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Fish and Shellfish: Contamination Problems Preclude Inclusion in the *Dietary Guidelines for Americans*

The Issue

The Fats Subcommittee of the Dietary Guidelines Advisory Committee, led by Dr. Penny Kris-Etherton, has recommended to the full committee that the *2005 Dietary Guidelines for Americans* include a guideline that Americans include 8 to 9 ounces of fatty fish per week in their diets, presumably to achieve adequate intake of omega-3 fatty acids and reduce the risk of heart disease. Although diets rich in fatty fish, as compared to red meat, have been shown to be associated with less cardiovascular risk, fish and shellfish often contain unsafe levels of contaminants. Fish is also high in animal protein, and often, in saturated fat and cholesterol. Omega-3 fatty acids are readily available in plant foods that do not have these attendant disadvantages.

The Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA) recently issued a joint statement warning pregnant women, women who may become pregnant, breastfeeding women, and children to limit the consumption of fatty fish because of the potential effects of mercury and organochlorine toxicity. Given the high levels of mercury, organochlorines, and other environmental toxins that accumulate in fish, and in view of our nation's already animal-protein-heavy diets, a recommendation to consume two to three portions of fish weekly is likely to do far more harm than good.

Understanding Mercury

Mercury is a global pollutant that comes from both natural and human-generated sources. Naturally occurring mercury is present in rock and soils. Combustion of fossil fuels is the main way mercury is released into the environment. Medical and municipal waste incinerators and coal-fired utility plants contribute much of the mercury released into the atmosphere. Once released, mercury can travel long distances and pollute the air, water, and food supply.[1]

In the environment, mercury exists in its elemental form and in a variety of organic forms. One of these organic forms, methylmercury, accumulates up the food chain in aquatic systems, concentrating especially in large predatory fish. The potential sources of mercury contamination for the general population are consumption of water or food stuffs contaminated with mercury, inhalation of mercury-containing vapors, and exposure to dental amalgams or medical treatments that contain mercury. Of these, the consumption of fish and shellfish contributes most to the methylmercury concentration in humans.[1]

Nearly all fish contain traces of methylmercury. Some fish and shellfish tend to contain higher levels either because they live in more contaminated waters or because they are larger carnivores consuming many contaminated smaller fish. Because mercury is eliminated slowly from the body, it may build to very high levels in the systems of animals—including humans—that consume it.

Shark, swordfish, king mackerel, and tile fish are known to have especially high concentrations of methylmercury (mean of samples tested: 0.73, 0.99, 0.97, and 1.45 parts per million (ppm), respectively). Other commonly eaten fish also contain high levels of methylmercury (between 0.25 and 0.55 ppm): bass, bluefish, grouper, halibut, lobster, marlin, orange roughy, canned albacore tuna, and fresh tuna. Some fish have more modest amounts on average (less than 0.1 ppm); these include anchovies, catfish, clams, cod, crab, haddock, perch, pollock, salmon, scallops, shrimp, and trout.[2]

Levels of contamination vary widely. Among tuna, for example, there is a three-fold difference in mean levels of contamination between canned light tuna (0.12 ppm) and canned albacore tuna (0.35 ppm) or tuna that is sold fresh or frozen (0.38 ppm).[2] Contamination also varies greatly between individual fish. Therefore, even well-informed consumers have no way of knowing whether the fish they have purchased has a high or low level of mercury contamination.

In 2000, the National Research Council convened a group of scientists to make recommendations on "acceptable" levels of mercury consumption. This level, known as the exposure reference dose (RfD), is the level of daily exposure to mercury thought likely to be without risk of adverse effects for humans (including sensitive subgroups), even if exposure occurred regularly over a lifetime. This committee set the RfD at 0.1 micrograms (µg) of mercury per kilogram of body weight per day.[1] This means that the weekly RfD would be about 7 µg per week for a toddler, about 14 µg per week for a five-year-old child, and about 42 µg per week for a 135-pound woman.[3]

Specific examples put these numbers in perspective. Two ounces of canned tuna with .36 ppm would provide 20 µg mercury—nearly three times the RfD for a toddler. Six ounces, the amount in two tuna salad sandwiches, would provide 61µg of mercury, which is more than four times the weekly RfD for a five-year-old; it would also be about 50 percent over the weekly RfD for an adult. Clearly, even modest consumption of moderately contaminated and commonly eaten fish can put consumers at risk very quickly.[3]

It is not surprising that the most recent surveys of methylmercury contamination (based on data from 1999—2000) found that 7.8 percent of women of childbearing age have blood mercury levels above the EPA's "safe" limit of 5.8 µg of mercury per liter. Moreover, 15.7 percent of women of childbearing age have levels above 3.5 µg/L, which is high enough to put a fetus or breastfeeding infant at risk.[4,5] The EPA estimates that about 7 million women and children are eating mercury-contaminated fish at or above levels it considers safe.[4] The bottom line: Significant numbers of Americans are already over-consuming mercury-laden fish and seafood. It is inadvisable from a public health perspective to encourage further consumption of this contaminated product.

Effects of Mercury Contamination

Mercury exposure has been linked to a wide variety of ills, including acute and chronic effects on the cardiovascular and central nervous systems. Moreover, the EPA and the International Agency for Research on Cancer (IARC) have designated mercury as a possible human carcinogen.[1] Human occupational studies suggest that methylmercury exposure alters immune function.[1] Methylmercury exposure has also been shown to affect reproduction.[1] In one study, the rate of spontaneous abortions for wives of mercury-exposed men (with urinary mercury greater than 50 µg per liter) was double that for controls.[6] Some exposure studies also suggest that fertility may be lower in mercury-exposed individuals.[1]

Mercury and the heart

Mercury accumulates in the heart, as well as other tissues, and has been associated with increased blood pressure, irregular and increased heart rate, and increased rates of death from cardiovascular disease in at least 12 scientific studies.[1]

Consumption of fish and omega-3 fatty acids, including docosahexaneonic acid (DHA) and eicosapentanoic acid, has been associated with decreased risk of heart attack in individuals consuming a western-style diet.[7,8] However, two recent studies have shown that mercury exposure may have the opposite effect. In a case-control study conducted in eight European countries and Israel, the relative risk of first myocardial infarction (heart attack) for men in the highest quartile of mercury exposure was 2.16 that of those in the lowest quartile, after adjustment for DHA levels and cardiovascular disease risk factors. When comparing patients to controls, the toenail mercury levels were 15 percent higher among those who had suffered a first heart attack.[9] A second study showed increased risk of cardiovascular mortality with increasing methylmercury exposure.[10]

A recent study of 14-year-old children who had been pre- and postnatally exposed to relatively high levels of methylmercury found the children were less capable of maintaining the normal variability of the heart rate necessary to secure adequate oxygen supply to the tissues (a risk factor for cardiovascular disease and sudden death) as level of exposure increased.[11] This study provides a possible mechanism for explaining the increased risk of cardiovascular disease in methylmercury-exposed individuals.

Mercury and the Central Nervous System

Acute methylmercury exposure has been shown to cause severe neurological dysfunction and developmental abnormalities, including mental retardation, abnormal reflexes, disturbances in physical growth, blindness, paralysis, cerebral palsy, and limb deformities in children whose mothers were exposed to high levels of mercury while they were in utero.[1]

Lower-dose chronic exposures also have very serious effects on the developing central nervous system in children and on the adult central nervous system. In general, children exposed to mercury show changes in neurological status and achieve lower scores on developmental scales, language development tests, IQ tests, visual-spatial skills scales, and other tests.[1] A recent paper showed that some of these neurodevelopmental effects of prenatal exposure to methylmercury persist through 14 years of age and thus are likely to be irreversible.[12] The study also found correlations between neurodevelopmental impairments and post-natal mercury exposure (i.e., the children's levels of fish consumption). The most striking finding in this study was that some of the adverse effects on brain function occurred in children who had exposure levels well below the RfD.[12]

Other Bioaccumulative Pollutants in Fish

There are four primary groups of pollutants in addition to the heavy metal mercury in waterways that accumulate in aquatic animals in concentrations many times higher than those in the water. Taken together, polychorinated biphenyls (PCBs), dioxin, chlordane, DDT, and mercury account for 96 percent of all fish advisories issued in 2002. Many other toxins, including other heavy metals and organochlorine pesticides, find their way into water and aquatic life as well.[13]

These pollutants are toxic to humans, fish, and other animals that consume and bioaccumulate them. Many of these chemicals are especially problematic, because they are not readily cleared from the body and accumulate over a lifetime. Thus, even if exposure is limited to a discreet period of time, the potential risks persist. According to the EPA, PCBs are known carcinogens in some species and a probable carcinogen in humans. PCBs also have been shown to disrupt immune function, cause learning disabilities, and disrupt neurological development; they may have endocrine effects as well. Furthermore, children born to women in fishing villages or exposed through occupational contact with PCBs have lower birth weight and lower weights for gestational age as PCB exposure level increases.[14] Dioxins, too, are known carcinogens and have also been shown to cause liver damage, weight loss, and reductions in immune function, and to have a negative effect on early development and hormone levels.[15] At high doses, human exposure to dioxins can result in a serious skin disease called chloracne.[16] The main route of human exposure to dioxins is consumption of contaminated foods, especially fish and other products containing animal fats.[17] Chlordane and DDT, an organochlorine, are pesticides that have been banned from use in the United States. Nonetheless, appreciable levels of these highly toxic chemicals remain in our waterways and bioaccumulate in fish.

Recent sources show that contamination with these pollutants is widespread both globally[18] and domestically, especially in the Great Lakes region and the Eastern seaboard.[13,19] In a survey of skipjack tuna from offshore waters around the world, Japanese researchers made an astonishing discovery. Organochlorines had contaminated every liver of every tested tuna, even though the fish came from a wide variety of locations, including Japan, Taiwan, the Philippines, Indonesia, Seychelles, and Brazil, as well as the Japan Sea, the East China Sea, the South China Sea, the Bay of Bengal, and the North Pacific Ocean. That researchers did not find even one uncontaminated liver illustrates how pervasive such pollution has become.[18]

Lessons Learned from Farmed Salmon

A consumer might think that farmed salmon would contain fewer toxins than sea or lake fish, since farmed fish live in a more controlled environment. But, at least in the case of salmon, the opposite is true. Researchers analyzed 2 metric tons of farmed salmon from major salmon-farming sites around the world for organochlorine contaminants and found that the levels of these toxic compounds are significantly higher in farmed than wild salmon.[20] Scientists suspect that this concentration of toxins is caused by the practice of feeding these fish large volumes of contaminated fish remains.

High-Risk Populations

Women who may become pregnant, pregnant and breastfeeding women, and children are especially vulnerable to the effects of environmental toxins that accumulate in fish. Exposure to even low levels of methylmercury in utero can cause developmental problems and impairments in motor and visual integration. Other environmental toxins—such as dioxins, some of which are known carcinogens—are especially dangerous during fetal development and early childhood.[16]

According to a new study in the April issue of *Environmental Health Perspectives*, women are already eating too much fish; as a result, as many as one in six newborns has a mercury level above that considered safe by the EPA. The authors reviewed diet records and tested the mercury levels in blood of more than 1,700 women (from 1999-2000 NHANES data) and found that those who consumed fish or shellfish two or more times per week had blood mercury concentrations seven times higher than those who ate no fish in the previous month.[21] Based on the distribution of blood mercury concentrations noted for various populations from this study and the number of U.S. births in 2000, the authors estimates that at least 300,000—and possibly as many as 630,000—newborns each year in the United States may have been exposed in utero to methylmercury concentrations sufficiently high to potentially cause neurodevelopmental problems.[21]

Toxins Pass from Mother to Child

Scientists and doctors have long known that chemicals consumed by mothers-to-be are readily passed to the fetus. Such chemicals are also passed to infants via breast milk. In fact, pollutants such as mercury show up in higher concentrations in fetal blood than in maternal blood. A recent report showed that blood mercury levels in a fetus may be as much as 70 percent higher than in the mother's levels.[3]

Infants and small children are often especially sensitive to the effects of toxins, because of their developing body systems and their small size; thus, it is essential for mothers to limit their exposure to toxins as much as possible. Avoiding foods and medicines known to contain toxins is one important way to do this. More than 20 years ago, when waterways were somewhat less polluted, the breast milk of vegetarian mothers had only 1 to 2 percent of the national average levels of certain pesticides and industrial chemicals compared to levels in the breast milk of omnivorous Americans.[22] A second contemporary study found that the organochlorine contaminants (such as DDT and PCBs) were highest in the breast milk of fish-eating omnivores, intermediate in omnivores, and lowest in vegetarians.[23]

Government Warnings

Recently, the Joint Federal Advisory Panel of the EPA and the FDA issued its "2004 Consumer Advisory: What You Need to Know About Mercury in Fish and Shellfish,"[24] which gives the following advice for women who might become pregnant, women who are pregnant, nursing mothers, and young children:

1. *Do not eat Shark, Swordfish, King Mackerel, or Tilefish because they contain high levels of mercury.*
2. *Eat up to 12 ounces (2 average meals) a week of a variety of fish and shellfish that are lower in mercury.*
    - *Five of the most commonly eaten fish that are low in mercury are shrimp, canned light tuna, salmon, pollock, and catfish.*
    - *Another commonly eaten fish, albacore ("white") tuna has more mercury than canned light tuna. So, when choosing your two meals of fish and shellfish, you may eat up to 6 ounces (one average meal) of albacore tuna per week.*
3. *Check local advisories about the safety of fish caught by family and friends in your local lakes, rivers, and coastal areas. If no advice is available, eat up to 6 ounces (one average meal) per week of fish you catch from local waters, but don't consume any other fish during that week.*

Follow these same recommendations when feeding fish and shellfish to your young child, but serve smaller portions.

While these warnings may seem sufficiently strict and detailed at first glance, many scientists and organizations have argued that they are not strict or clear enough to truly protect the consumer from harm. Organizations as varied as the Consumers Union, Physicians for Social Responsibility, Natural Resources Defense Council, and the National Wildlife Federation joined Michael Bender of the Mercury Policy Project in signing a letter to the FDA urging better protections for women and children from exposure to mercury. These organizations argue that current guidelines do not effectively protect sensitive populations from excess exposure to methylmercury from fish; they also say that efforts to monitor mercury levels in the food supply need great improvement.[3] For example, the mercury levels in some types of fish are derived from data collected in 1978. Even the figures from a 1990–92 FDA survey are likely to be outdated, since mercury pollution is largely due to industrial combustion of coal and other human-generated wastes, which may have significantly increased in scope and volume over the past decade.[2]

Vas Aposhian, a toxicologist and professor of molecular and cell biology and pharmacology at the University of Arizona who served as a key advisor on mercury issues to the FDA and EPA, reported that mercury levels in albacore tuna are so high consumers should avoid the fish completely. Dr. Aposhian also criticized the food industry for exerting influence to weaken mercury warnings.[25]

Contamination is widespread. The EPA's fact sheet "Update: National Listing of Fish and Wildlife Advisories" covering PCBs, dioxins, mercury, and chlordane notes that as of 2002, 28 states had statewide advisories. Overall, the 2,800 advisories in the national listing account for about one-third of the nation's lakes and about 15 percent of its total river miles; this includes each of the Great Lakes and their connecting water ways.[13] Mercury advisories are especially common, but New York, Washington, the District of Columbia, and most New England states also have advisories for PCBs, cadmium, and dioxins.[13]

Nutrient Composition of Fish

Like other meats, fish are especially dense in animal protein (15 to 20 grams in a 3-ounce cooked portion). People in the United States already consume well above the daily value for protein (50 to 65 grams). Protein intake averages about 15 percent of total calories, for a mean intake of approximately 100 grams per day for men and 70 grams per day for women.[26] Much of this protein comes from animal sources.

Diets containing excessive protein are associated with increased risk of impaired renal function,[27] osteoporosis,[28] and complications of diabetes.[29] Promotion of fish products may increase protein intake and aggravate these risks.

Furthermore, increasing fish intake would likely increase total fat and saturated fat intake. Although a small amount of the fat in fish is omega-3s, much of the remaining fat is saturated. Chinook salmon, for example, derives 55 percent of its calories from fat, and swordfish derives 30 percent. About one-quarter of the fat in both types of fish is saturated. Fish and shellfish are also significant sources of cholesterol. Three ounces of shrimp have 130 milligrams of cholesterol, while the same amount of bass has 68 milligrams; in comparison, a 3-ounce steak has about 80 milligrams.[30]

Safer Sources of Omega-3 Fatty Acids

High levels of toxins, fat, and cholesterol and a lack of fiber make fish a poor dietary choice. Fish oils have been popularized as a panacea against everything from heart problems to arthritis. The bad news about fish oils, though, is that omega-3s in fish oils are highly unstable molecules that tend to decompose and, in the process, release free radicals. Research has shown that omega-3s are found in a more stable form in vegetables, fruits, and beans.[31,32]

Individuals need to include foods rich in omega-3 fatty acids in their diets on a daily basis. Alpha-linolenic acid, a common omega-3 fatty acid, is found in many vegetables, beans, nuts, seeds, and fruits. It is concentrated in flaxseeds and flaxseed oil and also found in oils such as canola, soybean, walnut, and wheat germ. Omega-3 fatty acids can be found in smaller quantities in nuts, seeds, and soy products, as well as beans, vegetables, and whole grains.[33,34] Corn, safflower, sunflower, and cottonseed oils are generally low in omega-3s. Fish consumption is by no means the only way to ensure adequate intake of essential fatty acids.

Conclusion

Given the clear evidence that fish are commonly contaminated with toxins that have well-known and irreversible damaging effects on children and adults, public health policy should not encourage the consumption of fish. The risks are known, and especially for infants and women of childbearing age, significant.

Even if a fish recommendation were to carry a carefully-worded warning about how much and what types of fish might minimize potential risk from mercury toxicity, it would still be inadvisable. The other risks associated with fish consumption are also considerable--contamination with other bioaccumulated pollutants and diets that are already too high in saturated fat and animal protein to protect consumers from chronic disease. Further, due to the variability in levels of pollutants among and between species and individual fish, and to the fact that these toxins accumulate in the tissue of the fish so food safety practices at home will not reduce risk of contamination, consumers should not be encouraged to navigate these dangers, which they cannot truly minimize or control. Therefore, the Physicians Committee for Responsible Medicine urges the members of the 2005 Dietary Guidelines Advisory Committee to reconsider the proposed recommendation that Americans consume 8 to 9 ounces of fatty fish per week.

Instead, PCRM's doctors and dietitians recommend that the Committee discourage the consumption of fish and shellfish. Other, more healthful, foods from plant sources offer the full range of essential nutrients without the toxins and other health risks in fish.

Report compiled by Amy Joy Lanou, Ph.D.

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