet activation involves a conformational change in membrane glycoprotein (GP) IIb/IIIa receptors, allowing cross-linking (and thus aggregation) of platelets.

Even atheromas causing minimal obstruction can rupture and result in thrombosis; in > 50% of cases, pre-event stenosis is < 40%. Thus, although the severity of stenosis helps predict symptoms, it does not always predict acute thrombotic events. The resultant thrombus abruptly interferes with blood flow to parts of the myocardium. Spontaneous thrombolysis occurs in about two thirds of patients; 24 h later, thrombotic obstruction is found in only about 30%. However, in virtually all cases, obstruction lasts long enough to cause tissue necrosis. In view of this pathophysiology of ACS, it is logical to administer functional foods in patients with AMI as soon as patient can tolerate a Mediterranean style soup developed from functional foods^[32-34].

In randomized, controlled trial among 404 patients with ACS, intervention group was administered fruits, vegetable, whole grains, nuts and mustard oil initially as soup and later on as foods after few days compared to low fat diet^[32-34]. After a follow up of 2 years, this study reported that the total mortality was 14.7% in the Paleolithic style diet group and 25.2% in the control group^[34]. The differences in mortality are highly significant ($p = 0.008$). The findings of this study confirm that decreasing ω -6/ ω -3 fatty acid ratio of the diet in the Paleolithic style diet group from 32.5 to 3.5 was associated with significant reduction in total cardiac mortality, total cardiovascular mortality and total mortality compared to control diet group.

In the Lyon Diet Heart Study, 605 patients who had a MI were randomly assigned to a Mediterranean-style diet of Crete or a prudent diet as per guidelines of the National cholesterol Education Program^[35,36]. The experimental diet provide ratio of ω -6 to ω -3 of 4/1. This ratio was achieved by substituting olive oil and canola (oil) margarine for corn oil. In the Lyon Heart Study, the ratio of 4/1 of ω -6/ ω -3 fatty acids led to a 70% decrease in total mortality at the end of 27 months^[35]. The risk of new AMI and episodes of unstable angina were reduced by ~ 70% by the modified Mediterranean diet. Long-term follow up for 4 years also showed that the beneficial effects of diet were continued^[36]. Singh *et al* examined an Indo-Mediterranean diet in 1000 patients in India, with existing coronary disease or at high risk for coronary disease. Half of the patients ($n = 499$ vs 501) were administered a diet rich in fruits, vegetables, whole grains, walnuts, mustard oil and soy bean oil as a source for ω -3 fat and rest 501 patients were advised to take prudent diet advised by the NCEP step 1 diet in 1988^[37]. At the end of 2 year follow up, the mean intake of ω -3 fatty acids was over two fold greater in the Indo-Mediterranean diet group compared to control group (1.8 ± 0.4 vs 0.8 ± 0.2 g/day, $p < 0.001$). The ω -6/ ω -3 ratio of fatty acids was slightly higher at baseline in the intervention group than in the control group (39 ± 12 vs 34 ± 10) yet both these values are extremely high, reflecting a diet with a very high ω -6 content yet low ω -3^[37]. At the end of two years follow up, this ratio of fatty acids, showed a marked decline in the intervention group, which was greater than that observed in the control group consuming control diet (9.1 ± 12 vs 21 ± 10 , $p < 0.001$). The study end points were; significant decline in the total cardiac events, sudden cardiac death and nonfatal MI in the Indo-Mediterranean diet group compared to the control group.

Burr *et al*^[44] from United Kingdom reported 29% decline in total mortality including a decrease in sudden cardiac death in the group that received fish advice or took fish oil supplements relative to the group that did not among AMI patients. Singh *et al*^[38] compared fish oil and mustard oil with control vegetable oils in patients with ACS. There was a significant decline in total cardiac events in the fish oil and mustard oil groups compared to control group patients with ACS during a follow up of one year^[38]. The Lyon Heart Study was the first to attempt to modify the consumption of other fat components, and

reduce the intake of omega-6 fatty acids despite the fact that there is convincing support for such studies. The differences in the ω -6/ ω -3 ratio in the background diets and the dose of EPA and DHA could be an important factor in studies with conflicting results in intervention trials on the role of EPA and DHA in patients with ventricular arrhythmias in which a beneficial effect^[45-51]. These mechanisms of action of functional foods and their beneficial effects on AMI pose the possibility that functional food and herb extract, such as cocoa, green tea, apple, black grapes, guava juice should be triad among patients undergoing angioplasty to prevent restenosis.

The findings from the PREDIMED Study indicate that there is no upper limit for fat intake because increased consumption of olive oil and other fatty acids (41% en from total fat) was associated with a significant decline in CVDs compared to control group receiving high saturated fat diet^[39]. Hence, the US Department of Agriculture and International College of Cardiology have suggested no limit for total fat intake but limit the intake of saturated fat, trans-fat and possibly -6 fat which are known to have adverse effects. The best composition of fatty acid in the oil could be achieved by blending the oils as given in Table 2.

In brief, there is substantial evidence that increased consumption of functional foods can decrease cardiovascular events among patients with heart attack. Functional food security if foods are available at lower cost can enhance the consumption of these foods, resulting in to health promotion and global prevention of heart attack.

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