Fish consumption and docosahexaenoic acid (DHA) supplementation in pregnancy

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INTRODUCTION — Fish, including finfish and shellfish, is a healthful food that is low in saturated fat and high in protein. It is also the primary dietary source for two n-3 (also called omega-3) long-chain polyunsaturated fatty acids (n-3 PUFA): eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). EPA is a precursor of DHA and metabolized to DHA in the liver.

Maternal n-3 PUFA intake is necessary for optimal visual and cognitive development in offspring, and may also have other benefits when taken in pregnancy. However, fish consumption also exposes women to methylmercury and other environmental contaminants, toxins that cannot be completely avoided when fish are consumed. The beneficial effects of DHA and other nutrients in fish may outweigh the potential harmful effects of small amounts of methylmercury, especially when fish low in mercury and high in DHA are consumed [1,2].

DHA and EPA are also available as supplements and in fortified foods. These products are an alternative source of n-3 PUFA for women who cannot or choose not to consume fish, but may not have identical effects.

This topic will discuss potential obstetrical and fetal/infant benefits and risks of maternal consumption of fish and DHA supplements during pregnancy. Issues related to the health effects of fish and these supplements in the general population are reviewed separately (see "Fish oil and marine omega-3 fatty acids"). n-3 PUFA supplementation for breast- and formula-fed infants is also reviewed separately. (See "n-3 long-chain polyunsaturated fatty acids (LCPUFA) for preterm and term infants".)

FISH CONSUMPTION

Potential neurodevelopmental effects — DHA is preferentially incorporated into the rapidly developing brain during the last trimester of pregnancy and the first two years of infancy, concentrating in brain gray-matter and retinal membranes [3,4]. Although infants can convert shorter-chain n-3 fatty acids to DHA to a greater extent than adults, it is not known whether such conversion is adequate for the developing brain in the absence of adequate maternal DHA intake [5-7].

In most prospective cohort and retrospective studies, higher maternal prenatal fish consumption has been associated with improved neurodevelopment in offspring [1,2,8-16]. However, fish consumption is the primary source of non-occupational maternal methylmercury exposure. It is present in all fish tissues, cannot be cooked out of the fish, and over 95 percent is absorbed. (See 'Mercury levels in fish' below.)

Exposure to methylmercury in fetal life can cause diffuse and widespread neurologic damage [17]. In fact, the fetal brain is considered the tissue most sensitive to the harms of mercury. The particular sensitivity of the fetus to toxic effects from organic mercury exposure was revealed as a result of episodes of community-wide mercury poisoning in Japan (Minamata disease) and Iraq [18,19]. Pregnant women exposed to methylmercury in these communities developed no or minimal symptoms themselves, but their children had delayed attainment of developmental milestones and, in some cases, devastating neurologic handicaps, including blindness, deafness, and cerebral palsy. (See "Mercury toxicity" and "Overview of occupational and environmental risks to reproduction in females".)

In the 1970s and 1980s, longitudinal prospective studies were initiated in island populations to evaluate the effects of more modest methylmercury exposure from habitual fish consumption during pregnancy. Results from cohorts in New Zealand and the Faroe Islands suggested that higher prenatal methylmercury exposure from high seafood consumption was associated with decrements in attention, language, verbal memory, motor speed, and visuospatial function in offspring [20-22]. These findings prompted recommendations for pregnant women to limit fish consumption. However, a similar cohort study in the Seychelles Islands (Seychelles Child Development Study) found no harmful effect of prenatal methylmercury exposure through age 19 years [23,24], while another study of a smaller Seychelles cohort observed an inverse association between mercury levels in maternal hair and Psychomotor Developmental Index score at 30 months in offspring [25].

None of these studies initially included an estimate of the overall effect of maternal prenatal fish consumption on child development. When investigators from the Faroe Islands subsequently reanalyzed their data to better estimate the independent effects of fish intake and mercury exposure, they found that maternal fish intake was associated with improvements in motor and spatial function in children at age 14 years [15]. Additionally, in the Seychelles cohort, as prenatal methylmercury exposure increased, the investigators observed improved performance on four of 27 developmental endpoints at age 17 years, including

a reduction in behavioral problems [16]. This unexpected result may be because nutrients in fish with positive neurodevelopmental effects had a dominant impact; selenium, which is also present in fish, has protective effects that counteracted the toxic effects of mercury; other unknown factors; or chance [26]. Subsequent publications from cohorts with lower mercury exposures have not shown harmful associations of prenatal mercury exposure with infant development [27-29], cognition at 6 to 10 years [30], or behavior through 11 years [31] and several studies have reported that higher maternal prenatal fish consumption is associated with improved neurodevelopment in offspring [1,2,8-14].

The benefits of fish consumption in observational studies are limited by multiple factors. Available studies have relatively high rates of drop-out and loss to follow-up, as well as difficulties in accurately measuring the type and quantity of fish consumed. Confounding is a key issue as seafood intake may be a marker of a healthy lifestyle or socioeconomic status. Fish consumption may replace consumption of foods that are harmful and fish may have beneficial nutrients other than long-chain polyunsaturated fatty acids (n-3 PUFA). Thus, it is possible that high fish consumption is only an indirect marker of other factors associated with a good neurodevelopmental outcome.

It should also be noted that fish, especially fatty fish tissues, may also be contaminated with persistent organic pollutants, including polychlorinated biphenyls, brominated flame retardants, and dioxins. Exposure to these contaminants has been declining steadily since the 1970s, when government regulations in the United States and elsewhere reduced (but did not eliminate) industrial emissions [32]. More than 90 percent of exposure to persistent organic pollutants occurs from exposure to foods other than fish [33]. Evidence for adverse health effects associated with persistent organic pollutant exposure during pregnancy has been inconsistent [34]. (See "Overview of occupational and environmental risks to reproduction in females".)

Potential effects on preterm birth, birth weight, and growth — The effect of fish consumption on other pregnancy outcomes has not been studied extensively. A prospective cohort study including over 2000 pregnant women reported fish intake was not associated with length of gestation or risk of preterm birth after adjustment for maternal and child factors [35], but these data are subject to the same limitations of observational studies described above.

A single randomized trial has been performed. The Cardiovascular Risk Reduction Diet in Pregnancy (CARRDIP) trial reported a diet low in saturated fat and cholesterol and enriched with polyunsaturated fatty acids (ie, fish, low-fat meats and dairy products, oils, whole grains, fruits, vegetables, legumes) markedly reduced the rate of preterm birth in low-risk pregnancies compared with controls consuming their usual diet (preterm birth 1/141 versus 11/149; mean gestational age at delivery 281 versus 277 days) [36]. However, this trial did not distinguish between the effects of fish consumption versus other dietary changes.

In pooled cohort studies, moderate and high fish intake has also been associated with small increases in birth weight and infant growth rate [37,38].

Mercury levels in fish — Some mercury exposure is inevitable if fish are consumed. It is not possible to completely eliminate this risk without eliminating fish consumption. Reference levels for mercury in commercial fish and shellfish are available from the US Food and Drug Administration (FDA), although estimates may be based on as few as three fish samples (table 1) [39]. The most comprehensive information on mercury levels in commercial fish in the United States is available in a database maintained by Stony Brook University, based on a much larger foundation of data aggregated from government monitoring programs and the scientific literature [40].

Local advisories should be checked about the safety of fish caught by individuals in local lakes, rivers, and coastal areas.

A limitation of all of these estimates is the variability in the mercury content of fish of the same species. For example, the mean concentration of mercury in canned light tuna is 0.128 ppm (mcg/g), with a range from 0 to 0.889 ppm. Thus, a 60 kg woman consuming 4 oz of canned light tuna per week would on average get 0.03 mcg mercury/kg body weight per week (30 percent of the reference dose) but could get none (0 percent of the reference dose) or could get as much as 0.25 mcg/kg/week (250 percent of the reference dose).

Safe level of mercury intake — The United States Environmental Protection Agency's (EPA) reference dose of methylmercury is 0.1 mcg/kg body weight/day [41]. The reference dose is an estimate (with uncertainty spanning about an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

Other regulatory agencies have made different recommendations regarding intake limits for methylmercury, and these limits are two- to threefold higher than that of the Environmental Protection Agency. The United States Agency for Toxic Substances and Disease Registry derived a Minimal Risk Level of 0.3 mcg methylmercury/kg body weight/day [42]; the World Health Organization's Joint Expert Committee on Food Additives and Contaminants derived a Provisional Tolerable Intake of 0.23 mcg /kg/day [43]; and the Canadian Bureau of Chemical Safety recommended a Provisional Tolerable Intake of 0.20 mcg/kg/day [44].

Advice on fish consumption — For women who may become pregnant, are currently pregnant, or breastfeeding, the US FDA and EPA advise consumption of one to three weekly servings of a variety of types of seafood high in n-3 PUFA and low in mercury and other contaminants, while avoiding consumption of fish that is high in mercury (table 2) [45,46]. Local advisories

should be consulted about the safety of fish caught in local lakes, rivers, and coastal areas. If no advice is available, they suggest restricting intake of these fish to up to 6 oz (one average meal) per week and not consuming any other fish during that week.

There is evidence that fish consumption guidelines have not been effective in achieving a reduction in mercury exposure without adversely reducing fish or DHA intake [47-51]. For example:

- In a time-series analysis among a cohort of pregnant women, some surveyed before dissemination of a 2001 national mercury advisory in the United States, and others surveyed afterwards, average total fish intake after publication of the advisory was lower by about 1.4 monthly servings, a 17 percent decline [47]. Women surveyed after the advisory ate fewer fish servings, not only of the dark meat fish likely to have higher mercury contamination, but also of fish types not specifically named in the advisory and likely to be lower in mercury.
- Similarly, an analysis of data obtained from 15,000 United States households that scanned universal product codes on all purchased food products upon returning home from shopping found that at-risk consumers reduced fish intake in 2000 to 2002, resulting in declines in both mercury and n-3 intakes across the entire distribution, including those with already low intake [48]. Consumers did not differentially avoid high mercury fish, nor did they replace high mercury fish with low mercury, high omega-3 species.

Given that there are both benefits and risks to fish consumption, it appears that a nuanced approach is necessary to ensure that advice from expert groups leads to desired behavioral changes and no undesired changes [52].

LONG-CHAIN POLYUNSATURATED FATTY ACID CONSUMPTION

Potential neurodevelopmental effects — Although docosahexaenoic acid (DHA) is important for normal development of the retina and brain, the diet of most pregnant women does not contain DHA at levels recommended by expert groups. For this reason, maternal supplementation during pregnancy and lactation had been proposed as a potential means of enhancing visual and cognitive function in offspring. However, a 2016 Evidence Report/Technology Assessment by the Agency for Healthcare Research and Quality concluded that maternal long-chain polyunsaturated fatty acid (n-3 PUFA) supplementation had no consistent effect on various measures of neurologic development, cognitive development, or visual acuity in offspring [53]. This conclusion was largely based on low- to moderate-quality data from randomized trials of maternal n-3 PUFA supplementation versus no supplementation during pregnancy. Subsequently, a placebo-controlled randomized trial of prenatal DHA supplementation followed over 500 children to age seven years (the earliest age at which adult performance can be predicted) and reported no significant differences in language, academic ability, or executive functioning between groups [54]. Perceptual reasoning was slightly higher in the DHA supplementation group, but parent-reported behavioral problems were worse in this group.

Infant formula containing n-3 and n-6 PUFA became available in the United States in 2002. Several randomized trials attempted to determine whether use of these supplemented infant formulas was associated with improved outcomes compared with unsupplemented formulas. Systematic reviews and meta-analyses of these randomized trials did not find conclusive evidence of persistent beneficial effects of PUFA supplementation of formula milk on the physical, visual, and neurodevelopmental outcomes of term or preterm infants followed up to three years of age, but also did not find evidence of harm. (See "n-3 long-chain polyunsaturated fatty acids (LCPUFA) for preterm and term infants".)

Potential effects on preterm birth, atopic and allergic disease, asthma — n-3 PUFA are precursors to specific eicosanoids and other inflammatory mediators and have potential anti-inflammatory effects. For this reason, it has been hypothesized that maternal supplementation might reduce inflammation-mediated disorders, such as preterm birth or atopic or allergic disease.

- **Preterm birth** – The 2016 Evidence Report/Technology Assessment by the Agency for Healthcare Research and Quality analysis of randomized trials (discussed above) concluded that maternal n-3 PUFA supplementation did not reduce the incidence of preterm birth in healthy women (odds ratio [OR] 0.87, 95% CI 0.66-1.15), although a small increase in length of gestation was observed (weighted mean difference [WMD] +0.33 week, 95% CI 0.04-0.62 weeks) [53]. Supplementation also did not reduce the incidence of preterm birth in pregnant women at increased risk of preterm birth (OR 0.86, 95% CI 0.65-1.15).
- **Atopic and allergic disease, asthma** – The 2016 Evidence Report/Technology Assessment by the Agency for Healthcare Research and Quality analysis of randomized trials (discussed above) concluded that maternal n-3 PUFA supplementation during pregnancy did not reduce the incidence of asthma or other respiratory illnesses (OR 0.95, 95% CI 0.77-1.16; three trials, n = 1261 women), atopic dermatitis/eczema, or food/dust allergies in offspring [53]. Doses included 400 mg DHA daily, 3.7 g fish oil daily (56 percent DHA and 28 percent eicosapentaenoic acid [EPA]), and salmon twice weekly (each portion contains 1.16 g DHA and 0.57 g EPA).

  Subsequent to this analysis, a double-blind placebo-controlled randomized trial (n = 736 women) of third-trimester supplementation with n-3 PUFA (2.4 g daily, 55 percent EPA and 37 percent DHA) reported that the intervention resulted in a 7 percent absolute reduction in the risk of persistent wheeze or asthma in offspring followed to age three to five years (16.9 versus 23.7 percent, hazard ratio 0.69, 95% CI 0.49-0.97) [55]. The reduction was driven by the impact of maternal

treatment in women with EPA and DHA blood levels in the lowest third at baseline or with a *FADS* genotype associated with low EPA and DHA blood levels (low baseline EPA+DHA: persistent wheeze or asthma in offspring 17.5 versus 34.1 percent, hazard ratio 0.46, 95% CI 0.25-0.83). The estimated EPA+DHA intake of these women was below 321 mg/day before the intervention. There was also a reduction in risk of lower respiratory tract infections, but no difference in rates of asthma exacerbations, eczema, or allergic sensitization between groups. The supplement was well-tolerated, pregnancy outcomes were similar for both groups, and no adverse effects were described in the report.

Although high-dose maternal n-3 PUFA supplementation was effective for preventing asthma in offspring in this trial, it was not clear that offspring of women without very low blood levels of n-3 PUFA significantly benefit or whether benefits persist into the school-age years. Subsequent trials should address whether similar effects will be observed in other populations, whether the beneficial effects persist, and whether lower n-3 PUFA doses are effective (it would be essentially impossible to achieve a comparable n-3 PUFA dose from fish consumption as the dose was 20-fold higher than the average intake from fish consumption in the United States). In addition, an updated meta-analysis should be performed that includes the findings of this trial.

Other potential effects — The 2016 Evidence Report/Technology Assessment by the Agency for Healthcare Research and Quality analysis of randomized trials (discussed above) also concluded that maternal n-3 PUFA supplementation did not reduce the incidence of fetal growth restriction/small for gestational age infants in high-risk populations, gestational hypertension in normal-risk or high-risk populations, peripartum depression, autism spectrum disorder, or attention-deficit/hyperactivity disorder [53]. A multicenter randomized trial not included in the assessment found no reduction in preeclampsia or gestational diabetes [56].

Preparations — Supplements containing either fish oil or DHA synthesized by algae are available in a variety of doses, and include formulations marketed for pregnant women. Products commonly available at major drug or health food stores contain the labeled amount of EPA and DHA [57]. Different fish oil formulations contain variable amounts of EPA and DHA, with the remainder typically comprised of other n-3 PUFA, monounsaturated fats, saturated fats, and gelatin or glycerin [58,59]. Thus, a 1 g capsule of fish oil may contain between 200 and 950 mg of EPA and DHA.

Additionally, a number of foods fortified with DHA are now available, including yogurt, milk, eggs, and cereals. However, many supplemented foods contain the plant-based n-3 PUFA (alpha-linolenic acid [ALA]), rather than marine n-3 PUFA, which cannot be considered a replacement for EPA+DHA [60].

Side effects — The most common side effects of fish oil consumption are gastrointestinal disturbances such as nausea, occurring in approximately 4 percent of individuals at doses below 3 g/day and in approximately 20 percent of individuals at doses of 4 g/day or higher in a pooled analysis [61].

Fish oil supplements may cause a "fishy taste" following eructation (burping). Freezing the fish oil, switching to a different formulation, consumption with meals, or intake at a different time of day may minimize this symptom in some people.

Safety — Fish oil and DHA supplements are generally derived from small pelagic fish used for fish feed or from formulations produced by algae. Significant exposure to mercury or other contaminants is not a major concern for this reason [62,63].

Overall, current evidence does not support any major effects of fish or fish oil consumption on cancer risk.

The US Food and Drug Administration recommends that n-3 PUFA supplement labeling not recommend or suggest daily intakes of more than 2 g EPA and DHA [64], which is much higher than the amount recommended for pregnant women, women planning pregnancy, and nursing women. A total intake up to 3 g/day of EPA and DHA is Generally Recognized As Safe (GRAS) [65] to "safeguard against the possible adverse effects of fatty acids on increased bleeding time" in the general population.

Safety issues are discussed in more detail separately. (See "Fish oil and marine omega-3 fatty acids", section on 'Safety'.)

CLINICAL APPROACH

Advising women about fish consumption and DHA intake — For women who may become pregnant, are currently pregnant, or breastfeeding, we generally agree with the US Food and Drug Administration and Environmental Protection Agency advisory for consumption of one to three weekly servings of a variety of types of seafood high in long-chain polyunsaturated fatty acids (n-3 PUFA) and low in mercury and other contaminants, and completely avoiding consumption of fish high in mercury (table 2) [45,46]. However, we suggest that women choose fish that will achieve at least 200 to 300 mg/day docosahexaenoic acid (DHA) intake rather than merely relying on the number of servings of fish (table 3). This approach considers that available evidence of benefits to offspring are low to moderate quality but there is no evidence of harmful effects.

Expert panels worldwide have recommended that pregnant and lactating women should aim to achieve an average dietary DHA intake of at least 200 to 300 mg/day to support optimal visual and cognitive development in offspring [66-69]. Since fish is the only food in which n-3 PUFA naturally occur in abundance, regular fish consumption is the only way for women to achieve adequate DHA intake without using a supplement [66].

The DHA and mercury content of fish vary independently, so several options are available that are both high in DHA and low in mercury. These include anchovies, Atlantic herring, Atlantic mackerel, mussels, oysters, farmed and wild salmon, sardines, snapper, and trout [70,71]. However, the most commonly consumed fish in the United States that are low in mercury (shrimp, salmon, pollock, tilapia, cod, and catfish) vary considerably in their DHA content (table 3); therefore, consumption of 12 oz of some of these fish weekly may not provide adequate amounts of DHA [72]. In fact, a minority of women achieve recommended levels of DHA: in the 1999 to 2002 National Health and Nutrition Examination (NHANES) Survey, mean DHA intake was 73 mg/day among pregnant women, and 62 mg/day among women of childbearing age [34]. (See "Nutrition in pregnancy", section on 'Fish consumption'.)

For women who are not able or willing to consume fish, we suggest consumption of another source of n-3 PUFA to achieve intake of at least 200 to 300 mg/day (see 'Preparations' above), even though there is no high-quality evidence that DHA supplementation during pregnancy improves offspring neurodevelopment or other outcomes (see 'Long-chain polyunsaturated fatty acid consumption' above). We are concerned that total avoidance of seafood without another source of DHA intake may result in unfavorable effects in offspring by depriving the developing fetal neural system (and other physiological processes) of an essential nutrient.

Trials directly comparing the effects of various doses of n-3 PUFA supplements are not available. Supplements of up to 1 g/day of DHA or 2.7 g/day of n-3 LC-PUFA have been used in randomized trials without significant adverse maternal or offspring effects [68].

Although it is possible for pregnant women to achieve recommended DHA intake via supplements or fortified foods, we and other experts recommend regular fish consumption when possible [34,66,73]. Consumption of fish and other seafood provides potentially beneficial protein, vitamins, and selenium [74]. Thus, regular dietary seafood consumption can be considered the optimal method to obtain n-3 long-chain PUFA.

When should mercury levels be measured? — Routine screening of mercury levels in the general population is **not** recommended.

Testing is reasonable if the patient is at risk because of suggestive neurologic symptoms and frequent consumption of fish likely to have higher mercury contamination. The most useful biomarker of methylmercury exposure in clinical practice is the level in whole blood, measured in a reliable laboratory [75]. Individuals who are found to have elevated mercury levels should be advised to avoid intake of mercury-containing fish. In a case series of high consumers of fish, mercury levels declined rapidly in the first three weeks after advice to reduce fish intake [76]. (See "Mercury toxicity".)

The reference level of methylmercury in blood, set by the United States Environmental Protection Agency, is 5.8 microg/L, which is thought to define the average long-term level of mercury in blood that is without appreciable risk. However, research in the past decade suggests a level of 3.5 microg/L would be a better threshold. In the United States National Health and Nutrition Examination Survey (NHANES) 1999 to 2010, 10.8 percent of women of childbearing age in the Northeast had mercury concentrations ≥3.5 microg/L and 3.3 percent had concentrations ≥5.8 microg/L [77]. Southern women were much less likely to have elevated mercury levels, and elevated levels were rare among women living in the West. High blood mercury levels were associated with increased frequency of seafood consumption and living in coastal regions.

SUMMARY AND RECOMMENDATIONS

- Fish is the primary dietary source of two n-3 (also known as omega-3) long-chain polyunsaturated fatty acids (n-3 PUFA): docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA). (See 'Introduction' above.)
- DHA is a necessary structural component of the brain, nervous system, and eye. Maternal fish consumption during the prenatal and early postnatal periods may have modest beneficial effects on neurodevelopmental and cognitive outcome of offspring. (See 'Potential neurodevelopmental effects' above.)
- Fish may be contaminated by environmental pollutants, such as methylmercury. The fetal brain is the tissue most sensitive to the harms of mercury, thus maternal consumption of fish with potentially high levels of mercury, or very frequent consumption of fish with moderate levels of mercury, should be avoided. (See 'Potential neurodevelopmental effects' above.)
- We agree with guidelines that suggest women who may become pregnant, are currently pregnant, or breastfeeding consume two or three weekly servings of a variety of types of fish high in n-3 PUFA and low in mercury (table 2) (**Grade 2C**). This means not eating shark, swordfish, king mackerel, marlin, orange roughy, bigeye tuna, or tilefish because they can contain relatively high levels of mercury (table 1). (See 'Advising women about fish consumption and DHA intake' above.)
- We suggest that women choose fish that will achieve at least 200 to 300 mg/day DHA intake rather than merely relying on the number of servings of fish (table 3) (**Grade 2C**). Oily fish contain more DHA than non-oily fish. (See 'Advising women about fish consumption and DHA intake' above.)

- For pregnant women who are not able or willing to consume fish, we suggest other food sources of n-3 PUFA to achieve an intake of at least 200 to 300 mg/day of DHA (**Grade 2C**). A number of foods fortified with DHA are available, including yogurt, milk, and eggs. Supplements containing either fish oil or DHA synthesized by algae are also available.

  This is based on the observation that DHA is preferentially incorporated into the rapidly developing brain and retina during the last trimester and plays a role in various physiologic processes, and supplementation at this level is not harmful. However, there is no clear evidence that n-3 PUFA supplements during pregnancy improve offspring neurodevelopment, and there is no clear evidence that maternal fish intake or n-3 PUFA supplementation reduce the frequency of disorders with an inflammatory component, such as spontaneous preterm birth or asthma, allergic disease, or atopic disease in offspring. (See 'Advising women about fish consumption and DHA intake' above and 'Potential effects on preterm birth, atopic and allergic disease, asthma' above.)

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GRAPHICS

Mercury levels in commercial fish and shellfish

Species	Mercury concentration (PPM) (mean)	No. of samples
Fish and shellfish with highest levels of mercury		
Mackerel King	0.730	213
Shark	0.988	351
Swordfish	0.976	618
Tilefish (Gulf of Mexico)	1.450	60
Fish and shellfish with lower levels of mercury¶		
Anchovies	0.043	40
Butterfish	0.058	89
Catfish	0.049	23
Clam*	ND	6
Cod	0.095	39
Crab[Δ]	0.060	63
Crawfish	0.033	44
Croaker Atlantic (Atlantic)	0.072	35
Flatfish*[◇]	0.045	23
Haddock (Atlantic)	0.031	4
Hake	0.014	9
Herring	0.044	38
Jacksmelt	0.108	16
Lobster (spiny)	0.09	9
Mackerel Atlantic (N. Atlantic)	0.050	80
Mackerel Chub (Pacific)	0.088	30
Mullet	0.046	191
Oyster	0.013	38
Perch Ocean*	ND	6
Pollock	0.041	62
Salmon (canned)*	ND	23
Salmon (fresh/frozen)*	0.014	34
Sardine	0.016	29
Scallop	0.050	66
Shad American	0.065	59
Shrimp*	ND	24
Squid	0.070	200
Tilapia*	0.010	9
Trout (freshwater)	0.072	34
Tuna (canned, light)	0.118	347
Whitefish	0.069	28
Whiting	ND	2
Mercury levels of other fish and shellfish¶		
Bass (saltwater, black, striped)[§]	0.219	47
Bass Chilean	0.386	40
Bluefish	0.337	52
Buffalofish	0.19	4
Carp	0.14	2
Croaker White (Pacific)	0.287	15
Grouper (all species)	0.465	43
Halibut	0.252	46

Lobster (Northern/American)	0.310	88
Lobster (species unknown)	0.169	16
Mackerel Spanish (Gulf of Mexico)	0.454	66
Mackerel Spanish (S. Atlantic)	0.182	43
Marlin*	0.485	16
Monkfish	0.180	81
Orange Roughy	0.554	49
Perch (freshwater)	0.14	5
Sablefish	0.220	102
Scorpionfish	0.286	78
Sheepshead	0.128	59
Skate	0.137	56
Snapper	0.189	43
Tilefish (Atlantic)	0.144	32
Tuna (canned, Albacore)	0.353	399
Tuna (fresh/frozen, all)	0.383	228
Tuna (fresh/frozen, Albacore)	0.357	26
Tuna (fresh/frozen, Bigeye)	0.639	13
Tuna (fresh/frozen, Skipjack)	0.205	2
Tuna (fresh/frozen, Yellowfin)	0.325	87
Tuna (fresh/frozen, species unknown)	0.414	100
Weakfish (Sea Trout)	0.256	39

Source of data: FDA 1990-2004, "National Marine Fisheries Service Survey of Trace Elements in the Fishery Resource" Report 1978, "The Occurrence of Mercury in the Fishery Resources of the Gulf of Mexico" Report 2000. Mercury was measured as Total Mercury except for species (*) when only Methylmercury was analyzed.

ND: mercury concentration below detection level (Level of Detection (LOD) = 0.01 ppm).
¶ The following species have been removed from the tables: Bass (freshwater) - not commercial; Pickerel - not commercial.
Δ Includes: Blue, King, Snow.
◇ Includes: Flounder, Plaice, Sole.
§ Includes: Sea bass/Striped Bass/Rockfish.

Data from: Mercury levels in commercial fish and Shellfish. US Food and Drug Administration. Available at http://www.fda.gov/Food/FoodSafety/Product-SpecificInformation/Seafood/FoodbornePathogensContaminants/Methylmercury/ucm115644.htm. Accessed 1/26/2010.

Graphic 63441 Version 5.0

FDA advice on fish consumption in women who are pregnant, might become pregnant, or are nursing

Best choices (eat two to three servings a week)		
▪ Anchovy ▪ Atlantic croaker ▪ Atlantic mackerel ▪ Black sea bass ▪ Butterfish ▪ Catfish ▪ Clam ▪ Cod ▪ Crab ▪ Crawfish ▪ Flounder ▪ Haddock	▪ Hake ▪ Herring ▪ Lobster, American and spiny ▪ Mullet ▪ Oyster ▪ Pacific chub mackerel ▪ Perch (freshwater and ocean) ▪ Pickerel ▪ Plaice ▪ Pollock ▪ Salmon ▪ Sardine	▪ Scallop ▪ Shad ▪ Shrimp ▪ Skate ▪ Smelt ▪ Sole ▪ Squid ▪ Tilapia ▪ Trout (freshwater) ▪ Tuna, canned light (includes skipjack) ▪ Whitefish ▪ Whiting
Good choices (eat one serving a week)		
▪ Bluefish ▪ Buffalofish ▪ Carp ▪ Chilean sea bass/Patagonian toothfish ▪ Grouper ▪ Halibut ▪ Mahi mahi/dolphinfish	▪ Monkfish ▪ Rockfish ▪ Sablefish ▪ Sheepshead ▪ Snapper ▪ Spanish mackerel ▪ Striped bass (ocean)	▪ Tilefish (Atlantic Ocean) ▪ Tuna, albacore/white tuna, canned and fresh/frozen ▪ Tuna, yellowfin ▪ Weakfish/sea trout ▪ White croaker/Pacific croaker
Choices to avoid (highest mercury levels)		
▪ King mackerel ▪ Marlin ▪ Orange roughy ▪ Shark	▪ Swordfish ▪ Tilefish (Gulf of Mexico) ▪ Tuna, bigeye	

Note: On average, farm-raised fish tend to be lower in mercury compared with wild-caught fish.[1]

Reference:

1. *Karimi R, Fitzgerald TP, Fisher NS. A quantitative synthesis of mercury in commercial seafood and implications for exposure in the United States. Environ Health Perspect 2012; 120:1512.*

Reproduced from: U.S. Food and Drug Administration. Food: Eating Fish: What Pregnant Women and Parents Should Know. Available at: http://www.fda.gov/Food/FoodborneIllnessContaminants/Metals/ucm393070.htm (Accessed January 26, 2017).

Graphic 111607 Version 3.0

Weekly servings of fish to achieve 250 mg/day of EPA + DHA

Fish name	Number of 3.5 ounce (100 gram) servings*
Oily fish	
Anchovy, canned	1
Herring, Atlantic	1
Salmon, Atlantic	1
Tuna, Bluefin	2
Mackerel, Atlantic	2
Bluefish	2
Trout, Rainbow	2
Sardines, Atlantic canned	2
Striped Bass	2
Tilefish	2
Swordfish	2
Tuna, Albacore canned	3
Salmon, Sockeye	3
Carp	4
Salmon, smoked (lox)	4
King Mackerel	5
White fish	
Sea Bass	3
Pollock, Atlantic	4
Snapper	6
Flounder and Sole	6
Tuna, light canned	7
Grouper	8
Catfish, wild	8
Halibut	8
Haddock	12
Cod, Atlantic	12
Shellfish	
Mussels	3
Crab, Alaska King	5
Oysters, eastern raw	6
Clams	7
Shrimp	7
Lobster, northern	10
Scallops	11
Crab, Blue	11

EPA: eicosapentaenoic acid; DHA: docosahexaenoic acid.
* Servings rounded up to a whole number of servings.

Data from: United States Department of Agriculture (USDA) National Nutrient Database for Standard Reference. USDA website 2012. Available at: http://ndb.nal.usda.gov/. (Accessed June 10, 2013.)

Graphic 79454 Version 2.0

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