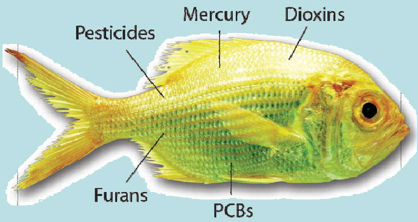
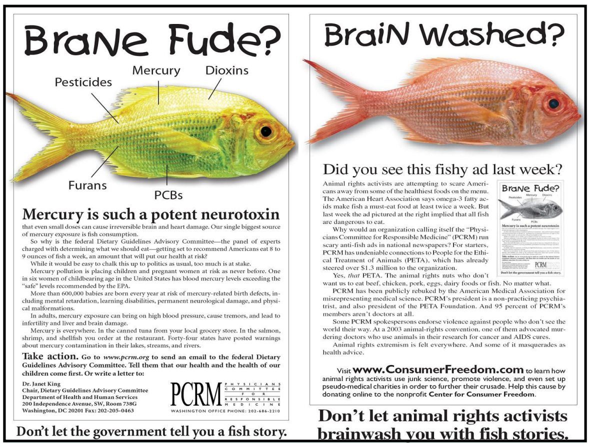
A Quantitative Model for Risk Benefit Assessment of Seafood Consumption



David James – FAO – November 2011

- Growing public concern regarding the presence of chemical contaminants in fish
- Multiple nutritional benefits of including fish in the diet have become increasingly clear



Brane Fude?

Pesticides Mercury Dioxins Furans PCBs

Mercury is such a potent neurotoxin that even small doses can cause irreversible brain and heart damage. Our single biggest source of mercury exposure is fish consumption.

So why is the federal Dietary Guidelines Advisory Committee—the panel of experts charged with determining what we should eat—getting set to recommend Americans eat 8 to 9 ounces of fish a week, an amount that will put our health at risk?

While it would be easy to chalk this up to politics as usual, too much is at stake.

Mercury pollution is placing children and pregnant women at risk as never before. One in six women of childbearing age in the United States has blood mercury levels exceeding the "safe" levels recommended by the EPA.

More than 600,000 babies are born every year at risk of mercury-related birth defects, including mental retardation, learning disabilities, permanent neurological damage, and physical malformations.

In adults, mercury exposure can bring on high blood pressure, cause tremors, and lead to infertility and liver and brain damage.

Mercury is everywhere. In the canned tuna from your local grocery store. In the salmon, shrimp, and shellfish you order at the restaurant. Forty-four states have posted warnings about mercury contamination in their lakes, streams, and rivers.

Take action. Go to *www.pcrm.org* to send an email to the federal Dietary Guidelines Advisory Committee. Tell them that our health and the health of our children come first. Or write a letter to:

Dr. Janet King
Chair, Dietary Guidelines Advisory Committee
Department of Health and Human Services
200 Independence Avenue, SW, Room 738G
Washington, DC 20201 Fax: 202-205-0463

PCRM PHYSICIANS COMMITTEE FOR RESPONSIBLE MEDICINE
WASHINGTON OFFICE PHONE: 202-686-2210

Don't let the government tell you a fish story.

BraiN Washed?

Did you see this fishy ad last week?

Animal rights activists are attempting to scare Americans away from some of the healthiest foods on the menu. The American Heart Association says omega-3 fatty acids make fish a must-eat food at least twice a week. But last week the ad pictured at the right implied that all fish are dangerous to eat.

Why would an organization calling itself the "Physicians Committee for Responsible Medicine" (PCRM) run scary anti-fish ads in national newspapers? For starters, PCRM has undeniable connections to People for the Ethical Treatment of Animals (PETA), which has already steered over $1.3 million to the organization.

Yes, *that* PETA. The animal rights nuts who don't want us to eat beef, chicken, pork, eggs, dairy foods or fish. No matter what.

PCRM has been publicly rebuked by the American Medical Association for misrepresenting medical science. PCRM's president is a non-practicing psychiatrist, and also president of the PETA Foundation. And 95 percent of PCRM's members aren't doctors at all.

Some PCRM spokespersons endorse violence against people who don't see the world their way. At a 2003 animal-rights convention, one of them advocated murdering doctors who use animals in their research for cancer and AIDS cures.

Animal rights extremism is felt everywhere. And some of it masquerades as health advice.

Visit **www.ConsumerFreedom.com** to learn how animal rights activists use junk science, promote violence, and even set up pseudo-medical charities in order to further their crusade. Help this cause by donating online to the nonprofit **Center for Consumer Freedom**.

Don't let animal rights activists brainwash you with fish stories.

USA TODAY

TOXIC LEGACY Fishing with caution October 29, 2007

As many as 600,000 babies may be born in the USA each year with irreversible brain damage because pregnant mothers ate mercury-contaminated fish, the Environmental Protection Agency says. Medical researchers are just beginning to explore such mercury exposure in adults, which can leave some people struggling through life in a disorienting "fish fog." Nationwide, more than 8,000 lakes, rivers and bays are compromised by mercury's toxic effects.

Outrageous claim:

"600,000 born annually with brain damage due to fish-eating mothers"

Expert Consultation on the Risks and Benefits of Fish Consumption

- Request from Codex Alimentarius
- Held in Rome January 2010

Task

- Review data on nutrient and specific chemical (MeHg and DLCs) contaminant levels in a range of fish species
- Review recent scientific literature covering the risks and benefits of fish consumption
- Consider risk-benefit assessments for specific end-points of benefits and risks

Intention

- Provide guidance to national food safety authorities and the Codex Alimentarius Commission on managing risks related to eating fish, taking into account the existing data on the benefits of eating fish

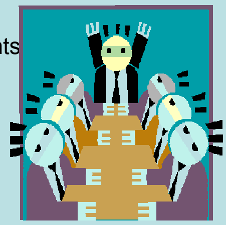
FAO/WHO Expert Consultation Terms of Reference:

- Assessment of the health risks associated with the consumption of fish and other seafood
- Assessment of the health benefits of fish and other seafood consumption
- Comparison of the health risks and health benefits of fish and other seafood consumption
- Develop a methodology for carrying out quantitative assessments of the risks and benefits related to seafood consumption

FAO/WHO Expert Consultation on the Risks and Benefits of Fish Consumption
25-29 January 2010

Experts

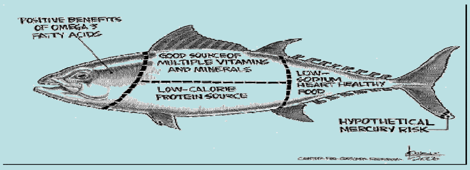
- 17 experts representing 11 countries and 5 continents
- Expertise in nutrition, toxicology, epidemiology, dietary exposure and risk-benefit assessments



There is convincing evidence that:

- LCn-3PUFA (DHA) is important for optimal brain development during gestation and infancy.
- Maternal fish consumption during gestation and nursing lowers the risk of suboptimal brain development in their children.

- Maternal MeHg intake during gestation increases the risk of suboptimal brain development in their children.
- Based on quantitative risk-benefit analysis of DHA and MeHg, the neurodevelopmental risks of not eating fish exceed the risks of eating fish under most circumstances evaluated.



MeHg and DHA/EPA

- Decided to conduct a comparison between the effects of prenatal exposure to LC n-3 PUFA and MeHg on child IQ
- Establish a dose-response relationship from multiple cohort studies

→ quantitative risk-benefit analysis

MeHg Risks

- Three meta-analyses studies
  - Faeroe Islands
  - Seychelles
  - New Zealand
- Assumptions:
  - Serving size 100g
  - Body weight 60 kg
  - Ratio Hg in hair and daily MeHg intake (μg/kg body weight/day) is 9.33

PUFA Benefits

- Four analyses considered
  - Cohen et al. 2005
  - FDA 2010
  - Oken et al. 2008
  - Oken et al. 2008
- Some assumptions:
  - 28 g fish gives 100 mg DHA (average)
  - DHA ratio of LC n-3 PUFA = 0.67

IQ increase/decrease

- 4 IQ points gain per 100mg/day DHA, maximum gain 5.8 IQ points
- 0.18 (central estimate) to 0.7 (upper limit) IQ points decrease per μg/g MeHg in maternal hair

Estimated changes in child IQ

2x 100g fish / week		EPA + DHA			
		x≤ 3 mg/g	3<x≤8 mg/g	8<x≤15 mg/g	x>15 mg/g
Methyl mercury	x≤0.1 μg/g	−0.04, −0.2 +1.5	−0.04, −0.2 +4.2	−0.04, −0.2 +5.8	−0.04, −0.2 +5.8
	0.1<x≤ 0.5 μg/g	−0.2, −0.9 +1.5	−0.2, −0.9 +4.2	−0.2, −0.9 +5.8	−0.2, −0.9 +5.8
	0.5 <x≤1 μg/g	−0.6, −2.3 +1.5	−0.6, −2.3 +4.2	−0.6, −2.3 +5.8	−0.6, −2.3 +5.8
	x >1 μg/g	−1.2, −4.7 +1.5	−1.2, −4.7 +4.2	−1.2, −4.7 +5.8	−1.2, −4.7 +5.8

Estimated changes in child IQ

4x 100g fish / week

Methyl mercury	EPA + DHA: $x\leq 3$ mg/g	$3<x\leq 8$ mg/g	$8<x\leq 15$ mg/g	$x>15$ mg/g
$x\leq 0.1$ µg/g	−0.08, −0.31 +3.1	−0.08, −0.31 +5.8	−0.08, −0.31 +5.8	−0.08, −0.31 +5.8
$0.1<x\leq 0.5$ µg/g	−0.48, −1.9 +3.1	−0.48, −1.9 +5.8	−0.48, −1.9 +5.8	−0.48, −1.9 +5.8
$0.5<x\leq 1$ µg/g	−1.2, −4.7 +3.1	−1.2, −4.7 +5.8	−1.2, −4.7 +5.8	−1.2, −4.7 +5.8
$x>1$ µg/g	−2.4, −9.3 +3.1	−2.4, −9.3 +5.8	−2.4, −9.3 +5.8	−2.4, −9.3 +5.8

Estimated changes in child IQ

7x 100g fish / week

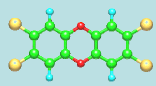
Methyl mercury	EPA + DHA: $x\leq 3$ mg/g	$3<x\leq 8$ mg/g	$8<x\leq 15$ mg/g	$x>15$ mg/g
$x\leq 0.1$ µg/g	−0.14, −0.5 +5.4	−0.14, −0.5 +5.8	−0.14, −0.5 +5.8	−0.14, −0.5 +5.8
$0.1<x\leq 0.5$ µg/g	−0.84, −3.3 +5.4	−0.84, −3.3 +5.8	−0.84, −3.3 +5.8	−0.84, −3.3 +5.8
$0.5<x\leq 1$ µg/g	−2.1, −8.2 +5.4	−2.1, −8.2 +5.8	−2.1, −8.2 +5.8	−2.1, −8.2 +5.8
$x>1$ µg/g	−4.2, −16.3 +5.4	−4.2, −16.3 +5.8	−4.2, −16.3 +5.8	−4.2, −16.3 +5.8

EPA + DHA by total mercury

Methyl mercury	EPA + DHA: $x\leq 3$ mg/g	$3<x\leq 8$ mg/g	$8<x\leq 15$ mg/g	$x>15$ mg/g
$x\leq 0.1$ µg/g	**Fish:** butterfish; catfish; cod, Atlantic; cod, Pacific; croaker, Atlantic; haddock; pike; plaice, European; pollock; saithe; sole; tilapia **Shellfish:** clams; cockle; crawfish; cuttlefish; oysters; periwinkle; scallops; scampi; sea urchin; whelk	**Fish:** flatfish; John Dory; perch, ocean and mullet; sweetfish; wolf fish **Shellfish:** mussels; squid	**Fish:** redfish; salmon, (wild); salmon, Pacific (wild); smelt **Shellfish:** crab, spider; swimcrab	**Fish:** anchovy; herring; mackerel; rainbow trout; salmon, (farmed); sardines; sprat **Fish liver:** cod, (liver); saithe (liver) **Shellfish:** crab (brown meat)
$0.1<x\leq 0.5$ µg/g	**Fish:** anglerfish; catshark; dab; grenadier; grouper; gurnard; hake; ling; lingcod and scorpionfish; Nile perch; pout; skate/ray; snapper, porgy and sheepshead; tuna, yellowfin; tusk; whiting **Shellfish:** lobster; lobster, American	**Fish:** bass, freshwater; carp; perch, freshwater; scorpion fish; tuna; tuna, albacore **Shellfish:** crab; lobster, ; lobsters, spiny	**Fish:** bass, saltwater; bluefish; goatfish; halibut, Atlantic (farmed); halibut, Greenland; mackerel, horse; mackerel, Spanish; seabass; seabream; tilefish, Atlantic; tuna, skipjack	**Fish:** eel; mackerel, Pacific; sablefish
$0.5<x\leq 1$ µg/g	**Fish:** marlin; orange roughy; tuna, bigeye	**Fish:** mackerel, king; shark	**Fish:** alfonsino	**Fish:** tuna, Pacific bluefin
$x>1$ µg/g		**Fish:** swordfish		

Dioxin-Like Compounds (DLC)

– Fish and EPA+DHA consumption lower the risk of CHD mortality.



– High DLC exposure increases the risk of cancer.

– Established CHD mortality benefits exceed theoretical upper estimate cancer risks for all frequencies and categories of fish consumption and DLC exposure evaluated.

Estimated changes in mortality (per million people)

7x 100g fish / week

Dioxins	EPA + DHA: $x\leq 3$ mg/g	$3<x\leq 8$ mg/g	$8<x\leq 15$ mg/g	$x>15$ mg/g
$x\leq 1.0$ pg/g	+330 −31 900	+330 −39 800	+330 −39 800	+330 −39 800
$1.0<x\leq 4.0$ pg/g	+4200 −31 900	+4200 −39 800	+4200 −39 800	+4200 −39 800
$4.0<x\leq 8.0$ pg/g	+10 000 −31 900	+10 000 −39 800	+10 000 −39 800	+10 000 −39 800
$x>8.0$ pg/g	+33 300 −31 900	+33 300 −39 800	+33 300 −39 800	+33 300 −39 800

EPA + DHA dioxins

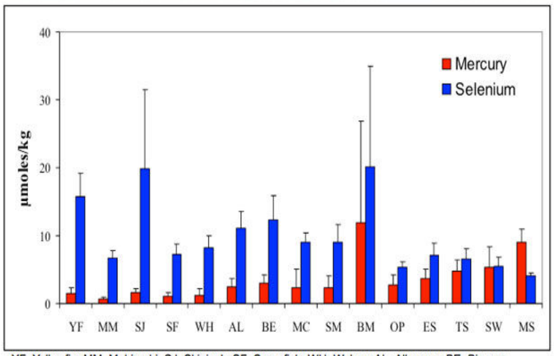
Dioxins	EPA + DHA: $x\leq 3$ mg/g	$3<x\leq 8$ mg/g	$8<x\leq 15$ mg/g	$x>15$ mg/g
$x\leq 1.0$ pg/g	**Fish:** anglerfish; catshark; cod, Atlantic; grenadier; haddock; hake; ling; marlin; orange roughy; pollock; pout; saithe; skate/ray; sole; tilapia; tuna, bigeye; tuna, yellowfin; tusk; whiting **Shellfish:** cockle; clams; crawfish; cuttlefish; periwinkle; scallops; scampi; sea urchin	**Fish:** flatfish; John Dory; perch, ocean and mullet; shark; sweetfish; tuna, albacore	**Fish:** redfish; salmon, Pacific (wild); tuna, skipjack	
$1.0<x\leq 4.0$ pg/g	**Fish:** catfish; dab; gurnard; plaice, European **Shellfish:** lobster; oysters; scallops; whelk	**Fish:** scorpion fish; swordfish; tuna **Shellfish:** mussels; squid	**Fish:** alfonsino; goatfish; halibut, Atlantic (farmed); halibut, Greenland; mackerel, horse; salmon, (wild); seabass; seabream	**Fish:** anchovy; herring; mackerel; mackerel, Pacific; rainbow trout (farmed); salmon, (farmed); tuna, Pacific bluefin **Shellfish:** crab (brown meat)
$4.0<x\leq 8.0$ pg/g			**Shellfish:** crab, spider	**Fish:** sardines; sprat
$x>8.0$ pg/g			**Fish:** bluefish	**Fish:** eel **Fish liver:** cod, (liver); saithe (liver)

Factors that might affect risks and benefits of consuming fish and sea mammals

- Position in the food chain
- Age of animal to be eaten
- Fatty acid composition
- Micronutrient content, such as selenium

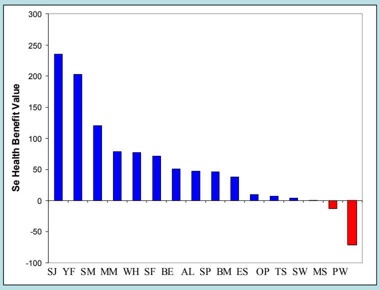
SELENIUM IN THE MERCURY ISSUE

- Methylmercury toxicity does not appear to occur when selenium is present in molar excess of mercury in tissues.
- Methylmercury toxicity occurs because mercury is an irreversible inhibitor of selenoenzymes.
- Biochemical effects of mercury toxicity correspond with expected effects of diminished selenoenzyme activities.
- Selenium-dependent protection against mercury toxicity supports the hypothesis that selenium sequestration is the primary molecular mechanism of mercury toxicity.
- Consumption of selenium-rich ocean fish prevents mercury toxicity rather than contributes to it.
- Consumption of high-mercury, selenium-poor freshwater fish may be far more toxic than is currently expected.



YF=Yellowfin; MM=Mahimahi; SJ=Skipjack; SF=Spearfish; WH=Wahoo; AL=Albacore; BE=Bigeye; MC=Monchong; SM=Striped Marlin; BM=Blue Marlin; OP=Opah; ES=Escolar; TS=Thresher Shark; SW=Swordfish; MS=Mako Shark

Selenium Health Benefit Values



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To minimize risks in target populations, the committee recommends that member states should:

- Acknowledge fish consumption as an important food source of energy, protein, and a range of essential nutrients and part of the cultural traditions of many peoples.
- Emphasize the CHD mortality benefits of fish consumption (and CHD risks of not eating fish) for the general adult population.
- Emphasize the neurodevelopment benefits to offspring through women of childbearing age, pregnant women, and nursing mothers consuming fish and the associated neurodevelopment risks to offspring through such women not consuming fish.
- Develop, maintain, and improve existing databases on specific nutrients and contaminants in fish consumed in their region.
- Develop and evaluate risk management and communication strategies that both minimize risks and maximize benefits from eating fish.

Regional differences

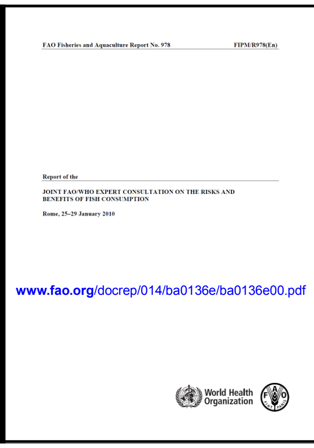
- Nutrients including LCn-3PUFA and contaminants in fish including MeHg and especially DLCs can have large regional differences.
- It is critical that national and regional authorities have specific information on nutrients and contaminants in fish consumed in their region.

CONCLUSIONS

- Consumption of fish provides energy, protein, and a range of essential nutrients, including the long-chain n-3 poly unsaturated fatty acids (LC n-3 PUFA's).
- Eating fish is part of the cultural traditions of many peoples and in some populations is a major source of food and essential nutrients.
- Among the general adult population, consumption of fish, particularly oily fish, lowers the risk of coronary heart disease (CHD) mortality. There is absence of probable or convincing evidence of CHD risks of MeHg. Potential cancer risks of DLCs are well below established CHD benefits.

- Among women of childbearing age, considering benefits of LC n-3 PUFA's vs. risks of MeHg: fish consumption lowers the risk of suboptimal neurodevelopment in their offspring compared to not eating fish in most circumstances evaluated.
- At levels of maternal DLC intake (from fish and other dietary sources) that do not exceed the provisional tolerable monthly intake (PTMI) of 70 picograms/kg bodyweight/month established by JECFA, the neurodevelopmental risk is negligible. At levels of maternal DLC intake (from fish and other dietary sources) that exceed the PTMI, neurodevelopmental risk may no longer be negligible.

- Among infants, young children, and adolescents, the data available were insufficient to derive a quantitative framework of health risks and benefits of eating fish. However, healthy dietary patterns that include fish established early in life influence dietary habits and health during adult life.


FAO Fisheries and Aquaculture Report No. 978 FIPM/R978(En)

Report of the

JOINT FAO/WHO EXPERT CONSULTATION ON THE RISKS AND BENEFITS OF FISH CONSUMPTION

Rome, 25–29 January 2010

www.fao.org/docrep/014/ba0136e/ba0136e00.pdf

World Health Organization