# Examination of hair mercury in areas concerned with methylmercury pollution around the world


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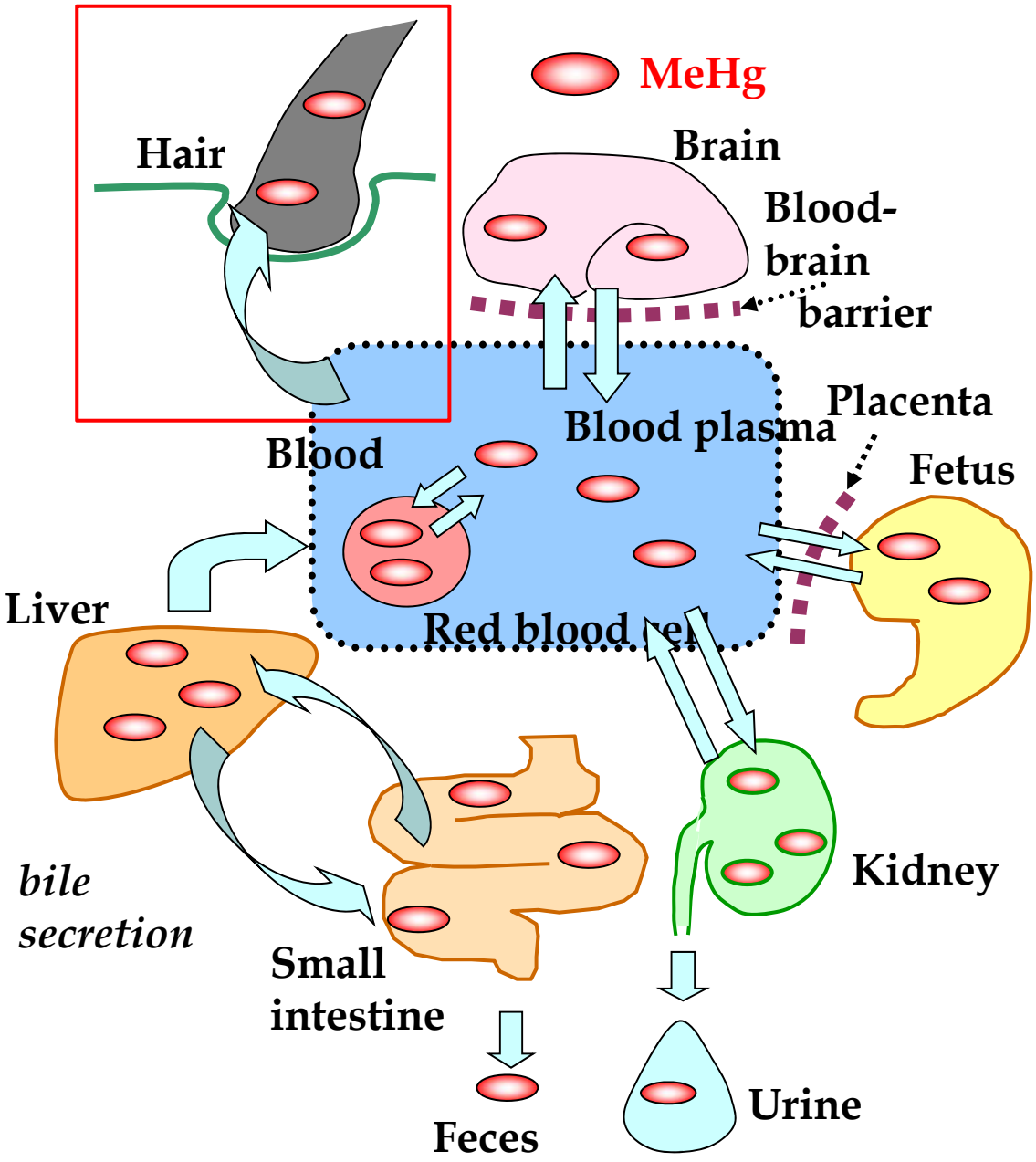
# Introduction




The most effective method to understand the human health risk of harmful substances such as methylmercury at the early stage is assessment of the exposure level.

"How much of the harmful substance is taken into the body?"

It is clear that methylmercury uptake from foods into the body is eliminated by urine and accumulates in hair at a constant rate.

The concentration of methylmercury in hair is an effective indicator to understand the level of human exposure to methylmercury.

# Objectives

The purpose of this investigation is to assess the methylmercury exposure level around the world by measuring the hair mercury level of the inhabitants in regions where methylmercury pollution is possible by gold mining, factory pollution related and fish dining habits etc., **contributing to prevention of related health hazard.**

Mercury

https://www.stabroeknews.com/2018/business/06/01/mercury-emissions-from-artisanal-and-small-scale-gold-mining/

# Research system for hair mercury analysis

**National Institute for Minamata Disease (NIMD)**

Advertisement for hair mercury analysis using homepage in our web and flyer distribution at international conference

**On-site collaborator**

Delivery of hair samples and related information

**NIMD**

Hair mercury analysis

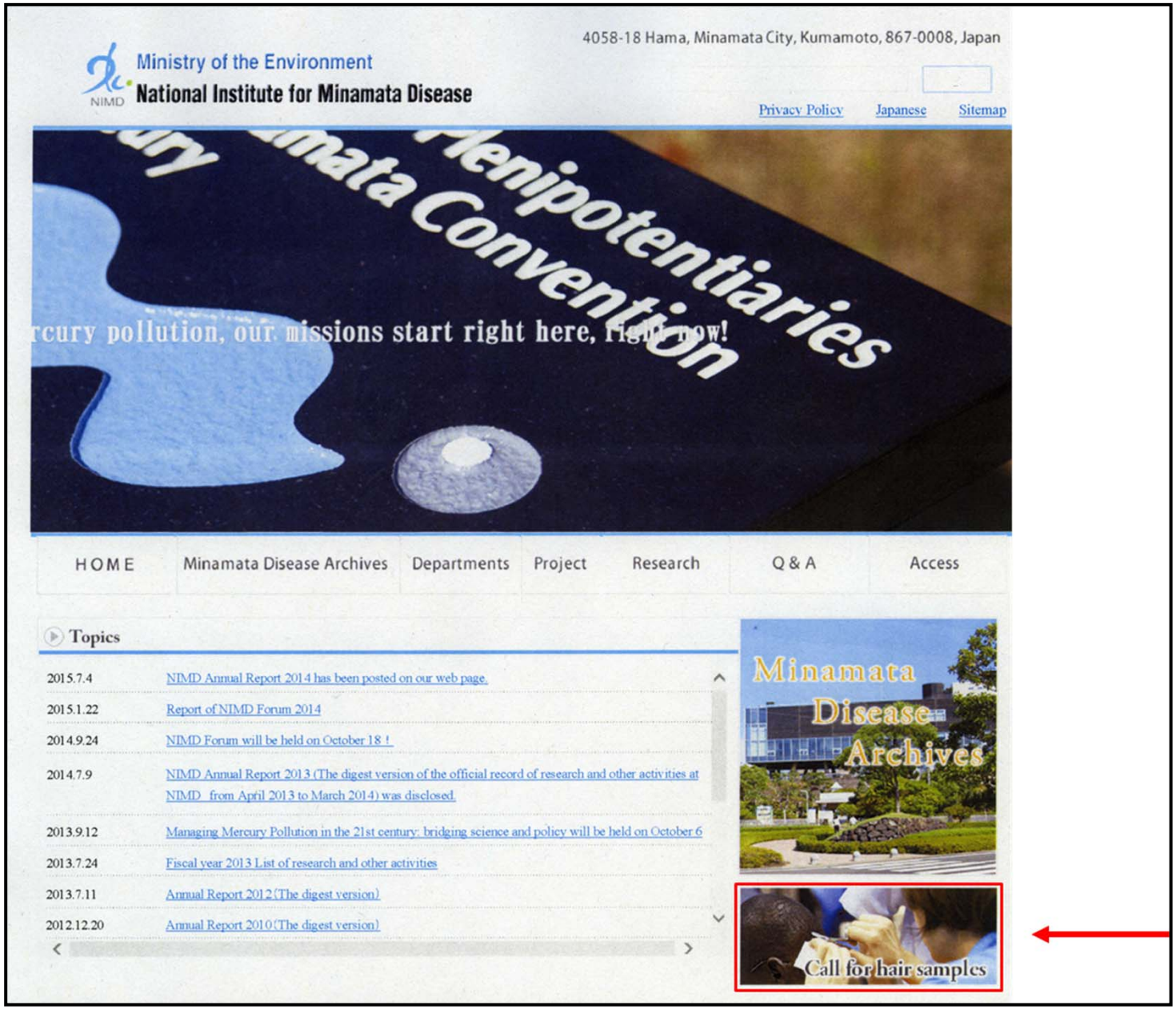
**On-site collaborator**

Utilization of data (Research or Supply information to residents)

In the confirmed high level of mercury pollution (Internal exposure to methylmercury ≈ 10 ppm)

Field survey
- Food mercury analysis
- Dietary survey

# Homepage in our web



# Homepage in our web / flyer

## National Institute For Minamata Disease

## TOP > CALL FOR HAIR SAMPLES

**National Institute for Minamata Disease studies on the mercury-pollution in developing countries. Hair is clearly the most suitable material for estimation of methylmercury exposure.**

**We collect hair samples of inhabitants living in a doubtful mercury-polluted area in developing countries to determine the mercury content.**

**Mercury content in hair will be analyzed by a flameless atomic absorption spectrometer in the institute and the mercury data will be sent to you promptly.**

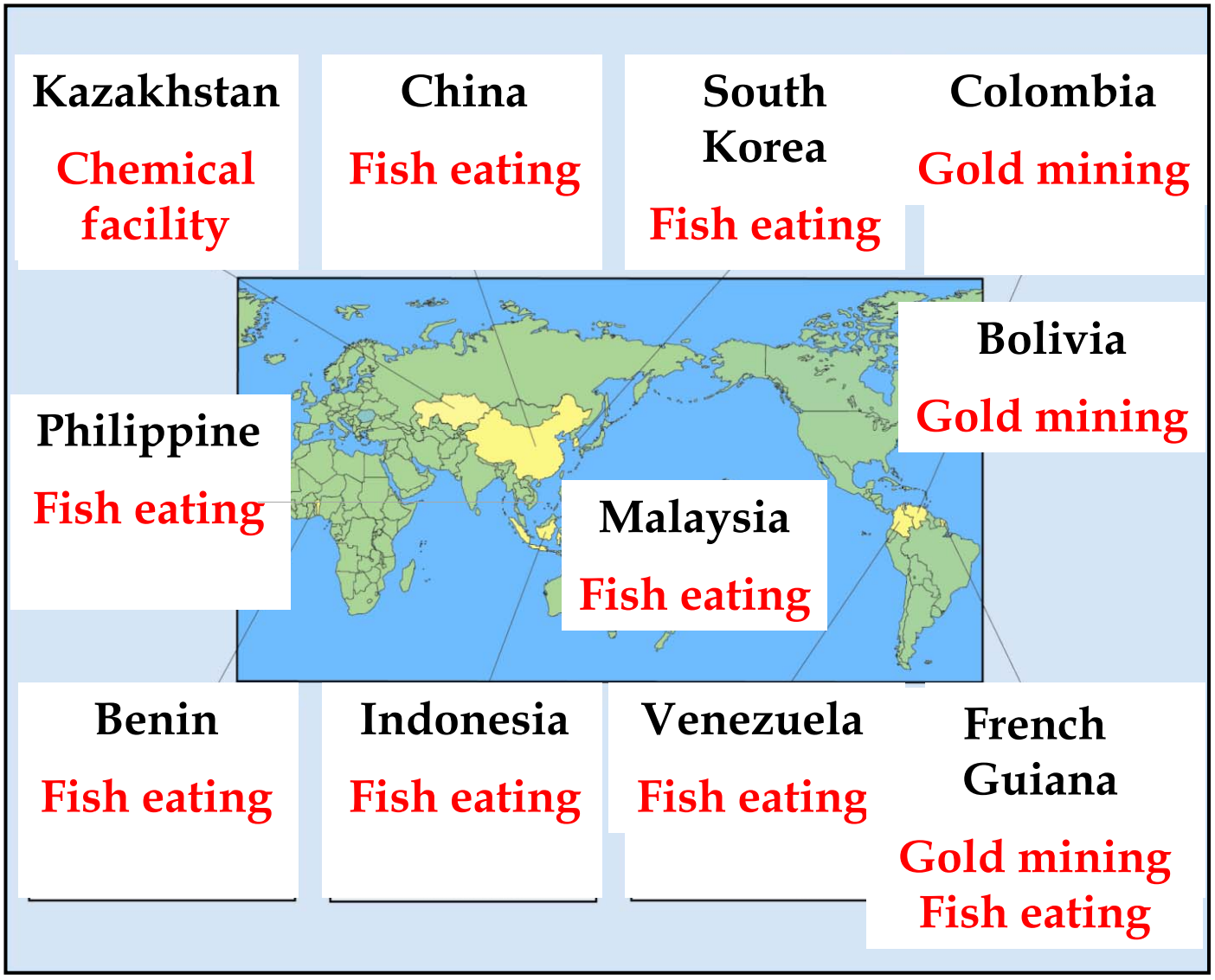
**We measure mercury content of samples for free.**
**We also need the identification number, sex and age of a participant, and sampling site.**

**Please send us hair samples prepared according to an attached paper "INSTRUCTIONS FOR HAIR SAMPLING".**

**We use the hair samples only for mercury determination. For more information, please contact to:**

**Dr. M. Fujimura**
**at Department of Basic Medical Sciences,**
**National Institute for Minamata Disease,**
**Minamata, 4058-18 Hama, Kumamoto, 867-0008, Japan.**
**E-mail : fujimura@nimd.go.jp**

# Research results (2003-2018)




16-years research
~4,000 inhabitants
(250 samples/year)
in 11 areas

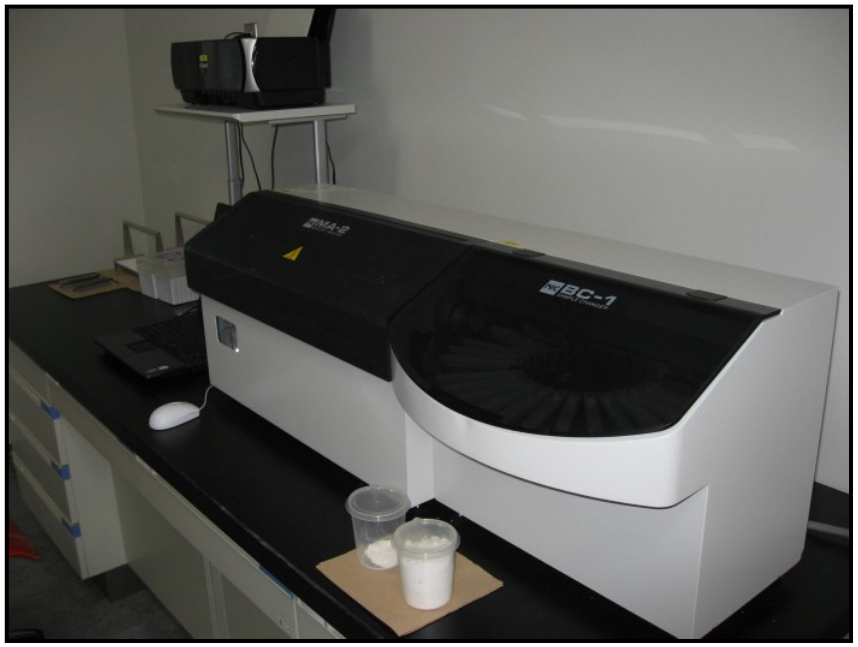
**Research paper : 5**

Invest Clin, 2007,
Venezuela
Environ Int, 2008,
Colombia
B Env Con Tox, 2012,
F Guiana
Environ Res, 2015,
Europe
Jap J Clin Ecol, 2016,
9 countries

# Materials and methods for hair mercury analysis

**The concentrations of total mercury in the hair were determined according to the oxygen combustion-gold amalgamation. Methylmercury analysis was determined by gas-liquid chromatography with electron capture determination (Akagi method).**

**Mercury Analysis Manual English version in NIMD home page**




**Mercury analyzer (MA2000)**
**Nippon Instruments**


**Gas chromatograph (G3800)**
**Yanaco**

# Hair mercury in 11 areas

| Country | Area | Average of Hair mercury (Total mercury, ppm) |
|---|---|---|
| French Guiana | River area (Maroni) | M: 9.4 (n=153), F 9.9 (n=234) |
| Venezuela | Urban area (Bolivar) | M: 1.5 (n=89), F: 1.2 (n=76) |
| Colombia | Coastal area (Sandander) | M: 2.6 (n=122), F: 0.5 (n=263) |
| Brazil | River area (Amazonas) | M: 11.0 (n=71), F: 8.3 (n=97) |
| Bolivia | Coastal area (Sorata) | M: 0.7 (n=23), F: 1.4 (n=30) |
| Indonesia | Coastal area (Kereng Pangi, Manado, Halmahara) | M: 5.9 (n=92), F: 2.7 (n=81) |
| Philippine | Coastal area (Benguet, Quezon, Paracale) | M: 2.6 (n=141), F: 0.9 (n=167) |
| Kazakhstan | River area (Nura, Ertis) | M: 0.7 (n=137), F: 0.4 (n=236) |
| Benin | Coastal area | M: 2.4 (n=41), F: 3.5 (n=54) |
| South Korea | Urban area (Soul) | M: 0.8 (n=153), F: 1.1 (n=152) |
| China | Urban area (Beijing, Shanghai) | M: 0.5 (n=134), F: 0.5 (n=122) |

M: male, F: female

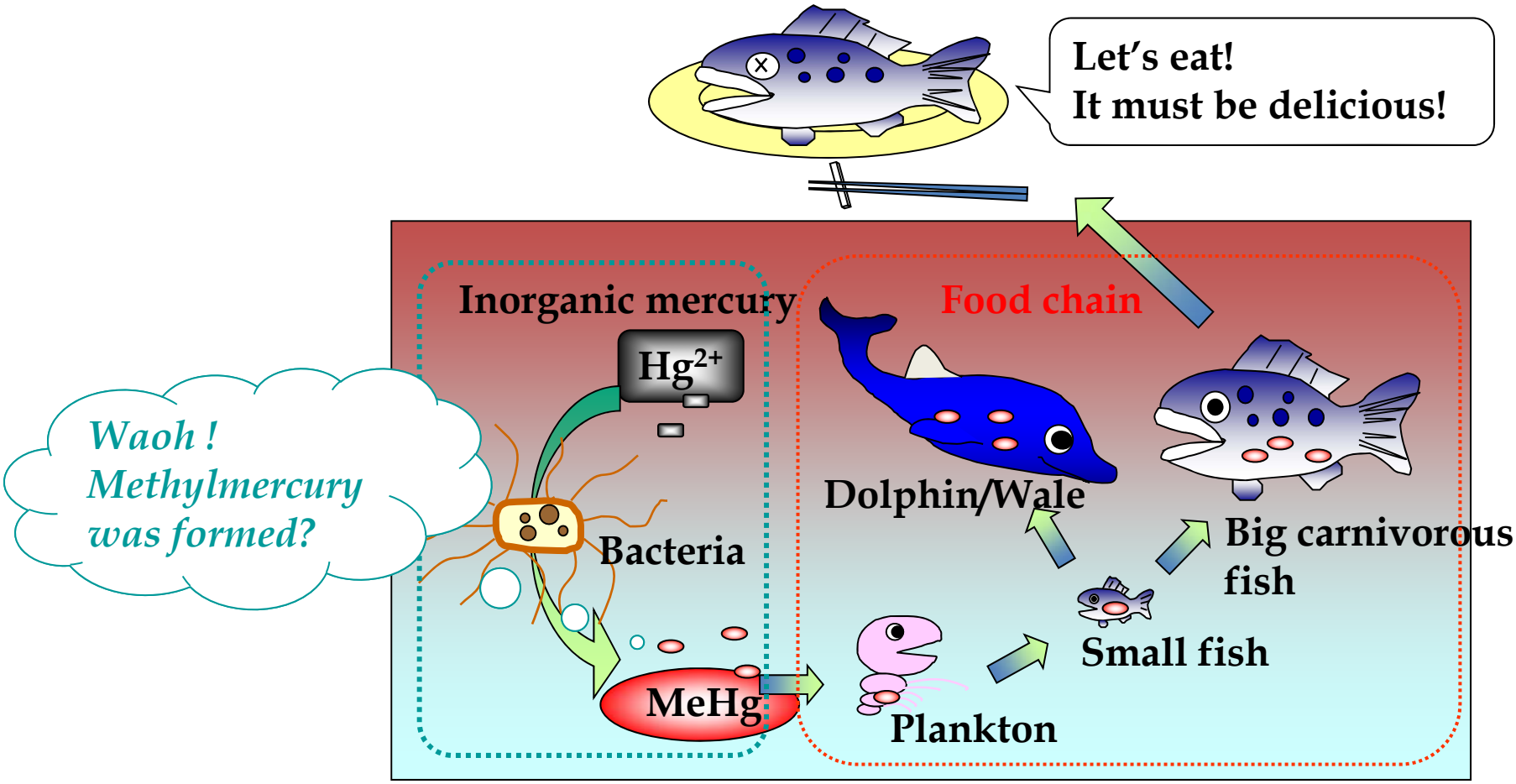
In the case of river area of French Guiana and Brazil, we detected high mercury concentration in hair (≈ 10 ppm).

Fujimura et al., Bull. Environ. Contam. Toxicol. 2012

# Internal exposure to mercury

**Food chain: Small fish eats plankton, then big carnivorous fish eat small fish. Finally, we eat fish.**

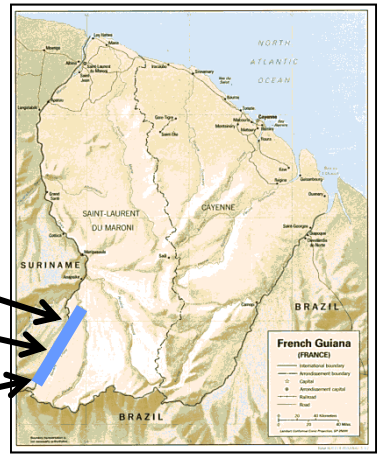
**Methylmercury is concentrated through a food chain.**




**In the case of internal exposure to mercury, almost mercury form in hair is methylated form.**

# French Guiana (Internal exposure to mercury)

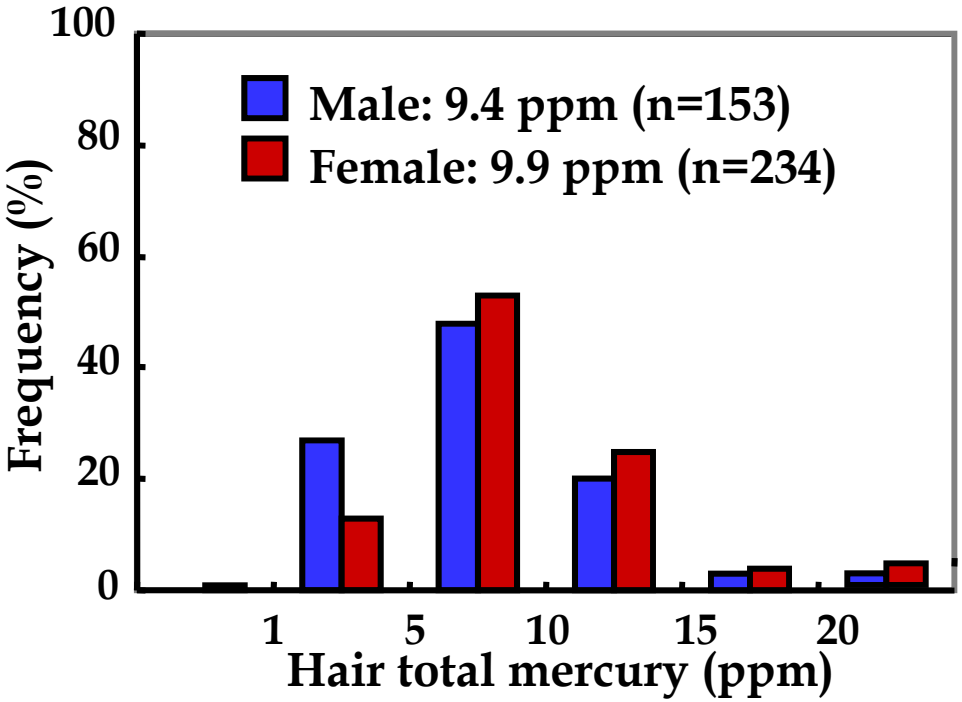
French Guiana




The native residents domicile

Gold mining area

Maroni river




We calculated the ratio of methylmercury to the total mercury about high contaminated hair (over 10 ppm). The ratio was 95.9% (n=52). It was collected from inhabitants who have a habit of eating fish in the mercury-polluted area near a gold mine. The high concentration of methylmercury was ascribed to consumption of mercury-polluted fish.

Fujimura et al., Bull. Environ. Contam. Toxicol. 2012

# Mercury concentrations of fish flesh collected from polluted river (1)

| Family | Species | Amerindian Name | No. of fish | Total mercury in muscle (ppm in wet weight, min-max) |
|---|---|---|---|---|
| Pimelodidate | *Pseudoplatystoma fasciatum* | Hulluwi | 6 | 0.33 (0.24-0.44) |
| Serrasaimidae | *Serrasalmus rhombeus* | Piraïe (Pene) | 3 | 0.40 (0.34-0.46) |
| Doradidae | *Platydoras costatus* | Hoké | 1 | 0.32 |
| Ageneiosidae | *Ageneiosus brevifilis* | Mitala | 1 | 0.18 |
| Doradidase | *Doras micropeus* | Agonosu | 1 | 0.11 |
| Characidae | *Astyanax/Moenkhausia spp.* | Yaya (Otululu, Opi) | 1 | 0.18 |

Hulluwi

Piraïe

Yaya etc.

Fujimura et al., Bull. Environ. Contam. Toxicol. 2012

# Mercury concentrations of fish flesh collected from polluted river (2)


**Hoplias aimara was mainly eaten by residents.**
**Length of body is approximately 1 m.**
**Unfortunately, we could not catch Hoplias aimara in our field investigation.**
**The mercury concentrations were taken from Frery et al., 2001.**
**Mercury concentration was definitely high, approximately 1 ppm**

# Fish consumption and daily mercury intake in upper Maroni, French Guiana

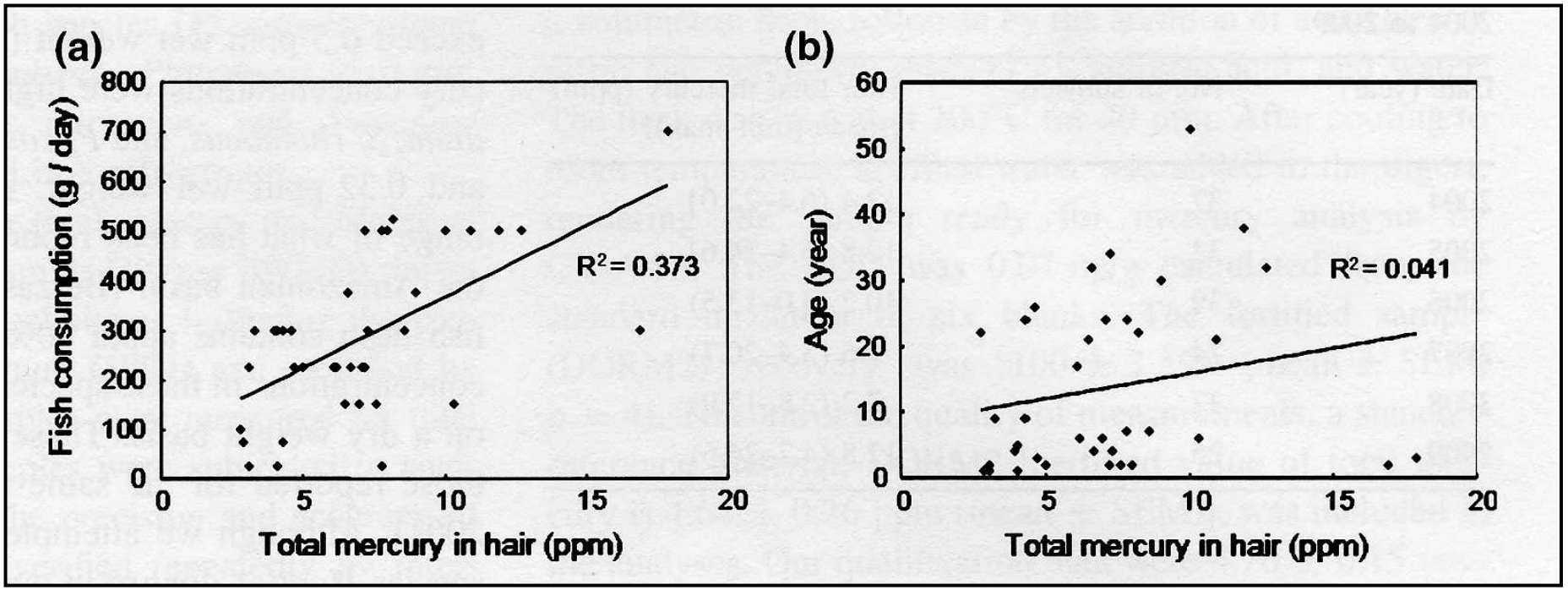
| Species | Average of fish consumption [mean (min–max)[a]] (g/day) | Calculated daily mercury intake (mg/day) mean[b]] |
|---|---|---|
| *Pseudopaltystoma fasciatum* | 59.8 (0–150) | 19.7 |
| *Hoplias aimara* | 52.7 (0–150) | 47.4 |
| *Serrasalmus rhombeus* | 49.2 (0–150) | 19.7 |
| *Platydoras costatus* | 44.0 (0-150) | 14.1 |
| *Ageneiosus brevifilis* | 36.2 (0–150) | 6.3 |
| *Doras micropeus* | 28.1 (0–50) | 3.1 |
| *Astyanax/Moenkhausia* spp. | 17.6 (0–100) | 3.2 |

**a The seven most preferred fish species were listed.**
**b Daily mercury intakes were calculated by the average fish consumptions and their mercury concentrations. In the case of Hoplias aimara, the mercury concentrations were taken from Frery et al., 2001.**

**This result showed that the major source of mercury intake was Hoplias aimara.**

**Fujimura et al., Bull. Environ. Contam. Toxicol. 2012**

# Correlation between total mercury concentration in hair and daily fish consumption (a) and age (b) in upper Maroni, French Guiana




We examined fish consumption by 37 residents in this area. There was a significant correlation between hair mercury concentration and fish consumption.

Fujimura et al., Bull. Environ. Contam. Toxicol. 2012

# External exposure to mercury

**Metal mercury and inorganic mercury directly adhere to the hair.**
**Metal mercury exposure is of mercury vapor in gold mining and inorganic mercury is of contaminated cosmetics.**

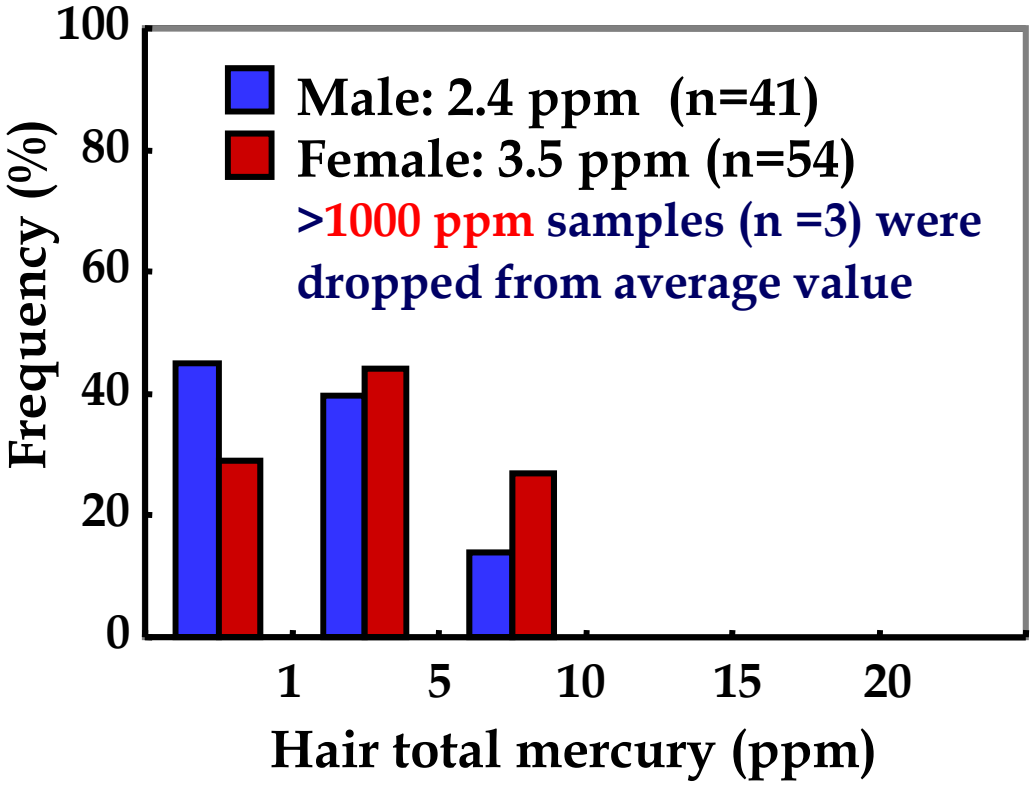
**In the case of external exposure to mercury, almost mercury in hair is non-methylated form.**

**http://science.sciencemag.org/content/341/6153/1448**



**https://ejatlas.org/conflict/high-mercury-level-in-cosmetics**

# Benin (External exposure to mercury)





To estimate whether internal or external exposure to mercury, we calculated the ratio of methylmercury to the total mercury using high contaminated hair (over 1000 ppm). The ratio was about 0.8% (n=3). Since no miner's hair included in these hair samples, it was suggested that cosmetics such as hair conditioner involved in mercury caused high value of mercury.

# Conclusion

**We found out some mercury pollution areas, especially in upper Maroni of French Guiana.**
**These results indicate that our research attempt using internet web is extremely used to discover the mercury pollution around the world.**





# Coworkers

**Akito MATSUYAMA, Jean-Pierre HARVARD, Jean-Paul BOURDINEAUD**

**Ayumi ONITSUKA, Michiko FUCHIGAMI,**
**Michiaki KINDAICHI**

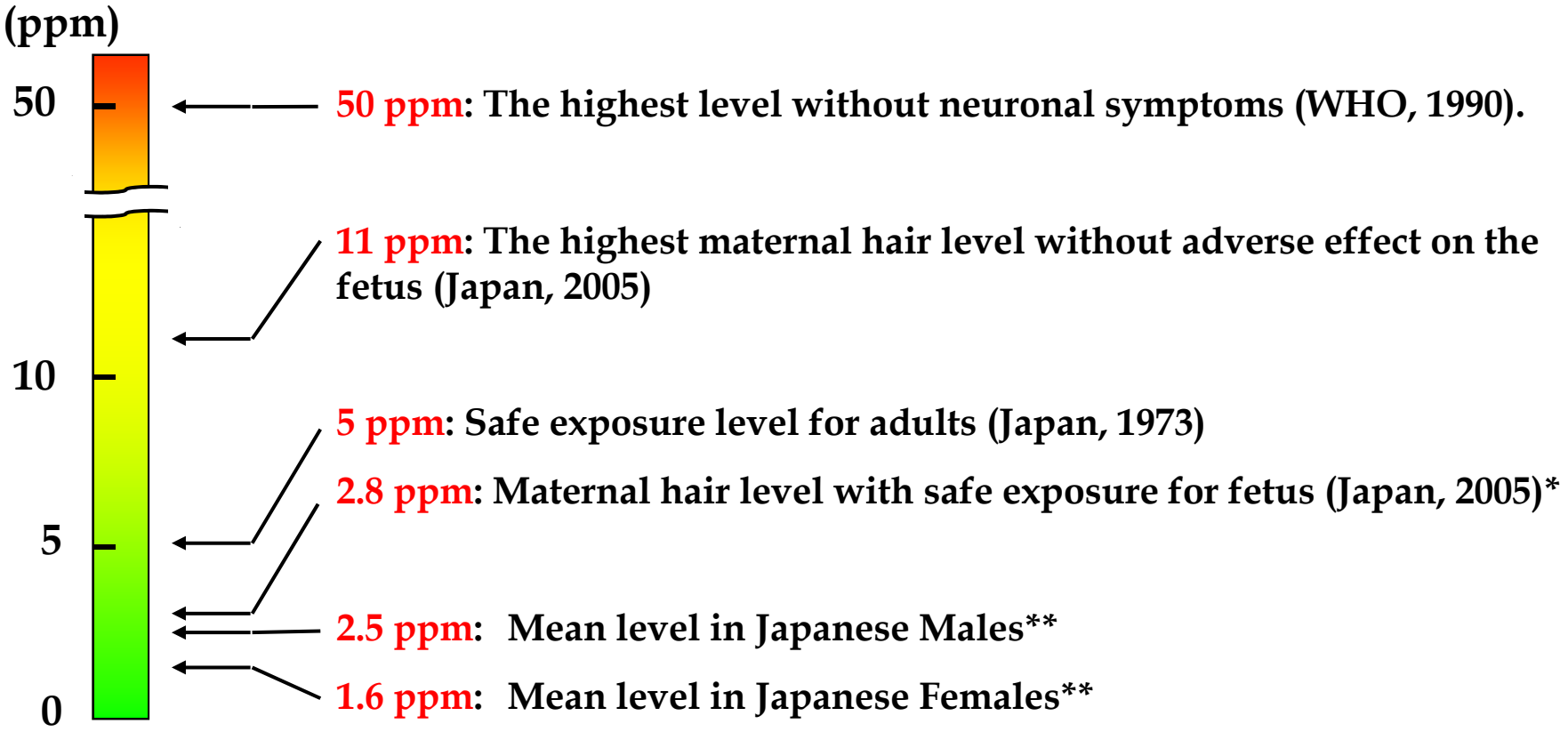
# Appendix

# Reference for mercury concentration of fish/shellfish in Japan

| Fish/shelfsh | Hg (ppm) | Fish/shelfish | Hg (ppm) |
|---|---|---|---|
| Mackerel | 0.16 | Octopas | 0.03 |
| Salmon | 0.01 | Flat fish | 0.03 |
| Saurel | 0.03 | Clam | 0.01 |
| Mackerel pike | 0.07 | Bonito | 0.17 |
| Squid | 0.02 | Yellow tail | 0.13 |
| Tuna | 0.97 | Sea beam | 0.08 |
| Fish paste | 0.01 | Eel | 0.04 |
| Shrimp | 0.03 | Crab | 0.02 |
| Sardine | 0.02 | | |

The order of fish are that of consumption rate (Data in NIMD, 2004).
Mercury concentrations are cited from Ministry of Health, Labour and Welfare, Japan.

# Reference for hair mercury level




* Corresponds to safe exposure level (PTWI, provisional tolerable weekly intake ) 2 μg/kg/week. PTWI was calculated from the highest exposure level without the fetal effect, which corresponds to 11 ppm, using uncertainty factor 4 (Japanese Food Safety Commission, 2005).

** Nationwide survey data in NIMD (2000-2004)

International Reference:

61st JECFA (Joint FAO/WHO Expert Committee on Food Additives) has suggested in 2003 that the highest maternal hair level without the fetus effect was 14 ppm. The hair level corresponding to its safe exposure level recommended was 2.2 ppm.