

The school of thought on fish has changed.

Omega-3s in Fish Are Critical to the Health of Mother and Child

A Call to Government to
Get the Right Messages to Women about Fish



NATIONAL
FISHERIES
INSTITUTE

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Executive Summary

In March 2004, the Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA) revised a joint consumer advisory on methylmercury in fish directed at “women who might become pregnant, women who are pregnant, nursing mothers and young children.”

Specifically, the fish advisory recommended that these audiences:

- 1) Avoid four rarely eaten fish;
- 2) Limit their fish consumption to 12 ounces per week; and
- 3) Check local advisories on the safety of locally caught fish.

Although the fish advisory never intended for pregnant women to stop eating fish or for them to severely cut fish from their diets, its highly precautionary nature resulted in further reduction in fish consumption in a population of women already seafood deficient. In fact, as a result of the fish advisory, a nutritional deficit has been created and American babies (and their moms) are being short-changed of nutrients, minerals and vitamins critical to healthy development and pregnancy. According to one study in the *Journal of Foodservice*, only 20 percent of American women of child-bearing age eat enough fish each week. This implies that nearly 80 percent of women who may become pregnant don't get enough fish in their diets and eat well below the FDA-recommended two to three fish servings per week.

Fish, of course, is an important part of any healthy diet. It is low in fat, high in lean protein and contains, among other essential nutrients, long-chain omega-3 fatty acids, which help protect the heart. It also plays a critical role in human brain development. According to a number of large and independent medical studies, infants whose mothers ate plenty of fish rich in omega-3s during pregnancy have improved vision, brain and nervous system development. These benefits last into childhood and may impact lifelong health and mental capacity. In addition, fish consumption is associated with a reduced likelihood of preterm labor.

We understand the need for the government to issue consumer advisories on potential risks to consumers. But the fish advisory was concerning for several reasons:

- The underlying science justifying the warning was based on a study that did not involve fish at all but the consumption of whale meat.
- The advisory effectively warned consumers away from albacore tuna – a fish that is naturally low in mercury and affordable for low-income populations, a group that traditionally does not have the healthiest prenatal care diet practices.
- As worded, the advisory has resulted in confusion about fish consumption, confusion that has led both pregnant women and consumers broadly to restrict or eliminate a critical and nutritious food source from their diets.

On Jan. 21, 2009, the Office of Management and Budget (OMB) posted a comprehensive, peer-reviewed draft report and research summary which assesses the latest research on the effects of seafood on heart health and baby brain development. The assessment specifically weighs the concerns and the benefits of a food for public health, and aims to help consumers understand the overall risk of eating fish compared to the risk of not eating fish during pregnancy and for sudden coronary death and stroke. Independent scientists in the fields of nutrition, health, and research reviewed the report, as did doctors from Harvard University's School of Public Health and a former Environmental Protection Agency official.

It has been five years since the Federal government last updated its seafood consumption advice. And in light of the FDA's recent assessment, we at the National Fisheries Institute call on Congress to commend the FDA for its recent efforts and urge the agency to leverage the report and its findings by:

- Reassuring Americans that the majority of the ocean fish they eat is safe.
- Issuing advice for commercial fish consumption that is separate from recreation and subsistence fishing because local fish advisories address local pollution threats, which are separate and unique from the low levels of naturally occurring mercury found in ocean fish.
- Developing and testing positive and clear messages to pregnant and breastfeeding women, as well as to the medical community, media and retail outlets that currently use point-of-sale warning signs that—according to the FDA itself—discourage women from eating fish. These messages should:
 - Alert “women who might become pregnant, women who are pregnant, and nursing mothers” that there is a serious nutritional deficit as a result of low fish consumption.
 - Highlight the pregnancy and developmental benefits of fish during pregnancy for mothers and babies.
 - Specifically recommend that as part of a healthy diet, pregnant and nursing mothers should eat 12 ounces of fish and/or seafood weekly.
 - Clearly state that the vast majority of seafood consumed by Americans is already naturally low in mercury, including all of the fish in the top 10 commonly eaten seafood in the United States – shrimp, canned tuna, salmon, pollock, tilapia, catfish, crab, cod, clams and scallops.
 - List the four rarely consumed commercial fish that are high in mercury which women should avoid – king mackerel, swordfish, tilefish and shark.
 - Reiterate that local fish advisories should be checked for information about fish caught by family and friends.
 - Remove albacore tuna from the advisory as it is a low mercury fish and should not have been placed on the advisory to begin with.
- Clarifying the advice to women who might become pregnant, women who are pregnant, nursing mothers, and young children.
- Encouraging young children to eat 2-3 servings of a variety of fish per week as part of a healthy diet.
- Reporting to Congress on the status of its messaging to women on fish consumption, particularly those who are pregnant and breastfeeding.

Despite a Nutritional Deficit, an Advisory is Issued

Fish is an important part of any healthy diet. It is low in total fat, high in quality protein and contains, among other essential nutrients, long-chain omega-3 fatty acids, which help protect the heart and fuel the human brain. For these and other reasons, the U.S. Department of Agriculture, the American Heart Association, the American Dietetic Association and the American Psychiatric Association recommend that consumers eat at least two servings of fish per week, or about 39 pounds annually, for optimum health.

Fish is particularly critical during pregnancy as studies have shown that infants whose mothers consumed fish during pregnancy may have longer gestation and improved vision, brain and nervous system development. These benefits last into childhood and may impact lifelong health and mental capacity.

Despite its many benefits, however, Americans on average eat less than one third of the recommended serving of fish. With scant regard to this existing nutritional deficit, in March 2004, the FDA and EPA effectively warned consumers away from eating fish.

"Our focus has been on mercury. That's part of the problem," says Dr. Michael Bolger, a toxicologist who leads the FDA's advisory team. When the current advice was drafted in 2004, "we simply didn't have enough time to look at the huge benefits of fish consumption."

St. Petersburg Times, March 8, 2008

Guidelines Focused on Theoretical Harm, Targeted at a Specific Population

All fish contain trace amounts of methylmercury, much of which is naturally-occurring in ocean fish. Because of this, the FDA and EPA—out of a desire to lean toward greater caution—issued a joint fish advisory for *rarely* eaten commercial fish and fish caught locally, directed specifically at women who might become pregnant, women who are pregnant, nursing mothers and young children.

This fish advisory, though, failed to take into account the fact that trace amounts of methylmercury have always naturally occurred in ocean-caught fish because of volcanic eruptions and other environmental activity, and a pattern of harm has never been associated with humans eating ocean fish, even in populations that consume far more fish than Americans – for example, people in the Seychelles Islands eat 12 fish meals per week.

Three Flawed Factors of the Fish Advisory Led to Significant Public Confusion

Setting aside the wisdom of warning pregnant or nursing women from eating a nutritious food source they rarely consume to begin with, there were several flaws in relation to the advisory:

- First, the advisory was poorly worded, heavily emphasizing the potential harm from fish consumption and failing to highlight its essential nutritional benefits during pregnancy. This poor wording led to unnecessary confusion among pregnant and nursing women as well as the general population.
- Second, sensational media reports amplified the poor wording of the fish advisory, causing further public confusion.
- Third, FDA and EPA officials did not challenge the press coverage surrounding the advisory.

Factor One: Fish Advisory Urged Women to Limit, Avoid or Be Wary of Fish

The first factor was the way the consumer advisory itself was written. The advisory briefly mentioned general health benefits of fish, simply stating that it “can contribute to heart health and children’s proper growth and development.” The second and most important part of the fish advisory **focused heavily on risk**. In fact, out of 435 words, more than 300 touched on the risk of eating fish, with only 11 dedicated to its benefits. And nowhere is it mentioned the now well-known nature of omega-3s found in fish and their essential role in fetal neurological development.

In essence, when it came to eating fish, the government’s fish advisory primarily centered on telling women to avoid it, limit it or be wary of it. This advice came with little context. However, had the government provided contextual information, the vast majority of pregnant women in the country would have realized that the warnings in the fish advisory did not apply to them. For example:

AVOID – The fish advisory urged women not to eat four specific fish—shark, swordfish, king mackerel and tilefish. Although these fish may be popular in some cultural diets, the vast majority of American consumers do not eat these fish or even have access to them. In fact, according to an industry analysis, the combined sales of these fish are less than one percent of all fish eaten in the United States.

LIMIT – The fish advisory urged women to **LIMIT** how much fish they eat, which created the impression that they should reduce the amount of fish in their regular diets. On average, Americans eat 16 pounds of fish annually, which is about five ounces per week. That means the average American could double his or her fish intake and still not come close to the approximate 39 pounds per year—or two to three fish meals – the government, physicians and leading nutritionists suggest they should be eating.

WARY – The fish advisory urged women to be wary of eating albacore (“white”) tuna, saying it has more mercury than canned light tuna. By singling out albacore tuna in this way, it created the false impression that it belonged in the same category or near the same category as the four high-mercury fish listed in the advisory. The reality is far different, as albacore tuna is a naturally low-mercury fish, comparable in mercury content to salmon, tilapia, catfish, crab, cod, clams and scallops.

Overly Risk-Oriented Advisory

Specifically, the fish advisory recommended “women who might become pregnant, women who are pregnant, nursing mothers and young children” follow three guidelines for eating fish or shellfish:

1. **Do not eat shark**, swordfish, king mackerel or tilefish because of high mercury levels.
2. Eat up to 12 ounces (two average meals) per week of various fish and shellfish that are **lower in mercury**.
 - Five common fish that are **low in mercury** are shrimp, canned light tuna, salmon, pollock and catfish.

Good Intentions, Unintended Consequences

- Albacore tuna **has more mercury** than canned light tuna, and consumption should be limited to six ounces (one average meal) per week.
3. Check local advisories on the safety of fish caught in local lakes, rivers and coastal areas. If none is available, eat up to six ounces (one average meal) per week of fish caught from local waters, but don't eat any other fish that week.

Factor Two: Media Sensationalizes Meaning of Fish Advisory

The second factor was coverage of the fish advisory itself. Not surprisingly, **media coverage amplified the advisory's focus on theoretical harm**. Across media outlets, the sensationalized interpretation of the fish advisory was that the government was urging Americans to eat less fish. This created unnecessary confusion about healthy fish choices among all consumers.

San Francisco Chronicle

March 20, 2004

U.S. urges limits on eating albacore / Concerns about mercury levels in some canned tuna

Top federal health officials released long-awaited advice to consumers Friday on how to avoid mercury in fish and for the first time sug

Los Angeles Times

March 20, 2004

THE NATION

Federal Caveat Issued on the Catch of the Day

WASHINGTON The federal government on Friday warned that pregnant women and young children should limit their intake of

Monterey County Herald

March 24, 2004

The Good and Bad of Eating Fish

Along last week's lines of "Is there anything safe to eat?" comes this question from a reader:

Factor Three: Government Inaction

Lastly, and perhaps most damaging, was what the government did in response to these two factors. The government had simply aimed to issue a targeted warning for pregnant women to avoid four rarely-eaten types of fish. But within days of its release, it was clear that the advisory was being widely misinterpreted by the media, the medical community and the general public.

And yet, clarification was not issued. Letters to the medical community were not sent. A concerted public relations effort by either federal agency—the EPA or the FDA—was not made to correct the misimpression.

In retrospect, it must have been clear to government officials that:

- a) Their advisory had been poorly worded
- b) It was being widely misinterpreted

Unfortunately, in response, the government did nothing.

Poorly Conceived Advisory + Sensationalized Media Coverage

= Wide Misperception

Government Inaction

These factors led to three unintended consequences that had major negative repercussions:

Women cut back on eating fish or stopped completely

- The majority of women of child-bearing age are not eating the FDA-recommended two to three servings of fish per week.

Increased risk of major health problems

- Consumers substitute a higher fat, higher calorie food thereby increasing risk for heart disease, diabetes or even cancer.

Americans perceived the advisory as a warning

- In the end, the lack of precision of the fish advisory, amplified by the media, created a misperception among the public that avoiding fish was a healthy and prudent option. The fish advisory, originally meant to guide pregnant women's consumption to include a variety of fish in their diet, was instead perceived as a warning. This misperception led many Americans, not just a majority of pregnant women, to take a "better safe than sorry" approach when considering fish in their diet. While avoiding the perceived dangers of fish, however, Americans have inadvertently introduced a new, tangible risk by denying themselves essential nutritional benefits that are unique to fish. **This is a result that even the issuers of the fish advisory never intended.**

End Result: Pregnant and Nursing Women Are Not Eating Enough Fish

According to one study, only 20 percent of American women of child-bearing age eat enough fish each week. This implies that nearly 80 percent of women who may become pregnant are not getting enough fish in their diets and are eating well below the FDA-recommended two to three servings of fish per week. The latest medical science shows that pregnant women have decreased their consumption of fish as a direct result of the 2004 FDA/EPA advisory,

Fish Advisory's Impact on Low-Income Women and Their Families

Unfortunately, between 2004 and 2006, 4.4 million U.S. households with incomes of less than \$30,000 stopped buying canned tuna. During those years, women in those households gave birth to nearly 260,000 children.

These data raise concerns because for many low-income families, canned tuna is the most readily available source of fish in their diet. As low-income families, like many others presumably confused by the government advisory, phase canned tuna out of their diets, they are likely replacing it with less nutrient-rich foods, such as carbohydrates or fattier meats.

FDA Fish Advisory Based on Faulty Science

Given the negative impact of the government fish advisory, it is important to take a step back and understand the factors that led to its release. What caused the government to issue the advisory in the first place? What science drove government concern? And how did we arrive at such negative unintended consequences?

In the Seychelles Island, people eat eight times more seafood than the average American, and studies show no pattern of negative effect from prenatal mercury exposure related to high fish consumption.

In 1999, Congress asked the EPA to create a comprehensive set of guidelines around mercury. The EPA, in turn, examined the available science at the time and decided to focus on a single study they felt was well designed, conducted and peer reviewed—the Faroe Islands study.

However thorough this study may have been, there was one glaring problem that the EPA overlooked—it was not applicable. The Faroe Island study examined diets based not on seafood consumption but the uncommon practice of eating pilot whale meat. Pilot whale meat is different from the popularly-consumed fish in the American diet because:

- 1) It is a mammal;
- 2) It is very high in mercury; and
- 3) It is low in selenium—a nutrient found in ocean fish but not in whales—that may counteract any effects of mercury.

In sum, a government advisory on seafood consumption was based on a different species entirely. In fairness, this apples to oranges— or mammal to fish in this case—comparison was made on the available science at the time.

But what about since the FDA and EPA issued the advisory? Has there been an apples-to-apples examination of this issue by an established and credible medical organization, and if so, what was their conclusion?

In 2006 the respected Institute of Medicine¹ conducted a review of seafood science called “Seafood Choices” in which it weighed benefits against potential risk. The review concluded that

The high nutritional quality of seafood makes it an important component of a healthy diet... Seafood is also a primary source of EPA and DHA in the American diet. There is evidence... to suggest there are benefits to the developing infant, such as increasing length of gestation, improved visual acuity, and improved cognitive development. In addition, there is evidence to support an overall benefit to the general population for reduced risk of heart disease among those who eat seafood compared to those who do not, and there may be benefits from consuming EPA and DHA for adults at risk for coronary heart disease. For [pregnant women]... consumers [should be] provided useful information on both benefits and risks to inform their choices.

¹ The Institute of Medicine (IOM) of the National Academies provides science-based advice on matters of biomedical science, medicine, and health. A nonprofit organization specifically created for this purpose as well as an honorific membership organization, the IOM was chartered in 1970 as a component of the National Academy of Sciences. The Institute provides a vital service by working outside the framework of government to ensure scientifically informed analysis and independent guidance. The IOM's mission is to serve as adviser to the nation to improve health. The Institute provides unbiased, evidence-based, and authoritative information and advice concerning health and science policy to policy-makers, professionals, leaders in every sector of society, and the public at large. For more information, please visit www.iom.edu.

What About Mercury?

When compared to the IOM recommendations, the FDA/EPA advisory falls short on two significant counts:

- First, it was based on improper and outdated science
- Second, the advisory highlighted only risks, certainly not the developmental benefits to babies

As a result, the government inadvertently has steered women away from consuming fish and towards depriving women and their children of fish's much needed nutrients. In fact, an unintended consequence of the fish advisory is that as many as two million children each year are born deficient in essential omega-3 fatty acids needed for optimum brain and eye development.

Tuna Included in Advisory for its Popularity, NOT for Mercury Levels

Since the advisory was released, the FDA has stated in a public letter that its choice to include albacore was because of its higher-than-average consumption level, not because of its mercury levels.

However, tuna lost its most-consumed status as a result of the 2001 FDA advisory. In fact, current albacore tuna consumption is less than three pounds or one-fifth of fish people eat per year and falling. So the 2004 joint FDA/EPA advisory contains broad advice on eating limits for the type of tuna (albacore) that is least consumed.

In terms of mercury, canned albacore tuna has similar levels as other popular seafood, including lobster and halibut. Unfortunately, the advisory exacerbates the generalization that albacore tuna should be avoided by lumping it in the same category as fish that is higher in mercury, e.g., shark and swordfish.

Comparison of Mercury Concentration in Fish (parts per million)			
Higher in Mercury Fish		Other Popular Fish	
King Mackerel	.730	Canned Albacore Tuna	.353
Shark	.988	Halibut	.252
Swordfish	.976	Lobster (North American)	.310
Tilefish	1.45	Chilean Bass	.386
Source: FDA www.cfsan.fda.gov/~frf/sea-mehg.html			

Catastrophic Accidents are Benchmarks for Harm; There Are No Cases of Mercury Poisoning from Normal Fish Consumption

No one in the United States has actually been harmed as a result of normal fish consumption. Actual harm from mercury has only been documented in two exceptional foreign cases related to industrial accidents in Minimata, Japan, and massive food contamination in 1971 in Iraq.

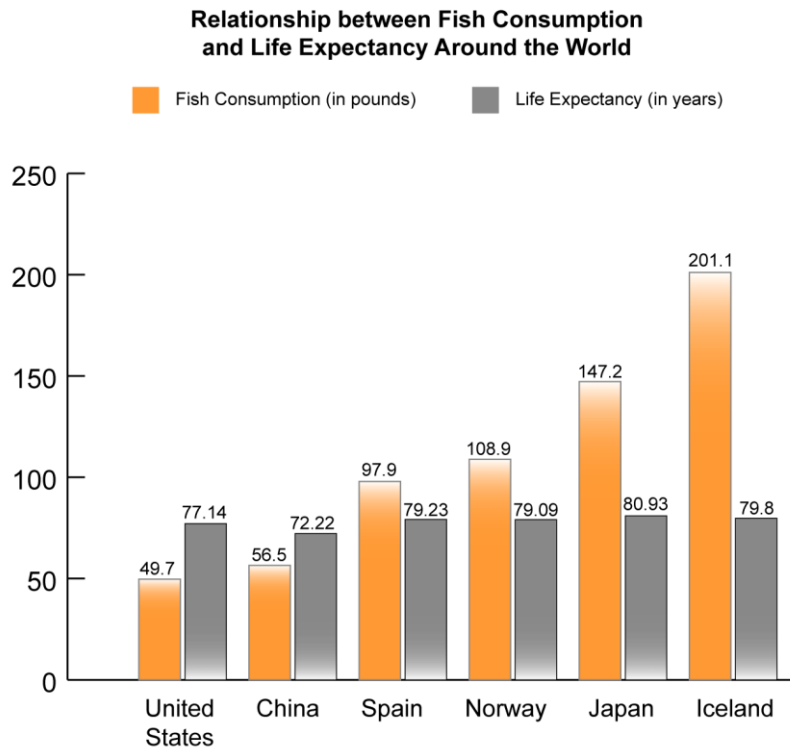
During the last 20 years, numerous studies have been conducted in the Seychelles Islands, where people eat 12 seafood meals a week, and there has been no evidence of adverse effects from prenatal methylmercury exposure from consuming a diet rich in fish during pregnancy. *The Journal of Clinical Nutrition* published a review of the latest data in December 2007, and researchers again reported no negative effects.

Ocean Mercury Levels Have Not Increased

Trace amounts of mercury have been present in ocean fish since the beginning of time. It is a naturally occurring substance that mostly comes from volcanic activity and ocean thermal vents. Even though relatively small amounts of mercury have been added by man, data has shown that over time the amount of mercury in the oceans has remained virtually unchanged. Trace amounts of mercury can be found in almost all fish. Mercury and selenium levels increase in fish as they grow larger. **A study led by Princeton University**

What About Mercury?

researcher Francois Morel compared mercury levels in yellow fin tuna caught off the coast of Hawaii in 1998 with mercury levels of fish caught in the same area in 1971. The study found no increase in mercury levels. Simply put, mercury levels in our oceans have remained constant and eating a normal diet including ocean caught fish has never been proven harmful.



A Relationship between Fish Consumption and Greater Life Expectancy

A review of the data shows there is a relationship between life expectancy and fish consumption. As the graph above shows, countries with higher fish consumption also have higher life expectancy rates.

It is worth noting that this holds true despite income disparities. For example, while Norway has a higher per capita income than the United States, the United States in turn has a high per capita income than Iceland, Spain or Japan. And yet the citizens of all three of those countries eat more fish than the average American, have lower per capita incomes, and live longer.

So how is it that people across the world are enjoying the health benefits of fish by eating it in significantly higher amounts than Americans and are not being hurt by fish?

Understanding the Science: The Possible Role of Selenium and Mercury

Regardless of whether the basis of the government fish advisory was incomplete or whether traces of mercury in fish occur naturally, the fact remains that fish contains mercury.

And yet, to date there has not been a single recorded case of illness from mercury-related commercial seafood from normal fish consumption in this country. Though elevated levels of mercury are sometimes reported in hair or blood, science has indicated that the presence of mercury is different from a toxic effect on the brain. More importantly, data the world over does not show a relationship between levels of fish consumption and physical harm. In fact, quite the opposite appears to be true. Mothers around the globe in certain countries

The Nutritional Value of Fish

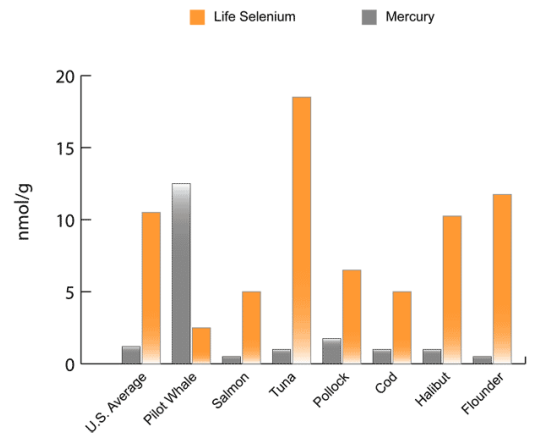
regularly consume levels of fish well beyond the U.S. government recommended levels to only the benefit of themselves and their children.

How can this be the case? **Emerging science shows that selenium—a naturally occurring, healthy mineral found in abundance in fish—may be one reason why humans have been eating fish since time immemorial without harm.** Scientists are finding that selenium may bind with mercury and neutralize its effects.

The graph to the right shows the ratio of trace mercury amounts to naturally occurring selenium levels in the flesh of a variety of seafood.

Moving from left to right, it's clear that selenium levels outweigh the trace levels of mercury in these popular fish.

However, the data also shows that mercury levels in pilot whale—which again is not a fish and served as the basis for the current FDA/EPA advisory—are substantially higher than selenium levels. This suggests that when it comes to fish, nature provides a way to counter balance the effects of naturally-occurring mercury in ocean fish with selenium, allowing humans to eat fish without harm.



Independent New Science Continues to Show Nutritional Benefits of Fish for Mother and Child

At the heart of the FDA/EPA fish advisory was a concern for the health of pregnant women and breastfeeding babies. Lost, however, were the many benefits of eating fish.

Are All Omega-3s Alike?

In reading or hearing about omega-3 fatty acids, you may have seen them described in different ways, because there are different types of omega-3s.

EPA (Eicosapentaenoic acid) and **DHA** (docosahexaenoic acid) are both long-chain omega-3s. These are the kinds of omega-3s that are most easily used by the human body. They are found in significant amounts in ocean fish.

ALA (Alpha-linolenic acid) is a shorter-chain omega-3. Shorter-chain omega-3s are plant-based and found in walnuts, flaxseed, soybeans, canola oil, or pumpkin seeds.

To get the optimal benefit from omega-3s, pregnant women should consume these long-chain fatty acids from seafood and not the shorter-chain fatty acids from plant sources. Plant-based (shorter-chain) omega-3 fats from flaxseed and walnuts do not efficiently convert to active DHA and should not be seen as a substitute for long-chain omega-3 essential fats from ocean fish.

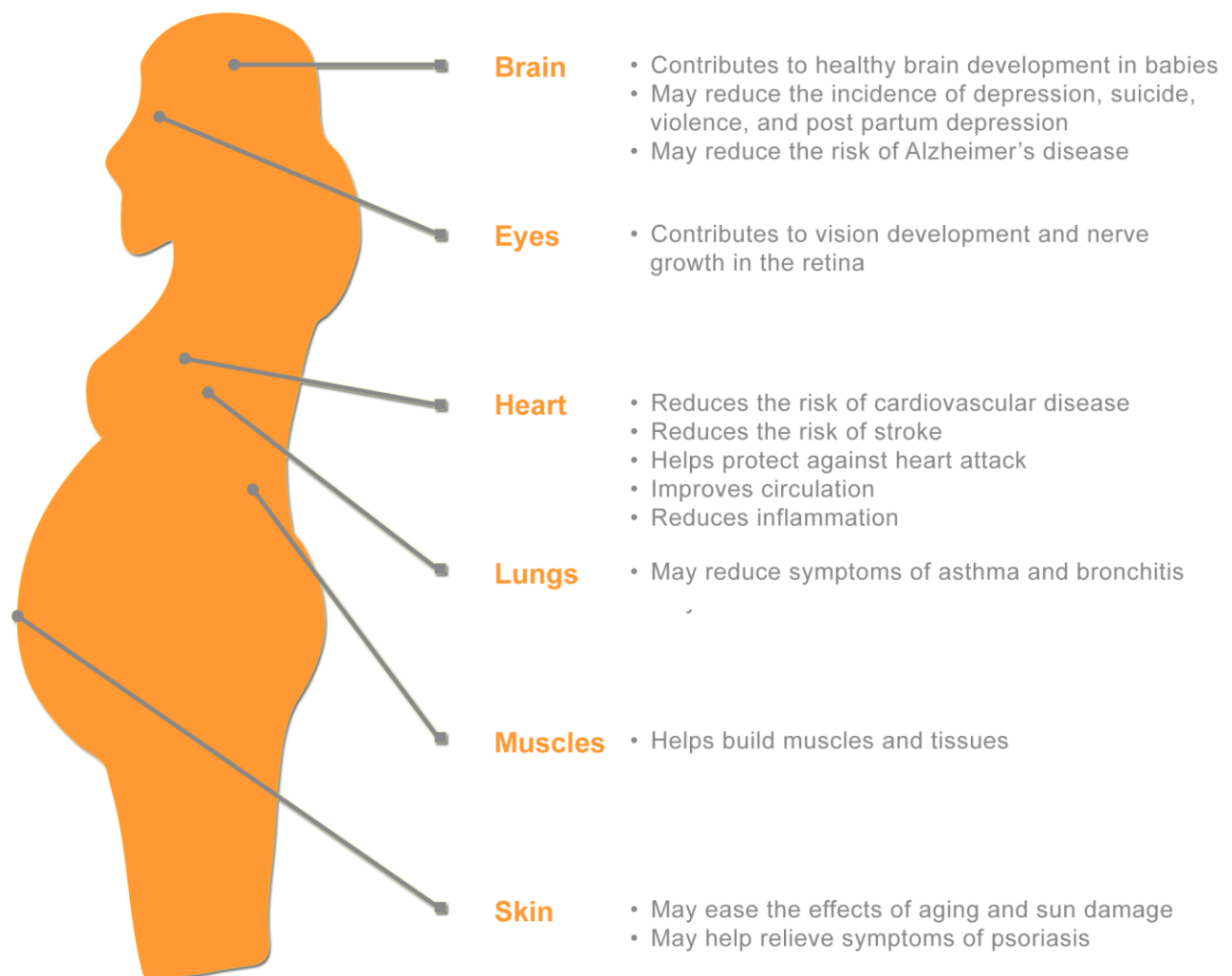
“We’ve been trying to get the word out about just how vital omega-3 fatty acids are to a developing child. And the only way babies in the womb get their omega-3s is through mom’s diet.” Mary Harris, PhD, RD, an expert in fetal nutrition from Colorado State University.

Below is a chart with the findings of recent scientific studies on the effects of fish consumption—and impact of omega-3s—on women and their developing babies.

PUBLICATION	CONCLUSION	YEAR
<i>The Lancet</i>	Of the 14,541 babies followed during eight years, mothers who ate the most fish while pregnant had smarter children than those who did not.	2007
<i>American Journal of Clinical Nutrition</i>	Infants of women who followed their “normal” fish-deficient diet had lower visual test scores than infants of mothers in the omega-3 DHA intervention group, indicating that if DHA intake is too low it may impact vision.	2008
<i>The American Journal of Epidemiology</i>	When evaluated for vocabulary skills, children whose mothers ate canned tuna at least twice per week during their second-trimester scored substantially higher on cognitive tests than the children of mothers who reported not eating fish.	2008
<i>Pediatric Allergy and Immunology</i>	Study results support a potential protective effect of fruits, vegetables and fish intake during childhood on asthma, wheezing and allergic reactions.	2007
<i>The Journal of Pediatrics</i>	In this study of the Inuit of Arctic Quebec, higher cord DHA concentration was associated with more optimal visual, cognitive and motor development, which indicated a need for substantial increases in DHA during the spurt of brain development in the third trimester.	2008
<i>American Journal of Clinical Nutrition</i>	This study looked at over 25,000 children born from 1997-2002 and found both higher fish consumption and longer breastfeeding are linked to better physical and cognitive development of infants.	2008

Beyond Pregnancy—Health Benefits of Eating Fish

So what do all the nutrients found in fish mean for the body in practical terms? By examining the impact that fish consumption has on various parts of the body, it is easy to see how this unique combination of vitamins, minerals and other nutrients provides real, tangible, health benefits. The nutrients in fish have been shown to help fight obesity, heart disease and other major health problems facing many Americans today. Considering these benefits to the human body, it is not surprising that the U.S. Department of Agriculture, the American Heart Association, the American Psychiatric Association and the American Dietetic Association recommend that consumers eat at least two servings of fish per week.



Case Study: Canned Tuna

According to volume, some of the most popular and most affordable fish consumed in America is canned tuna. From tuna fish sandwiches to tuna-topped salads, canned tuna is the second most eaten seafood.

So how beneficial is canned tuna to the typical American diet?

Like all fish, tuna contains a number of important nutrients that most Americans would benefit from, but get in limited amounts from other food sources. For example, canned tuna is an excellent source of high-quality proteins, essential amino acids and omega-3 fatty acids like DHA. In fact, canned tuna has nearly three times as many omega-3 fatty acids as chicken, turkey, pork and beef combined.

U.S. Per Capita Consumption of Five Most Popular Fish During 2007 (In Pounds)	
Shrimp	4.10
Canned Tuna	2.70
Salmon	2.36
Pollock	1.73
Tilapia	1.14

One-Stop Nutritional Shopping

So why is it so important that we include fish in our diet? Even if there is no real danger from mercury, why shouldn't pregnant women and other consumers remove fish from their diet and replace it with some other culinary alternative to be safe?

Simply put, fish provides one-stop shopping for many of the essential nutrients that we all need in our daily diet. Fish is a natural and unique food source that provides the body and brain with the nutritional-building blocks they need to stay healthy and strong.

A nutrient-rich food, fish is an excellent source of:

- Long chain omega-3 fatty acids, e.g., EPA and DHA
- Lean, high-quality protein
- Vitamins B and D
- Essential amino acids—lysine, methionine, arginine, and taurine
- Zinc, iodine and selenium

The Nutritional Value of Fish

As the chart below indicates, fish is also an excellent source of many of the necessary minerals we all need.

Seafood: The Nutrition Star

Cooked by moist or dry heat with no added ingredients

	Calories	Protein	Total fat	Saturated fat	Long-chain omega-3 fats	Sodium	Selenium	Iron	Vitamin B-12
Seafood (3 ounces)		grams	Grams	grams	milligrams (mg)	mg / % daily value	mg / % daily value	mg / % daily value	mg / % daily value
Shrimp	84	18	1	0	267	190 8%	34 62%	2.6 14%	1.3 54%
Canned tuna									
White	109	20	2.5	1	733	320 14%	56 102%	0.8 4%	0 42%
Light	99	22	1	0	230	287 12%	68 124%	1.3 7%	2.5 106%
Salmon									
Farmed	175	19	11	2	1825	52 2%	35 64%	0.3 2%	2.4 100%
Wild	155	22	7	1	1564	48 2%	40 73%	0.9 5%	2.6 108%
Pollock	100	21	1	0	460	94 4%	40 73%	0.5 3%	3.1 129%
Tilapia	109	22	2	0	115	48 2%	46 84%	0.6 3%	1.6 67%
Catfish	129	16	7	2	151	68 3%	12 22%	0.7 4%	2.4 100%
Crab	87	17	2	1	403	237 10%	34 62%	0.8 4%	6.2 258%
Cod	89	19	1	0	134	66 3%	32 58%	0.42 2%	0.89 37%
Clams	126	22	2	0	241	95 4%	54 98%	24 133%	84 3500%
Scallops	95	20	1	0	310	225 10%	24 44%	2.6 14%	1.1 46%

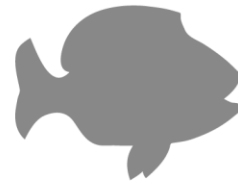
These vitamins, minerals and other nutrients provide the bedrock of a healthy diet and are essential to the growth and maintenance of the body. By combining all of these elements in the most commonly eaten fish, nature has provided a simple alternative to the less nutritious, carbohydrate- and fat-rich foods that make up too much of Americans' diets.

More Bang for the Bite: Fish Is the More Nutrient Rich Choice over Supplements, Science Says

With so much science behind the benefits of omega-3 DHA, many people might say the answer should be to find a way for women to get the benefit of fish without eating the food itself. Such a solution would naturally point to the use of omega-3 DHA supplements. Although supplements might be a good alternative for those who cannot eat fish for dietary reasons, alternatives to fish do not measure up to the food itself and deny both mother and child the unique combination of nutrients available in seafood.

A recent study in *Current Opinion in Clinical Nutrition and Metabolic Care* demonstrated that only by eating the fish itself will consumers receive the full nutritional benefits. The chart below illustrates the benefits women miss out on when they choose supplements over the whole fish.

Eating fish rather than omega-3 supplements like flax seed or fish oil is a well-rounded approach for the health of women and their children.



Fish Oil Supplements

Long Chain Omega 3-DHA

Short Chain Omega 3s

Selenium

Iodine

Protein

Low Fat

Essential Amino Acids,
lysine, methionine,
arginine and taurine

Vitamin A

Vitamin B

Vitamin D

Potassium

Zinc

Long Chain Omega 3-EPA

Long Chain Omega 3-DHA

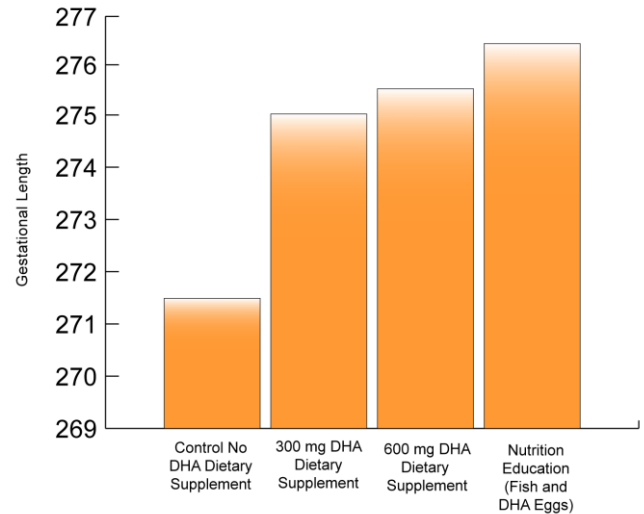
A nutrient-rich food, fish is an excellent source of high-quality proteins, essential amino acids and fatty acids, such as EPA, DHA and linolenic acid. It also contains selenium, zinc, iodine, vitamin B, vitamin D, protein and potassium.

The Nutritional Value of Fish**Fish Does Not Spike Blood Sugar**

In addition to being nutrient rich, fish also has a better effect on blood sugar, or glucose, levels. Glucose levels help ensure healthy metabolic regulation in the human body.

When people eliminate fish from their diets, they can end up eating less nutrient-dense food such as carbohydrates, which spike blood sugar levels.

Having high levels of blood sugar makes it more likely that a person would develop a number of serious health conditions, such as infections, the inability to heal wounds and cuts, diabetes and eye, kidney or nerve damage.



Model adjusted for Ethnicity, Pregnancy BMI
Values with different superscripts are significantly different ($p=0.026$)

It is Time for FDA to Clear the Confusion

The Institute of Medicine (IOM) urged in its 2006 report, *Seafood Choices: Balancing Benefits and Risks*, that federal agencies “should encourage pregnant women, or those who may become pregnant, to include seafood in their diets” and cautioned that advice on avoiding fish, targeting narrow subpopulations, may have a “spillover” effect to other people. The report also says there is no mercury risk for those individuals eating up to 12 ounces of seafood a week.

Possibly in response to the IOM’s findings, in 2008 the FDA assessed the latest research on the effects of seafood on heart health and baby brain development.

Released for public comment in January 2009, the draft report is a comprehensive review of the latest scientific research issued since the last FDA advisory issued in 2004. This includes research from:

- Harvard Medical School
- Publications like *Pediatrics* and *The Journal of the American Medical Association*
- Government organizations including Health Canada
- Researchers at the National Institutes of Health

The FDA has also included the names of seven individuals who participated in the peer review process as well as their comments. These individuals include:

- Elaine M. Faustman, Ph.D., School of Public Health and Community Medicine, University of Washington, Seattle
- Herman J. Gibb, Ph.D., Sciences International, Alexandria, Va.
- Dariush Mozaffarian, MD, Dr.PH, FACC, FAHA, Harvard School of Public Health, Boston
- Gregory M. Paoli, M.A.Sc., Risk Sciences International, Inc., Ottawa, ON, Canada
- Barbara Petersen, Ph.D., M.P.H., Exponent, Washington, DC
- Kimberly M. Thompson, Sc.D., Harvard School of Public Health, Boston

The FDA clearly recognizes the confusion around eating fish during pregnancy and is working to better quantify the risks and benefits of fish consumption to consumers.

With two million children born annually with deficiencies in essential omega-3 fatty acids, we believe further delay is not acceptable. The FDA must act and act quickly.

The Nutritional Value of Fish

We believe Congress should ask the FDA/EPA to clarify the confusion their 2004 advisory caused. To do so, the FDA should:

- Reassure Americans that the majority of the ocean fish they eat is safe.
- Issue advice for commercial fish consumption that is separate from recreation and subsistence fishing because local fish advisories address local pollution threats, which are separate and unique from the low levels of naturally occurring mercury found in ocean fish.
- Develop and test positive and clear messages to pregnant and breastfeeding women, as well as to the medical community, media and retail outlets that currently use point-of-sale warning signs that—according to the FDA itself—discourage women from eating fish. These messages should:
 - Alert “women who might become pregnant, women who are pregnant, and nursing mothers” that there is a serious nutritional deficit as a result of low fish consumption.
 - Highlight the pregnancy and developmental benefits of fish during pregnancy for mothers and babies.
 - Specifically recommend that as part of a healthy diet, pregnant and nursing mothers should eat 12 ounces of fish and/or seafood weekly.
 - Clearly state that the vast majority of seafood consumed by Americans is already naturally low in mercury, including all of the fish in the top 10 commonly eaten seafood in the United States – shrimp, canned tuna, salmon, pollock, tilapia, catfish, crab, cod, clams and scallops.
 - List the four rarely consumed commercial fish that are high in mercury which women should avoid – king mackerel, swordfish, tilefish and shark.
 - Reiterate that local fish advisories should be checked for information about fish caught by family and friends.
 - Remove albacore tuna from the advisory as it is a low mercury fish and should not have been placed on the advisory to begin with.
- Clarify the advice to women who might become pregnant, women who are pregnant, nursing mothers, and young children.
- Encourage young children to eat 2-3 servings of a variety of fish per week as part of a healthy diet.
- Report to Congress on the status of its messaging to women on fish consumption, particularly those who are pregnant and breastfeeding.

Although the original FDA/EPA joint fish advisory may have been well intentioned, its very premise is flawed and it is clear it resulted in confusion that is harming pregnant women and their developing children by denying them much needed nutrients. It is important for the government to address the confusion it has caused, reverse the impact that confusion is having and effectively communicate to women and their physicians and other health providers about the critical health benefits fish plays during pregnancy.



U.S. Department of Health and Human Services
and
U.S. Environmental Protection Agency



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March 2004

EPA-823-R-04-005

What You Need to Know About Mercury in Fish and Shellfish

2004 EPA and FDA Advice For: Women Who Might Become Pregnant Women Who are Pregnant Nursing Mothers Young Children

Fish and shellfish are an important part of a healthy diet. Fish and shellfish contain high-quality protein and other essential nutrients, are low in saturated fat, and contain omega-3 fatty acids. A well-balanced diet that includes a variety of fish and shellfish can contribute to heart health and children's proper growth and development. So, women and young children in particular should include fish or shellfish in their diets due to the many nutritional benefits.

However, nearly all fish and shellfish contain traces of mercury. For most people, the risk from mercury by eating fish and shellfish is not a health concern. Yet, some fish and shellfish contain higher levels of mercury that may harm an unborn baby or young child's developing nervous system. The risks from mercury in fish and shellfish depend on the amount of fish and shellfish eaten and the levels of mercury in the fish and shellfish. Therefore, the Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA) are advising women who may become pregnant, pregnant women, nursing mothers, and young children to avoid some types of fish and eat fish and shellfish that are lower in mercury.

By following these 3 recommendations for selecting and eating fish or shellfish, women and young children will receive the benefits of eating fish and shellfish and be confident that they have reduced their exposure to the harmful effects of mercury.

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.

The over-focus by the media and environmental activist groups on supposed health risks from mercury ignores the many essential health benefits of consuming a complex, nutrient-dense food like ocean fish. These scare tactics are driving consumers away from eating ocean fish like canned tuna and are causing a nutritional deficiency among those who need to eat fish the most—women and children.

Benefits vs. Potential Harm

It is important for consumers to balance the potential risk from mercury with the clear benefits of eating ocean fish. Mercury from ocean fish is not cause for concern like mercury from other sources, like whale meat, because of the protective benefits of essential omega-3 fatty acids and selenium. The following points explain why mercury from ocean fish is different than from other sources.

- Trace amounts of mercury have been present in fish since the beginning of time. It is a naturally occurring substance that mostly comes from volcanic activity and ocean thermal vents. Some mercury has been added by man, but data has shown that over time the amount of mercury in the ocean remains the same. Trace amounts of mercury can be found in almost all fish. Mercury and selenium levels usually increase in fish as they grow larger. A study led by Princeton University researcher Francois Morel compared mercury levels in yellowfin tuna caught off the coast of Hawaii in 1998 with mercury levels of fish caught in the same area in 1971. The study found no increase in mercury levels.
- The risk and benefits of consuming seafood with trace levels of mercury must be properly weighed. Numerous studies, including recent ones published in leading health journals such as *The Lancet* and *The Journal of the American Medical Association* have shown that the benefits of seafood consumption greatly outweigh any risks from trace levels of mercury, and that when pregnant women avoid fish in an attempt to lower their exposure to mercury, they are likely depriving their baby of optimal brain and eye development.
- A study of more than 14,000 women, published in *The Lancet*, showed that women who do not eat enough fish have children with lower verbal IQ scores.
 - Ninety percent of the women studied ate less than 12 ounces of fish each week, increasing the risk that their child would be born with a nutritional deficiency.
 - This study, which analyzed actual—not perceived—mercury levels from the umbilical cord, found that a higher concentration of mercury in the blood is directly associated with better outcomes in children. Children of mothers with higher mercury levels caused by consuming more fish than is recommended by the FDA had the best health outcomes. These benefits included stronger motor, communication and social skills than children of mothers who ate little or no seafood, and thus had lower levels of mercury.
- In addition to the nutritious omega-3 fatty acids in fish like canned tuna, there is a growing body of evidence that selenium, an essential mineral found in abundance in ocean fish, accumulates with mercury and appears to be a protective force against the harm of mercury exposure. Additionally, selenium is essential for human development, especially thyroid function and a reduced risk of some cancers.
- When considering whether to take fish oil supplements to try to avoid mercury, according to a recent study in *Current Opinion in Clinical Nutrition and Metabolic Care*, consuming ocean fish, rather than omega-3 supplements like flax seed or fish oil, is the best approach for the health of women and their children. Only by eating the fish itself will consumers receive the full nutritional benefits.

- Mercury levels determined through bio-monitoring tests, such as hair analysis, do not prove harm to human beings. Such tests prove only an exposure to mercury, not its source—which is equally, if not more, important to consider. For example, risks of higher mercury levels are minimal if obtained from the consumption of nutrient-rich ocean fish, like canned tuna. However, increased mercury exposure from other sources may indeed be harmful to women or children.

References:

Morel FM, Malcolm EG, Chin HB, Keller K, Kraepiel AM. Sources and Variations of Mercury. *Environ. Sci. Technol.* 2003; 37: 5551-5558.

Hibbeln JR, Davis JM, Steer C, Emmett P, Rogers I, Williams C, Golding J. Maternal seafood consumption in pregnancy and neurodevelopmental outcomes in childhood (ALSPAC study): an observational cohort study. *Lancet* 2007; 369:578-85.

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Racine RA, Deckelbaum RJ. Sources of the very-long-chain unsaturated omega-3 fatty acids: eicosapentaenoic acid and docosahexaenoic acid [Lipid metabolism and therapy]. *Current Opinion in Clinical Nutrition and Metabolic Care* 2007; 10: 123-28

Omega-3 Fatty Acids and Perinatal Depression: A Review of the Literature and Recommendations for Future Research

Freeman MP

Introduction: Perinatal depression refers to major depression in the context of pregnancy and postpartum. In consideration of its prevalence and consequences, the treatment and prevention of perinatal depression should be important public health priorities. Omega-3 fatty acids are attractive for consideration in perinatal women, due to known health benefits for the mother and baby. Antidepressant medications may pose risks in utero and in breastfeeding. **Methods:** MEDLINE and manual searches were conducted. **Results:** Epidemiological and preclinical data support a role of omega-3 fatty acids in perinatal depression. Two studies failed to support a role of omega-3 fatty acids for postpartum depression prophylaxis, although one included a small sample, and the other utilized a low dosage. Two pilot studies suggest good tolerability and potential efficacy in the acute treatment of perinatal depression. **Conclusions:** Further research studies are warranted to determine the role of omega-3 fatty acids in the treatment of perinatal depression.

Randomized dose-ranging pilot trial of omega-3 fatty acids for postpartum depression

Freeman MP, Hibbeln JR, Wisner KL, Brumbach BH, Watchman M, Gelenberg AJ.

Objective: Postpartum depression (PPD) affects 10–15% of mothers. Omega-3 fatty acids are an intriguing potential treatment for PPD. **Method:** The efficacy of omega-3 fatty acids for PPD was assessed in an 8-week dose-ranging trial. Subjects were randomized to 0.5 g/day (n = 6), 1.4 g/day (n = 3), or 2.8 g/day (n = 7). **Results:** Across groups, pretreatment Edinburgh Postnatal Depression Scale (EPDS) and Hamilton Rating Scale for Depression (HRSD) mean scores were 18.1 and 19.1 respectively; post-treatment mean scores were 9.3 and 10.0. Percent decreases on the EPDS and HRSD were 51.5% and 48.8%, respectively; changes from baseline were significant within each group and when combining groups. Groups did not significantly differ in pre- or post-test scores, or change in scores. The treatment was well tolerated. **Conclusion:** This study was limited by small sample size and lack of placebo group. However, these results support further study of omega-3 fatty acids as a treatment for PPD.

Omega-3 fatty acids: evidence basis for treatment and future research in psychiatry

Freeman MP, Hibbeln JR, Wisner KL, Davis JM, Mischoulon D, Peet M, Keck PE Jr, Marangell LB, Richardson AJ, Lake J, Stoll AL.

OBJECTIVE: To determine if the available data support the use of omega-3 essential fatty acids (EFA) for clinical use in the prevention and/or treatment of psychiatric disorders. **PARTICIPANTS:** The authors of this article were invited participants in the Omega-3 Fatty Acids Subcommittee, assembled by the Committee on Research on Psychiatric Treatments of the American Psychiatric Association (APA). **EVIDENCE:** Published literature and data presented at scientific meetings were reviewed. Specific disorders reviewed included major depressive disorder, bipolar disorder, schizophrenia, dementia, borderline personality disorder and impulsivity, and attention-deficit/hyperactivity disorder. Meta-analyses were conducted in major depressive and bipolar disorders and schizophrenia, as sufficient data were available to conduct such analyses in these areas of interest. **CONSENSUS PROCESS:** The subcommittee prepared the manuscript, which was reviewed and approved by the following APA committees: the Committee on Research on Psychiatric Treatments, the Council on Research, and the Joint Reference Committee. **CONCLUSIONS:** The preponderance of epidemiologic and tissue compositional studies supports a protective effect of omega-3 EFA intake, particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), in mood disorders. Meta-analyses of randomized controlled trials demonstrate a statistically significant benefit in unipolar and bipolar depression ($p = .02$). The results were highly heterogeneous, indicating that it is important to examine the characteristics of each individual study to note the differences in design and execution. There is less evidence of benefit in schizophrenia. EPA and DHA appear to have negligible risks and some potential benefit in major depressive disorder and bipolar disorder, but results remain inconclusive in most areas of interest in psychiatry. Treatment recommendations and directions for future research are described. Health benefits of omega-3 EFA may be especially important in patients with psychiatric disorders, due to high prevalence rates of smoking and obesity and the metabolic side effects of some psychotropic medications.

Maternal Seafood Consumption In Pregnancy and Neurodevelopmental Outcomes In Childhood (ALSPAC study): An Observational Cohort Study

Hibbeln JR, Davis JM, Steer C, Emmett P, Rogers I, Williams C, Golding J

Summary: Background Seafood is the predominant source of omega-3 fatty acids, which are essential for optimum neural development. However, in the USA, women are advised to limit their seafood intake during pregnancy to 340 g per week. We used the Avon Longitudinal Study of Parents and Children (ALSPAC) to assess the possible benefits and hazards to a child's development of different levels of maternal seafood intake during pregnancy. **Methods:** 11 875 pregnant women completed a food frequency questionnaire assessing seafood consumption at 32 weeks' gestation. Multivariable logistic regression models including 28 potential confounders assessing social disadvantage, perinatal, and dietary items were used to compare developmental, behavioural, and cognitive outcomes of the children from age 6 months to 8 years in women consuming none, some (1–340 g per week), and >340 g per week. **Findings:** After adjustment, maternal seafood intake during pregnancy of less than 340 g per week was associated with increased risk of their children being in the lowest quartile for verbal intelligence quotient (IQ) (no seafood consumption, odds ratio [OR] 1.48, 95% CI 1.16–1.90; some, 1.09, 0.92–1.29; overall trend, $p=0.004$), compared with mothers who consumed more than 340 g per week. Low maternal seafood intake was also associated with increased risk of suboptimum outcomes for prosocial behaviour, fine motor, communication, and social development scores. For each outcome measure, the lower the intake of seafood during pregnancy, the higher the risk of suboptimum developmental outcome. Interpretation Maternal seafood consumption of less than 340 g per week in pregnancy did not protect children from adverse outcomes; rather, we recorded beneficial effects on child development with maternal seafood intakes of more than 340 g per week, suggesting that advice to limit seafood consumption could actually be detrimental. These results show that risks from the loss of nutrients were greater than the risks of harm from exposure to trace contaminants in 340 g seafood eaten weekly.

Essential n-3 fatty acids in pregnant women and early visual acuity maturation in term infants.

Innis SM, Friesen RW.

Background: Docosahexaenoic acid (DHA) is important to neural development. Whether DHA intakes are low enough in some pregnant women to impair infant development is uncertain. **Objective:** We sought to determine whether DHA deficiency occurs in pregnant women and contributes to poor infant development. **Design:** Biochemical cutoffs, dietary intakes, or developmental scores indicative of DHA deficiency are not defined. Infant development has a distribution in which an individual's potential development is unknown. This was a randomized intervention to establish a distribution of developmental scores for infants of women with DHA intakes considered to be above requirements against which to compare the development of infants of mothers consuming their usual diet. DHA (400 mg/d; n = 67) or a placebo (n = 68) was consumed by the women from 16 wk gestation until delivery. We determined maternal red blood cell ethanolamine phosphoglyceride fatty acids, dietary intakes at 16 and 36 wk gestation, and infant visual acuity at 60 d of age. **Results:** We described an approach to identify DHA deficiency when biochemical and functional markers of deficiency are unknown. In multivariate analyses, infant visual acuity was related to sex (beta = 0.660, SE = 0.93, and odds ratio = 1.93) and maternal DHA intervention (beta = 1.215, SE = 1.64, and odds ratio = 3.37). More infant girls in the placebo than in the DHA intervention group had a visual acuity below average (P = 0.048). Maternal red blood cell ethanolamine phosphoglyceride docosatetraenoic acid was inversely related to visual acuity in boys (rho = -0.37, P < 0.05) and girls (rho = -0.48, P < 0.01). **Conclusions:** These studies suggest that some pregnant women in our study population were DHA-deficient.

Beneficial Effects of a Polyunsaturated Fatty Acid on Infant Development: Evidence from the Inuit of Arctic Quebec

Joseph L. Jacobson, PhDa, Sandra W. Jacobson, PhDa, Gina Muckle, PhDb, Melissa Kaplan-Estrin, PhDc, Pierre Ayotte, PhDd, Eric Dewailly, MD, PhDd

Objectives To examine the relation of cord plasma docosahexaenoic acid (DHA) concentration to gestation length, birth size, growth, and infant visual acuity, cognitive, and motor development and the effects on growth and development associated with DHA intake from breast-feeding. **Study design** DHA, other polyunsaturated fatty acids, and 3 environmental contaminants (polychlorinated biphenyls, mercury, and lead) were assessed in cord plasma and maternal plasma and milk in 109 Inuit infants in Arctic Quebec. Multiple regression was used to examine the relation of cord DHA and DHA from breast-feeding on growth and development at 6 and 11 months, after controlling for contaminant exposure and other potential confounders. **Results** Higher cord DHA concentration was associated with longer gestation, better visual acuity and novelty preference on the Fagan Test at 6 months, and better Bayley Scale mental and psychomotor performance at 11 months. By contrast, DHA from breast-feeding was not related to any indicator of cognitive or motor development in this full-term sample. **Conclusions** The association of higher cord DHA concentration with more optimal visual, cognitive, and motor development is consistent with the need for substantial increases in this critically important fatty acid during the third trimester spurt of synaptogenesis in brain and photoreceptor development.

Fish Intake, Contaminants and Human Health: Evaluating the Risks and the Benefits

Mozaffarian D and Rimm EB

Context Fish (finfish or shellfish) may have health benefits and also contain contaminants, resulting in confusion over the role of fish consumption in a healthy diet. **Evidence Acquisition** We searched MEDLINE, governmental reports, and metaanalyses, supplemented by hand reviews of references and direct investigator contacts, to identify reports published through April 2006 evaluating (1) intake of fish or fish oil and cardiovascular risk, (2) effects of methylmercury and fish oil on early neurodevelopment, (3) risks of methylmercury for cardiovascular and neurologic outcomes in adults, and (4) health risks of dioxins and polychlorinated biphenyls in fish. We concentrated on studies evaluating risk in humans, focusing on evidence, when available, from randomized trials and large prospective studies. When possible, metaanalyses were performed to characterize benefits and risks most precisely. **Evidence Synthesis** Modest consumption of fish (eg, 1-2 servings/wk), especially species higher in the n-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), reduces risk of coronary death by 36% (95% confidence interval, 20%-50%; P<.001) and total mortality by 17% (95% confidence interval, 0%- 32%; P=.046) and may favorably affect other clinical outcomes. Intake of 250 mg/d of EPA and DHA appears sufficient for primary prevention. DHA appears beneficial for, and low-level methylmercury may adversely affect, early neurodevelopment. Women of childbearing age and nursing mothers should consume 2 seafood servings/wk, limiting intake of selected species. Health effects of low-level methylmercury in adults are not clearly established; methylmercury may modestly decrease the cardiovascular benefits of fish intake. A variety of seafood should be consumed; individuals with very high consumption (>5 servings/wk) should limit intake of species highest in mercury levels. Levels of dioxins and polychlorinated biphenyls in fish are low, and potential carcinogenic and other effects are outweighed by potential benefits of fish intake and should have little impact on choices or consumption of seafood (women of childbearing age should consult regional advisories for locally caught freshwater fish). **Conclusions** For major health outcomes among adults, based on both the strength of the evidence and the potential magnitudes of effect, the benefits of fish intake exceed the potential risks. For women of childbearing age, benefits of modest fish intake, excepting a few selected species, outweigh risks.

Seafood Choices: Balancing Benefits and Risks

Committee on Nutrient Relationships, Malden C. Nesheim MC and Yaktine AL, Editors

The fragmented information that consumers receive about the nutritional value and health risks associated with fish and shellfish can result in confusion or misperceptions about these food sources. Consumers are therefore confronted with a dilemma: they are told that seafood is good for them and should be consumed in large amounts, while at the same time the federal government and most states have issued advisories urging caution in the consumption of certain species or seafood from specific waters.

Seafood Choices carefully explores the decision-making process for selecting seafood by assessing the evidence on availability of specific nutrients (compared to other food sources) to obtain the greatest nutritional benefits. The book prioritizes the potential for adverse health effects from both naturally occurring and introduced toxicants in seafood; assesses evidence on the availability of specific nutrients in seafood compared to other food sources; determines the impact of modifying food choices to reduce intake of toxicants on nutrient intake and nutritional status within the U.S. population; develops a decision path for U.S. consumers to weigh their seafood choices to obtain nutritional benefits balanced against exposure risks; and identifies data gaps and recommendations for future research.

Maternal Fish Consumption, Hair Mercury and Infant Cognition In a U.S. Cohort

Oken E, Wright RO, Kleinman KP, Bellinger D, Amarasiriwardena CJ, Hu H, Rich-Edwards JW, Gillman MW

Fish and other seafood may contain organic mercury but also beneficial nutrients such as n-3 polyunsaturated fatty acids. We endeavored to study whether maternal fish consumption during pregnancy harms or benefits fetal brain development. We examined associations of maternal fish intake during pregnancy and maternal hair mercury at delivery with infant cognition among 135 mother—infant pairs in Project Viva, a prospective U.S. pregnancy and child cohort study. We assessed infant cognition by the percent novelty preference on visual recognition memory (VRM) testing at 6 months of age. Mothers consumed an average of 1.2 fish servings per week during the second trimester. Mean maternal hair mercury was 0.55 ppm, with 10% of samples > 1.2 ppm. Mean VRM score was 59.8 (range, 10.9—92.5). After adjusting for participant characteristics using linear regression, higher fish intake was associated with higher infant cognition. This association strengthened after adjustment for hair mercury level: For each additional weekly fish serving, offspring VRM score was 4.0 points higher [95% confidence interval (CI), 1.3 to 6.7]. However, an increase of 1 ppm in mercury was associated with a decrement in VRM score of 7.5 (95% CI, —13.7 to —1.2) points. VRM scores were highest among infants of women who consumed > 2 weekly fish servings but had mercury levels ≤ 1.2 ppm. Higher fish consumption in pregnancy was associated with better infant cognition, but higher mercury levels were associated with lower cognition. Women should continue to eat fish during pregnancy but choose varieties with lower mercury contamination.

Maternal Fish Intake during Pregnancy, Blood Mercury Levels, and Child Cognition at Age 3 Years in a US Cohort

Emily Oken, Jenny S. Radesky, Robert O. Wright, David C. Bellinger, Chitra J. Amarasiriwardena⁴, Ken P. Kleinman, Howard H, and Matthew W. Gillman

The balance of contaminant risk and nutritional benefit from maternal prenatal fish consumption for child cognitive development is not known. Using data from a prospective cohort study of 341 mother-child pairs in Massachusetts enrolled in 1999—2002, the authors studied associations of maternal second-trimester fish intake and erythrocyte mercury levels with children's scores on the Peabody Picture Vocabulary Test (PPVT) and Wide Range Assessment of Visual Motor Abilities (WRAVMA) at age 3 years. Mean maternal total fish intake was 1.5 (standard deviation, 1.4) servings/month, and 40 (12%) mothers consumed >2 servings/week. Mean maternal mercury level was 3.8 (standard deviation, 3.8) ng/g. After adjustment using multivariable linear regression, higher fish intake was associated with better child cognitive test performance, and higher mercury levels with poorer test scores. Associations strengthened with inclusion of both fish and mercury: effect estimates for fish intake of >2 servings/week versus never were 2.2 (95% confidence interval (CI): 2.6, 7.0) for the PPVT and 6.4 (95% CI: 2.0, 10.8) for the WRAVMA; for mercury in the top decile, they were 14.5 (95% CI: 18.5, 10.4) for the PPVT and 14.6 (95% CI: 18.3, 10.9) for the WRAVMA. Fish consumption of "2 servings/week was not associated with a benefit. Dietary recommendations for pregnant women should incorporate the nutritional benefits as well as the risks of fish intake.

Sources of the Very-Long-Chain Unsaturated Omega-3 Fatty Acids: Eicosapentaenoic Acid and Docosahexaenoic Acid

Racine RA and Deckelbaum RJ

Purpose of review We assess the toxicological, environmental and economic aspects of sources of fish oil and omega-3 fatty acids (n—3 fatty acids). **Recent findings** Fish oils are the most common source of the very-long-chain n—3 fatty acids eicosapentaenoic acid and docosahexaenoic acid, which have protective and beneficial effects on conditions such as cardiovascular, inflammatory, or neurological diseases. Fish oils can also be potential hazards for human health, because of external pollutants bioaccumulating in fish. Wild and farmed fish are generally both similar in n—3 fatty acid content but may vary in terms of potential toxins. Reports on aquaculture and fish oil production, and other sources of n—3 fatty acids, are reviewed to assess which may be more suitable economically and ecologically for higher fish oil production and availability. **Summary** Although today's fish oil production meets demand, it is likely that this will not be able to increase without adversely affecting the world's wild stock of fish. Neither wild nor farmed fish constitute a sustainable source of n—3 fatty acids for supplementation. Solutions may be found through the evolution of the current aquaculture system or the utilization of alternative manufacturing sources for increasing intakes of n—3 fatty acids.

Maternal and Perinatal Roles In Preterm Birth Long-Chain Fatty Acids: Possible Roles In Preterm Birth

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Objective: We conducted a case-control study to evaluate whether maternal and fetal m-3 and m-6 essential fatty acid status play possible roles in the pathogenesis of preterm birth. **Study Design:** Essential fatty acid status in blood and trophoblast tissues was measured in (1) women and their newborns with spontaneous preterm birth and (2) control women and newborns at 34 weeks' gestation (maternal blood) and at term delivery. **Results:** Thirty-seven preterm (mean gestational age 34 weeks) and 34 control mother-baby dyads (gestational age 40 weeks) were evaluated. The maternal percent of total arachidonic acid in red blood cells and plasma was increased in preterm cases versus controls at delivery (3.8- and 1.6-fold, respectively, $p < 0.05$). Maternal red blood cell eicosapentaenoic acid (1.98 ± 0.15 , $p < 0.0001$) and m-3Ao-6 ratios (0.58 ± 0.22 , $p < 0.009$) were lower in preterm cases than in controls at delivery (4.64 ± 0.32 and 1.27 ± 0.12 , respectively). Docosapentaenoic acid, a marker of ~o-3 essential fatty acid deficiency, was higher in preterm maternal red blood cells (1.26 ± 0.18 , $p < 0.0001$) and amnion (1.27 ± 0.19 , $p < 0.001$) compared with term controls (0.12 ± 0.07 and 0.58 ± 0.13 , respectively). **Conclusion:** Women delivered preterm demonstrated higher arachidonic acid and docosapentanoic acid levels in maternal blood and trophoblast tissue than did women delivered at term. This suggests (1) altered essential fatty acid intake or metabolism in a portion of women delivered preterm and (2) increased maternal red blood cell arachidonic acid is associated with an increased risk of preterm birth.