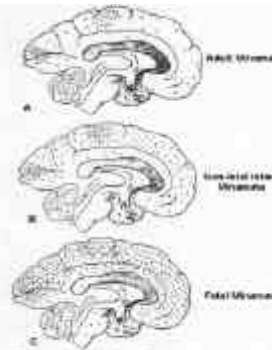


## Health Implications of Methylmercury in Fish and Seafood

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The super-greens base their misinformation on a problematic study of Faroe Island children. The Faroe mothers also consumed enormous amounts of mercury, though from seafood (such as whale) most Americans don't eat... Moreover, the U.S. mercury "safety" level (which the EPA unfortunately sets off the Faroe study) is one-tenth that of the smallest amount of mercury connected with a lower Faroe test score. A Food and Drug Administration official has pointed out that even women who are over the U. S. limit still have an eight-fold margin of safety. All this science is compiled neatly at the Center for Science and Public Policy ([www.scienceandpolicy.org](http://www.scienceandpolicy.org)).

The frequent claim of adverse neurodevelopmental harm to young children from exposure of methylmercury through fish consumption is based on unconfirmed and unresolved evidence from a study of Faroe Island children... "No evidence of adverse effect from either pre- or post-natal exposure to methyl mercury," is how Thomas W. Carson of the University of Rochester School of Medicine characterizes the results of an ongoing study of children in the Seychelles Islands... A smaller study of Faroe Islands children reported only "subtle" (invisible?) effects at the same levels of exposure.



Poisoning at high doses causes focal damage

Poisoning at lower doses causes more widespread damage

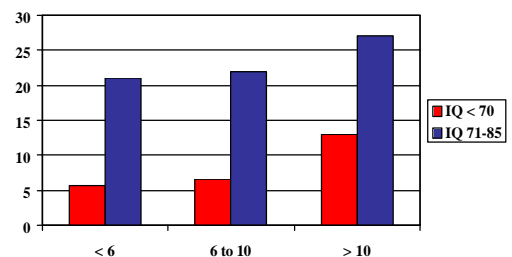
Poisoning at low doses (the mother is healthy) causes diffuse damage

## Cross-sectional studies:

Mercury effects mainly on attention, motor coordination and speed, visuospatial function, and brainstem auditory evoked potentials

- Canada (McKeown-Eyssen et al., 1983)
- Peru (Marsh et al., 1995)
- Ecuador (Counter et al., 1998)
- Madeira (Murata et al. 1999)
- Brazil (Grandjean et al., 1999)
- French Guyana (Cordier et al., 2002)
- Greenland (Weihe et al., 2002)
- Philippines (Ramirez et al., 2003)
- Japan (Murata et al., 2003)

## New Zealand study: Prevalence of low IQ (%) at age 7 years in relation to prenatal methylmercury exposure (hair-Hg in µg/g)



### Cofactors in the Seychelles study

- Tropical fish: Variability in Hg content and in essential nutrients
- Maternal alcohol intake from homebrew
- Pesticide exposure: food, residence
- Cassava intake: cyanide exposure
- Hg exposure assessment: sampling time, hair structure and hair treatment
- Test validity and administration
- Family structure: 75% born out of wedlock, 25% without a known father, children accompanied by 'caregiver'

### Faroe Islands

- Homogeneous, western culture
- Scandinavian-type health care and social security
- Traditional food includes pilot whale meat (MeHg) and blubber (POPs)
- Individual reliance on traditional foods varies, depends on seasonal availability, and is weakly associated with confounders

### Assessing developmental neurotoxicity

- Neurotoxicity may not be immediately apparent
- Nervous system must mature to express relevant functions
- Participation in clinical tests difficult at preschool age
- Reversibility or compensation
- Test validity and appropriateness

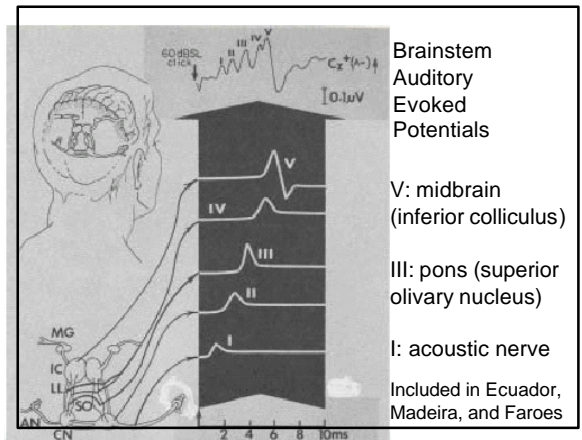
### Mercury effect as delay in development (months, age 7) for each doubling of exposure

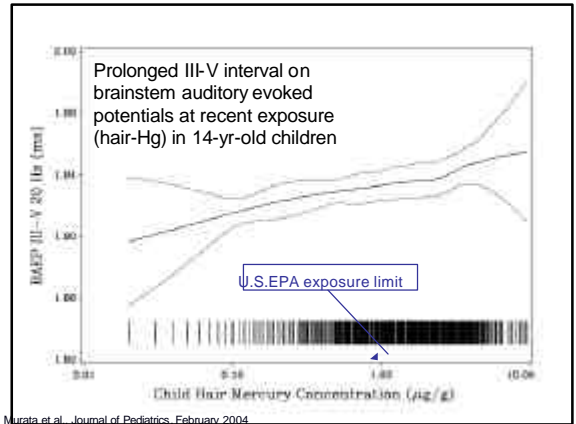
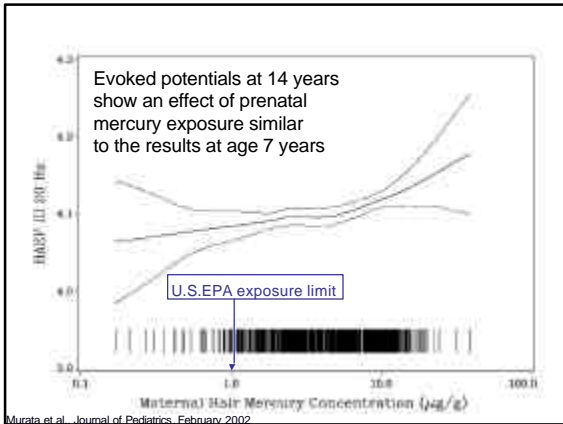
Motor (Finger tapping, PH)	0.9
Attention (CPT-reaction time)	1.3
Visuospatial (Bender errors)	0.6
Language (Boston Naming)	1.6
Verbal memory (CVLT short delay)	2.0
<i>(~10% of s.d. and ~1.5 IQ points)</i>	

### NES2 Continuous Performance Test (animal silhouette version)



- Reaction time as outcome variable
- First minute as practice period
- 4 min at age 7, 10 min at age 14
- Consideration of missed responses
- Dependence on test duration

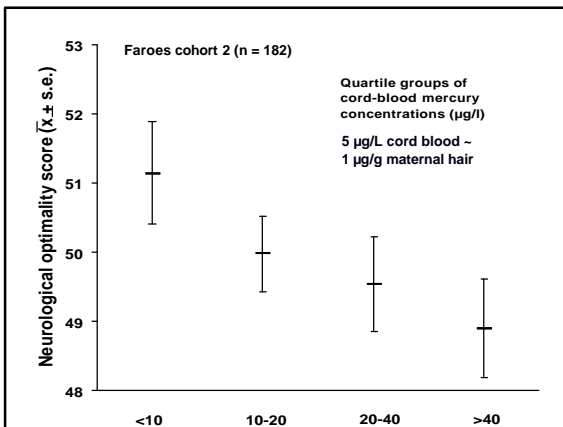
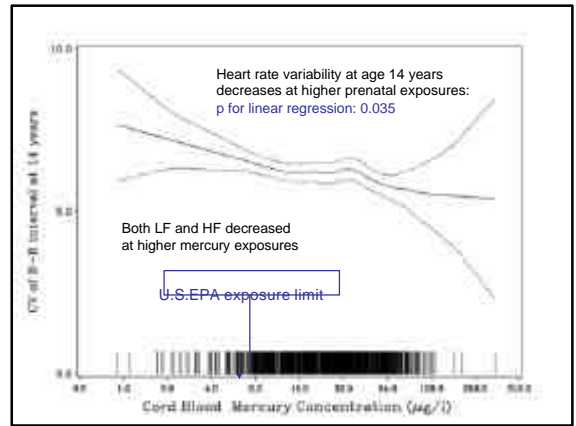




### Heart rate variability

The sinus rhythm shows fluctuations around the mean heart rate due to continuous changes in the sympatho-vagal balance.

Under physiological conditions, frequent small adjustments in heart rate act on cardiovascular control mechanisms, which give rise to periodic fluctuations in heart rate, i.e., respiratory sinus arrhythmia (RSA) at a high frequency (0.15-0.4 Hz), baroreflex-related heart rate variation (Mayer wave related sinus arrhythmia, MWSA) at a low frequency (0.04-0.15 Hz), and thermoregulation-related heart rate variation at a very low frequency (below 0.04 Hz).



### Differences between prospective cohort studies

Attribute	New Zealand	Faroese	Seychelles
Source of exposure	Shark and other large ocean fish	Whale, ocean fish and shellfish	Ocean fish
Exposure assessment	Maternal hair at parturition	Cord blood and maternal hair at birth	Maternal hair < 6 mo after parturition
Concomitant exposures	Lead in house paint and air	PCBs (whale blubber)	Pesticide use in tropics
Language	English (and Pacific languages)	Faroese (and Danish)	Creole (English and French)
Socioeconomic setting	Industrialized Western	Industrialized Scandinavian	Middle-income developing
Family-setting	Urban, mixed cultures	Traditional	Mainly matriarchal
Outcome tests	Omnibus	Domain-related and neurophysiological	Omnibus and domain-related
	Clinical examiners	Clinical specialists	Clinical specialists
			Nurse/student



## Total measurement error by structural equation modeling

	Loading factor	Error variance	CV
Blood	1	0.015	28%
Hair	0.809	0.058	55%

\*log transformed

## The results from the Faroes and the Seychelles do not disagree

Confounder-adjusted linear effect of increase in maternal hair mercury of 10 µg/g on total number of correct responses on the Boston Naming Test at age 7 or 8 years:

Seychelles: -0.012 (95% CI -1.0; 0.8)  
 Faroes: -0.99 (95% CI -1.8; -0.2).  
 (p for difference: 0.16)

Myers et al., Lancet 2003; 361: 1686-92  
 Keiding et al., Lancet 2003; 362: 664-5

## NRC evaluation (2000)

- Study conducted by 10 mercury experts over 18 months
- Interviews of project leaders and stakeholders, peer review of report
- 2004: Conclusions reconfirmed

## JECFA evaluation (2003)

- Experts in toxicology met over 2 weeks, draft prepared in advance
- Summary report released a year later

## Differences between evaluations by NRC and JECFA

- NRC used Faroes data in combination with Seychelles and New Zealand -- JECFA excluded New Zealand
- NRC chose a 'most sensitive' effect -- JECFA chose an 'average' for Faroes-Seychelles
- Both used benchmark dose results, but neither adjusted for imprecision
- NRC applied an uncertainty factor of 10 (individual differences and incomplete data base), JECFA used 3.2 (only for differences in kinetics)

## Population at risk extended to all adults

- Mercury from fish and seafood may promote or predispose to the development of heart disease
- Increase in intima-media thickness of the carotid arteries in apparent association with the degree of mercury exposure from fish (Salonen et al., 2000).
- While essential fatty acids from fish may prevent cardiovascular mortality, this beneficial effect may be cancelled or overwhelmed by concomitant exposure to methylmercury (Rissanen et al., 2000).
- The increased risk seems to occur at hair-mercury concentrations above 2 µg/g, i.e., only twice the level corresponding to the U.S.EPA Reference Dose.
- A multi-center study from Europe showed an increased risk of cardiovascular disease associated with toenail mercury concentrations (Guallar et al., 2002), although mainly due to a particularly strong risk observed in one of the centres.
- A U.S. study of health care workers showed only a minimal overall risk, but after exclusion of the dentists, the risk was similar to the one observed in the European study (Yoshizawa et al., 2002).
- Update of Finnish study confirms findings (Virtanen et al., 2005)



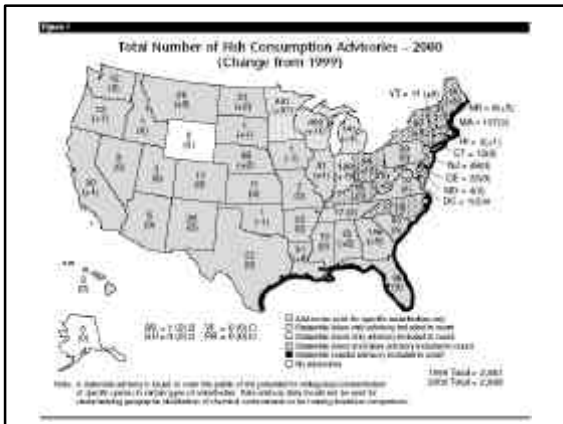
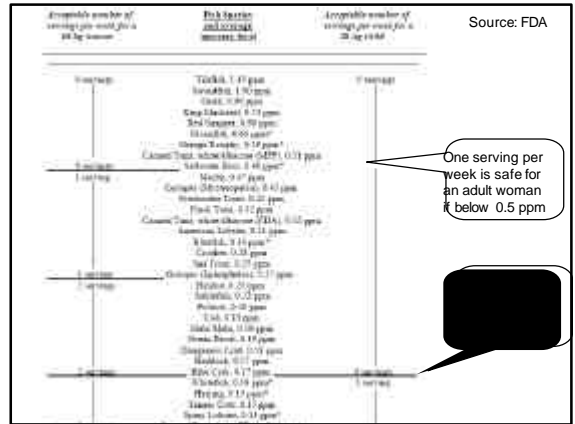
(AHA) recommends:

- Recommends that people eat tuna or salmon twice a week
- The benefits and risks of eating fish vary depending on a person's stage of life.
  - Children, pregnant and nursing women usually have low CVD risk but may be at higher risk of exposure to excessive mercury from fish. Avoiding potentially contaminated fish is a higher priority for these groups.
  - For middle-aged and older men, and women after menopause, the benefits of eating fish far outweigh the risks within the established guidelines of the FDA and Environmental Protection Agency.
  - Eating a variety of fish will help minimize any potentially adverse effects due to environmental pollutants.

### Recommended Fish Meals per Day Based on Methylmercury Fish Tissue Levels

$$CR_{lim} \text{ (kg/day)} = \frac{RfD \times BW}{C_m} \quad (\text{Eq. 3-3})$$

- $CR_{lim}$  Maximum allowable daily fish consumption rate (kg/day)
- RfD Reference dose (.0001 mg/kg-day)
- BW Consumer body weight (65 kg)
- $C_m$  Measured concentration of chemical contaminant "m" in a given species of fish (mg/kg)



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.
  - o Five of the most commonly eaten fish that are low in mercury are shrimp, canned light tuna, salmon, pollock, and catfish.
  - o 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.

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CHEF: Child Health and the Environment in the Faroes  
 URL: [www.chef-project.dk](http://www.chef-project.dk)