The Effects of Low-fat, High-carbohydrate Diets on Plasma Lipoproteins, Weight Loss, and Heart Disease Risk Reduction

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Although there is consensus about restriction of dietary saturated and trans fatty acids, cholesterol, and sugars, there is debate about what the optimal total fat and carbohydrate content of the diet should be for weight loss and coronary heart disease (CHD) risk reduction. The overall evidence that dietary composition plays an important role in determining caloric intake is limited. Three recent randomized trials have indicated that low-carbohydrate diets are more effective in promoting weight loss in overweight and obese subjects over 4 to 6 months, but not over 1 year. In our own randomized trial no such differences were noted, and compliance with extreme diets was limited. Moreover little attempt has been made to control for the type of carbohydrate used in the low-fat, high-carbohydrate arms of these trials. Available evidence suggests that restriction of sugars and carbohydrates having a high glycemic index would be preferable to total carbohydrate restriction, and that an increased intake of fiber and essential fats (especially omega-3 fatty acids) is also important for overall heart disease risk reduction.

Introduction

Coronary heart disease (CHD) remains the leading cause of death and disability in developed societies. Major risk factors for CHD, in addition to age and gender, include elevated level of total cholesterol and low-density lipoprotein (LDL) cholesterol, decreased high-density lipoprotein (HDL) cholesterol, hypertension, diabetes, and cigarette smoking [1]. Worldwide epidemiology studies and transmigration studies indicate a strong role for dietary composition with foods rich in saturated fat, cholesterol, and sugar being related to increased CHD mortality, and increased intake of fruits, grains, vegetables, and vegetable oils, as well as moderate alcohol intake, being associated with protection. Obesity, defined as a body mass index of greater than 30 kg/m², significantly increases the prevalence of all major heart disease risk factors except smoking [2].

Although there is consensus that saturated fat should be restricted to less than 10% of calories and dietary cholesterol to less than 300 mg/d in the general population, with even greater restrictions in hypercholesterolemic subjects (saturated fat < 7% of calories and dietary cholesterol < 200 mg/d), there is little consensus about what the total fat and other fatty acid content of the diet should be or what the level of carbohydrate should be. The Adult Treatment Panel of the National Cholesterol Education Program (NCEP) now recommends that carbohydrate intake should be between 50% and 60% of calories, fiber should be between 20 and 30 g/d, and total fat should be between 25% and 35% of calories [1]. This panel also recommended that polyunsaturated fats be no more than 10% of calories and that monounsaturated fat intake could be as high as 20% of calories [1].

In 2003, the World Health Organization (WHO) established population nutrient intake goals for the prevention of chronic disease at 15% to 30% of calories from fat, 55% to 75% of calories from carbohydrate, less than 10% of calories from free sugar, 1% to 2% intake from omega (n)-3 fatty acids, 5% to 8% from n-6 fatty acids, and at least 400 g/d from fruits and vegetables [3•]. The WHO panel concluded that there was convincing evidence that increased intake of linoleic acid, fish and fish oil, vegetables, and fruits, and also moderate alcohol, would decrease heart disease risk. There is also probable evidence that alpha-linolenic acid, oleic acid, fiber, cereal, and folate would decrease heart disease risk. Conversely, their analysis indicated that increased palmityc and myristic acids and trans fatty acids, sodium, being overweight, and consuming excessive alcohol would all increase risk, and that increased dietary cholesterol would probably increase CHD risk [3•]. The panel also concluded that there was convincing evidence that a
sedentary lifestyle and an increased intake of energy-dense foods would increase the risk of developing obesity, and that the marketing of fast foods and a high intake of sugar would probably do so too. They also concluded that regular physical activity and dietary fiber would reduce obesity risk, and that healthy food choices for children and breastfeeding of children would probably do so as well [3•].

Some investigators have maintained that the epidemic of obesity that is currently being experienced worldwide is a direct result of attempts at dietary fat restriction, causing sugar intake to go up. However the WHO data indicate that caloric intake has increased worldwide between 1965 and 1998 by 19% (by 31% in developed countries and by 15% in industrialized countries) [3•]. Moreover, fat intake in this same time period has also increased worldwide by 20% (by 26% in North America, by 55% in China, and by 31% in Europe) [3•]. Sugar intake has also increased significantly. Those experts who have done a careful analysis of this problem have concluded that the major cause for the epidemic of obesity is increased caloric intake and decreased physical activity, with decreased smoking rates possibly contributing to this epidemic, especially in the United States.

A panel convened by the Department of Agriculture and the Department of Health and Human Services in the United States in 2005 recommended that consumers eat a variety of nutrient-dense foods and beverages from among the basic food groups while choosing foods that limit the intake of saturated (< 10% of calories) and trans fats (as low as possible), cholesterol (< 300 mg/d), and added sugars, salt, and alcohol. They recommended keeping fat intake between 20% and 35% of calories, with most fats coming from sources of polyunsaturated and monounsaturated fatty acids, such as fish, nuts, and vegetable oils. They recommended that carbohydrate intake should come mainly from fiber-rich fruits, vegetable, and whole grains, and that sugar intake be limited. They also recommended less than 2300 mg/d of sodium (1 teaspoon of salt), and that individuals who choose to drink should do so sensibly (up to 1 drink per day for women, and up to 2 drinks per day for men). They had fairly striking exercise recommendation: consumers should balance energy intake with energy expenditure to maintain a healthy weight, and exercise at least 30 min/d to reduce chronic disease risk, 60 min/d to help manage body weight in adulthood, and 60 to 90 min/d to promote and sustain weight loss in adulthood. They also recommended striving to achieve physical fitness by including cardiovascular conditioning, stretching exercises for flexibility, and resistance exercises or calisthenics for muscle strength and endurance [4•]. For the purposes of this review of recent research since 2000 in this area, a low-fat diet is defined as one with less than 30% of calories from fat, and a very low-fat diet as one with less than 15% of calories from fat.

**Dietary Intervention and Coronary Heart Disease Risk Reduction**

Dietary intervention studies to decrease heart disease risk have been previously reviewed [2]. These studies clearly indicate that decreasing saturated fat and increasing both n-6 and n-3 fatty acids in the diet will decrease heart disease risk (eg, Oslo Diet Heart, Veterans Affairs Study, Finnish Mental Hospital Study). There have been no large-scale studies of very low fat diets, only the Lifestyle Heart Study conducted by Dr. Dean Ornish, who assessed the benefits of restricting fat to less than 10% of calories [2]. Although this study had a positive outcome, it was only carried out in a very small number of individuals, and the endpoint was coronary angiography. Moreover, such diets are difficult to tolerate, and long-term compliance with these diets has not been well documented. There are very few data to justify marked fat restriction (< 15% of calories from fat).

Since the year 2000, one important CHD outcome study has been reported with dietary modification. This was the Indo-Mediterranean diet study [5•], in which 1000 CHD patients were randomized equally to a standard local diet similar to the NCEP Step 1 diet (< 10% of calories as saturated fat and < 300 mg/d of cholesterol) or a program in which patients were encouraged to eat a diet rich in whole grains, fruits, vegetables, walnuts, and vegetable oil (4 servings daily of mustard seed or soybean oil, which is rich in alpha-linolenic acid and linoleic acid) over a 2-year period. In the intervention arm of the study, the saturated fat intake went from 13% to 8% of calories, whereas in the control arm it remained at about 12% of calories. The polyunsaturated fat intake overall did not change substantially, but the intake of n-3 fatty acids increased from approximately 0.5% of calories to approximately 1.8% of calories in the experimental group, but it did not change in the control group. There was also an 84% decrease in dietary cholesterol and a significant increase in total fiber and soluble fiber in the intervention group, but not in the control group. The investigators also documented that the intervention group consumed more fruits, vegetables, legumes, walnuts, almonds, and vegetable oil than did the control group. Importantly, they documented a significant decrease in total cardiac endpoints in the intervention group: 39 (7.8%) versus 76 (15.2%) in the control group ($P < 0.001$; 50% reduction). There was also a significant reduction in sudden cardiac death, with six in the intervention group versus 16 in the control group ($P = 0.015$), and also a reduction in nonfatal myocardial infarction, with 21 in the intervention group versus 43 in the control group ($P < 0.001$). Therefore, the intervention diet was clearly beneficial in terms of heart disease risk reduction. The experimental diet contained 59.5% carbohydrate, with 48.1% as complex carbohydrate, whereas fat intake of all of the diet groups was less than 30%, but it was slightly lower in the intervention group, at 26.3%. In this regard, this study was similar to a much smaller angiographic study that previously was.