



Omega-3 EPA/DHA and the Major Dietary Deficiency in the Western Diet



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Omega-3 fatty acids are considered to be essential nutrients for human health and normal growth and development. There are three forms of omega-3. ALA (α -linolenic acid) is an 18-carbon polyunsaturated fatty acid from plant sources such as flaxseed oil. The human body converts ALA into two physiologically essential forms of omega-3, which includes eicosapentaenoic acid (EPA), a 20-carbon long chain polyunsaturated fatty acid (LCPUFA) and docosahexaenoic acid (DHA), a 22-carbon LCPUFA.

EPA and DHA are considered biologically active in man. They are present in every cell in our bodies, structurally important in cell membranes, and play many important roles in human biochemistry. Through evolution, man evolved with a large amount of fish in their diet. Fish, particularly oily fish like tuna, salmon, and anchovies, contains high levels of EPA and DHA. Research suggests that the availability of EPA and DHA from oily fish was the primary source of these essential nutrients in the human body during evolution. People can convert the omega-3 ALA to EPA and DHA; however, the conversion efficiency is less than 5%. (18)

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People ate a large amount of fish until 50 years ago when the western diet changed dramatically because of food processing and the availability and cost of fish. In fact, according to the National Marine Fisheries Institute, 25% of Americans do not eat any fish. In 2005, the United States Department of Agriculture made changes to the food pyramid by adding the recommendation that people eat 2–4 meals of oily fish per week (26). This is a difficult task for the average American because of the inconvenience and cost of fish.

EPA has been demonstrated to have anti-inflammatory properties, and when consumed on a regular basis, may play an important role in disease prevention. Research suggests that most diseases of an epithelial origin (the skin on the inside and outside of your body) begin with chronic inflammation.

DHA is also considered a vital nutrient; however, its efficacy is attributed to a different mode of action than that for EPA. DHA plays an important physiologic role in structure and conduction within the nervous system. For example, the retina of the eye is approximately 22% DHA, and the dry mass of the brain is comprised of 20% DHA (19). DHA is also a key structural component of heart tissue. Research suggests it plays a role in the regulation of heart muscle contraction through nervous conduction across the heart tissue, which can assist in the prevention of cardiac arrhythmias.

On the basis of the amount of scientific evidence demonstrating the efficacy of EPA

and DHA, the Food and Drug Administration (FDA) has allowed a qualified heart health claim for both supplement and food products containing EPA and DHA. This enables manufacturers of nutritional products to claim their products are heart healthy because both EPA and DHA play important roles in heart health. For example, the qualified health claim for foods containing omega-3 fatty acids is “Supportive but not conclusive research shows that consumption of EPA and DHA omega-3 fatty acids may reduce the risk of coronary heart disease. One serving of [name of food] provides [X] grams of EPA and DHA omega-3 fatty acids” (27).

In the United States, there has recently been approval for a prescription form of concentrated fish oil for the reduction of hypertriglyceridemia, an independent risk factor for coronary artery disease. In Italy, concentrated fish oil is prescribed by physicians to prevent secondary myocardial infarctions. Collectively, these examples demonstrate that there is a positive regulatory environment supporting the efficacy and value of fish oil as a food ingredient.

Over 8,000 research publications demonstrate the health benefits and efficacy of EPA and DHA. Only calcium has as much scientific evidence for efficacy and importance in human health. The constant stream of research over the last 25 years has resulted in publications demonstrating benefits of EPA and DHA in many health conditions.

An advertisement appeared here
in the printed version of the journal.

Research continues to provide exciting new results for the importance of EPA and DHA in human health, which has generated significant media attention, and in turn, has built consumer awareness to unprecedented levels. In the United States, 60% of the mass level consumers are aware of omega-3 and believe it is important for health.

Many more studies than those listed below have been conducted for various life stages and health conditions. Below are just a few examples of the conditions that have been researched demonstrating the importance of EPA and DHA.

Cardiovascular Health

EPA and DHA have been shown to play important roles in cardiovascular health. As outlined above, EPA has demonstrated anti-inflammatory properties, indicating that it may contribute to health by mitigating disease risk associated with inflammation. For example, chronic inflammation of the coronary vessels precedes atherosclerosis, a condition that leads to reduced blood flow and oxygen deprivation of heart muscle tissue, and depending on severity, may lead to angina or even myocardial infarction (13). Similarly, chronic inflammation has been clearly associated with early phases of many diseases such as carotid artery occlusion, potentially leading to strokes (2).

DHA appears to work at the cellular level and play a role in the electrical conductivity associated with heart muscle contraction. Literature also suggests that DHA acts in the ionic exchange at the cellular membrane level, which leads to cellular contraction and relaxation in the heart muscle (10). It is believed this is why omega-3s have demonstrated anti-arrhythmic properties and have beneficial effects on heart rate (7,11).

The largest study conducted to date is the GISSI trial, which was conducted in several sites in Italy over a 3.5-year period (8). Approximately 11,000 patients, who suffered a recent myocardial infarction, were randomized to receive 850 mg/day of omega-3 EPA/DHA, vitamin E (300 mg/day), both treatments, or a placebo. Treatment with the omega-3 supplements significantly reduced the rate of death, nonfatal myocardial infarction (MI), and stroke compared to the placebo subjects.

Brain Health and Development

The effects of EPA and DHA on infant cognitive development and neurodevelopmental disorders such as attention deficit hyperactivity disorder (ADHD) and dyslexia, as well as other disorders such as depression, bipolar disorder, schizophrenia, and Alzheimer's disease in the adult population, have been studied in recent years (4,5,14,23–25).

DHA is thought to work primarily in association with the nervous system at the

cellular level. As mentioned above, DHA is a key structural component of the nervous system and it comprises 20% of the dry mass of the brain. An example demonstrating the marketing implication is that DHA has been approved in the United States as an ingredient in infant formulae. From 2002 to 2005, the market share of U.S. infant formulae containing DHA grew from zero to approximately 80% (15).

Cognitive Development

DHA is involved in the structure of the brain, the retina of the eyes, and the nervous system. It is important that infants receive ample omega-3 to enable proper development of these vital organs. In fact, the International Society for the Study of Fatty Acids and Lipids (ISSFAL) recommends that pregnant women receive 300 mg of DHA daily. However, the reality is that most women are not getting nearly enough. In a dietary study of 112 pregnant and lactating women in the United States, the average intake of DHA was just 54 mg/day (1).

Helland and coworkers studied maternal supplementation with omega-3 PUFAs during pregnancy and lactation and examined the resulting IQ of the children at 4 years (9). This randomized, double-blind study involved 90 children assessed at 4 years of age. Children who were born to mothers who had taken the omega-3 supplement during pregnancy and lactation scored higher on the mental processing composite. The children's scores correlated significantly with maternal intake of DHA and EPA, indicating that maternal intake of omega-3 EPA and DHA during pregnancy and lactation may be beneficial for children's cognitive development.

Also of note is that in women with no or low fish consumption, small amounts of omega-3, provided as fish or fish oil, may improve protection against preterm delivery and low birth weight (17,21).

Neurodevelopmental, Psychiatric, and Cognitive Disorders

Substantial amounts of research have accumulated in the area of omega-3 fatty acids and their effects on ADHD, bipolar disorder, dyslexia, depression, schizophrenia, and Alzheimer's Disease (4,5,14,23–25).

ADHD has been associated with reduced levels of omega-3 in the blood. Stevens and coworkers, in two studies, found lower concentrations of essential fatty acids, including omega-3, in ADHD subjects versus controls, as well as a positive relationship between reduced omega-3 fatty acid status and increased behavioral problems in children (23,24).

The Oxford-Durham Study investigated the effects of dietary supplementation with fish oil (80%) and evening primrose oil (20%) on children with developmental coordination disorder (DCD), which over-

laps with ADHD, dyslexia, and autistic spectrum disorders (20). It involved 117 children, ages 5-12 with DCD. Over the 3 months of treatment, (daily dosage: 558 mg of EPA, 174 mg of DHA, 60 mg of gamma-linolenic acid, and 9.6 mg of alpha-tocopherol), significant improvements occurred in reading, spelling, and behavior, suggesting that fatty acid supplementation may be safe, tolerable, and efficacious in improving academic progress and behavior among DCD children.

Inflammatory Conditions

As mentioned previously, EPA has demonstrated anti-inflammatory properties. Accordingly, fish oil has been shown to have potential benefits in a variety of inflammatory-related conditions, including inflammatory bowel diseases, asthma, and arthritis (16).

Rheumatoid Arthritis (RA). Studies examining potential benefits of omega-3 fatty acid supplementation in subjects with RA have yielded mostly positive results (3,12,22).

Fortin and coworkers conducted a meta-analysis of 10 research studies using fish oil in subjects with RA (6). A review of the journal articles allowed them to conclude that the use of fish oil significantly reduced the number of tender joints ($P < 0.05$) and duration of morning stiffness in subjects with RA at 3 months ($0.05 < P < 0.08$) when compared with placebo subjects.

Applications

Omega-3 EPA/DHA from fish oil has been successfully included in numerous food types by companies all over the world. Several successful food types in the market include bread/bread mix, frozen pizza dough, muffins, tortillas, biscuits, nutrition bars, cookies, yogurt, milk, juice, gummies, nutritional drinks, and many more.

There are numerous companies who have successfully put fish oil/powder into their food products to provide their customers with the added benefit of EPA and DHA. In Australia, George Weston Bakeries Inc. used EPA/DHA fish oil powder in their Tip Top Up muffins and their Up white and whole wheat breads. In the United States, Wegmans put EPA/DHA fish oil powder into their white, whole wheat, and whole grain breads. In Canada, Taco Rio Inc. put it in their Cali-Wrap tortillas.

In United States, New Era Nutrition uses EPA/DHA fish oil powder in the chocolate mint and lemon cranberry flavors of their SoLo Gi low glycemic nutrition bars.

In Canada, Good Foods Enterprises includes EPA/DHA fish oil powder in three flavors of their Mr. Cookie cookies, which are part of the school lunch program across Ontario.

These are just a few examples of companies who are using EPA and DHA from marine sources in their bakery products.

Conclusion

EPA and DHA from fish oil are essential to good health and normal growth and development because they are part of every cell in our body and are structurally important in cell membranes. Since the body cannot produce these essential nutrients effectively, they must be consumed through the diet. Thousands of studies and reviews support the health benefits of EPA and DHA and since 25% of Americans do not eat fish, it is important that they receive these important nutrients another way. Technology now allows EPA and DHA from fish oil to be included in food applications to provide customers with an added benefit. There are many success stories in the industry and many more to come as the demand for omega-3 EPA and DHA from fish oil increases.

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