# Health Effects of Omega-3 Polyunsaturated Fatty Acids

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There are two families of essential fatty acids, the omega-6 and omega-3 polyunsaturated fatty acids (PUFA). They are essential because human beings cannot make them and they must be obtained from the diet.

On the basis of estimates from studies in Paleolithic nutrition and modern-day hunter-gatherer populations, it appears that **human beings evolved consuming a diet that was much lower in saturated fatty acids than is today's diet**. Furthermore, the diet contained small and roughly equal amounts of omega-6 and omega-3 PUFA (**ratio of 1–2:1**) and much lower amounts of *trans* fatty acids than does today's diet.

**The current Western diet is very high in omega-6 fatty acids (the ratio of omega-6 to-omega-3 fatty acids ranges between 10–30:1)** because of the recommendation to substitute vegetable oils —corn oil, sunflower, safflower, cottonseed and soybean oil— that are high in omega-6 fatty acids for saturated fats to lower serum cholesterol concentrations. **Furthermore, intake of omega-3 fatty acids is much lower today because of the decrease in fish consumption, and the industrial production of animal feeds rich in grains containing omega-6 fatty acids, leading to production of meat rich in omega-6 and poor in omega-3 fatty acids. The same is true for poultry, eggs and farmed fish**. Even cultivated vegetables contain fewer omega-3 fatty acids than do plants in the wild. In summary, modern agriculture, with its emphasis on production, has decreased the omega-3 fatty acid content in many foods: green leafy vegetables, animal meats, eggs, and even fish, while it has increased the amount of omega-6 fatty acids in foods, leading to high omega-6 intake for the first time in the history of human beings in many countries around the world. The traditional diet of Crete (Greece) is consistent with the Paleolithic diet relative to the omega-6:omega-3 ratio. The Lyon Heart Study, which was based on a modified diet of Crete, had an omega-6:omega-3 ratio of 4:1 resulting in a 70% decrease in risk for cardiac death. The higher the ratio of omega-6 to omega-3 fatty acids in platelet phospholipids, the higher is the death rate from cardiovascular disease. As the ratio of omega-6 PUFA to omega-3 PUFA increases, the prevalence of type 2 diabetes also increases. A balance between the omega-6 and omega-3 fatty acids is a more physiologic state in terms of gene expression, eicosanoid metabolism and cytokine production.

Today, more is known about the mechanisms and functions of omega-3 fatty acids than other fatty acids. **Research has shown** that docosahexaneoic acid **(DHA)—an omega-3 fatty acid found in fish oil—is essential for the development of the premature infant relative to visual acuity, visual function and maturation**. In the full term infant, DHA

may influence visual acuity and neural pathways associated with the developmental progression of language acquisition. These findings have led to inclusion of DHA and arachidonic acid (AA), an omega-6 fatty acid, in infant formula by most countries around the world.

**When humans ingest fish or fish oil, the ingested EPA and DHA partially replace the omega-6 fatty acids [especially AA] in cell membranes, particularly those of platelets, erythrocytes, neutrophils, monocytes and liver cells**. Recent research suggests that the response to omega-3 fatty acids may be genotype dependent, since certain individuals respond more than others. It is essential to take genetic variation into consideration in setting up clinical intervention trials. There is a need to move away from the long-term prospective studies, and proceed with genotype specific clinical intervention trials.

**Most of the research on the role of omega-3 fatty acids in chronic diseases has been carried out in patients with coronary heart disease**. Intervention trials have clearly shown that omega-3 fatty acids have anti-inflammatory, antithrombotic, hypolipidemic and antiarrhythmic properties, and decrease sudden death and all cause mortality in the secondary prevention of coronary heart disease and in one study also in the primary prevention. **Omega-3 fatty acids lower c-reactive protein (CRP) more so than any other nutrient, which accounts for decreasing the risk for coronary heart disease**. The decrease in sudden death is most likely due to the antiarrhythmic effects of omega-3 fatty acids. **Inflammation and cell proliferation are at the base of many chronic diseases and conditions, especially atherosclerosis and cancer, but also diabetes, hypertension, arthritis, mental health, and various autoimmune diseases. Individuals carrying genetic variants for these conditions are much more prone to develop them because the high omega-6:omega-3 ratio leads to pro-inflammatory and pro-thrombotic states**.

**The time has come to return the omega-3 fatty acids into the food supply** and decrease the omega-6 intake. There is good scientific evidence from studies on the Paleolithic diet, the diet of Crete, other traditional diets (Okinawa), intervention studies, and finally studies at the molecular level using transgenic rodents that the physiologic omega-6:omega-3 ratio is 1:1 or 2:1. **Japan has already recommended a ratio of 2:1**. Industry has moved in the direction of including omega-3 fatty acids in various products starting with omega-3 enriched eggs, which are based on the Ampelistra (Greek) egg as a model obtained under complete natural conditions and which has a ratio of omega-6:omega-3 of 1:1.

In the past, industry focused on improvements in food production and processing to increase shelf life of the products, whereas now and in the future the focus will be on nutritional quality in product development. This will necessitate the development of research for the nutritional evaluation of the various food products and educational programs for professionals and the public. The definition of food safety will have to expand in order to include nutrient structural changes and food composition. The dawn of the twenty-first century will enhance the scientific base for product development and

expand collaboration among agricultural, nutritional, and medical scientists in government, academia and industry. This should bring about a greater involvement of nutritionists and dieticians in industrial research and development to respond to an ever-increasing consumer interest in the health attributes of foods. #

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