Worries about the effects on childhood development of mothers' eating mercury-contaminated seafood have come mainly from studies of mothers and children in the Faroe Islands. There, women eat fish and pilot whale during pregnancy. Researchers reported that prenatal mercury exposure was significantly linked to deficits in various neurodevelopmental tests when the children were 14 years of age[20]. In contrast, a different study of mothers and children in the Seychelles Islands, where fish consumption is 10 times greater than in the U.S., researchers found no evidence of adverse effects of maternal fish and mercury intake on child development through 11 years of follow-up[21,22]. Why are the findings in these two large studies different?

There is a catch. In the Faroe Islands, pregnant women are exposed to mercury from consuming pilot whale, which is highly contaminated with mercury and organic pollutants. Fish consumption contributes relatively little mercury. When the contribution of pilot whale mercury is taken into account, the effects of fish consumption were all beneficial, whereas those including pilot whale were negative[23]. Thus, much of the fear about the developmental effects of mercury is based on eating contaminated pilot whale, not fish consumption. As Myers and Davidson commented, "There has never been even one child with prenatal mercury poisoning from [mothers] consuming fish documented outside Japan"[24].

The Mercury Shield in Fish: Selenium

The potentially toxic effect of mercury appears to be abolished by the selenium fish contains. That selenium protects against the toxicity of heavy metals has been known for 40 years, although how it works has only recently been described[25,26]. Selenium, a potent antioxidant, is incorporated into proteins capable of binding heavy metals. One of these proteins, SeP, is especially rich in metal binding sites. A recent study reported that when people were exposed to high levels of mercury, SeP bound the mercury and binding increased with greater mercury exposure[27]. Further, the selenium proteins protected against harmful oxygen products resulting from the increased mercury. Thus, when mercury exposure is high, more selenium is retained which binds the mercury, preventing its toxic effects. The brain selectively takes up and retains selenoproteins, even when dietary selenium is low, creating a cache to guard against the neurotoxic effects of mercury[28,29]. Feeding sufficient selenium completely protected against the detrimental effects of a high mercury diet on growth[30].

It so happens that seafood is the richest source of selenium in the diet. Amounts of selenium in fish nearly always exceed those of mercury, even in large pelagic fish that are more likely to carry higher levels of mercury[31]. A recent study of 15 species of pelagic fish reported that only mako shark had more mercury than selenium. In the Faroe Islands, pilot whale also has considerably more mercury than selenium, making it more harmful than if selenium were more abundant than mercury. Freshwater fish also vary widely in their selenium and mercury levels, so fish with high mercury and low selenium would be expected to pose a greater health risk than ocean fish. The relative amounts of selenium and mercury may be the most reliable way to assess the potential risk from mercury in fish[29].

Choosing Fish Wisely

Smart consumers will include seafood on the menu regularly, at least 2 to 3 times a week so they obtain the many health benefits of long-chain omega-3s. Many, if not most, of these benefits cannot be obtained from plant sources of omega-3s (e.g., flax, walnuts, canola and soybean oils) because the body converts the omega-3 in plants to the long-chain omega-3s very inefficiently. Conversion to DHA is almost negligible, so pregnant and nursing women would be especially short-changed by relying solely on plants for their omega-3s.

All seafoods have some long-chain omega-3s, but the fattier species, such as salmon, rainbow trout, light tuna, mackerel, sardines, black cod and herring have the greatest amounts. Most fish are low in mercury, but large long-lived fish, such as shark, marlin, swordfish and very large halibut tend to have higher levels. With the exception of shark and possibly swordfish, even these large fish may pose minimal risk from mercury because of their abundant selenium. However, the FDA's advice to pregnant and nursing women to avoid eating shark, swordfish, tilefish (golden bass or golden snapper) and king mackerel is safest. These species are more likely to have higher concentrations of mercury than is desirable.

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SEAFOOD

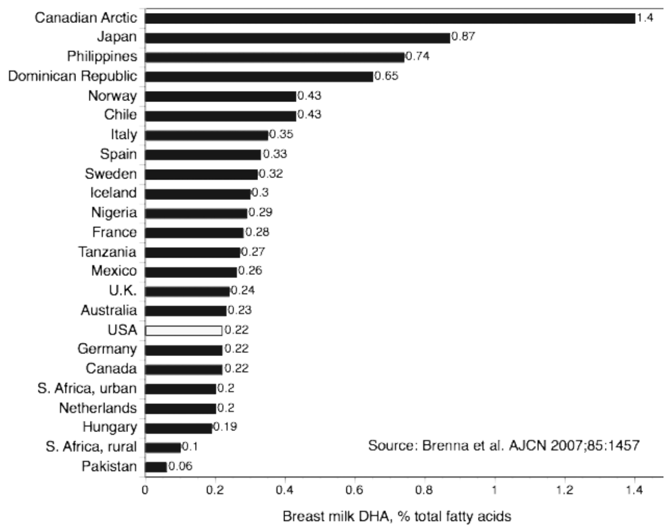
WEIGHING THE BENEFITS AND THE RISKS

Few foods have confused consumers as much as seafood. Even though the health benefits associated with eating fish and shellfish continue to expand, fears of seafood contaminants sometimes overshadow the good associated with eating more fish. Are we being irrational? Risk experts say that people exaggerate the chance of rare but nasty events occurring, following their gut instincts rather than logic. Faced with conflicting information, consumers say, "Why take the chance when I don't have to?" This paper takes a close look at what we might gain or lose by eating fish and shellfish more often.

US Seafood Consumption

Compared with meat and poultry, Americans eat little seafood, about 14 g (1/2 oz) a day versus 210 g (7 1/2 oz) a day for meat and poultry[1]. Most people eat fewer than 2 servings of fish/week, the amount currently recommended[2,3]. Low seafood consumption means that the intakes of long-chain omega-3 fatty acids—mainly EPA and DHA (eicosapentaenoic and docosahexaenoic acids)—are also low, about 100 mg/day[4]. These fatty acids occur almost exclusively in seafood and cannot be substituted by the omega-3 fatty acid found in plants[5]. That is because only tiny amounts of the plant omega-3 are converted to the active long-chain forms. In contrast with Americans, Japanese adults consume 2 to 13 times more seafood, eating fish once to 8 times a week[6].

Low US seafood consumption is of particular concern for pregnant and nursing women. They obtain about 100 mg of DHA/day[4], half what experts believe they need for themselves and their infants—200 mg of DHA daily[7]. The result of not eating much fish appears in the low DHA content of US women's breast milk (chart). The question is, do these low intakes matter? Much evidence says they do.



Special Need for DHA in Pregnancy and Lactation

Just as vitamins and minerals are needed for fetal development during pregnancy, long-chain essential fatty acids are key nutrients for the developing nervous and vascular systems[8,9]. Sufficient arachidonic acid, a long-chain omega-6, is provided in the usual diet, but adequate DHA depends on dietary intake and tissue stores of the preformed fatty acid. Vegetarians and women who do not eat fish have lower levels of DHA than women who eat fish or other foods with preformed DHA, such as omega-3-enriched eggs[10]. Their infants also have less DHA. Higher maternal DHA translates into higher DHA in the infant[11]. DHA is needed for the infant's brain and eye development, brain structure and function, cognitive development, visual acuity, more mature sleep patterns and for healthy immune system maturation[7,9,12]. DHA also contributes to slightly longer gestation with lower chance of complications or preterm delivery[13]. Mothers who consume more DHA during pregnancy lose less of their own DHA and may be less prone to postpartum depression. For these and other reasons, most US women need to boost their DHA intake during pregnancy and lactation.

Diverse Health Benefits From Seafood's Long-Chain Omega-3s

The long-chain omega-3s found in seafood benefit everyone's health. Evidence continues to accumulate revealing how seafood omega-3s may improve our health. The benefits include:

* **Heart health** – Lower chance of dying from coronary heart disease and sudden cardiac death – 20% to 50% less likely
* Improved electrical properties of the heart, including more stable rhythms, lower heart rate and better heart rate variability (adaptability)
* Less chance of a first heart attack and other nonfatal cardiac events
* Improved blood lipid patterns with lower blood triglycerides (fats) and higher HDL or "good" cholesterol levels; however, seafood omega-3s have little effect on LDL or "bad" cholesterol
* Less unwanted blood clotting that could lead to a heart attack or stroke
* Reduced inflammation, an underlying contributor to heart disease and other disorders
* Healthier blood vessel function and blood flow
* Slower progression of atherosclerosis and clogged arteries
* **Brain function** – Sharper brain function including neurotransmission (communication between brain cells), protection of neurons from injury and disease, rapid responses to hormones and regulatory substances, and improved brain cell repair and regeneration
* Healthy cognition and memory, especially in aging; seafood omega-3s may lower the risk of developing Alzheimer's disease, other dementias and possibly Parkinson's disease
* Proper brain growth and development in fetal and infant life; insufficient intake of DHA and EPA is associated with lower brain DHA content and a greater chance of childhood behavioral disorders such as dyslexia, attention deficit hyperactivity disorder and conditions affecting movement and coordination
* **Mental health** – Reduced risk and severity of several mental disorders, including depression, bipolar disorder, and mood disorders such as anxiety, hostility and aggression
* **Visual function** – Long-chain omega-3s are vital for healthy visual and retinal function; they may lower the chance of developing age-related macular degeneration and possibly cataract, dry eye, glaucoma and other visual disorders. The retina has the body's highest concentration of DHA, which aids in converting light to visual signals and in dim-light and night vision. DHA promotes healthy visual development in early infancy and protects against loss of blood vessels in visual damage
* **Immune function** – Seafood omega-3s promote immune system maturation in infancy and may lower the chance of childhood allergies. Increased omega-3 consumption may ease the symptoms of inflammatory conditions, such as rheumatoid arthritis, asthma, certain allergies and digestive disorders. Omega-3s tone down overactive immune responses making symptoms less severe, but they do not cure the conditions
* High levels of long-chain omega-3s have been used to treat rheumatoid arthritis, without the adverse side effects of some anti-inflammatory drugs. Some evidence suggests that increased intake of long-chain omega-3s during pregnancy reduces the infant's chance of developing allergies, such as eczema, allergic rhinitis and asthma
* **Clinical conditions** – Long-chain omega-3s may reduce the chance of type 2 diabetes and improve the welfare of patients needing total parenteral nutrition; they may be helpful in post-surgery and trauma, inflammatory bowel and Crohn's disease, possibly some forms of cancer and most recently bone health

New products such as yogurt, margarine, spreads and snack bars may have omega-3s added, but may not indicate which ones they have. Such foods nearly always have alpha-linolenic acid from flax seed or oil. Unless the label specifically mentions "long-chain" omega-3s, or EPA, or DHA, it will not have fish oil omega-3s. Be sure to read the label.

What Is the Potential Downside of Eating Seafood?

Most seafood contains detectable levels of contaminants because these are part of the environment and food chain. Of greatest concern is methylmercury, a heavy metal readily absorbed and potentially toxic. Inorganic mercury from volcanoes, the weathering of soils and rocks, coal-fired power plants, mining and various industrial processes is converted by aquatic microorganisms to methylmercury, the form found in fish[14,15]. The concern about methylmercury (mercury) is 3-fold: it accumulates through the food chain and is most concentrated in large predator and long-lived fish; seafood is the major source of mercury in humans; and mercury is potentially toxic to the developing nervous system of the fetus and infant. Other undesirable effects in adults are much less certain[16].

In contrast to the potential harm from mercury, the great majority of scientific evidence suggests that eating fish does much more for your health than against it. Seafood consumption has net health benefits in cardiovascular, neurologic, immune, behavioral and mental health outcomes. Moreover, seafood carries a protective factor against mercury toxicity.

Who Could be at Risk from Mercury?

Because mercury can affect the developing nervous system, pregnant and nursing mothers exposed to large amounts of mercury could jeopardize the brain development of the fetus and infant. Most other adults are at very low risk from mercury. Detrimental effects of mercury have been observed in accidental poisonings in Japan and Iraq, but there is no clinical evidence that women who consume fish, even large amounts of fish, as women in Japan and Iceland do, harm their infants. In fact, the opposite seems to be the case. A large study in the United Kingdom reported that children whose mothers had the greatest fish consumption—more than the US Food and Drug Administration (FDA) recommends—had higher neurodevelopmental scores than children whose mothers consumed less fish or none[17]. Children whose mothers avoided fish had suboptimal scores. Other studies suggest that children whose mothers have high fish intakes during their pregnancy are less likely to develop eczema and asthma[18,19]. Thus, several lines of evidence suggest that avoiding fish consumption during pregnancy may be detrimental to the child's health and development.

(continued)