N-3 Fatty Acid Intake and Longitudinal Mercury Exposure From Fish Consumption within the Japanese and Korean Communities

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Fish consumption guidance is based on exposure to contaminants

Contaminants → Adverse Health Effects

- MeHg, Dioxin, Polychlorinated biphenyls (PCBs), Polybrominated diphenyl ethers (PBDEs), Dichloro-Diphenyl-Trichloroethane (DDT), etc.
- Health effects of MeHg include neurodevelopmental impacts
  - First noted in Minamata & Iraqi incidents in 1970s
- US EPA's RfD for MeHg: 0.1µg /kg/d (2001)

Fish also contains nutrients

Nutrients → Essential to Optimal Health

- Omega-3 fatty acids:
  - Docosahexaenoic acid (DHA) & Eicosapentaenoic acid (EPA)
- Fish is the major source of DHA and EPA in our diet
- Fish consumption is related with ↓CVD
- DHA and EPA intake is associated with ↑neurodevelopment

- Recommended intake:
  - DHA: 100-300 mg/day (Akabas 2006)
  - DHA+EPA: 400-500 mg/day for women (or 2 meals of fatty fish /week) (AHA)

Why study Asians in the U.S.?

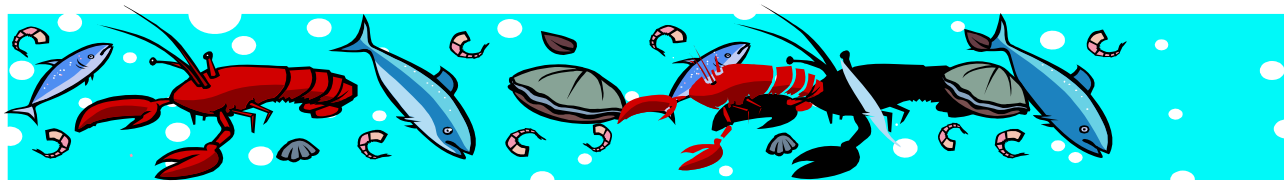
- Asians consume large amounts of seafood
  - US EPA's estimate for US general population = 0.3 g/kg/day
  - Asians in Seattle area =1.9 g/kg/day (n=202) (Sechena et al, 2004)

- Previous studies have indicated Asians have elevated Hg level (Mahaffey et al 2009, Knobeloch et al 2005)

- In Washington State: 300,000^{+} (~6%)
  - 36,000 Japanese (0.6% of total pop)
  - 47,000 Koreans (0.8% of total pop) (APIAHF 2000)

Photo credit: Microsoft Clipart

Arsenic Mercury Intake Biometric Study



Principal Investigator: Koenraad Mariën

Washington State Department of Health

Project Overview

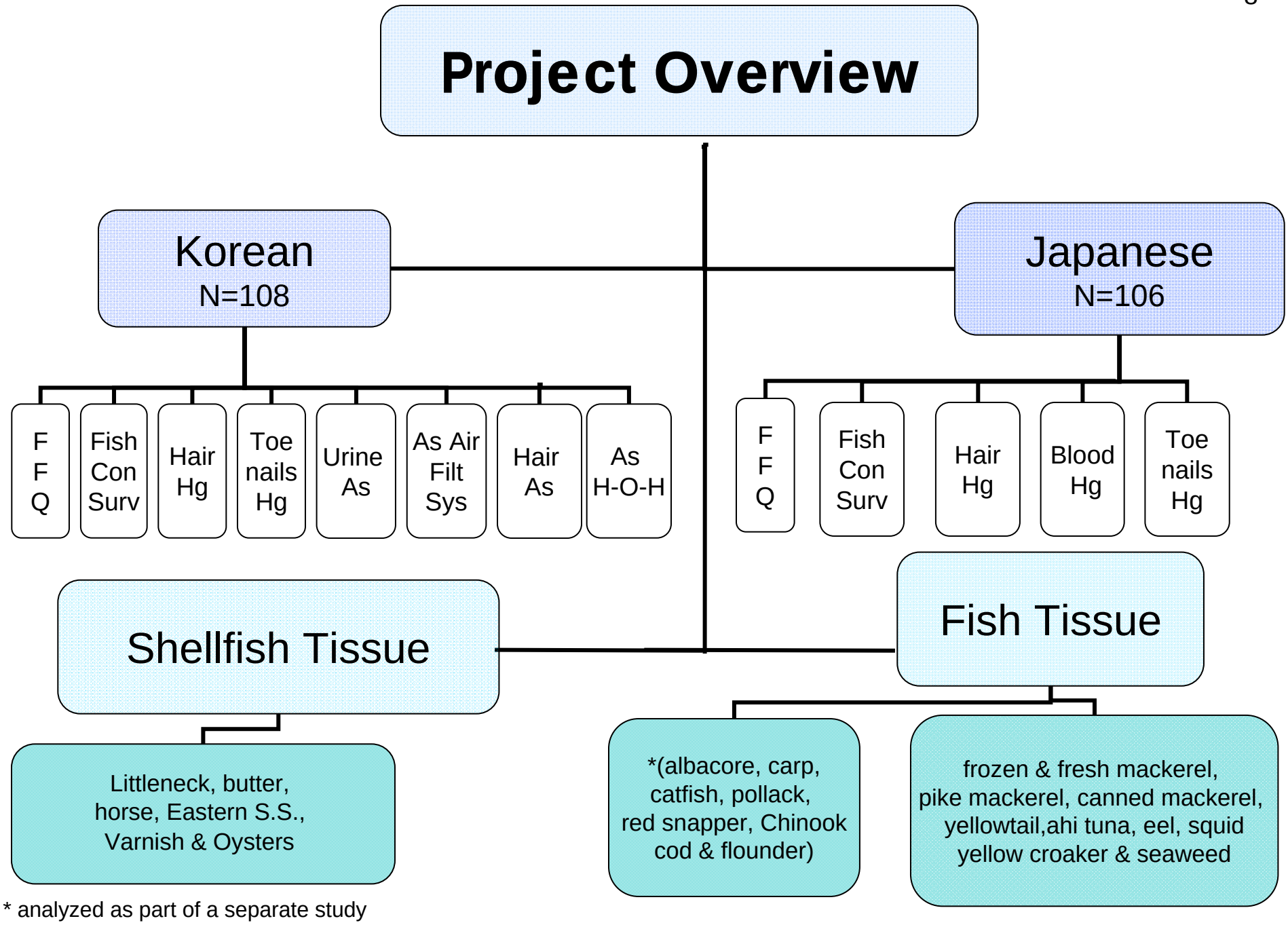
- To determine exposure to mercury and arsenic
- To assess dietary patterns
- To collect biological samples (blood, hair, urine, toenails) for mercury and arsenic analysis
- To assess exposure overtime

- To collect fish and shellfish samples for metal analysis

- Study Populations:

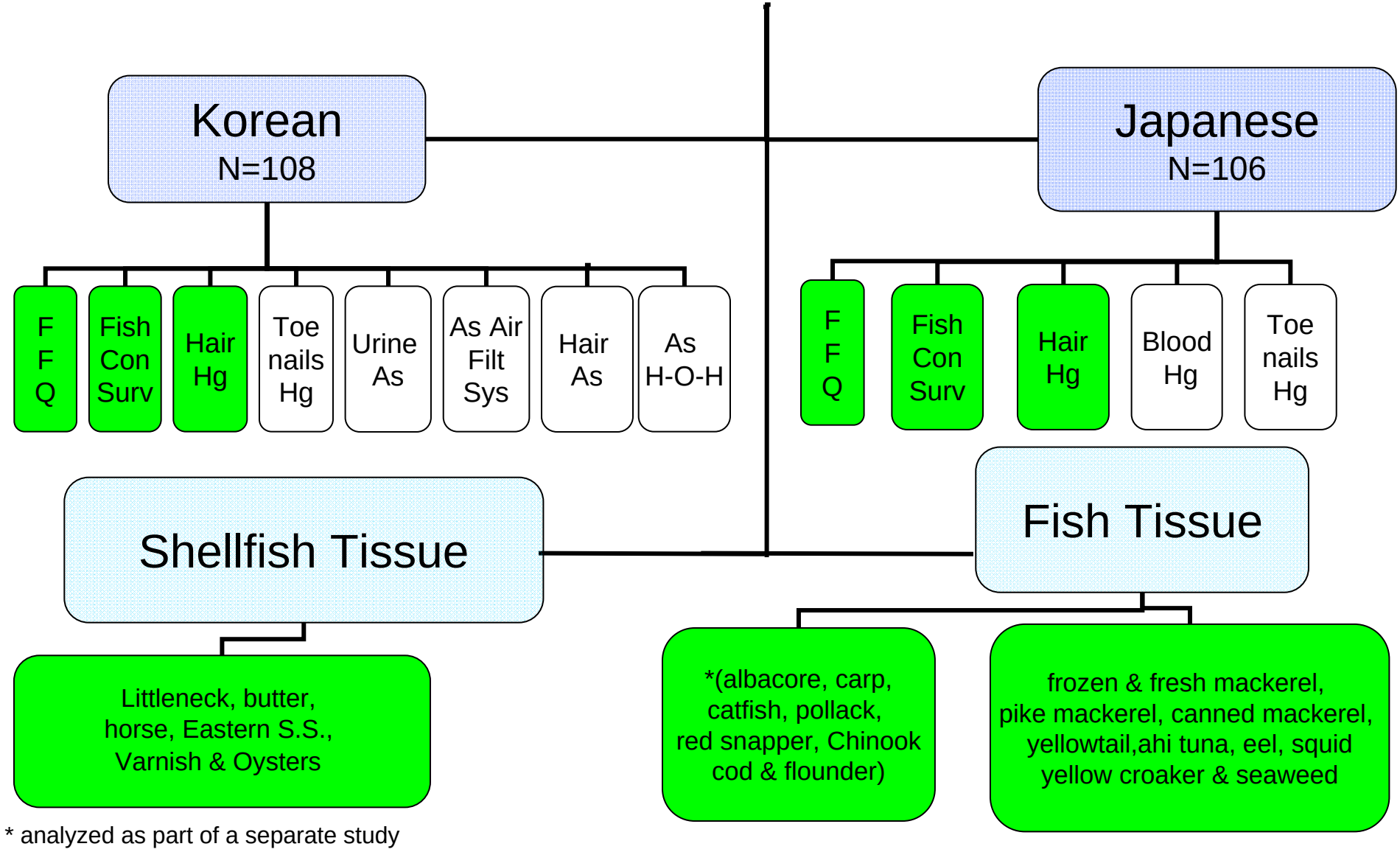
  Japanese and Korean women of childbearing age living in Seattle area, Washington, US.

Project Overview



* analyzed as part of a separate study

Project Overview



* analyzed as part of a separate study

Questionnaires

- Structured interviews

- Fish Consumption Surveys:
  - Fish eaten (with pictures)
  - Frequency of consumption for each fish species eaten
  - Usual portion size for each fish species (with models)

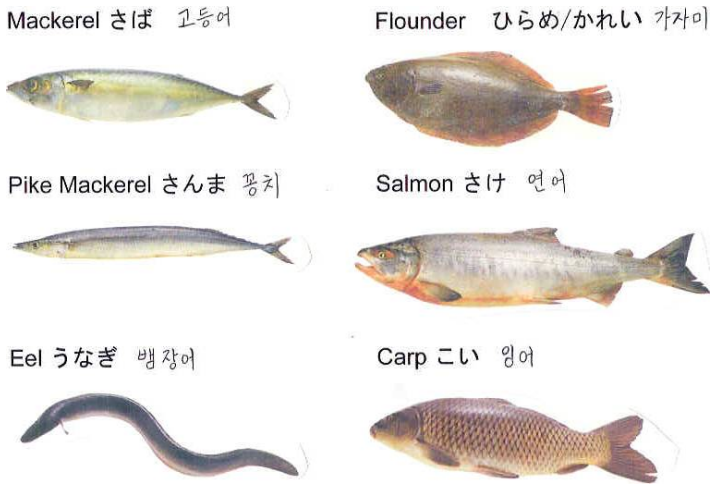


Photo credit: K. Mariën

Fish Models

Mercury Analysis

- Hair Analysis:
  - By the US EPA lab, Nevada
  - Hg measurement:
    combustion, amalgamation and atomic absorption spectrophotometry *(US EPA Method 7473)*
  - Detection limit: 0.01 ng

Photo credit: A.Scherer

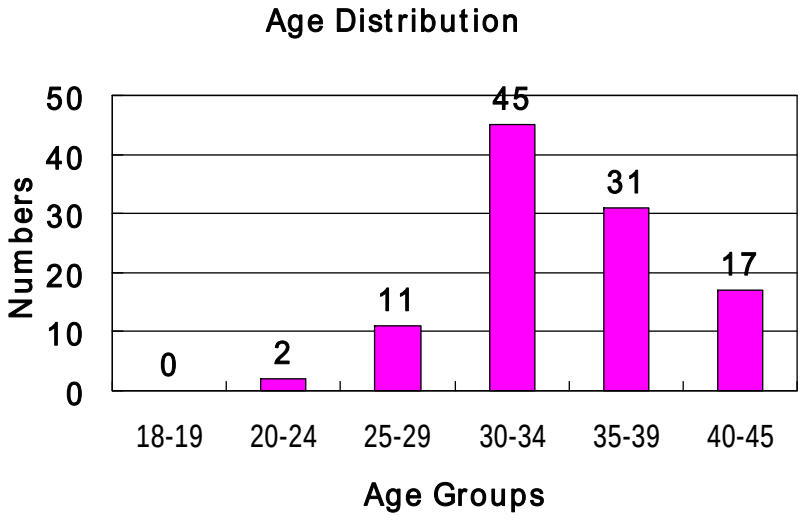
- Fish Tissue Analysis:
  - By a local lab, cold-vapor atomic absorption method *(US EPA Method 7471A)*
  - Commonly consumed fish among the community were purchased from stores in Puget Sound area (Shoreline to Olympia) over 4 weeks
  - Detection limit: 0.01 µg/g

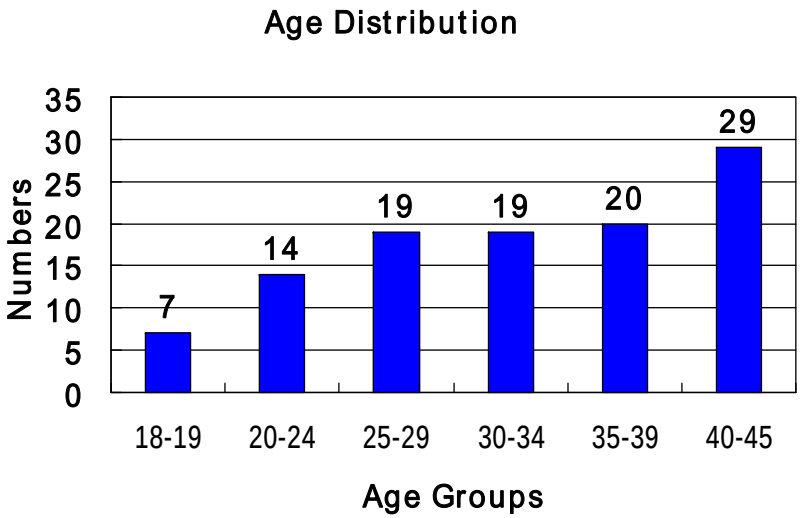
Photo credit: Microsoft Clipart

Study Population (n=214)

- 106 Japanese
- 97 % (n=103) preferred to be interviewed in Japanese
- 25 % were pregnant
- Average wt: 55.4 kg

- 108 Korean
- 66 % (n=71) preferred to be interviewed in Korean
- 5 % were pregnant
- Average wt: 59.4 kg





Finfish intakes were similar

	Finfish			Shellfish			Finfish & Shellfish combined		
	Mean	50th%	95th %	Mean	50th%	95th %	Mean	50th%	95th %
Japanese (n=106)	60	43	159	14	9	59	73	55	188
Korean (n=108)	59	49	147	23	13	84	82	64	230

g/person/day

Japanese & Korean fish intake is at 95th

	Finfish & Shellfish combined		
	Mean	50th%	95th %
Japanese (n=106)	73	55	188
Korean (n=108)	82	64	230
US General (CSFII[1])	14	NA	72
US General (NHANES[2])	1.8*	NA	87

g/person/day

1:Jacobs 1997, 2: Mahaffey 2004 , *geometric mean

Average Japanese Hg intake is close to 95th

		n	Mean	Percentiles			
				50th	75th	90th	95th
Estimated Hg Intake (ug/kg/d)	Japanese	106	0.14	0.09	0.18	0.25	0.37
	Korean	108	0.07	0.05	0.09	0.15	0.19
	US General (NHANES 1999-2000[1)]	1,727	0.02*	NA	0.0	0.04	0.13

1:Mahaffey 2004, *geometric mean

Average Korean Hg intake is 90th-95th percentile

		n	Mean	Percentiles			
				50th	75th	90th	95th
Estimated Hg Intake (ug/kg/d)	Japanese	106	0.14	0.09	0.18	0.25	0.37
	Korean	108	0.07	0.05	0.09	0.15	0.19
	US General (NHANES 1999-2000[1)]	1,727	0.02*	NA	0.0	0.04	0.13

1:Mahaffey 2004, *geometric mean

Average Japanese hair Hg is 90th-95th percentile

		n	Mean	Percentiles			
				50th	75th	90th	95th
Hair Hg (ppm)	Japanese	106	1.57	1.37	1.96	2.68	3.52
	Korean	108	0.75	0.67	1.02	1.29	1.52
	US General (NHANES 1999-2000*	1,727	0.47	0.19	0.42	1.11	1.73

*McDowell 2004

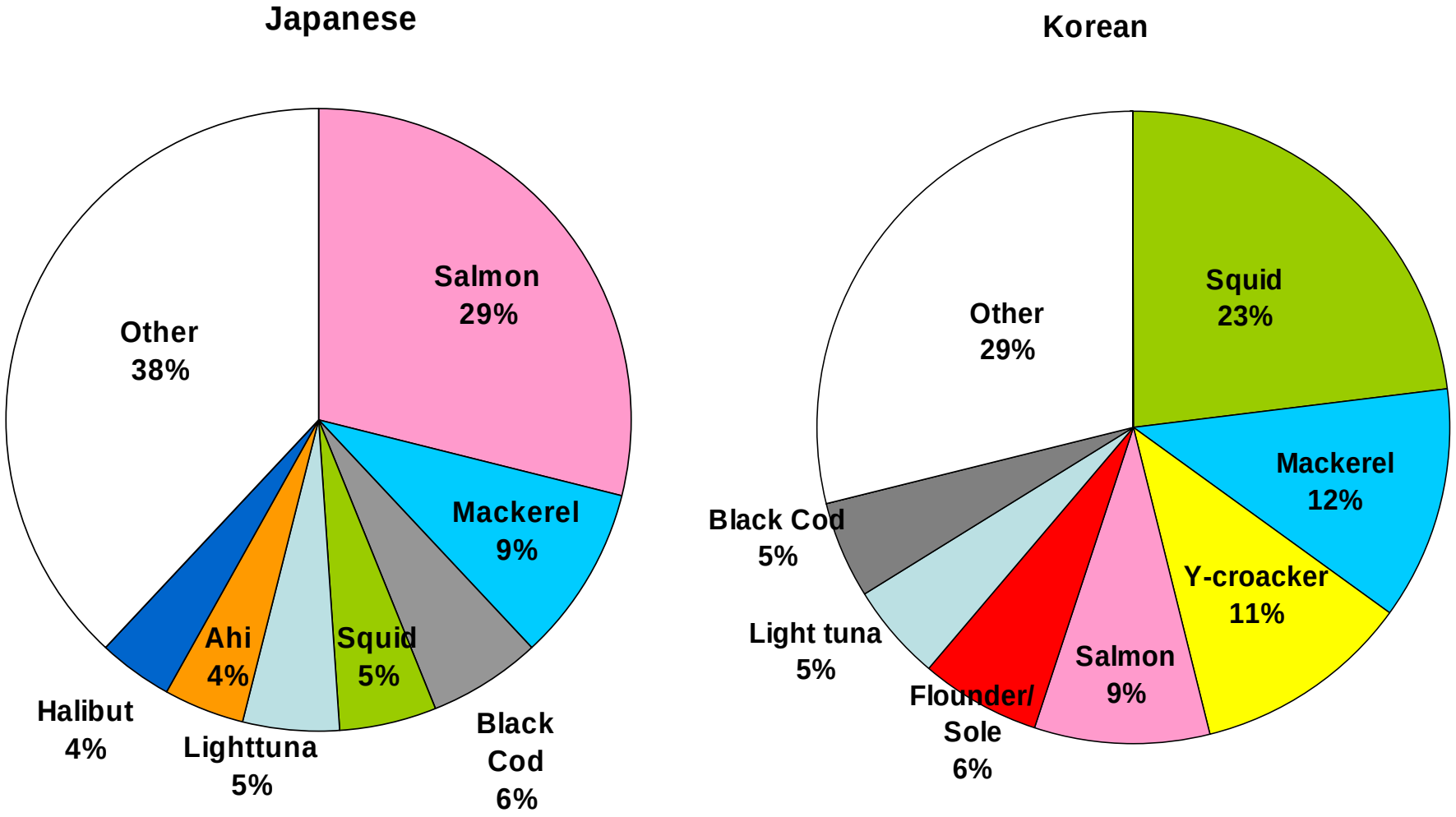
Korean hair Hg is 75th-90th percentile

		n	Mean	Percentiles			
				50th	75th	90th	95th
Hair Hg (ppm)	Japanese	106	1.57	1.37	1.96	2.68	3.52
	Korean	108	0.75	0.67	1.02	1.29	1.52
	US General (NHANES 1999-2000*)	1,727	0.47	0.19	0.42	1.11	1.73

*McDowell 2004

Many different fish species were consumed

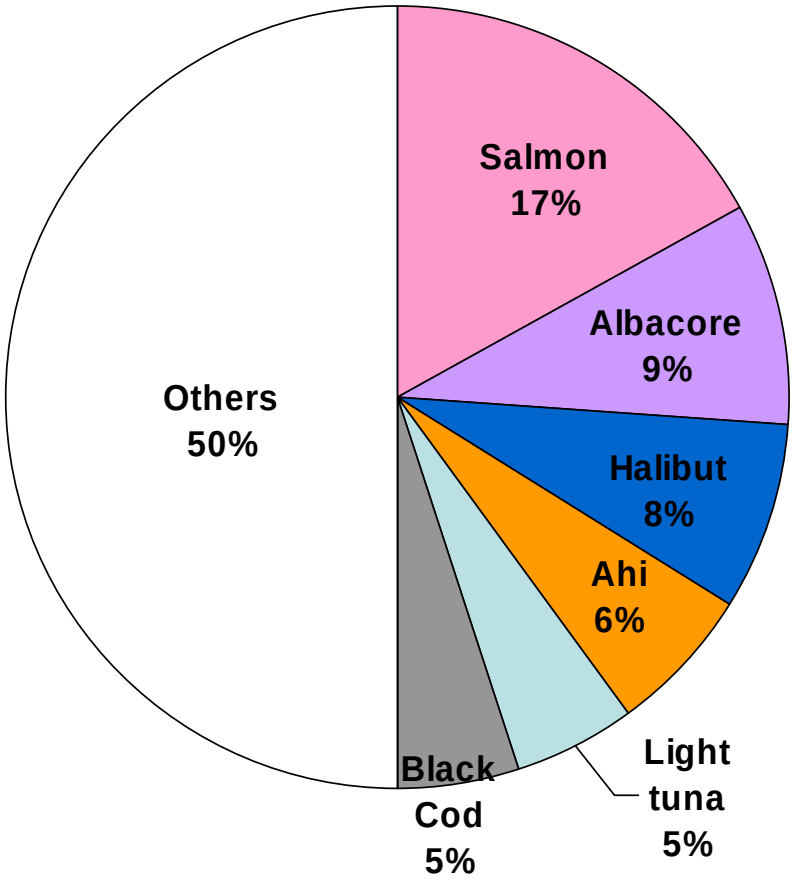
Species Providing Greatest % to Total Intake in weight (>4% total)



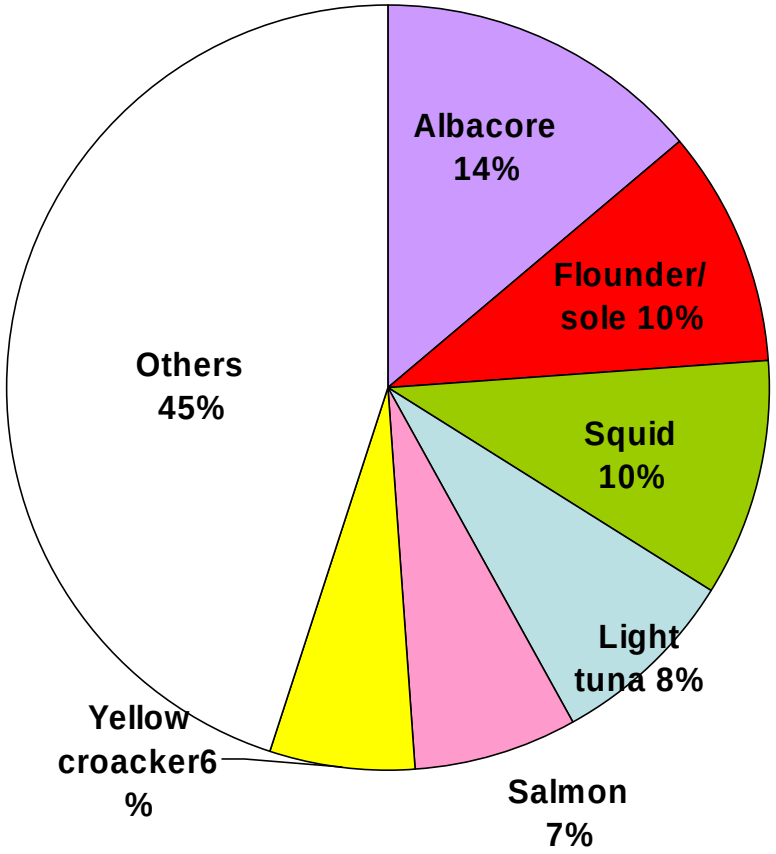
Sources of Hg exposures are very different

Species Providing Greatest % to Total Hg Intake (>5%total)

Japanese

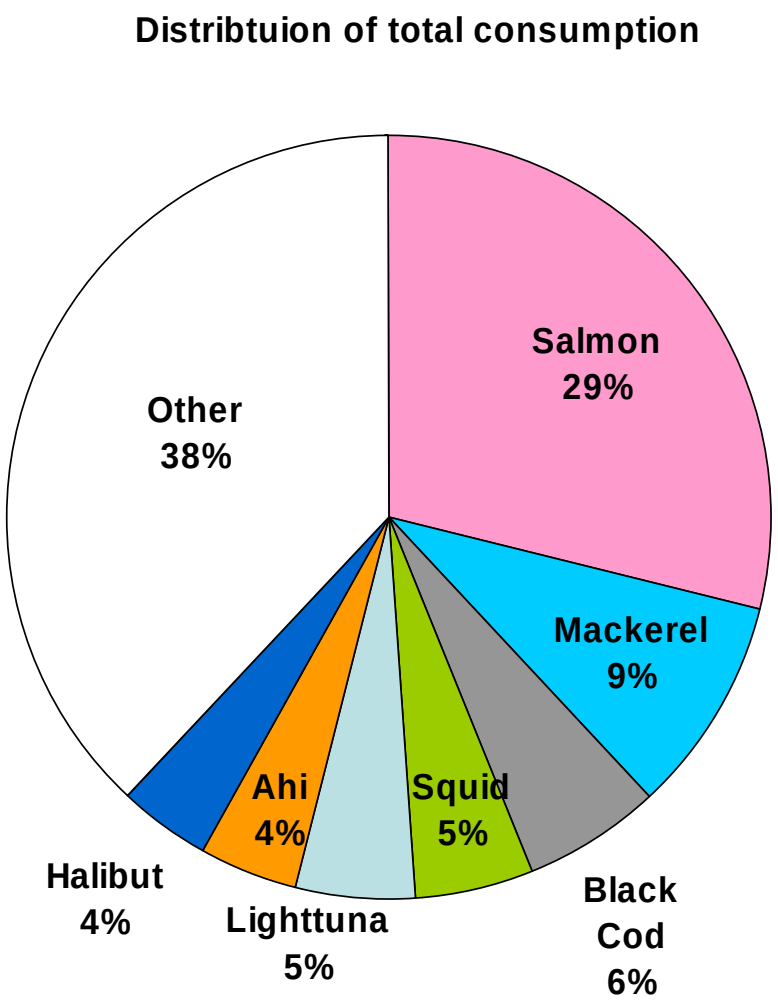


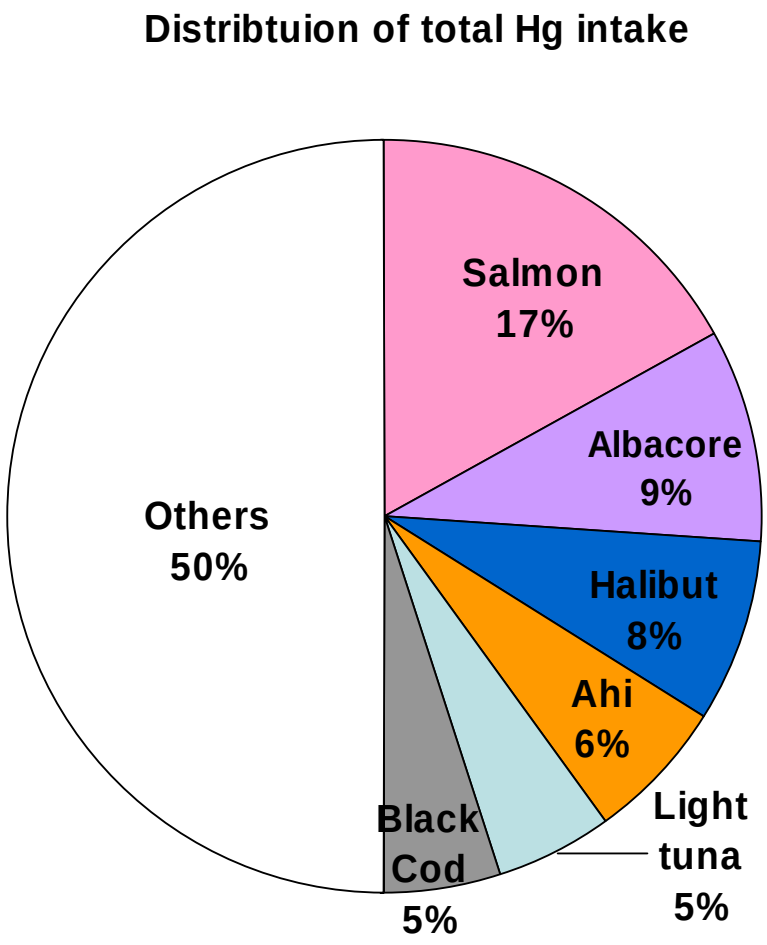
Korean



Fish intake of Japanese: weight vs. Hg

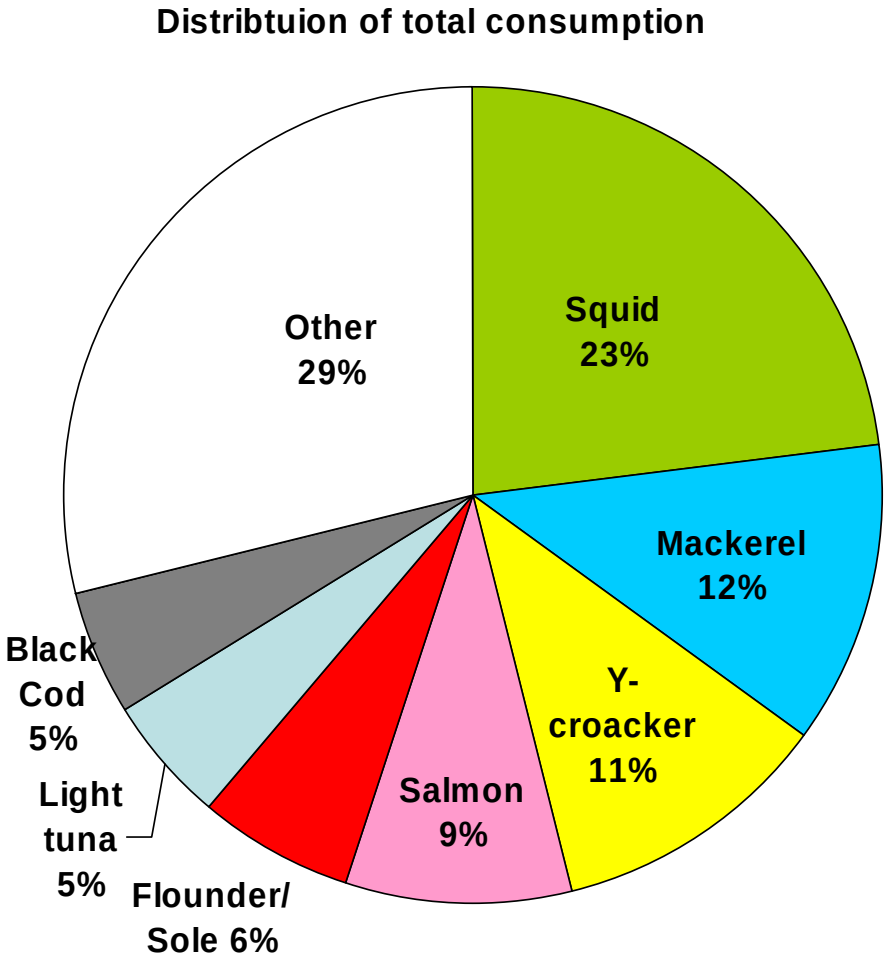
Species Providing the Greatest % to Total intake & Hg Intake

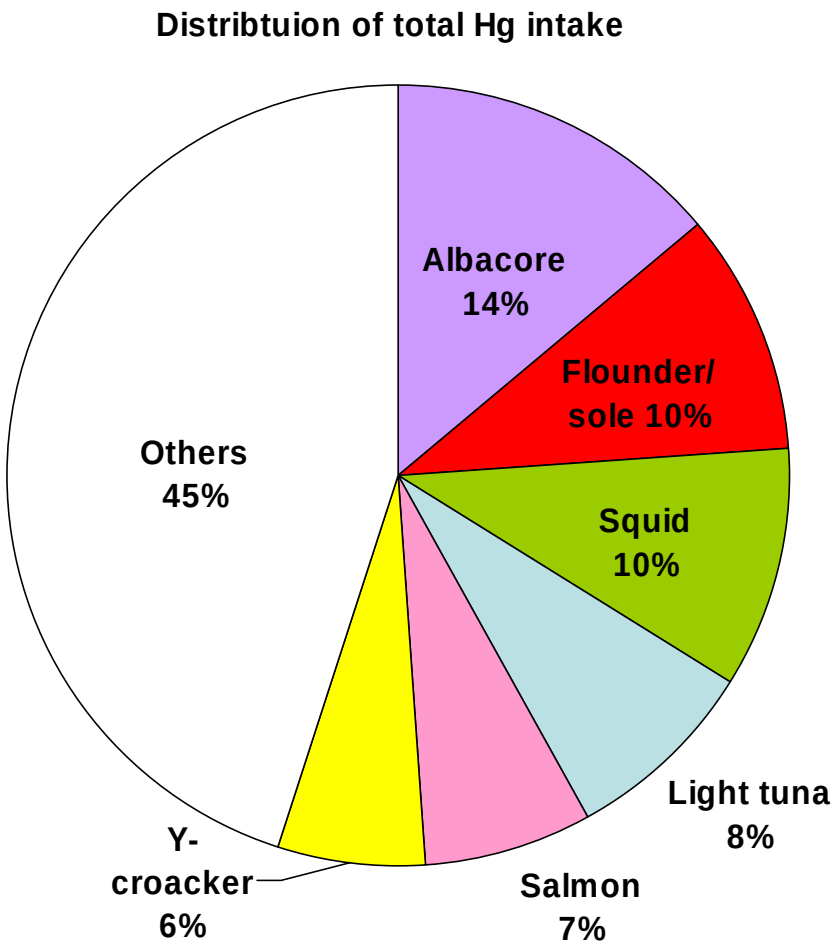




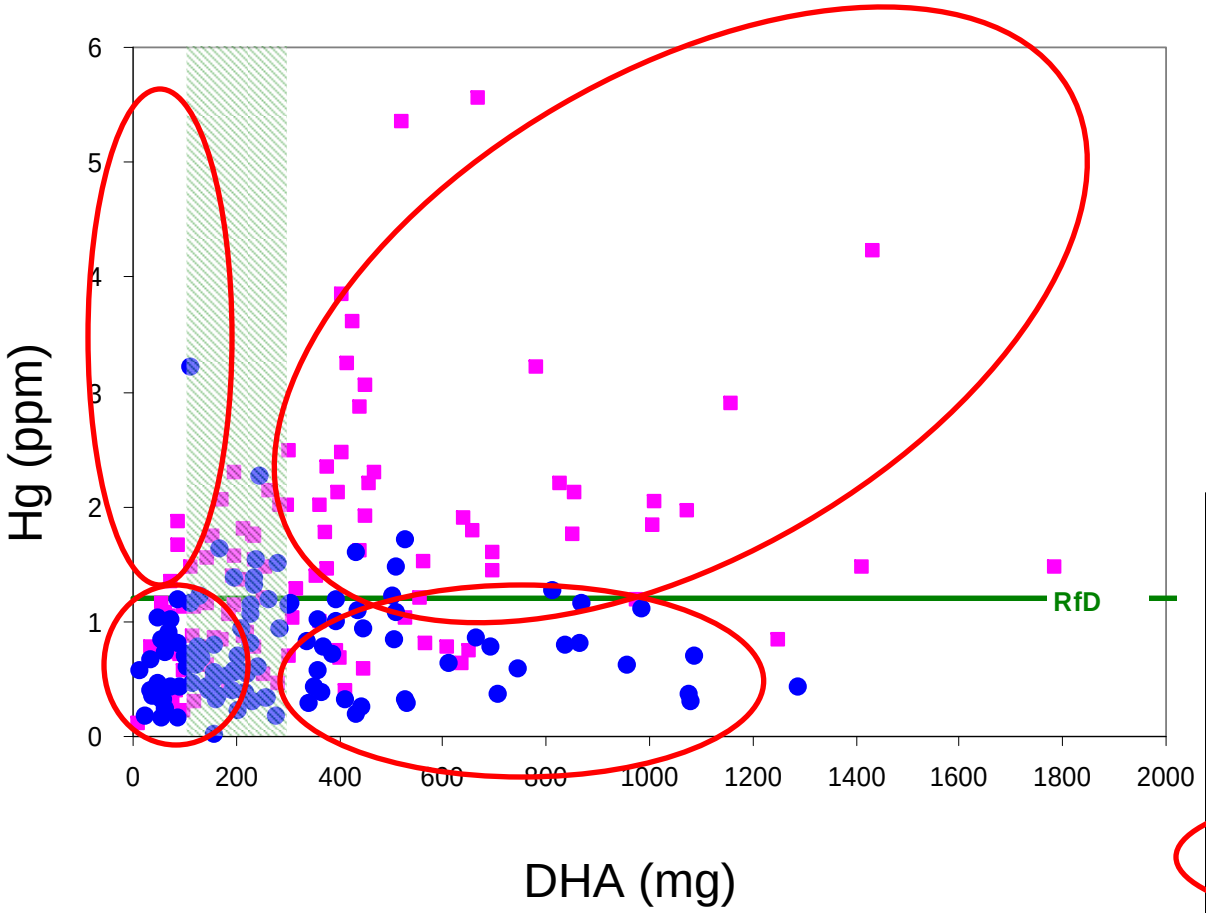
Fish intake of Korean: weight vs. Hg

Species Providing the Greatest % to Total intake & Hg Intake





Estimated DHA intake & Hg exposure



Japanese

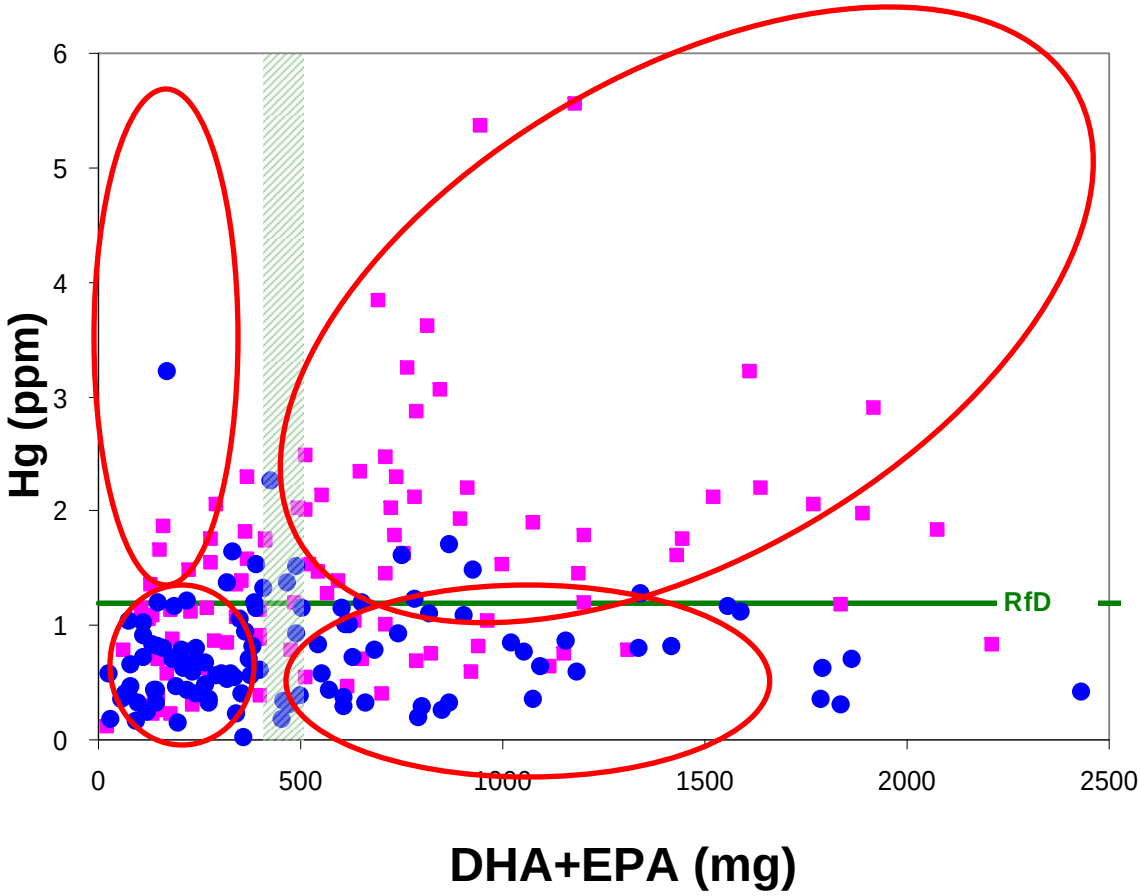
Korean

Reference Dose (RfD) (1.2 ppm hair-Hg)

Rec. DHA (100-300 mg/day)

	Japanese (n=106)	Korean (n=108)
DHA < 100mg/d	18 %	20 %
Hg >1.2ppm	53 %	13 %
Hg < 1.2ppm & DHA <100mg/d	15 %	20 %
Hg >1.2ppm & DHA >300mg/d	38 %	8 %
Hg >1.2ppm & DHA < 100mg/d	3 %	0

DHA+EPA intake & Hg exposure



Japanese

Korean

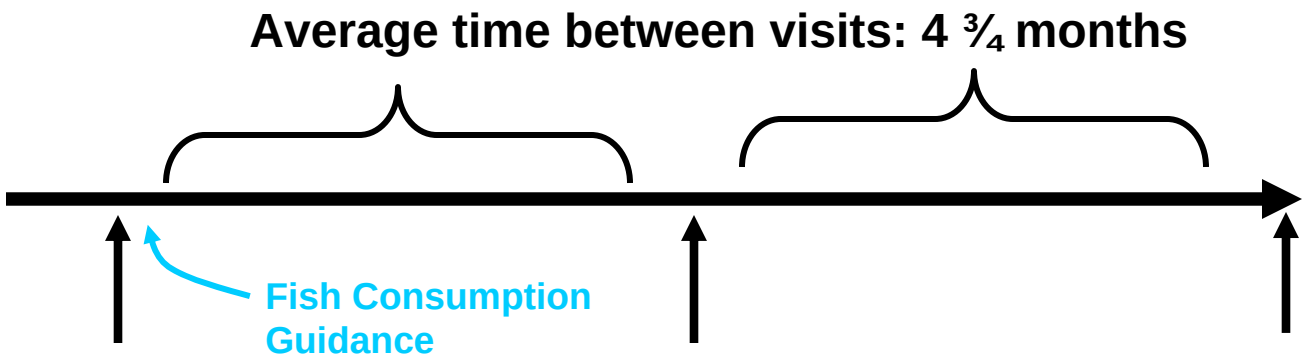
Reference Dose (RfD) (by US EPA 1.2 ppm hair-Hg)

Rec. DHA + EPA (400-500 mg/day)

	Japanese (n=106)	Korean (n=108)
DHA+EPA < 400mg/d	38 %	57 %
Hg >1.2ppm	53 %	13 %
Hg >1.2ppm & DHA+EPA < 400mg/d	11 %	5 %
Hg >1.2ppm & DHA+EPA >500mg/d	40 %	8 %
Hg < 1.2ppm & DHA+EPA <400mg/d	26 %	54 %

Longitudinal Aspects

Length of study : 14 months



	1st Visit	2nd Visit	3rd Visit
Japanese	n=108	n=90	n=85
Korean	n=106	n=63	---
FCS Recall Periods	open-ended	2 weeks	2 weeks

Total fish intake for each visit by Hg exposure

		1st Visit			2nd Visit			3rd Visit		
		total	≤1.2ppm	>1.2ppm	total	≤1.2ppm	>1.2ppm	total	≤1.2ppm	>1.2ppm
Japanese	N	85	36	49	85	40	45	85	41	44
	Mean Fish Intake (g/day)	63.5	46.0	76.4	33.7	26.6	38.2	31.3	23.0	39.1
Korean	N	63	54	9	63	51	12	-	-	-
	Mean Fish Intake (g/day)	71.7	72.6	66.2	29.1	25.3	45.3	-	-	-

Results Summary

- Fish intake and Hg exposure levels were above the 95th percentile levels to national levels
- Nearly identical amounts of finfish intakes
  - ~ 60 g/person/day
  - Consumed different types of fish
- Different Hg exposure levels
  - 55% of Japanese vs.13% of Korean exceed US EPA's RfD for mercury
- Large % do not obtain recommended DHA or DHA+EPA levels
  - ~20% did not consume daily rec DHA, larger for DHA+EPA

Recommendations

- Asian populations should not be grouped as a whole, but treated independently by cultural heritage
- The goal of fish consumption guidance should ensure that optimal health is achieved
  - Not just minimize exposure to the contaminant
  - Nutritional elements and contaminant concerns need to be quantitatively incorporated (into fish consumption guidelines)

Acknowledgements

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Future Directions

- Nutrient intake and fish consumption
  - Macronutrients, vitamin, mineral intakes by the population
- Relationship between blood-Hg and hair-Hg
- Determining shellfish consumption pattern by Korean and Japanese populations
  - Species, method of obtaining, harvesting locations