International Food Information Council

OMEGA-3 FATTY ACIDS

It is well-established that dietary fats are an important part of a healthy and balanced diet. They add flavor and texture to foods and at the same time can be a source of health-promoting, vital nutrients. Of particular interest is a subgroup of dietary fats known as omega-3 fatty acids. These fats gained the attention of researchers in the late 1970s during observational studies of Greenland Inuits. The low occurrence of coronary heart disease (CHD) in Inuits was attributed to their traditional diet, which is rich in marine animals and fish.[1] Other population studies have also shown that cultures with high fish consumption, such as Japan, have similarly low rates of CHD mortality.[2] Discoveries like these jumpstarted a massive body of research on omega-3 fatty acids and their effects on human health. This fact sheet covers the current state of the science on these important compounds, as well as dietary recommendations and food sources of omega-3 fatty acids.

WHAT ARE OMEGA-3 FATTY ACIDS?

Understanding the role of omega-3 fatty acids in human health begins with knowledge of the chemical makeup of fatty acids, which are distinguished based on the number of unsaturated bonds between carbon atoms in the fatty acid chain. Polyunsaturated fatty acids (PUFA) have more than one cis double bond in their carbon chain. Omega-3 fatty acids, including alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA), are a type of PUFA. These omega-3 fatty acids contain their first double bond on the third carbon molecule from the methyl (or omega) end of the fatty acid's carbon chain[3] (see figure below).

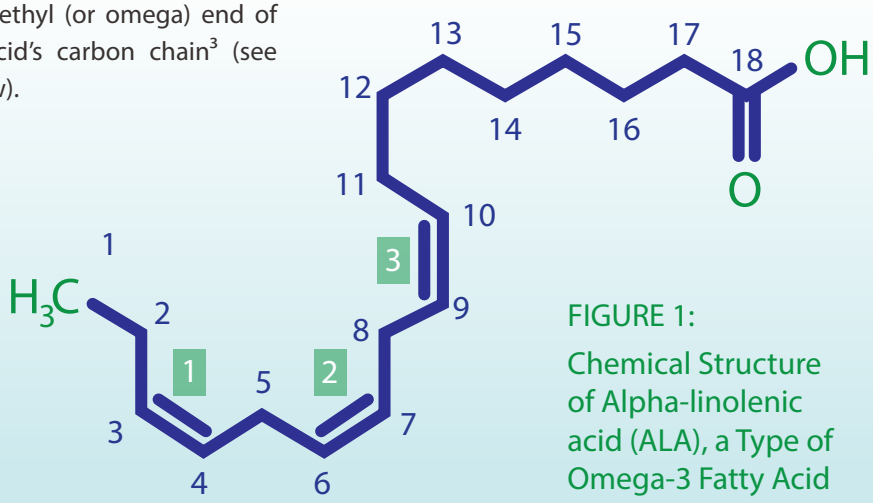

FIGURE 1:
Chemical Structure of Alpha-linolenic acid (ALA), a Type of Omega-3 Fatty Acid

The naming of each fatty acid provides information regarding its chemical structure. As an example, DHA has a structure of 22:6n-3. The first part of the name (22:6) indicates that DHA is a 22-carbon fatty acid with six double bonds, whereas the second part (n-3) means that the first double bond is in the n-3 position, which qualifies it as an omega-3 fatty acid.[4,5] ALA contains 18 carbon atoms, while EPA and DHA contain 20 and 22 carbon atoms, respectively. EPA and DHA are considered to be "long-chain" omega-3s.[6]

ALA cannot be formed in the body, so it is considered an essential fatty acid and must be obtained through the diet. ALA can be converted into EPA and further into DHA in the liver, although this process is inefficient. As a result, consuming EPA and DHA through foods or supplements may be a more realistic way to ensure that the body obtains an adequate amount of these omega-3s.

TABLE 1: Types of Omega-3 Fatty Acids

NAME OF OMEGA-3	ABBREVIATION	STRUCTURE	FOOD SOURCES
Alpha-linolenic acid	ALA	18:3n-3	Chia seed, flaxseed and flaxseed oil, walnuts, canola oil
Eicosapentaenoic acid	EPA	20:5n-3	Fatty fish and seafood, fish oils, krill oil, cod liver oil, algal oils
Docosahexaenoic acid	DHA	22:6n:3	Fatty fish and seafood, fish oils, krill oil, cod liver oil, algal oils

OMEGA-3 FATTY ACIDS AND HUMAN HEALTH

Omega-3 fatty acids are perhaps best known for their potential heart health benefits,[7-9] although not all evidence supports these outcomes.[10,11] A growing body of research continues to examine the effects of omega-3s in other areas, such as certain types of cancers, neurological disorders, arthritis and infant neurocognitive development.[6,12]

Observational research often notes a relationship between a higher intake of fish and other seafood with improved health-related outcomes. Unfortunately, it is often difficult to determine whether or not those benefits are a result of greater intake of omega-3 fatty acids; if fish or seafood choices replace other, unhealthier diet choices; or if the benefits are due to a combination of factors.[6] In all areas, additional research in the form of long-term, placebo-controlled, clinical trials will be useful in understanding the health outcomes associated with omega-3 intake.

CARDIOVASCULAR HEALTH

Observational studies have reported that greater intakes of fish and seafood as well as higher dietary levels or plasma levels of omega-3s are associated with lower risks of heart failure, CHD and fatal coronary heart disease.[6] Several systematic reviews and meta-analyses based on observational data completed before 2014 reported that omega-3s reduce the risk of cardiac death.[13-15] However, the results of randomized clinical trials have not always consistently aligned with the observational findings. A 2016 review reported that higher intakes of omega-3s (EPA and DHA from fish, seafood, and dietary supplements) reduced triglyceride levels and increased high-density lipoprotein (HDL, or "good" cholesterol) levels but also increased low-density lipoprotein (LDL, or "bad" cholesterol) levels. In addition, the review stated that these higher intakes did not affect major adverse cardiovascular events, sudden cardiac death, or all-cause mortality.[16]

In 2017, a review by the American Heart Association (AHA) found that the available evidence did not support the use of omega-3 supplements for those in the general population who were not at a high risk of cardiovascular disease (including people with diabetes mellitus and prediabetes). However, the AHA continues to suggest that physician-

monitored omega-3 supplementation may be a reasonable addition for secondary prevention of CHD in people with a recent CHD-related event, such as a heart attack.[11] After removing studies deemed to be at high risk of bias, a 2018 Cochrane systematic review found that "moderate- and high-quality evidence suggests that increasing EPA and DHA has little or no effect on mortality or cardiovascular health (evidence mainly from supplement trials)."[10] Additional clinical trials investigating omega-3 fatty acids and cardiovascular events are needed. However, in general, research still supports the idea that consuming a balanced diet, including omega-3 containing fatty fish and other seafood, or omega-3 supplementation (following a physician's guidance), helps promote heart health.[17]

CANCER

It has been hypothesized that greater consumption of omega-3s from foods or supplements might decrease the risk of cancer as a result of anti-inflammatory properties of omega-3s and their potential to inhibit cell growth factors.[18] However, results from observational studies have been inconsistent and differ by the location of the cancer in the body as well as factors such as gender and genetic risk.[6] Some studies have noted associations between higher intake of omega-3s (or blood levels of omega-3s) and a reduction in risk for cancers such as breast or colorectal cancer, while others report no effect of omega-3 intake on cancer risk. Further, some researchers have suggested that intake of omega-3s might contribute to the risk of developing prostate cancer.[6] A 2020 review of 15 meta-analyses of observational studies focusing on brain, breast, endometrial, liver, prostate and skin cancers found no convincing, highly suggestive or suggestive evidence of an association between fish or omega-3 fatty acid consumption and cancer risk.[19]

ALZHEIMER'S DISEASE AND COGNITIVE FUNCTION

Many, but not all, observational studies report that high dietary intake of omega-3s is associated with a reduced risk of cognitive decline, Alzheimer's disease, and dementia.[6] Conversely, the results of multiple systematic reviews and meta-analyses have noted that supplementation with omega-3s does not affect cognitive function in healthy people or those with Alzheimer's disease.[6] However, for people who suffer from milder forms of cognitive dysfunction, consuming omega-3s may improve key areas of cognitive function, like processing speed and memory.[20]

ARTHRITIS

Omega-3 fatty acids have anti-inflammatory properties and as a result have been theorized to help mitigate symptoms of rheumatoid arthritis (RA). A 2017 meta-analysis noted that the use of supplemental omega-3 in subjects with RA was associated with a reduction in tender joints, early morning stiffness, and pain levels compared with a placebo.[21] However, a 2017 systematic review of the effects of omega-3 supplements on subjects with RA noted that only four of 18 placebo-controlled trials saw a benefit of omega-3s for pain level.[22]

INFANT NEUROCOGNITIVE DEVELOPMENT (MATERNAL CONSUMPTION)

Results from observational studies have shown that maternal intake of at least eight ounces of DHA-containing seafood per week during pregnancy and breastfeeding is associated with better infant health-related outcomes.[12] However, results from a 2013 systematic review of maternal omega-3 intake and potential effects on early childhood cognitive development found no difference between the DHA and control groups in measures of cognition or neurodevelopment (including language, behavior, or motor function).[23] Most recently, the Scientific Report of the 2020 Dietary Guidelines Advisory Committee (DGAC)'s review of the literature aligns with current recommendations for pregnant women to consume eight to 12 ounces of seafood lower in methylmercury and higher in omega-3 fatty acids.[24]

OMEGA-3 FATTY ACID DIETARY RECOMMENDATIONS AND CURRENT INTAKE

When the Institute of Medicine (or IOM, now called the National Academy of Medicine) last reviewed omega-3 fatty acids, there were insufficient data to establish an estimated average requirement (EAR), so adequate intakes (AIs) were developed for all ages based on omega-3 intakes in healthy populations. Human breast milk contains ALA, EPA, and DHA, so the AI for infants from birth to 12 months is equal to the average intake of omega-3s in healthy, breastfed infants. The AIs for infants refer to total omega-3s. For ages one and older, the AI refers only to ALA because it is the only essential omega-3. Specific intake recommendations for EPA, DHA, or other long-chain omega-3s have not been established.[6] Additionally, the National Academy of Medicine has not established a tolerable upper intake level (UL) for omega-3 fatty acids,[4] and the U.S. Food and Drug Administration (FDA) has ruled that intakes of EPA and DHA of up to three grams per day are Generally Recognized as Safe (GRAS) for inclusion in the diet.[26] Doses of greater than five grams of EPA and DHA per day are generally not recommended by the FDA due to evidence that intake at those levels may lengthen bleeding time in susceptible people.[26]

Table 2 lists the AIs for omega-3s in grams per day.

The 2015–2020 Dietary Guidelines for Americans (DGA) provide intake goals for ALA that are based on the AIs and include a goal of consuming eight ounce-equivalents of seafood per week.[12] The Scientific Report of the 2020 DGAC is consistent with the seafood-related recommendations of the 2010 and 2015 DGAC reports, with minor revisions.[24] The 2020 DGAC report states that "[t]wo or more servings of cooked seafood per week are recommended for ages 2 years and older to ensure intake of key nutrients and as part of an overall healthy dietary pattern." Also, consuming fish and seafood species with higher amounts of omega-3s and low levels of methylmercury is advised, using guidance from federal and local fish and seafood advisories. The upcoming 2020–2025 DGA may provide information on the types of seafood and amounts to consume (or avoid) based on methylmercury content.[24] For people wishing to avoid seafood intake, regular intake of other foods high in omega-3s, such as flaxseed, walnuts, algae, and soybean oil may be adequate.

TABLE 2: Adequate Intakes (AIs) for Omega-3 Fatty Acids (grams per day)[4]

AGE	MALE	FEMALE	PREGNANCY	LACTATION
Birth to 6 months*	0.5 g	0.5 g	--	--
7 to 12 months*	0.5 g	0.5 g	--	--
1 to 3 years **	0.7 g	0.7 g	--	--
4 to 8 years**	0.9 g	0.9 g	--	--
9 to 13 years **	1.2 g	1.0 g	--	--
14 to 18 years**	1.6 g	1.1 g	1.4 g	1.3 g
19 to 50 years**	1.6 g	1.1 g	1.4 g	1.3 g
51+ years**	1.6 g	1.1 g	--	--

*As total omega-3s **As ALA

The National Health and Nutrition Examination Survey (NHANES) from 2011–2012 reported that most children and adults consume the recommended amounts of omega-3s as ALA: the average intake of ALA from foods is 1.32 grams in females and 1.55 in males ages 2 to 19 years. In adults ages 20 and older the average intake of ALA from food is 1.59 grams per day for females and 2.06 grams per day for males.[27] Food sources of EPA and DHA provide about 40 milligrams (mg) in children and teens and about 90 milligrams in adults.[27]

The Safety of Omega-3s

A common safety concern regarding omega-3 intake from fish and seafood relates to the risk of unsafe intake levels of methylmercury, a toxic and heavy metal. However, this risk can be mitigated somewhat through avoidance of certain fish and seafood species that tend to contain higher amounts of methylmercury, including king mackerel, marlin, orange roughy, shark, swordfish, tilefish (from the Gulf of Mexico), and bigeye tuna.[25] Omega-3 supplements have not been found to contain methylmercury, an outcome of rigorous processing and purification steps.

SOURCES OF OMEGA-3 FATTY ACIDS

Table 3 captures a list of common foods that provide ALA, EPA, and DHA.[28,29]

Certain foods, such as specific brands of juice, milk, yogurt and soy beverages are fortified with DHA and other omega-3s. Omega-3 enriched eggs are also available; their omega-3 content is enhanced by feeding hens a diet that is supplemented with omega-3 fatty acids. Additionally, since 2002, infant formula manufacturers in the United States have added DHA and arachidonic acid (two of the most prevalent long-chain PUFAs in the brain) to their products.[31]

Omega-3s are also available as dietary supplements in the form of fish oil, cod liver oil, krill oil, and algal (vegetarian) oils. In general, fish oil supplements that are roughly 1,000 mg fish oil may contain about 180 mg EPA and 120 mg DHA, although doses can vary considerably.[32]

TABLE 3: Food Sources of ALA, EPA, and DHA[28,30] (grams per serving)

FOOD	SERVING	ALA	DHA	EPA
Flaxseed oil	1 tbsp	7.26		
Chia seeds	1 ounce	5.06		
Walnuts, English	1 ounce	2.57		
Flaxseeds, whole	1 tbsp	2.35		
Salmon, Atlantic, farmed, cooked	3 ounces		1.24	0.59
Salmon, Atlantic, wild, cooked	3 ounces		1.22	0.35
Canola oil	1 tbps	1.28		
Sardines, canned in tomato sauce, drained	3 ounces		0.74	0.45
Salmon, pink, canned, drained	3 ounces	0.04	0.63	0.28
Soybean oil	1 tbsp	0.92		
Edamame, frozen, prepared	1/2 cup	0.28		
Tuna, light, canned in water, drained	3 ounces		0.17	0.02
Shrimp, cooked	3 ounces		0.12	0.12
Reduced fat milk, fortified with DHA	8 ounces		0.03	
Soymilk, fortified with DHA	8 ounces		0.03	
Orange juice, omega-3 enriched	8 ounces		0.03	0.02
Egg, omega-3 enriched*	1 egg	0.048	0.002	0.1-0.15

*The amount of ALA, DHA, and EPA in omega-3 enriched eggs can vary considerably among brands.

THE BOTTOM LINE

Omega-3 fatty acids may have beneficial effects on infant development and, in adults, on cardiovascular health and other disease conditions such as cancer, arthritis, Alzheimer's disease and cognitive function. People at varying stages of the life cycle, including during pregnancy, may benefit from consuming appropriate amounts of omega-3 fatty acids. The current food supply offers a variety of sources of dietary omega-3 fatty acids. Additional research is needed to better understand the complexities of omega-3 fatty acids and the impacts they have on the body and on disease prevention and management.

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