Prof. Laurie H.M. Chan

○アブストラクトデータ

Elevated concentrations of mercury (Hg) are commonly found in the traditional foods, including fish and marine mammals, of Inuit living in Canada's Arctic. As a result, Inuit often have higher dietary Hg intake and elevated Hg blood concentrations. However, these same traditional foods are excellent sources of essential nutrients. The goals of this study were to: (1) identify the traditional food sources of Hg exposure for Inuit, (2) estimate the percent of Inuit that meet specific nutrient Dietary Reference Intakes (DRI) and/or exceed the Toxicological Reference Values (TRV), and (3) evaluate options that maximize nutrient intake while minimizing contaminant exposure. A participatory cross- sectional survey was designed in consultation with Inuit in three Canadian Arctic jurisdictions (Nunatsiavut, Nunavut, and the Inuvialuit Settlement Region). Estimated intake of Hg, Se, EPA, and DHA were correlated with their respective blood concentrations. Mean Hg intake (7.9 μg·kg-1·wk-1) exceeded the TRV of 5.0 μg·kg-1·wk-1 with 35% of the population above this guideline. Estimated intakes for EPA and DHA met suggested dietary targets and estimated Se intake fell within its Acceptable Range of Oral Intake (AROI). Since the estimated intakes of each of these nutrients were strongly correlated (Se: $r = 0.92$, $P < 0.001$; EPA: $r = 0.82$, $P < 0.001$; DHA: $r = 0.81$, $P < 0.001$) with estimated Hg intake, efforts to decrease Hg exposure must emphasize the overall healthfulness of traditional foods and be designed to prevent concomitant harm to the nutrient intakes of Inuit.

○発表データ

Balancing Benefits And Risks Of Consumption Of Marine Mammals Among Inuit In Northern Canada

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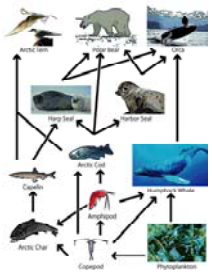
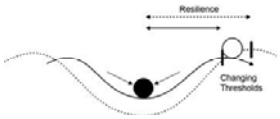
University of Ottawa

2013 ICMGP
August 2 Edinburgh, UK

Arctic Ecosystem: Relatively Simple and Low Resiliency





Arctic Resiliency Report: The Arctic-Council

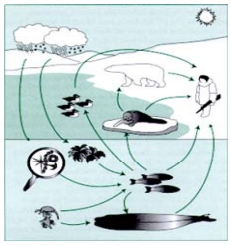
Population size

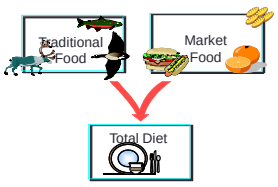
Country		Arctic Region	
USA	288 m	Alaska	641,700 (0.2%)
Canada	31.6 m	N. Canada	101,400 (0.3%)
Denmark	5.4 m	Greenland	56,900 (1.1%)
Norway	4.6 m	N. Norway	462,800 (10 %)
Sweden	9.0 m	N. Sweden	509,400 (5.6%)
Finland	5.3 m	N. Finland	185,800 (3.5%)
Russia	145 m	N. Russia	7,167,500 (4.9%)
		Iceland	299,400

Inuit or Eskimos

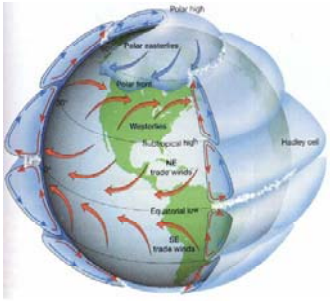
Cultural Groups	Country	Populations
Yupik	Alaska	25,000
	Russia	45,000
Inupiat	Alaska	50,000
	Russia	2,000
Inuit	Canada	50,000
	Greenland	55,000
Total		227,000

Fish and Marine mammals are very important part of the Inuit diet





Long Range Transport of Global Pollutants



Mercury from Asia reaching Canada and the Arctic by air currents

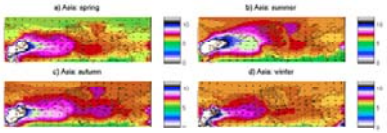


Table 4. Statistics pertaining to the number of long range transport events recorded over all verification stations over a year.

Source region	Median	75th percentile	Maximum
Asia	38	52	61
North America	11	14	25
Russia	20	24	33
Europe	1	5	27

Durnford et al. Atmos Chem Phys 10:6063-6086, 2010

Inuit Health Survey 2007- 2008

Survey content

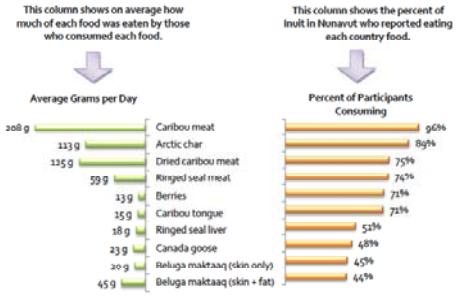
- Clinical examination
  - Body composition
  - Blood pressure and pulse
  - Skeletal health for women > 40 yrs
  - Diabetes and Cardiovascular risk factors
- Nutrition markers
- Infection
- Contaminants

A total of 1374 households and 1923 individuals 18 years of age or older participated

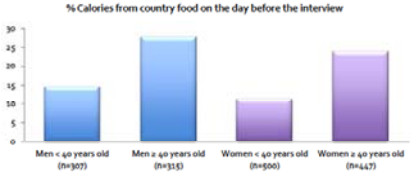
Participation by Inuit in Nunavut

	Age		Sex	
	<40 yr	≥40 yr	Men	Women
Number of participants	963	955	772	1151

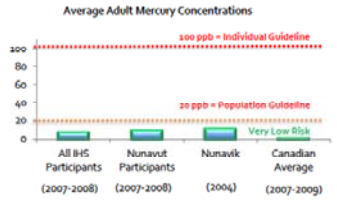
Most commonly consumed country food



Decline use of country food



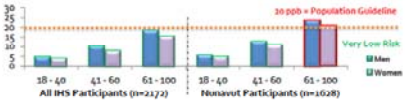
Average blood Hg were 10x higher than Canadian average but still below guideline level of 20 ppb



Wide range of Hg and Se in blood samples

Metal	N	% < LOD	Geometric mean	95% CIs		Range		95th percentile
				lower	upper	min	max	
Mercury	2172	0	6.97	6.62	7.32	0.09	130	41
Selenium	2172	0	319.4	312.1	326.9	85	2800	940

Blood Hg conc by age and gender



- Men had higher mercury concentrations in their blood than women.
- Participants over 61 years of age had higher blood mercury levels than participants between 18 and 60 years of age.
- Average blood mercury concentrations of Inuit men and women in Nunavut aged 61 and above exceed the guideline of 20 ppb.

Elevated levels of mercury were found especially among women of child bearing age

Table 4A. Characteristics of population divided by mercury concentration

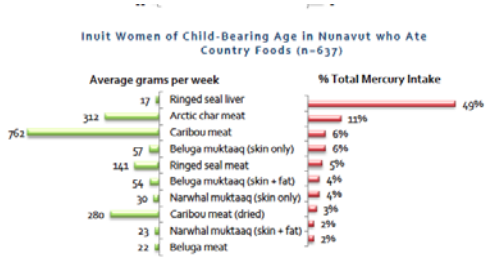
haracteristics	Blood Mercury Level		Blood Mercury Level (µg/L)	
	<20	≥20	<100	≥ 100
otal	1732(79.7%	440(20.3%)	2170(99.9%)	2(0.1%)

Table 4B. Characteristics of Inuit women of childbearing age divided by blood mercury concentration§

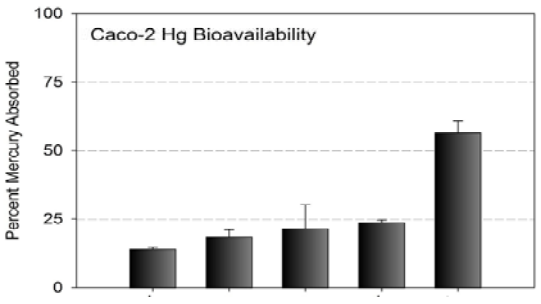
haracteristic s	Blood Mercury Level (µg/L)		Blood Mercury Level (µg/L)	
	<5.8	≥5.8	<58	≥58
otal	455(54.2%)	385(45.8%)	839(99.9%)	1(0.1%)

§5.8 mcg/L is the WHO's blood mercury reference level for the women of childbearing age

Ringed seal liver is the major source of mercury



Difference in Hg bioavailability between food samples

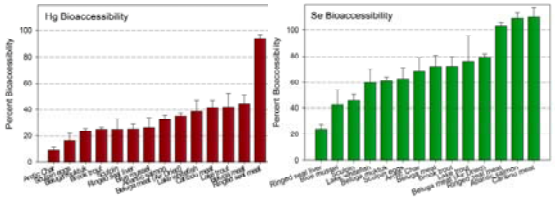


Country foods are important source of essential nutrients

- Selenium 91%
- Omega 3 fatty acids 85

- These top ten country food sources combine to provide, on average, 91% of the weekly intake of selenium by Inuit in Nunavut.
- Eating a small amount (eg. 39 g) of ringed seal liver provides a relatively large percentage of selenium intake (13%).
- On average, caribou meat, beluga muktaaq, and arctic char meat contribute more selenium than other country foods.

Se Bioaccessibility is generally higher than Hg Bioaccessibility



The Journal of Nutrition
Community and International Nutrition

Dietary Advice on Inuit Traditional Food Use Needs to Balance Benefits and Risks of Mercury, Selenium, and n3 Fatty Acids[1–3]

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Significant correlation between estimated dietary intake and blood conc of Hg, Se, EPA and DHA

TABLE 2 Correlations between dietary intakes of Hg, Se, EPA, and DHA and their respective blood concentrations in 2074 participants of the International Polar Year Inuit Health Survey 2007–2008[1]

	Hg[2], nmol/L		Se[2], nmol/L		EPA, % fatty acids[3]		DHA, % fatty acids[3]	
	n	r_s	*n*	r_s	*n*	r_s	*n*	r_s
Hg[4], μg · kg^{-1} · wk^{-1}	1979	0.48	1979	0.41	2008	0.38	2008	0.27
Se[4], μg · kg^{-1} · wk^{-1}	1979	0.47	1979	0.44	2008	0.33	2008	0.22
EPA[4], g/wk	1979	0.42	1979	0.37	2008	0.32	2008	0.26
DHA[4], g/wk	1979	0.41	1979	0.37	2008	0.32	2008	0.28
Hg[2], nmol/L	—		1979	0.83	1971	0.61	1971	0.40
Se[2], nmol/L	—		—		1971	0.50	1971	0.30
EPA[3], % fatty acids	—		—		—		2008	0.72

[1] All Spearman correlation coefficients (r_s) were significant at $P < 0.001$.
[2] Whole-blood concentrations.
[3] Percentage of RBC total fatty acids.
[4] Intake estimates were generated with Monte-Carlo simulations by using Crystal Ball software (Oracle) using the FFQ responses of study participants and food composition data.

Laird et al. 2013

Risk-Benefit Assessment

Laird et al. 2013

Biological interactions of Se and Hg

Author's Choice

patient-oriented and epidemiological research

New insights regarding tissue Se and Hg interactions on oxidative stress from plasma IsoP and IsoF measures in the Canadian Inuit population

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New biomarkers for oxidative stress

Lipid peroxidation products

- F2 -isoprostanes (IsoPs)
  - produced under low oxygen tension
- isofurans (IsoFs)
  - produced under high oxygen tension

Negative association IsoP and IsoF with Se
Positive association IsoF with Hg

TABLE 5. Multivariate associations showing the regression coefficient (β) of plasma IsoP concentrations

	Stepwise Regression	F_2-IsoPs β (SE)	IsoPs β (SE)	IsoF:F_2-IsoPs β (SE)
Model (a)	Constant	1.449 (0.16)	1.264 (0.28)	0.664 (0.10)
	Independent variables:			
	Se	−0.138 (0.05)*	−0.258 (0.07)*	NS
	WC	0.003 (0.001)**	0.007 (0.002)**	0.005 (0.001)**
	Sex	0.052 (0.03)**		—
	R^2	0.104	0.121	0.038
	F	7.13**	12.75**	7.31**
Model (b)	Constant	1.16 (0.09)	0.55 (0.15)	0.528 (0.11)
	Independent variables:			
	Mercury	NS	0.222 (0.050)**	0.118 (0.03)**
	WC	0.003 (0.001)**	0.007 (0.002)**	0.003 (0.05)*
	Sex	0.054 (0.03)*		
	Age	−0.002 (0.001)**	−0.003 (0.002)*	—
	R^2	0.101	0.182	0.102
	F	6.90**	13.75**	10.56**