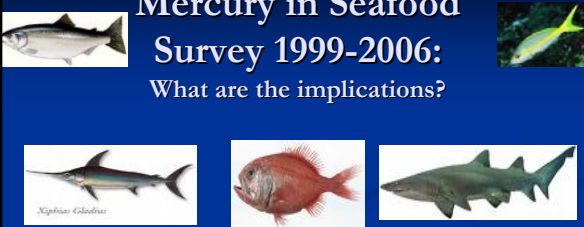


Mercury in Seafood Survey 1999-2006: What are the implications?



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How Mercury Gets To Your Table

Major Sources

- Combustion of Fossil Fuels* (**deposition update**)
- Mining and Smelting of Metals (**Haber Gold Process: green electrochemical process success in Ghana exp.**)
- Cement Kilns
- Incineration of Waste
- Cremation (**dental amalgams ~50% mercury** VT to not allow use of hg in fillings**)
- Volcanic Activity and Wildfires

*Especially coal burning power plants
** Burlington Free Press 03/22/06

How Mercury Gets To Your Table

Environmental Fate

Bacteria convert mercury to methylmercury, a highly toxic form of mercury

Methylmercury is most highly concentrated in large predatory fish (bioaccumulates)

- Mercury blood levels are correlated to dietary intake

several studies inc. Hightower J., Moore, D., EHP 2003

Metabolism and Toxicity of Methylmercury

- Methylmercury is absorbed by the gastrointestinal system with greater than 90% efficiency
- It has a half life of 40-90 days in the blood
- It is excreted through breast milk, feces and urine
- Mercury binds -SH groups of proteins and amino acids. This allows it to easily enter cells and interfere with protein synthesis

Mercury: Cells and Disease

- Methylmercury exposure can increase the oxidative state of the cell and this can interfere with cell proliferation and differentiation pathways. (Zibo, Li et. al., 2007 PLOS Biology)
- Developmental Disease: After reviewing mercury exposure studies from the Faroe Islands, Seychelle Islands and New Zealand, Axelrad et. al. determined that for every ppm of mercury exposure found in cord blood IQ dropped 0.18 points. (Axelrad et. al. EHP, 115, n.4, 2007, p.609)
- Neurological Disorders: Rat cells from the cortex and the granule layer of the cerebellum were poisoned with MeHg+ Protein synthesis did not return to the granular layer cells

Mercury may Counteract Omega 3 Fatty Acid Benefits

- Heart Disease Men
Several studies
- Shorter term pregnancies (> 35 weeks)
MI study of 1024 women, 5 communities central and southern MI (rural, suburban, urban)
More data needed. Longer term studies more diversified groups.

Jukka T. Salonen, MD, PhD, MScPH, et. al., Intake of Mercury From Fish, Lipid Peroxidation, and the Risk of Myocardial Infarction and Coronary, Cardiovascular, and Any Death in Eastern Finnish Men, Circulation, v. 91, 645-655, 1995.

Xue, F. et al., Maternal Fish Consumption, Mercury Levels and Risk of Preterm Delivery, EHP online <http://dx.doi.org>, doi:10.1289/ehp.9329

Dietary Exposure Case Studies

Major Studies

- Faroe Islands (USEPA used for Rfd determinations)
- Seychelles Islands
- New Zealand
- Hightower, Moore *
- NHANES 1999-2000 *

EPA Reference Dose (Rfd)/FDA Action Limit

- USEPA Rfd is 0.1 ug/kg body weight/day (NRC, Faroe Island)
- USEPA Rfd for blood levels 5.8 ug/L
- FDA has a 1 ppm action limit

FDA does not have a mercury tolerance for fish

Hightower and Moore The wine and cheese group

- San Francisco doctor of internal medicine notices patients with symptoms consistent with high mercury exposures
 - 720 patient filled out dietary surveys
 - 89 patients had their blood level data statistically analyzed (128 patients blood was analyzed)
 - Blood levels range 2.0 ug/L – 89 ug/L
 - Consumption of swordfish had the highest correlation to high mercury blood levels
 - Blood levels reduced with dietary changes
 - Above 50 ug/L toxic symptoms may occur

Hightower, JM, Moore D., Mercury levels in high-end consumer fish, EHP, 111:604-608 2003.

NHANES 1999 – 2000

National Health and Nutrition Examination Survey

- The study was conducted by the CDC and designed to look at health and nutritional status of children and adults. Mercury was added in 1999.
- 1250 children 1-5 years old and 2314 women from 16-49 years old
- 8% of women had blood levels above the EPA reference dose (Rfd 5.8 ug/L)

NHANES 1999 and 2000

- According to an evaluation of this study more than 600,000 infants are exposed to mercury levels considered to be higher than levels “without risk” each year (above the Rfd)
- Women who consumed 9 meals of fish within a 30 day period had mercury levels 7x greater than those that had not consumed fish within a 30 day period

Mahaffey, Kathryn R., et al., Blood Organic Mercury and Dietary Mercury Intake National Health and Nutrition Examination Survey, EHP, 112:562-570, 2004.

Method

- A serving size portion of fish is ground in a Robot Coupe
- 0.5 g of fish are closed vessel microwave digested in nitric acid
- Analysis is performed on a ICP MS
- All samples are analyzed in duplicate

Mercury Concentration Data 1999-2006

All You Ever Wanted to Know About Canned Tuna



Skipjack 7-22 lbs, light meat

Albacore 20-45 lbs, white meat

Yellowfin up to 300 lbs, light meat

Tongol: 30-45 lbs line caught Indian Ocean Pacific
Ocean white meat



Canned Tuna

(canned tuna is the second most commonly consumed seafood product)

- Light Tuna:
 - Skipjack tuna weigh 10-20 lbs and yellowfin tuna can weigh over 300 lbs
 - 138 samples of light tuna were analyzed and had an
 - Average concentration of 0.206 ppm
 - Results range BQL-0.963 ppm
- Albacore weigh up to 60 lbs
- 89 samples of white tuna were analyzed
 - Average mercury concentration 0.354 ppm
 - Results range BQL- 0.771 ppm

© 2007 EPA, averaged by species, 1999-2006 ppm

Fresh and Frozen Tuna

- 107 samples fresh or frozen tuna were analyzed
 - Average mercury concentration 0.487 ppm
 - Mercury concentration range 0.106 ppm-2.25 ppm

Grouper

- 39 samples fresh or frozen grouper were analyzed
 - Average mercury concentration 0.340 ppm
 - Mercury concentration range 0.028 ppm-1.3 ppm

Red Snapper vs. Smaller Snapper Species: Does Size Matter ?

- Sixteen red snapper were analyzed and had an average concentration of 0.271 ppm. Results ranged from 0.052-0.778 ppm. It is not uncommon for red snapper to weigh over 30 lbs
- Twenty-three snapper that were either yellowtail, lane or vermillion snapper had an average concentration of 0.110 ppm. Results ranged from 0.034-0.221 ppm. These smaller snapper species average less than 2 lbs.



Shark

- 11 samples analyzed
 - Average mercury concentration 2.58 ppm
 - Mercury concentration range 0.86 ppm – 4.02 ppm

All but one sample analyzed was above the FDA action level



Swordfish

- 52 samples analyzed
 - Average mercury concentration 1.53 ppm
 - Mercury concentration range 0.67 ppm – 3.32 ppm

36 of the 52 (69%) samples analyzed were above the FDA action level



Orange Roughy

- 14 samples analyzed
 - Average mercury concentration 0.868 ppm
 - Mercury concentration range 0.278 ppm – 1.66 ppm
 - 4 samples were above 1.0 ppm (~ 29%)

Implications

AMA Concerns

In 2004 the American Medical Association advised physicians to educate their patients on issues of mercury in seafood

(<http://www.ama-assn.org/ama/pub/category/13619.html>)

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
and Young Children

Albacore or white tuna has more mercury than light tuna; eat only 1 six ounce meal/week

For this document go to:
www.cfsan.fda.gov/~dms/admehg3.html

Health Canada Sets Mercury Limits for Fish

March 30, 2007

- Fresh or frozen shark, swordfish, orange roughy, tuna, escolar and marlin will not be allowed to be sold in stores if they contain more than 1 ppm mercury
- Earlier this year Health Canada issued an advisory warning people not to eat too much albacore tuna because of elevated mercury
- Health Canada also emphasized that fish is an important dietary component and 2 servings of fish low in mercury should be eaten weekly

Avoid

The Institute of Medicine and the Harvard Medical School have said:

Swordfish, shark, tilefish, and king mackerel should be avoided by pregnant women, women that may become pregnant, nursing mothers, and kids under 12

Nesheim, M et., al., ed. Seafood Choices Balancing Benefits and Risks. 2007.

Intelligent Selection: What can I eat if I want to reduce my exposure mercury ?

What Typically Influences the Concentration of Mercury in Fish

- Environment: Fish found in waters with high levels of methylmercury have higher concentration of mercury
 - Subsistence and recreational fishermen may have a higher mercury exposure
- Size: Larger fish tend to have higher concentrations of mercury
- Feeding Habits: Fish higher in the food chain have higher concentrations of mercury

Risks vs. Benefits

Eicosapentaenoic (EPA) and Docosahexaenoic acid (DHA) vs. mercury

- Omega 3 fatty acids benefits
 - Longer term births and neurological development
 - Heart healthy
 - May relieve ADHD symptoms in children 7-12
 - May reduce the instance of depression
 - Seafood low in mercury high in omega 3 fatty acids (DHA +EPA)
 - Farmed Salmon
 - Atlantic herring
 - Wild Salmon
 - Oysters (1/3 the amount of DHA+EPA compared to wild salmon)
 - Shrimp (1/2 the amount of oysters)
- Natural ratios of EPA and DHA and other nutrients found in seafood appear to be an important health aspect

Mozaffarian, D et., al., JAMA, v296, n15, p 1885.

Seafood

Choices: Balancing Benefits and Risks, Food and Nutrition Board, Nat'l Academies Press, 2006.

Norwegian Study Fishdate.com 6/13/07

Conclusions

- When consuming fish choose fish that are lower in the food chain; smaller species and smaller fish within a species.
- Commonly eaten seafood products that tend to have lower levels of mercury are; shrimp, salmon, oysters, small snapper, crabmeat and light tuna
- Follow FDA/EPA guidelines and advice issued by your state

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Disclaimer:

The conclusions are the author's and not the opinions of the
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