EXECUTIVE SUMMARY

# MERCURY IN WOMEN OF CHILD-BEARING AGE IN 25 COUNTRIES

BIODIVERSITY RESEARCH INSTITUTE
innovative wildlife science

IPEN
a toxics-free future

# MERCURY IN WOMEN OF CHILD-BEARING AGE IN 25 COUNTRIES

*Lead Author*
***Lee Bell***
*IPEN Mercury Policy Advisor*

**September 2017**

**IPEN** is a network of non-governmental organizations working in more than 100 countries to reduce and eliminate the harm to human health and the environment from toxic chemicals.

**www.ipen.org**

**Biodiversity Research Institute** is a nonprofit ecological research group whose mission is to assess emerging threats to wildlife and ecosystems through collaborative research, and to use scientific findings to advance environmental awareness and inform decision makers. BRI a the leading international institute supporting the global mercury monitoring efforts for the Minamata Convention on Mercury.

**www.briloon.org**

**Front cover photo: Mercury hair sampling in Nepal village.** Ram Charitra Sah, CEPHED, Nepal

## KEY FINDINGS

- 1044 women of child-bearing age from 25 countries participated in the study. 42% of them had mercury levels greater than 1 ppm – the level that approximately corresponds to the US EPA reference dose.* 55% of the women had mercury levels greater than 0.58 ppm mercury, a more recent, science-based threshold based on data indicating harmful effects at lower levels of exposure. Mercury is a health threat to women and the developing fetus.
- Women of the Pacific Islands have elevated mercury levels, likely due to a fish-rich diet. Distant air emissions of mercury from coal-fired power plants, cement kilns and other industries contaminate ocean fish that serve as a primary protein source for Pacific Islanders.
- Artisanal small-scale gold mining results in high mercury body burdens in women from Indonesia, Kenya, and Myanmar. Two likely mercury exposure sources are burning mercury amalgam and eating contaminated fish.
- Industrial mercury emissions contaminate local fish and elevate mercury levels in Thai women living nearby.
- Indigenous women in Alaska have mercury levels of concern due to their subsistence diet of sea mammals and fish. Consumption of seals may be a key source of mercury exposure.
- Women from locations in Albania, Chile, Nepal, Nigeria, Kazakhstan, and Ukraine have mercury levels of concern due to localised pollution of waterways and suspected fish contamination.
- Women using mercury to gold plate statues in Nepal have elevated mercury levels.

* This is the daily exposure that US EPA considers "likely to be without an appreciable risk of deleterious effects during a lifetime."

# OVERVIEW

Mercury is a potent neurotoxin, especially to the developing brain, and can affect the developing fetus months after the mother's exposure. The harmful effects that can be passed from the mother to the fetus when the mother's mercury levels exceed 1 ppm include neurological impairment, IQ loss, and damage to the kidneys and cardiovascular system. At high levels of mercury exposure this can lead to brain damage, developmental disabilities, blindness, seizures and the inability to speak. While researchers have studied mercury body burden in specific regions of the world, information in developing and transition countries is lacking. This comprehensive study focused on measuring the mercury body burden of 1044 women of child-bearing age in 25 developing and transitioning countries. The data indicates that there is a serious and substantial threat to women's and children's health from mercury exposure.

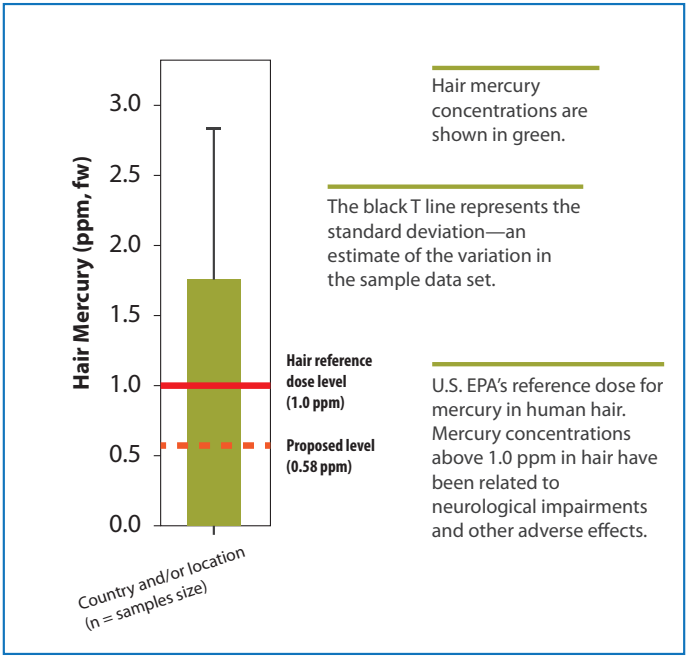
"THE DATA INDICATES THAT THERE IS A SERIOUS AND SUBSTANTIAL THREAT TO WOMEN'S AND CHILDREN'S HEALTH FROM MERCURY EXPOSURE."

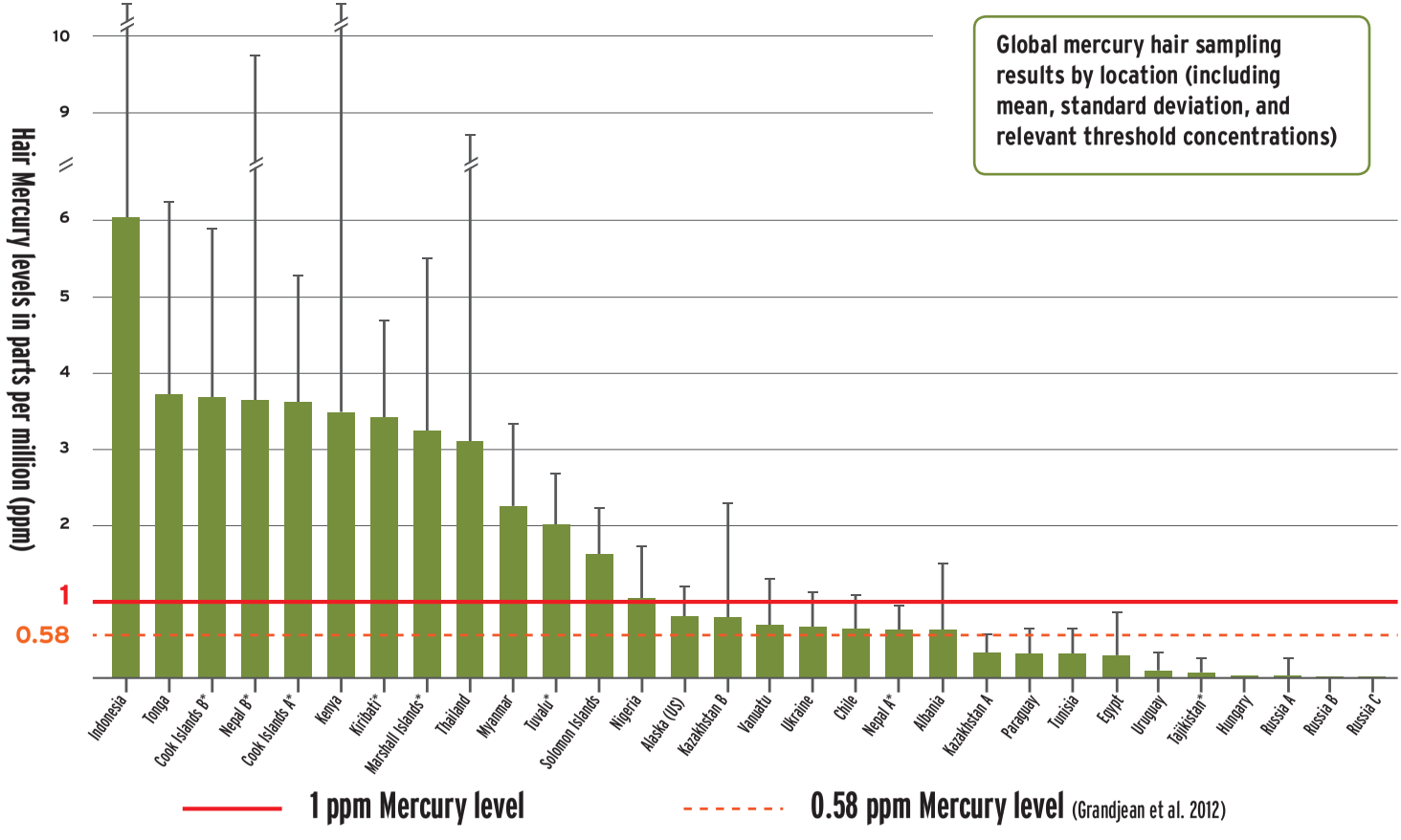
Indonesia, mother and child in mining community. Larry C. Price, Pulitzer Centre on Crisis Reporting

# METHODOLOGY

Sampling was undertaken across the globe during 2015 and 2016 by public interest Participating Organisations (POs) of IPEN – a global network operating in more than 100 countries. IPEN POs reached out to communities in areas with known mercury contamination hotspots as well as areas that may be susceptible to mercury contamination of food supplies such as fish, which can transfer their methylmercury body burden to humans when consumed. The study resulted in samples being taken from 1044 women in 37 locations across 25 countries. The methodology for the study required IPEN POs to identify groups of 30-35 women of child-bearing age (denoted as 18 – 44 years old) in one or two locations in each country. The women provided signed consent to participate in the study. Participants were required to provide a small sample of hair and to complete a questionnaire to assist with contextual analysis. The samples of hair were shipped to the laboratories of BRI in the United States for analysis.

**Interpreting the hair mercury concentration chart.**






* Data source: Bell, L., (2017) Mercury Monitoring in Women of Child-Bearing Age in the Asia and the Pacific Region. A joint study by UN Environment, Biodiversity Research Institute and IPEN. April 2017.

**Baby and children with birth defects in gold mining communities in Indonesia.** (Left) Larry C. Price/Pulitzer Centre on Crisis Reporting; (Right) BaliFokus, Indonesia

Women in this age range were selected as they constitute part of the vulnerable sub-population groups at risk from mercury, a powerful neurotoxin that can affect both the health of the mother and impact on a range of developmental endpoints in the developing fetus with lifelong consequences.[1] Sample results were assessed against the internationally recognised reference level of 1 ppm total mercury (THg), above which health effects to the developing fetus of pregnant mothers may occur.

The basis for the use of this reference level in this study is that it corresponds closely with the U.S. EPA's reference dose (RfD) of 0.1 µg/kg bw/day and a blood mercury concentration of 4-5 µg/L.[2] For some time, the scientific literature has suggested that adverse effects on the sampled individual begin to occur at[3] or above the reference level of 1 ppm.[4] However, the latest scientific literature concludes that negative developmental effects may occur at even lower levels[5] and that a threshold level of 0.58

---

1 Bose-O'Reilly, S., et al (2010) Mercury exposure and children's health. Curr Probl Pediatr Adolesc Health Care, 2010 Sep; 40(8):186-215.

2 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

3 Trasande L, Landrigan PJ, Schecter C (2005) Public health and economic consequences of Methyl Mercury Toxicity to the Developing Brain, Environ Health Perspect 113:590-596

4 Grandjean P, Weise P, White RF, Debes F, Araki S, Yokoyama K, Murata K, Sorensen N, Dahl R, Jorgensen PJ (1997) Cognitive deficit in 7-year-old children with prenatal exposure to methylmercury. Neurotoxicol Teratol
19:417-428

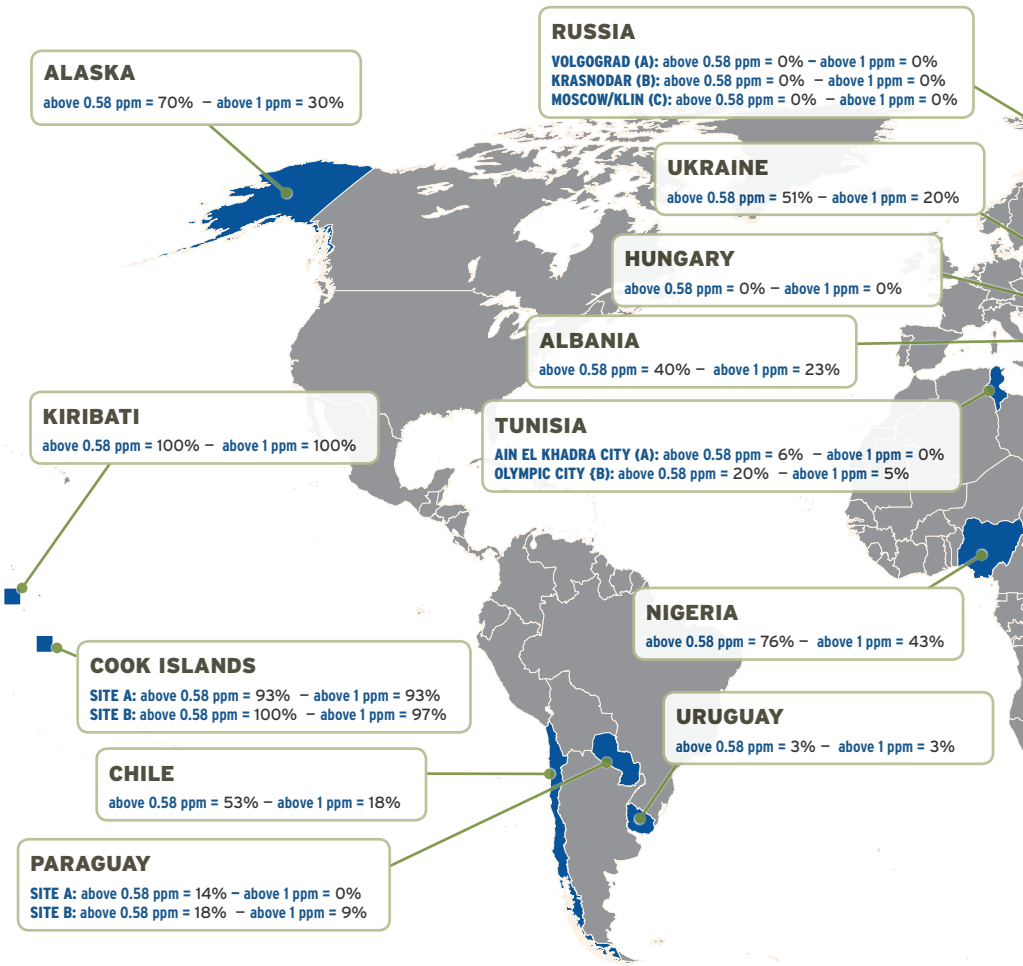
5 Murata K, Weihe P, Budtz-Jorgensen E, Jorgensen PJ, Grandjean P. (2004) Delayed brainstem auditory evoked potential latencies in 14-year-old children exposed to methylmercury. J Pediatr 144(2):177-183

ppm should be adopted as the level below which impacts on the developing fetus are negligible.[6] For the purposes of this study we used the accepted threshold of 1 ppm to assess elevated mercury levels in participants. However, where appropriate we have also included references to the latest science-based threshold concentration of 0.58 ppm for comparison.

Woman and daughter gold mining in Africa. Larry C. Price, Pulitzer Centre on Crisis Reporting

6 Grandjean P, Pichery C, Bellanger M, Budtz-Jørgensen E (2012) Calculation of Mercury's effect on Neurodevelopment. Environ Health Perspect. 2012 December; 120(12)

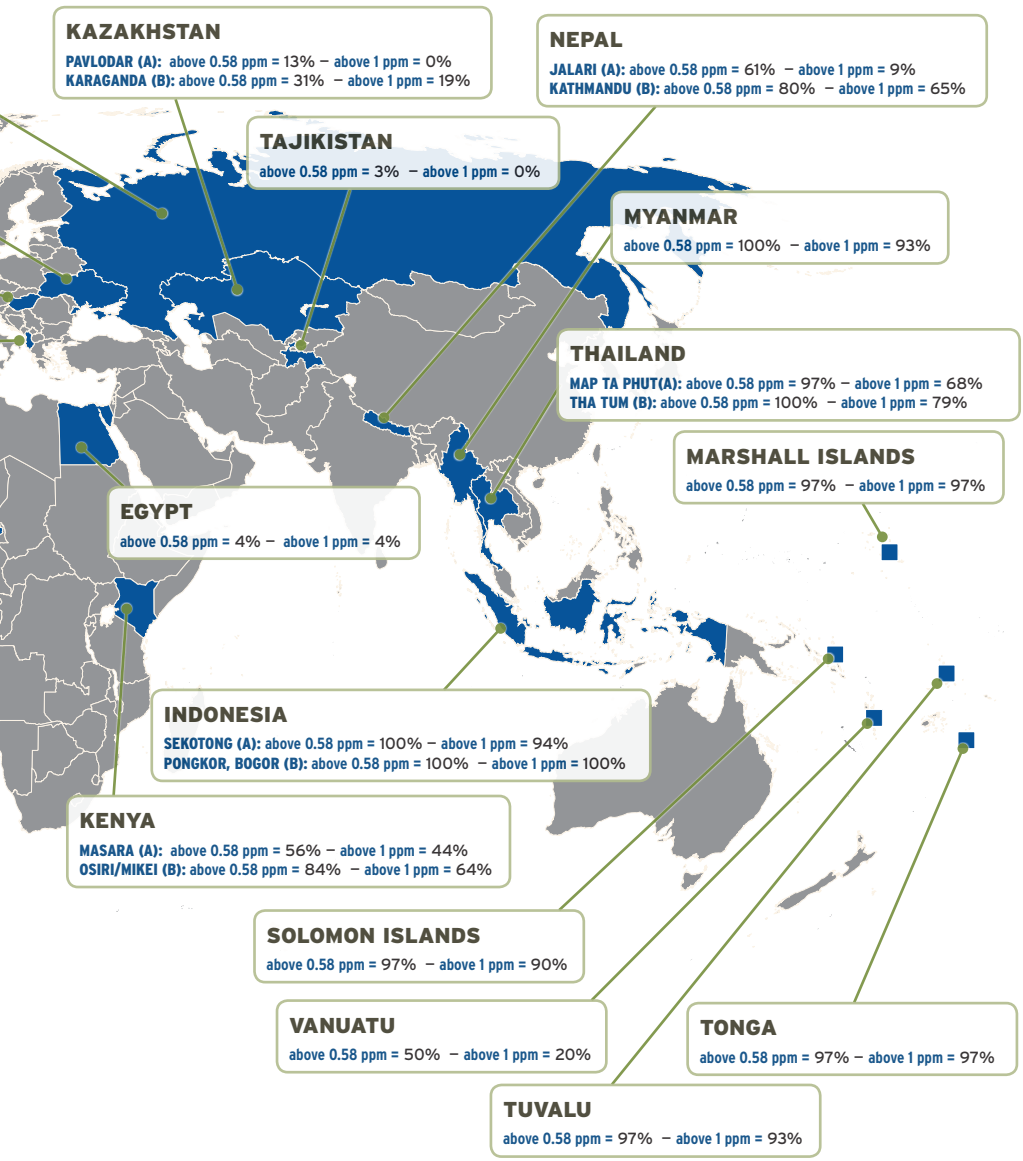
# MERCURY IN WOMEN OF
## RESULTS FROM COMMUNITIES




**Mercury levels above 1 ppm can be linked to brain damage, IQ loss, and kidney and heart damage. Fetal neurological damage can begin at mercury levels greater than 0.58 ppm.**

*(US EPA reference dose for mercury in human hair is equivalent to 1ppm.)*

# CHILD-BEARING AGE
## ACROSS THE GLOBE




IPEN
a toxics-free future

**Woman mining with child on her back.**

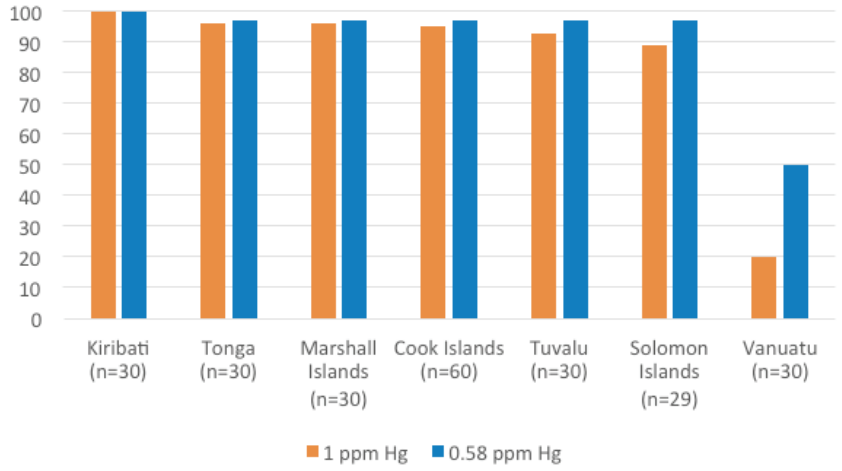
# KEY FINDINGS

Mercury pollution poses a serious and substantial threat to the health of women and the developing fetus in many parts of the world. Of the 1044 women who participated in this study, 42% had a mercury body burden that exceeded the reference level of 1 ppm total mercury in hair. Locations where the mean (average) level for the group of women exceeded the 1 ppm reference level for mercury were the Cook Islands, Indonesia, Kenya, Kiribati, Marshall Islands, Myanmar, Nepal (location A), Nigeria, Solomon Islands, Thailand, Tonga, and Tuvalu. A second tier of women from Alaska, Albania, Chile, Kazakhstan (location B), Ukraine, and Vanuatu exceeded the 0.58 ppm mercury level as the mean for the group.[7]

The analysis suggests three specific factors resulted in elevated levels of mercury in mothers and potential mothers across different countries and continents: a fish-rich diet; the practice of artisanal and small-scale gold mining (ASGM); and proximity to industrial locations.

The data from the Pacific Islands illustrates the impact of a fish-rich diet. Women from Small Island Developing States (SIDS) in the Pacific were

**Percentage of Pacific Islander hair samples exceeding the 1 ppm reference level and the 0.58ppm level.**




7 Grandjean, P., et al (2010) Adverse Effects of Methylmercury: Environmental Health Research Implications. Environmental Health Perspectives, Vol 118. No.8. August 2010, 1137-1145

found to have very high levels of mercury body burden compared to most other locations except those engaged in ASGM. Of the 239 participants located in Pacific Island States, 209 (86%) exceeded the 1 ppm mercury threshold level. In Cook Islands, Kiribati, Marshall Islands, Tonga, and Tuvalu, 90% or more of each group exceeded 1 ppm mercury in hair. For Kiribati, 100% of women sampled exceeded the 1 ppm threshold level.

The high mercury levels in Pacific Island women are consistent with data from the study questionnaires and prior studies indicating that most of these women have a diet rich in seafood. Large predatory fish that feature in the diet of women in the Pacific SIDS are commonly cited in the literature[8] as having high methylmercury (MeHg) concentrations in their flesh. The absence of local industries with mercury emissions in the Pacific Islands and the remote distribution of the islands indicate mercury contamination of seafood as the primary factor in the elevated mercury body burden of these women. This points to a serious food chain contamination problem caused by global mercury deposition from industrial emissions to oceans. Subsequent bacterial methylation of mercury in oceans results in its magnification through the food chain, impacting on women reliant on fish as dietary protein such as Pacific Islanders.

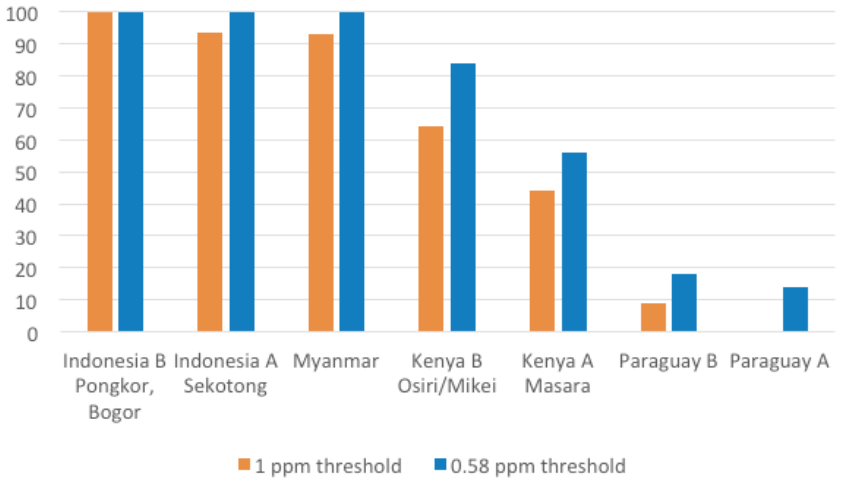
"OF THE 1044 WOMEN WHO PARTICIPATED IN THIS STUDY 42% HAD MERCURY BODY BURDENS WHICH EXCEEDED THE REFERENCE LEVEL OF 1 PPM TOTAL MERCURY IN HAIR."

The results from this study strongly suggest that the practice of artisanal and small-scale gold mining (ASGM) using mercury leads to elevated mercury levels for women engaged in this activity. In ASGM, elemental mercury is often used to amalgamate gold dust obtained by low technology mining (e.g. panning, sluicing and ball milling). The gold and mercury amalgam is 'roasted', often in domestic settings, to vaporise the mercury, leaving a small amount of gold. This leads to direct mercury exposure through handling and fume inhalation. Sampling results from women directly engaged in ASGM, or who had family members practicing

"IN COOK ISLANDS, KIRIBATI, MARSHALL ISLANDS, TONGA, AND TUVALU, 90% OR MORE OF EACH GROUP EXCEEDED 1 PPM MERCURY IN HAIR."

8 Silbernagle, et al, (2011) Recognizing and Preventing overexposure to Methylmercury from Fish and Seafood Consumption: Information for Physicians. J Toxicology 2011;2011 983072

**Percentage of small-scale gold mining related hair samples exceeding the reference level of 1ppm and the 0.58 ppm level.**




ASGM with mercury in Indonesia, Kenya, and Myanmar, show significantly elevated mercury levels in their hair. In Indonesia, 100% of women sampled exceeded the 1 ppm threshold level. In Kenya and Myanmar, the percentage of women exceeding the 1 ppm threshold level was 44% – 93% respectively. When compared to the 0.58 ppm threshold level, the percentage rose to 71% and 100% respectively.

Proximity to heavily industrialised areas or those areas with hotspots caused by historical industrial activities also led to high mercury body burden levels. This occurred in Thailand, where two locations featured

**Gold plating worker mixes and burns off mercury-gold amalgam.** (CEPHED, Nepal)

**In many parts of the world babies and young children remain close to mothers throughout the day. Here women use mercury in an ASGM site in Kenya.** (CEJAD, Kenya)

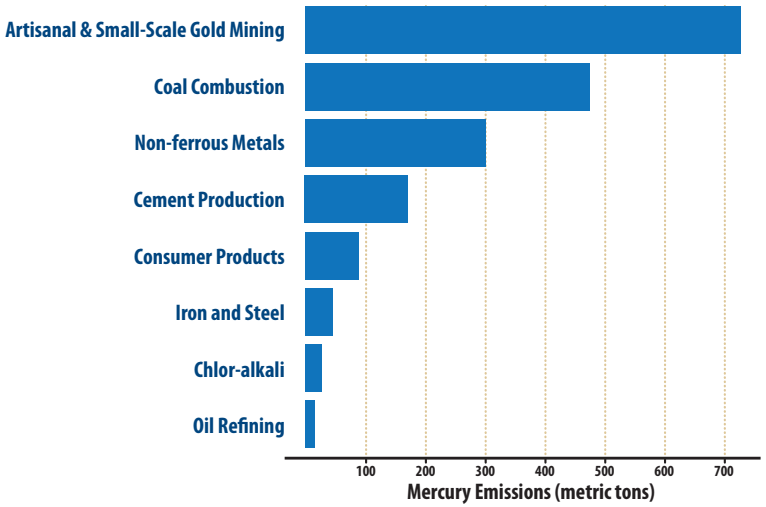
mixed heavy industry facilities with known mercury releases adjoining waterways from which local people consumed fish. The percentage of women exceeding the 1 ppm threshold level in the two Thai locations ranged from 68% - 79%. When compared to the 0.58 ppm reference level, the percentage rose to 97% and 100% respectively for the two locations. The elevated mercury levels reported by these women were comparable with those of women from most of the Pacific Islands where sampling took place.

# CONCLUSION

The data indicates that there is a serious and substantial threat to the health of women and the developing fetus in many parts of the world as a result of mercury pollution. Reducing or eliminating atmospheric mercury pollution and deposition to oceans from coal fired power plants and other industrial sources should be a priority for the international community. In addition, urgent action must be taken to reduce and eliminate mercury exposure of women involved in ASGM activity. An outright ban on mercury use in ASGM and the trade in mercury associated with it would have the most immediate beneficial health impacts for women.

The Minamata Convention on Mercury represents a global consensus that mercury pollution poses a serious threat to human health. However, the time frame for action in the Convention and the multiple exemptions for mercury use will limit its effectiveness in the medium term. National governments should take matters into their own hands by banning the import and export of mercury and introducing tough measures to eliminate domestic sources of mercury pollution as soon as possible. Hotspot contamination from industrial sources such as those in Thailand must be much more strictly controlled and mercury emissions heavily restricted or, preferably, eliminated, to protect the women and children in those localities.

**Global sources of mercury emissions to air.** (UNEP, 2010)



An immediate step that should be taken to reduce impacts of mercury pollution in all the locations studied is to intensify and expand monitoring of women's body burden and food sources (especially fish and marine mammals). This should lead to locally relevant food advisories that should be rapidly developed to inform women of the safest types of fish and marine mammals to consume where alternative protein sources are unavailable. In the absence of urgent action, generations of women and their offspring will bear the brunt of mercury contamination, while others will profit from ongoing mercury pollution.

## ABSTRACT

# MERCURY IN WOMEN OF CHILD-BEARING AGE IN 25 COUNTRIES

**Background and Objectives:** Mercury is a potent neurotoxin and harms the kidneys and cardiovascular system. Recognition of mercury's health impacts and its designation as a global pollutant led to the Minamata Convention on Mercury, which became international law in August 2017. While researchers have studied mercury body burden in specific regions of the world, information in developing and transition countries is lacking – particularly in women. Mercury body burdens in women are important because mercury can harm both women and the developing fetus even months after the mother's exposure, causing brain damage, developmental disabilities, blindness, seizures and the inability to speak. This is the most far-reaching study of mercury in women to date, with 1044 women participants of child-bearing age in 37 locations across 25 countries on six continents.

**Methodology:** Hair samples and questionnaires were taken from 1044 of women of child-bearing age (18 – 44 years old) in 37 locations in 25 countries. The samples were analyzed in the laboratories of the Biodiversity Research Institute (BRI) in the US. Results were compared with the internationally recognized reference level of 1 ppm total mercury (THg), above which health effects on the developing fetus of pregnant mothers may occur. Samples were also compared with a level of 0.58 ppm mercury, a more recent, science-based threshold based on data indicating harmful effects at even lower levels of exposure.

**Key Findings:** High levels of mercury were found in women of child-bearing age. Of the 1044 women who participated in this study, 42% had mercury body burdens that exceeded the reference level of 1 ppm total mercury in hair. Women from the Cook Islands, Indonesia, Kenya, Kiribati, Marshall Islands, Myanmar, Nepal (location A), Nigeria, Solomon Islands, Thailand, Tonga, and Tuvalu exceeded the 1 ppm level as a group average. A second tier of women from Alaska, Albania, Chile, Kazakhstan (location B), Ukraine, and Vanuatu exceeded the 0.58 ppm mercury level as a group average. Altogether, women from 18 countries exceeded the 0.58 ppm

mercury level as a group average. In total, 55% of the 1044 women who provided samples exceeded the 0.58 ppm level.

**Conclusion:** Mercury pollution poses a serious and substantial threat to the health of women and the developing fetus in many parts of the world. This study showed high mercury levels in women of child-bearing age from six continents. The analysis suggests three specific factors resulted in elevated levels of mercury: a fish-rich diet; the practice of artisanal and small-scale gold mining (ASGM); and proximity to industrial locations. An immediate step that should be taken to reduce impacts of mercury pollution in all of the locations studied is to intensify and expand monitoring of women's body burden and food sources (especially fish and marine mammals). In addition, locally relevant food advisories should be rapidly developed to inform women of the safest types of fish and marine mammals to consume where alternative protein sources are unavailable. In the absence of urgent action, generations of women and their offspring will bear the brunt of mercury contamination, while others will profit from ongoing mercury pollution. The Minamata Convention on Mercury represents a global consensus that mercury pollution poses a serious threat to human health. However, the time-frame for action in the Convention and the multiple exemptions for mercury use will limit its effectiveness in the medium term. National governments should take matters into their own hands by banning the import and export of mercury and introducing tough measures to eliminate domestic sources of mercury pollution as soon as possible.

## *DOWNLOAD THE FULL REPORT*

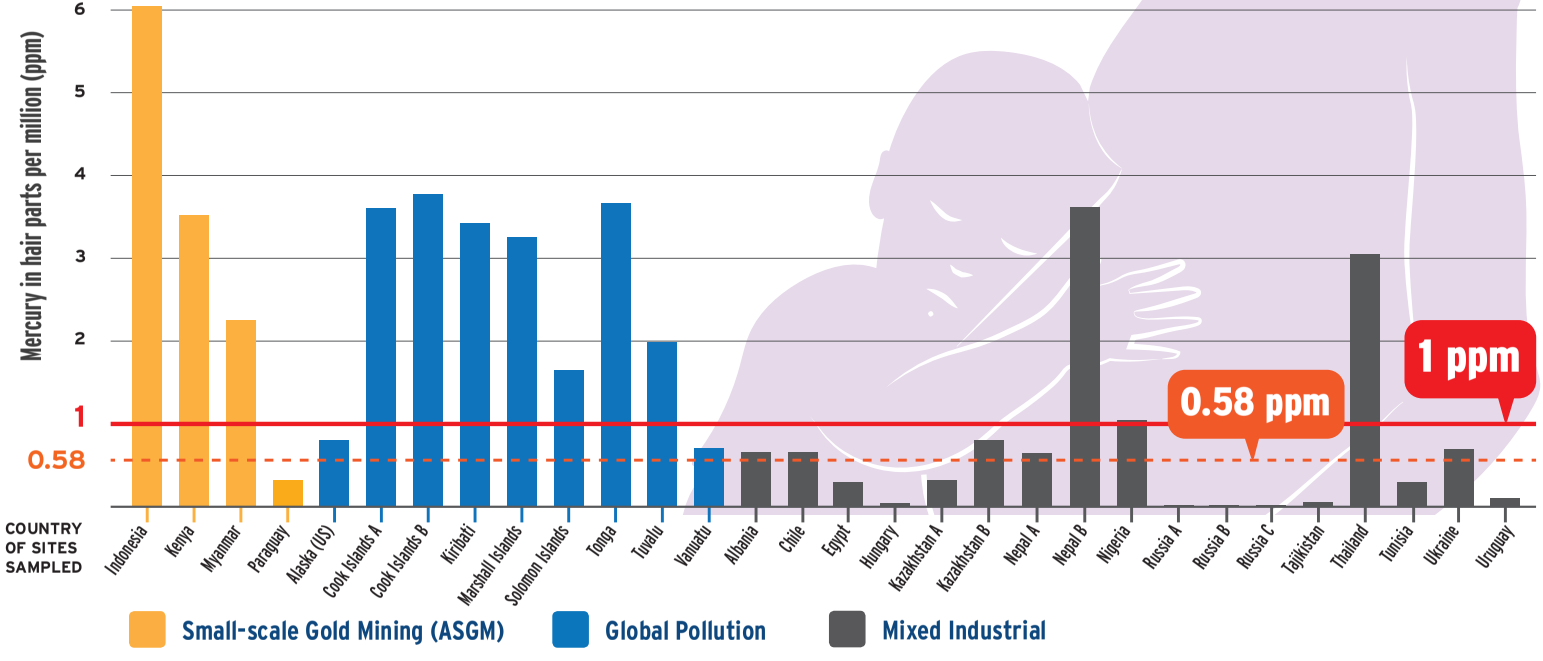
### *MERCURY IN WOMEN OF CHILD-BEARING AGE IN 25 COUNTRIES*

***http://ipen.org/mercury-and-women***

# RESULTS BY MERCURY POLLUTION SOURCE

**Mercury levels above 1 ppm can be linked to brain damage, IQ loss, and kidney and heart damage. Fetal neurological damage can begin at mercury levels greater than 0.58 ppm.**

*(US EPA reference dose for mercury in human hair is equivalent to 1ppm.)*



## ACKNOWLEDGEMENTS

IPEN and Biodiversity Research Institute (BRI) would like to acknowledge the participation of 1044 women in 37 communities across 25 countries who contributed hair samples for this study. In addition, we would like to recognize the contributions from the following IPEN Participating Organizations (listed below) that conducted research and prepared reports characterizing the participating community locations; collected samples for mercury analysis; and communicated the results of this study to the participants, their governments, media, and other public health and civil society groups:

- Island Sustainability Alliance Cook Islands Inc. (ISACI), Cook Islands;
- Centre for Public Health and Environmental Development (CEPHED), Nepal;
- Foundation to Support Civil Initiatives (FSCI) Dastgirie-Center, Tajikistan;
- Centre for Environmental Justice and Development (CEJAD), Kenya;
- Sustainable Research and Action for Environmental Development (SRAdev), Nigeria;
- Observatorio Latinoamericano de Conflictos Ambientales (OLCA), Chile;
- La Red de Acción en Plaguicidas y sus Alternativas para América Latina (RAPAL), Uruguay;
- Alter Vida, Paraguay;
- The Environmental Development, Education and Networking Center (EDEN), Albania;
- Ecomuseum, Karaganda, Kazakhstan;
- Public Association EKOM, Kazakhstan;
- Szubjektiv Értékek Alapítvány (Subjective Values Foundation), Hungary;
- Kenana NGO for Sustainable Development, Egypt;
- Association d'Education Environnementale pour la Future Génération (AEEFG), Tunisia;
- Dawei Development Association (DDA), Myanmar;
- Alaska Community Action on Toxics (ACAT), USA;
- BaliFokus, Indonesia;
- Ecological Alert and Recovery Thailand (EARTH), Thailand;
- NGO Rozbudova, Ukraine; and
- Volgograd-Ecopress Information Centre, Russia.

IPEN would also like to acknowledge the contributions from Biodiversity Research Institute (BRI), for assisting in developing the methodology and protocols, and thereafter organizing the international shipments of materials and samples and conducting sample analysis.

IPEN gratefully acknowledges the financial support provided by the:

- Government of Germany;
- Government of Sweden;
- Government of Switzerland;
- and other donors that made the production of this document possible.

The expressed views and interpretations herein shall not necessarily be taken to reflect the official opinion of any of the institutions providing financial support. Responsibility for the content lies entirely with IPEN.

Bundesministerium
für Umwelt, Naturschutz,
Bau und Reaktorsicherheit

SWEDEN

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

**Federal Office for the Environment FOEN**


www.briloon.org


www.ipen.org