Can we maximize nutritional intake while minimizing toxic risk from fish consumption?

An update of our knowledge on mercury and omega-3 fatty acids from marine and fresh-water fish consumption

Donna Mergler PhD

Professor Emerita

Center for Interdisciplinary Research on Biology, Health, Society and Environment (CINBIOSE)

University of Quebec at Montreal

PAHO-WHO Collaborating Center

The Madison Declaration on Mercury Pollution

Henry Anderson, USA
Laurie Chan, Canada
Kathryn Mahaffey, USA
Donna Mergler, Canada
Michael Meyer, USA
Michael Murray, USA
Mineshi Sakamoto, Japan
Mark Sandheinrich, USA
Anton Scheuhammer, Canada
Alan Stern, USA

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The Panel on Health Risks and Toxicological Effects of Methylmercury:
Donna Mergler, Henry A. Anderson, Laurie Hing Man Chan, Kathryn R. Mahaffey, Michael Murray, Mineshi Sakamoto and Alan H. Stern

Methylmercury Exposure and Health Effects in Humans: A Worldwide Concern

- **"Methylmercury is a highly toxic compound that biomagnifies through the aquatic food web, placing at risk humans who consume significant quantities of predatory fish … or who rely heavily on fish as a food source."**
- **"..there is growing evidence that current exposures are sufficient to alter normal function of several physiological and developmental systems.. Long-lasting effects of fetal methylmercury exposure have been described in children throughout the world."**
- **"Current studies suggest that exposure to methylmercury could increase the risk of adverse cardiovascular effects in a significant fraction of the human population."**

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- **"Fish can contain both methylmercury and beneficial omega-3 fatty acids. Methylmercury exerts toxicity and can also diminish the beneficial health effects of omega-3 fatty acids…."**
- **"There is some evidence from animal studies showing that selenite protects against inorganic mercury toxicity. However, there is almost no evidence showing protection against methylmercury toxicity by organo-selenium compounds… found in the human diet."**

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Nervous system effects in children

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- **The panel discussed at length the different findings from the 2 major birth cohort studies in the Faroes and the Seychelles Islands studies:**
  - **The Faroes study has consistently shown associations between cord blood Hg and neurobehavioral deficits and electrophysiological changes up to 14y**
  - **The Seychelles study only showed delayed development in their study among the most highly exposed (mothers' hair Hg) at 9 years old.**

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Recent findings from the Seychelles study

- **Re-analysis of the data from the Seychelles study of the 9 year olds suggests that susceptibility may not be homogeneous:**
  - **Motor proficiency and activity level improved significantly with increasing MeHg for children who had an average home environment.**
  - **However, motor proficiency significantly decreased with increasing prenatal MeHg exposure in children whose home environment was below average.**

(Huang et al, 2008)

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A new Seychelles cohort

- **In a new cohort study the Seychelles, extensive data was obtained on dietary factors that may positively influence neurobehavioral development.**
- **An adverse association between MeHg and the mean Psychomotor Developmental Index (PDI) score at 30 months, when nutritional factors were included in the multiple regression model.**

(Davidson et al, 2008)

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Opposing effects of Hg and fish consumption on neurobehavioral performance in 3 year olds

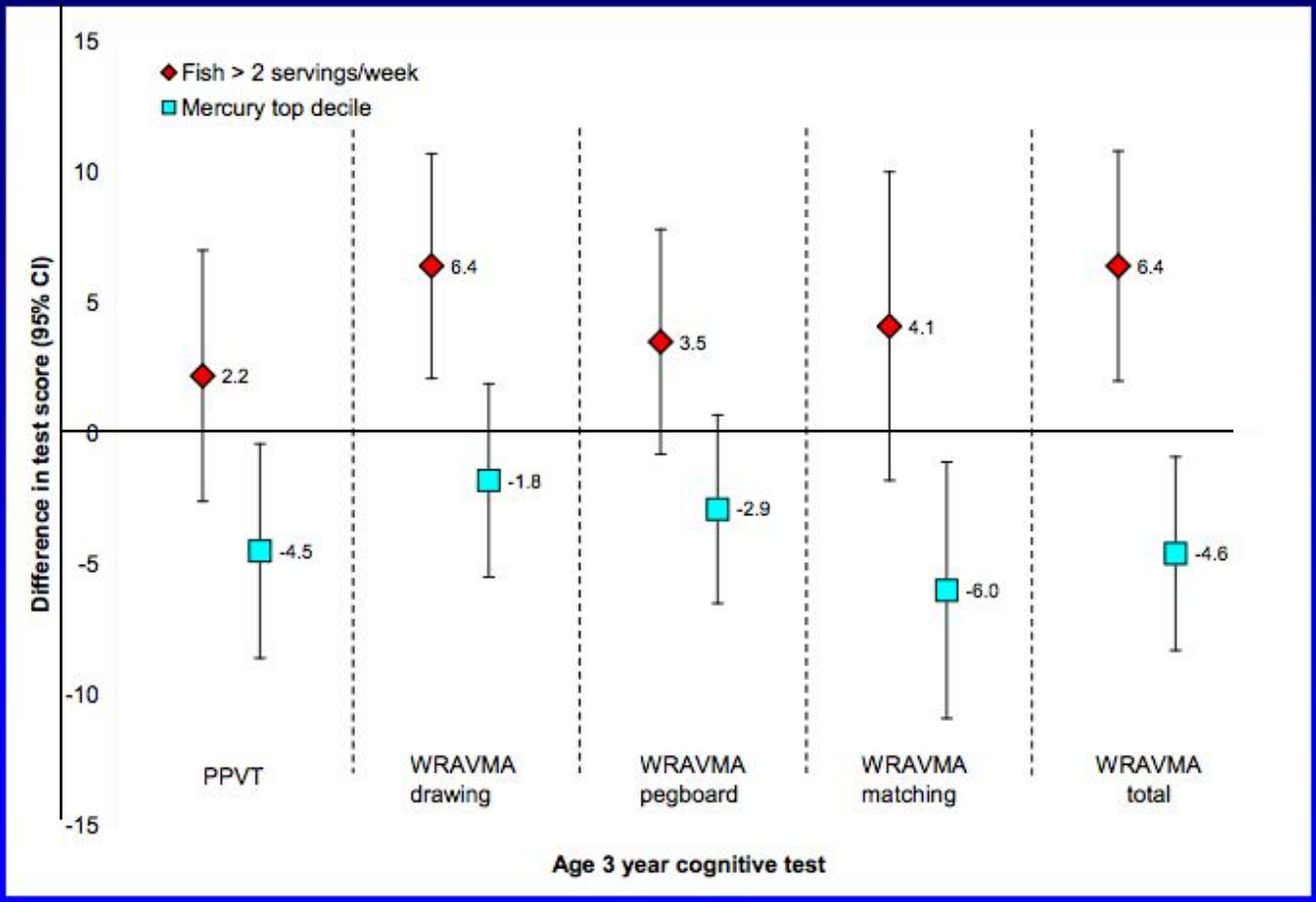
N = 341 mother/child pairs (Massachusetts)

Mean maternal total fish intake :1.5 ± 1.4 servings/week

40 (12%) mothers consumed >2 servings/week

.

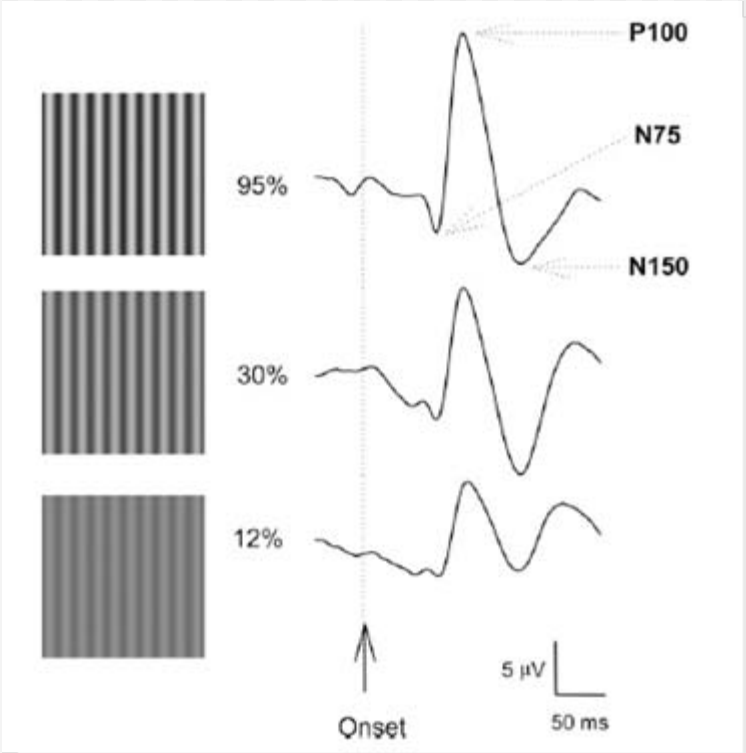
Mean maternal hair mercury level: 3.8 ng/g. Top decile >1.2µg/g



Oken et al. 2008

A study with Inuit children reported Hg-induced electrophysiological changes

- **In Canadian Inuit children, prenatal and current Hg exposure were associated with changes in latencies for Visual Evoked Potentials**



(St-Amour et al, 2006)

Cardiovascular system in adults

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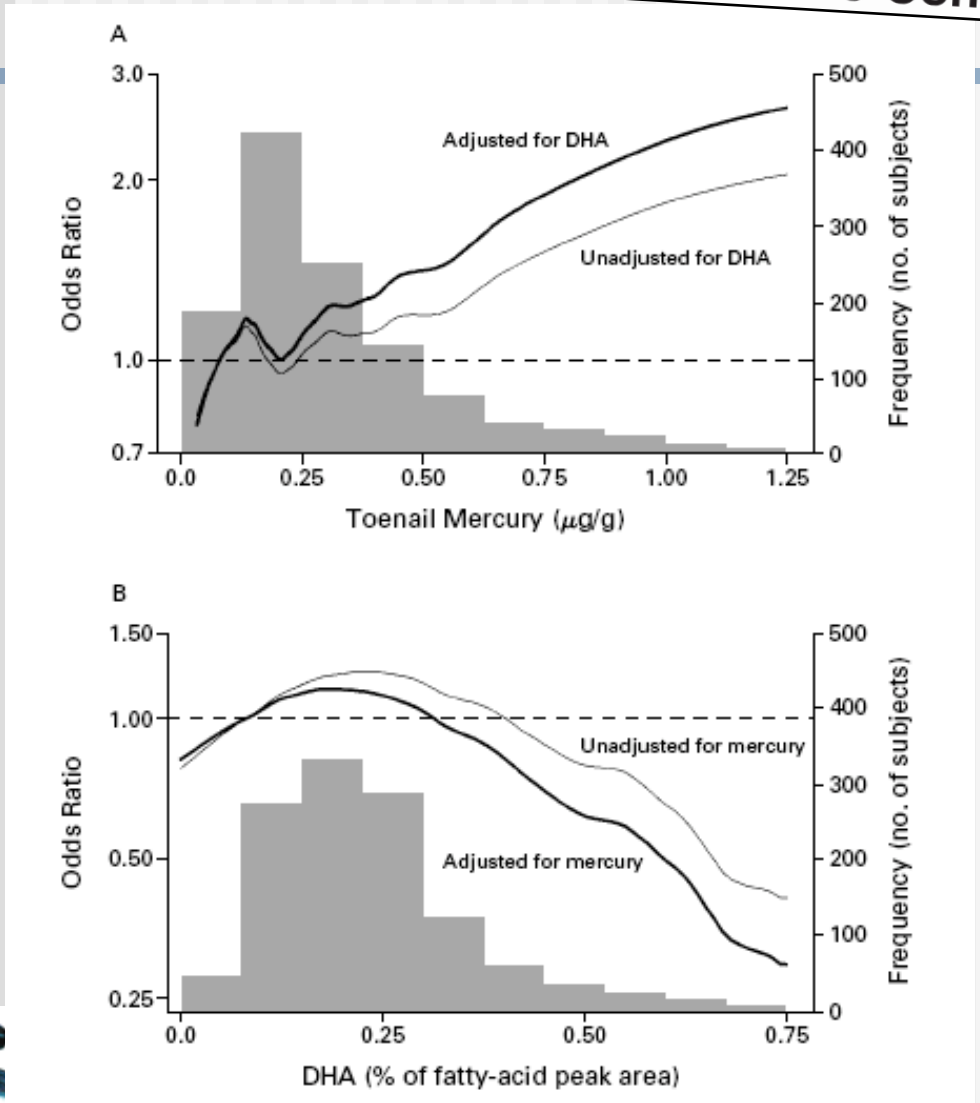

Case control study of 684 men with a first diagnosis of myocardial infarction and 724 controls

(Guallar et al, 2004)

Recent studies on myocardial infarction

- **At the Mercury as a Global Pollutant Meeting in June 2009:**
  - **Jykri Virtanen presented data showing an increased incidence of myocardial infarction in a Finnish longitudinal cohort study in relation to mercury exposure,**
  - **Bengt Vessby presented data from Sweden showing decreased risk with Hg exposure in Swedish study; the authors consider that at these lower exposures, Hg is a proxy for fish consumption**

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Cardiovascular function

- **Blood Hg was associated with changes in heart rate variability (HRV) and increased systolic pressure in Canadian Inuit men and women (Valera et al, 2008)**
- **In Faroese whalers, Hg exposure was associated with increased blood pressure and common carotid intima-media thickness, but HRV was equivocal (Choi et al, 2009)**

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Systolic Blood Pressure in a Canadian Inuit Population (n =731)

	Beta estimate	p
Blood Hg (log)	**+1.27**	**0.05**
Serum %EPA	**- 1.75**	**0.05**
Blood Se	**- 2.80**	**0.03**
Blood Hg (log)	**+2.14**	**0.0004**

- **EPA and Hg did NOT modify the relation between blood Hg and blood pressure (interaction term not significant)**
- **Not adjusting for these elements could underestimate effect size**

Valera et al . Hypertension (in press)

Since the Madison Declaration in 2006

- **Mercury developmental neurotoxicity has been confirmed at very low doses**
- **There is more evidence for mercury-induced cardiovascular alterations and illness**
- **There is growing evidence that omega-3 Fatty Acids (FA) and possibly Selenium (Se) can offset some of the toxic effects of mercury**
- **BUT, is increased fish consumption synonymous with increased omega-3 FA and Se?**

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Nutrients from fish consumption

- There is a lot of information on omega-3 and Se from marine fish

- What about freshwater fish eaters?

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Omega-3 Fatty Acids in serum of freshwater fisheaters

- **Great Lake fish-eaters** (Cole et al, 2002)
  - **No relation between GL fish consumption and serum omega-3 FA for Euro-Canadians (n=45)**
  - **Significant relation between GL fish meals and serum DHA for Asian Canadians (n = 41), but not EPA**
  - **Significant relation between consumption of "other" fish meals and serum omega-3 FA.**
- **Sportfishers (n=112) in the fluvial lakes of the St. Lawrence** (Godin et al, 2003)
  - **No relation between St. Lawrence fish consumption and serum omega-3 FA**

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Fishermen at James Bay, Quebec (n= 31)

	Prior to fishing season (june)	Post fishing season (November)	difference
Blood Hg (nmol/L)	21.9 ± 3.7	35.6 ± 5.2	+ 63%***
Hair Hg (µg/g)	1.4 ± 0.3	2.8 ± 0.4	+100%***
Blood Se (µg/L)	242.9 ± 6.2	247.7 ± 5.6	-
EPA + DHA (%)	4.92 ± 0.20	5.30 ± 0.60 %	-

Bélanger et al, Metabolism Clinical and Experimental 57: 630-636 (2008)

Omega-3 Fatty Acids in serum of freshwater fisheaters

- A study of 259 persons who eat fish from lakes of the St. Lawrence and Abitibi
- Extensive food frequency questionnaire on fish species from local lakes, other lakes and market (frequency and portion = g/day)
- Measures of multiple contaminants, fatty acids and selenium (Se)
- Using published data, omega-3 FA from each species was estimated

(Philibert et al. 2006)

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Results

- Highly significant ($p<0.0001$) relation between fatty fish intake and serum omega-3 F
- Highly significant ($p<0.0001$) relation between estimated omega-3 FA intake and serum omega-3 FA
- No relation between local catch consumption and serum omega-3 FA
- No relation between estimated omega-3 FA intake from local catch consumption and serum omega-3 FA

(Philibert et al. 2006)

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Fish consumption and biomarkers

	mean intake (g/day)	% EPA + DHA	Blood Se (µg/L)	Hair Hg (µg/g)
Total fish	57.1 ± 64.9 (3.26 - 641)	ns	ns	↑ **
Local catch	26.7 ± 59.9	ns	ns	↑ ***
Lean marine	18.2 ± 18.4	ns	ns	ns
Fatty marine	6.09 ± 8.70	↑ *	↑ **	ns
Trout	1.63 ± 3.77	↑ *	ns	↑ **

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A conundrum

- This group ate on average 57 g/day of fish (median: 40 g/day)
- Based on published estimates of EPA and DHA in fish species, mean EPA + DHA intake would be 225 mg/d ± 202 (median: 171 mg/day)
- But: EPA+ DHA levels were low: 0.12 mg/mL ± 0.07
- The % EPA + DHA in fatty acids were : 2.1% ± 1
- Overall, there was no relation between estimated intake and serum EPA+DHA

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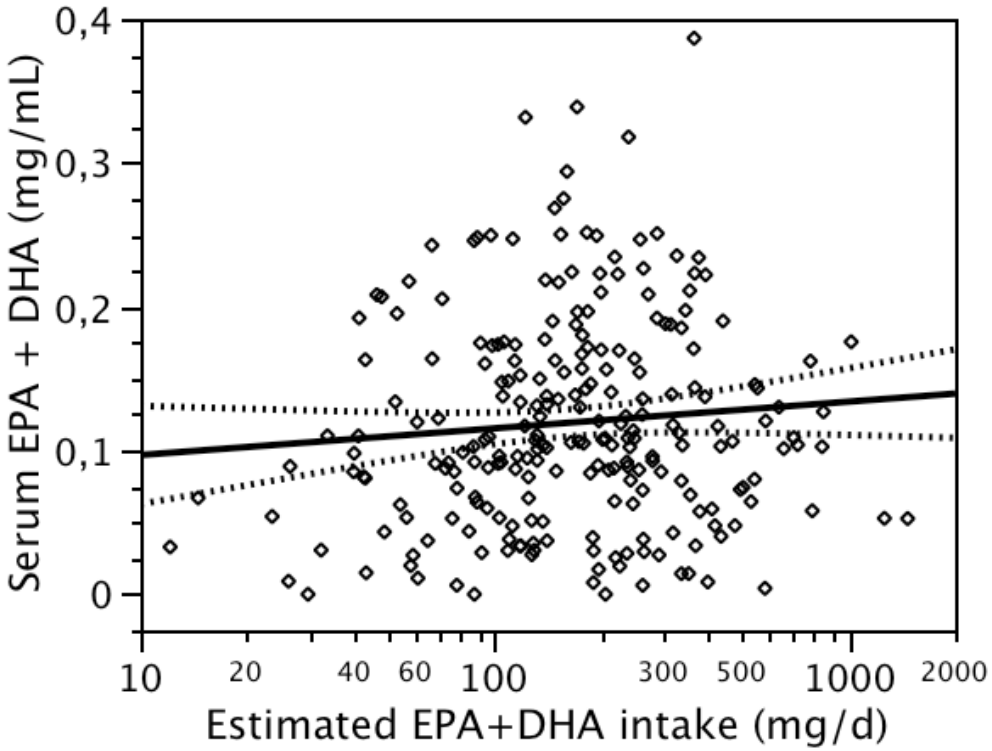
No overall relation between estimated EPA + DHA intake and serum EPA + DHA



$R^{2=}$ 0.002 ; p = 0.45

Conclusions from these studies

- **The results from these studies confirm the relation between estimated omega-3 FA in fish and serum omega-3 FA for fatty fish**
- **For lean fish, this relation does not appear to hold,**
  - **Animal studies suggest that fatty fish oils may be necessary for the assimilation of EPA and/or DHA in plasma**
  - **Seasonal and fish size variations in EPA and DHA may be more important in lean fish**
  - **Cooking differences? Frying fish reduces omega-3**
- **Marine fatty fish appear to be the only fish contributor to blood Se.**

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- **Why is this important?**
  - **Because according to current estimates and guidelines, many people who are eating primarily lean fish (which includes many freshwater fish) think that they are getting adequate nutrient intake…**
  - **Because when regulators estimate benefits, they may overestimate for lean fish consumption**
- **What to do?**

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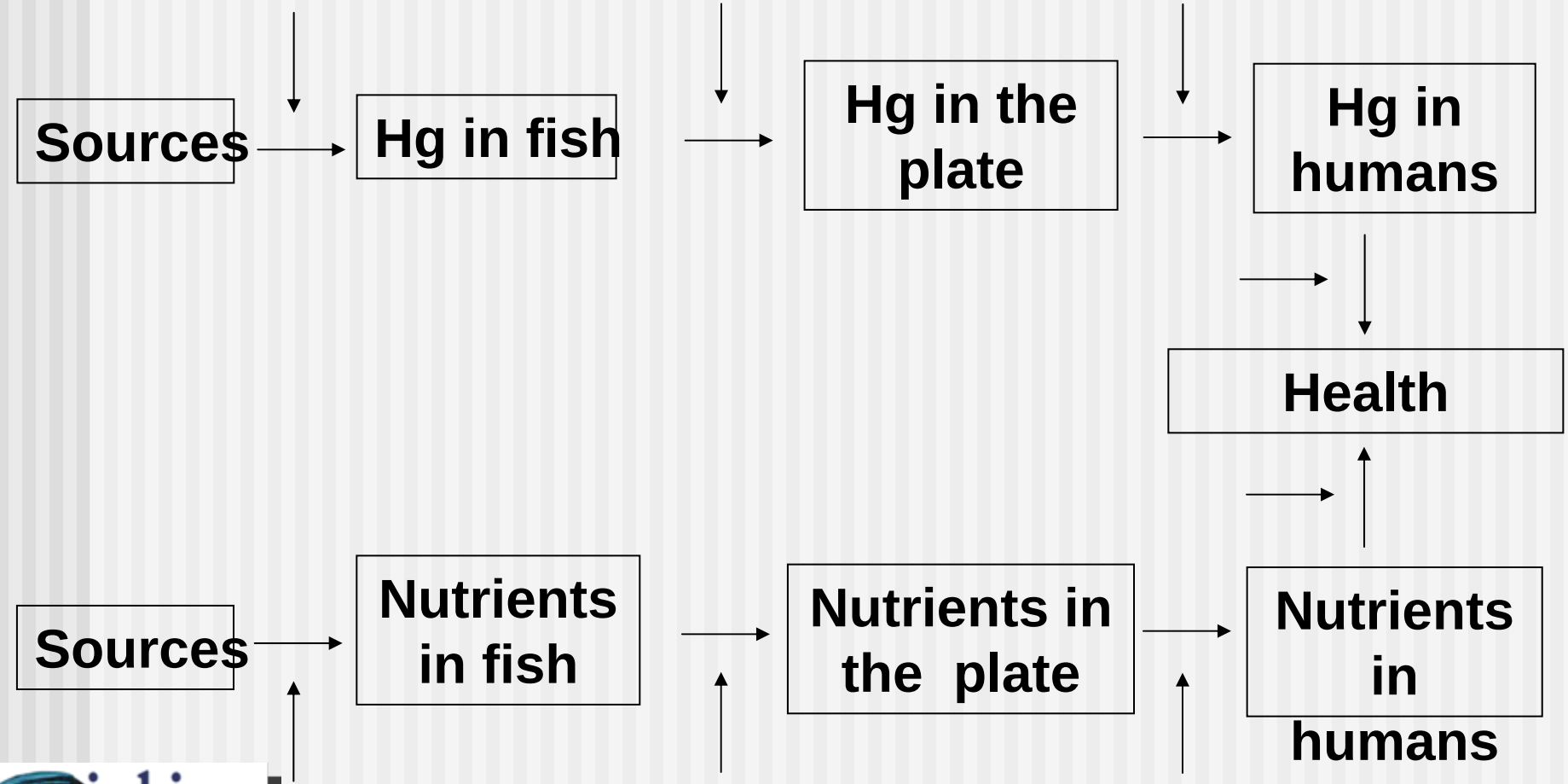
Fishermen at James Bay, Quebec (n= 31)

	Prior to fishing season (june)	Post fishing season (November)	difference
Cholesterol VLDL (mmol/L plasma)	0.60 ± 0.04	0.55 ± 0.04	- 8%*
Cholesterol VLDL (mmol/L plasma)	0.77 ± 0.04	0.81 ± 0..05	+5%*
GPx (U/g Hb)	75.1 ± 2.3	82.4 ± 2.8	+ 9.7%**
Beta-carotene (µmol/L)	0.37 ± 0.04	0.54 ± 0.07	+ 46%*

Bélanger et al, 2008

Maximize nutrition, minimize risk




Comer peixe é bom para a saúde
O mercúrio pode prejudicar o feto
VITAMINAS
PROTEÍNAS
ÔMEGA 3
MERCÚRIO