Mercury in Hair of Fish Eaters: Case studies from Tokyo, Japan and Rarotonga, Cook Islands

Rarotonga – Tokyo – January 2013

Report by Arnika Association, ISACI, CACP and IPEN

Citizens Against Chemicals Pollution

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IPEN toxics-free future

Mercury in hair of fish eaters: Case studies from Tokyo, Japan and Rarotonga, Cook Islands

Prepared by Island Sustainability Alliance CIS Inc. – ISACI (Cook Islands), Citizens Against Chemical Pollution – CACP (Japan), Arnika Association (Czech Republic) and the IPEN Heavy Metals Working Group

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Introduction

In 2009, the Governing Council of the United Nations Environment Programme (UNEP GC) decided to develop a global legally binding instrument on mercury to reduce risks to human health and the environment (UNEP GC25/5). The UNEP GC noted that mercury is a substance of global concern due to its long-range transport, persistence, ability to bioaccumulate, and toxicity. Its conclusions were based in part on the 2002 UNEP Global Mercury Assessment which noted that mercury is present in fish all over the globe at levels that adversely affect humans and wildlife (UNEP 2002). In humans, hair is widely accepted as a matrix for reliable estimations of the body burden of methylmercury, which likely comes from eating fish (Grandjean, Weihe et al. 1998); (Harada, Nakachi et al. 1999); (Knobeloch, Gliori et al. 2007); (Myers, Davidson et al. 2000).

This report focuses on mercury exposure in humans from two Pacific Ocean countries; Cook Islands and Japan. Both countries were chosen as sites related to non-point sources, or global deposition. We examined levels of mercury in the hair of people who eat fish frequently to examine whether atmospheric releases of mercury and/or releases to water and subsequent distribution with ocean currents and global deposition can be traced in human hair from these locations. In addition, we considered how the draft treaty text will address mercury from these exposition routes.

Materials and methods

Island Sustainability Alliance CIS Inc. (ISACI) in Cook Islands and Citizens Against Chemicals Pollution (CACP) in Japan conducted sampling of human hair using protocols developed by IPEN (2011). Nine hair samples were taken in total for this study at the Avana Harbour area at Rarotonga Island, capital of the Cook Islands and 19 hair samples were taken in Tokyo, capital of Japan. Biodiversity Research Institute (BRI) measured mercury levels (total mercury content = THg) in hair samples in their laboratory in Gorham, Maine, USA. ISACI and CACP conducted also research about age, diet, occupation and gathered other information about volunteers for this research.

Results and discussion

This study focused on cultures in the Pacific Ocean area that depend on fish in their diet, which is known to be major route of exposure to methylmercury (IOMC 2008).

Table 1 shows the levels of mercury (Hg) in human hair from Tokyo, Japan and Rarotonga, Cook Islands, two countries, where fish and/or sea food makes up a major portion of the diet. All the volunteers selected for this research eat fish at least once per week, but a majority of them eat 2 – 3 fish meals per week or more. In fact, 84% of the volunteers from Japan and 89% of the group from Cook Islands eat multiple fish meals per week. Approximately 60% of them eat tuna fish quite often.

Table 1: Mercury content in hair samples from Tokyo, Japan and Rarotonga, Cook Islands

	Sample Size	Hg Mean (ppm)	St Dev	Min Hg (ppm)	Max Hg (ppm)	Reference dose (ppm)[a]	Fraction over Ref. Dose
Tokyo, Japan	19	2.739	1.923	0.523	8.537	1.00	95%
Rarotonga, Cook Islands	9	3.290	1.371	0.935	4.996	1.00	89%

Abbreviations: Hg, mercury; ppm, parts per million or mg/kg; st dev, std deviation; min, minimum; max, maximum

Table 1 shows that 95% of the human hair samples from Japan and 89% of the samples from Cook Islands exceeded the US EPA reference dose for mercury. The results show that the mean mercury level in the hair samples from Japan is more than 2.7-times higher than the US EPA reference dose of 1 ppm. Among Cook Islands volunteers, the mean mercury level was almost 3.3-times higher than the reference dose. Maximum mercury levels in Japan were 8.5 times higher than the reference dose and in the Cook Islands maximum mercury levels were approximately five times higher than the reference dose. In fact, only one sample from each group was below the US EPA reference dose of 1 ppm.

Levels of mercury in hair in this study were higher than those in a study of the Japanese population by Yasutake, Matsumoto et al. (2003), who found 2.55 ppm and 1.43 ppm in Japanese males and females respectively. Note that this study focused on smaller group.

Airey (1983) reviewed older studies focused on fish eaters and suggested that "*arithmetic mean mercury concentrations for people who ate fish 1–4 times each month were: Australia, 2.5 ppm; Canada, 1.2 ppm; China, 0.9 ppm; West Germany, 0.5 ppm; Hong Kong, 3.0 ppm; Italy, 1.5 ppm; Japan, 3.9 ppm; Monaco, 1.7 ppm; New Zealand, 1.3 ppm; Papua New Guinea, 1.8 ppm; South Africa, 1.9 ppm; U.K., 1.6 ppm and USA, 2.4 ppm. The differences are believed to be due to diet and environment. Mean hair mercury concentrations were significantly different for the group that ate fish once or less a month (1.4 ppm) once a fortnight (1.9 ppm) once a week (2.5 ppm) and once or more a day (11.6 ppm).*" Mercury concentrations in hair in this study are higher than Airey suggests for people eating fish once a week.

In Abe, Ohtruka et al. mercury concentrations in hair were measured in 134 fish-eating subjects in the Lake Murray area and in 13 non-fish-eating subjects in the upper-Strickland area in Papua New Guinea. Hair mercury levels among the subjects in the Lake Murray area (mean = 21.9 ppm, range = 3.7-71.9 ppm) were markedly higher than levels found in subjects from the upper-Strickland area (mean hair mercury = 0.75 ppm) (Abe, Ohtsuka et al. 1995). Levels of mercury in hair in this study are higher than those in the non-fish-eating group in Papua New Guinea, but lower than for the fish-eating population there.

[a] U.S. EPA's RfD is associated with a blood mercury concentration of 4-5 μg/L and a hair mercury concentration of approximately 1μg/g." US EPA (1997). Mercury study report to Congress, Volume IV, An assessment of exposure to mercury in the United States. EPA-452/R-97-006**:** 293.

High levels of mercury in hair were also observed among islanders in Europe (Renzoni, Zino et al. 1998) and from Vieques Island, where Ortiz-Roque and Lopez-Rivera (2004) concluded that: ***„Women of reproductive age in the island of Vieques were exposed to mercury concentrations that are unsafe to their developing fetus.“*** The mean hair (Hg) for the Vieques group was 4.4 ppm with range between 0.5–8.9 ppm.

The results in this study are in agreement with other studies showing elevated or high levels of mercury in human hair for fish-eating populations. It is also notable that many communities on the islands depending on fish for their diet are highly exposed to mercury, although they are far from mercury pollution sources.

Fish eating communities and the mercury treaty

High levels of mercury in hair of volunteers from fish eaters in Japan and Cook Islands provoke questions about how the mercury treaty might mandate actions to eliminate mercury pollution in order to make the world safe enough for people of different nations and cultures to eat fish as major part of their diet.

Small Island Developing States such as the Cook Islands and other Pacific Island nations rely on fishing resources for their preferred source of protein. It is therefore imperative to prevent continuous mercury pollution of the ocean, in order to avoid impacts on human health and the marine environment. Addressing the health aspects of mercury pollution in the treaty is very important to Small Island Developing States as well as many other island and coastal populations that depend on fish as a major part of their diet. However, currently there is no agreement on proposed treaty text concerning the health aspects of mercury pollution. [b]

Coal-fired power plants are the single largest source of atmospheric emissions of mercury. However, many countries are rapidly expanding their national electricity generating capacity, including the construction of many new coal-fired power plants. The treaty's proposed provisions will not likely result in a reduction of the number of coal-fired power plants in operation or even slow their growth. Nor are its mercury control provisions on coal-fired power plants likely to reduce mercury emissions from individual plants on a scale sufficient to offset the new mercury emissions that are likely to result from the rapid growth of this sector.

Mercury emissions from ASGM are the second largest source of global mercury pollution (Pirrone, Cinnirella et al. 2010). The current treaty text requires actions if Parties determine that ASGM is "more than insignificant" but there are no guidelines to determine "significance".[1] In addition, the current text allows countries to import unlimited quantities of mercury for use in ASGM with no phase-out date.[2] Finally, no obligations exist to identify or cleanup contaminated ASGM sites.

Taken together, the expected growth of global mercury emissions from the combination of coal-fired power plants and ASGM is likely to be greater than the decline of mercury emissions from other sources that may result from the treaty's provisions. This suggests global mercury pollution will likely continue to grow even after the new mercury treaty enters into force.

[b] **UNEP**(DTIE)/Hg/INC.5/3; Article 20 bis on Health aspects is in brackets.

Sunderland and Mason (2007) have suggested that open ocean mercury concentrations will increase if anthropogenic mercury emissions remain at their present level. As oceans and seas are polluted not only by mercury deposition from air, but also by mercury bound in sediments from rivers it is important to look how the current mercury treaty text addresses mercury releases to water. Currently the proposed treaty text offers some vague options for controlling releases to land and water but there is no agreement if best available techniques should be required and no agreement on whether existing sources should be treated differently than new sources. The list of mercury sources that release mercury to land and water contains three categories but does not include a previous proposal to require amalgam separators in dental practices – a source of mercury water pollution. In addition, large scale mining of metals is missing in the inventory of sources and the text appears to restrict only facilities that deliberately produce mercury as a by-product and not include the far greater number of facilities that generate mercury as an unintentional by-product. (UNEP (DTIE) 2012).

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[1] **UNEP(DTIE)/Hg/INC.5/3**: Draft text for a global legally binding instrument on mercury. Chair's draft text. Intergovernmental negotiating committee to prepare a global legally binding instrument on mercury - Fifth session - Geneva, 13– 18 January 2013, United Nations Environment Programme: 44

[2] **UNEP(DTIE)/Hg/INC.5/3**; Article 9 para 5 "Each Party that is subject to the provisions of paragraph 3 of this Article and determines that domestic sources of mercury are not available: a. May import mercury for use in artisanal and small-scale mining consistent with its action plan developed in accordance with paragraph 3 of this Article; and"