

Mercury Monitoring Efforts by Maldives

Aug 2024



**Ministry of Climate Change,
Environment and Energy**

Country Profile

- Situated in the central part of the Indian Ocean
- Consists of approximately 1,190 low-lying coral reef islands that form 26 natural atolls
- Total area over 90,000 sq kms
- Total population: Approximately 568,362, dispersed across 187 inhabited islands
- Fish/fisheries products: over 98% of the physical exports from Maldives by quantity and value



Status of Mercury in Maldives

- Only source of mercury in the Maldives: **Import + transboundary pollution**
 - No mining, manufacturing or production of mercury/mercury added products
- Mercury containing products imported into the Maldives (**Minamata Initial Assessment, 2019**)
 - Batteries, Compact fluorescent lamps (CFL), Dental amalgam, Thermometers, Sphygmomanometers
- Mercury release sources (Minamata Initial Assessment, 2019):
 - 84% from 'waste incineration and open waste burning'
 - 15% from 'use and disposal of other products'
- Legal framework on Mercury: No overarching legislation
 - **Mercury Free Policy for Health Care 2018** (Policy /23-MOH/2018/01): Hg products phased out from healthcare facilities
 - The **Ministry of Climate Change, Environment and Energy** are responsible for the Minamata Convention (MIA, Ratification, etc)
- **Ratification** of the Minamata Convention expected to be completed before the end of 2024

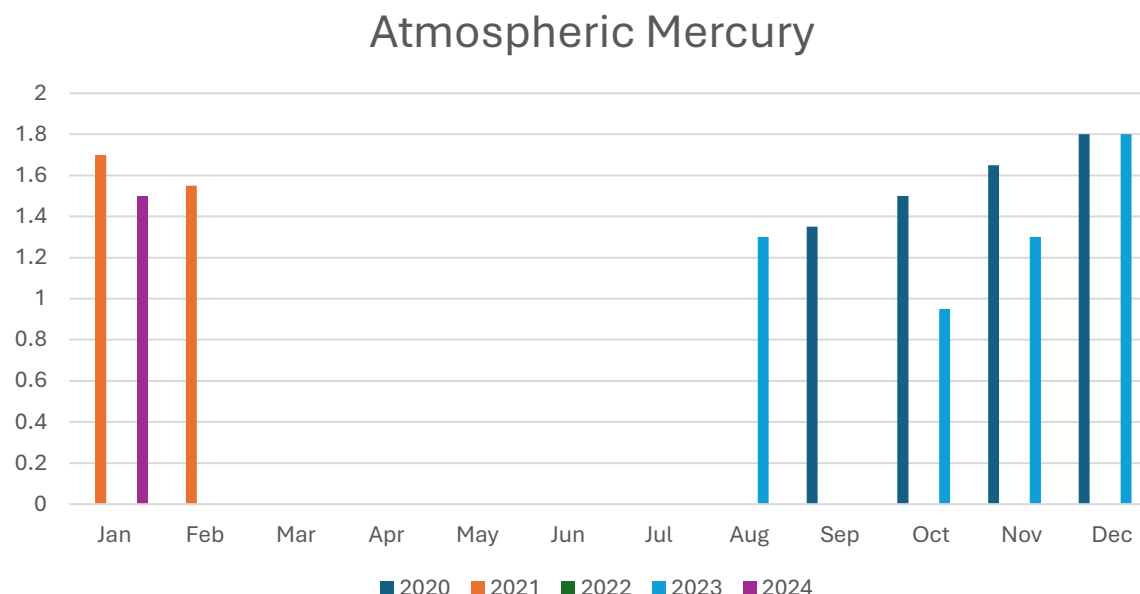


Air Monitoring

- Sampling location: Maldives National University FEST Campus
Gold amalgamation: manual sampling method – funded by MOEJ and supported by IDEA Con

- Results: (ng/m³)

*Feb to Aug 2024: samples collected, not yet analysed



- Observation:

- The range of concentration at 0.95-1.8 ng/m³ (average: 1.49 ng/m³)
- Slightly seasonal variation observed: increase in levels during the dry season. Overall air quality deteriorates in the country during the dry season due to an increase in transboundary air pollution as a result of the winds moving south west from the South Asian continent



Fish Samples Analysed by NHL

- The **National Health Laboratory (NHL)** of Maldives conducts mercury analysis of fish samples upon request by clients (for periodic food quality monitoring by fish exporters/MFDA)
- NHL uses a **direct mercury analyzer (DMA-80)** (compliant with US EPA method 7473)



- The levels of mercury found in fish samples analysed by NHL from 2022 to 2023:

Type of Fish	Number of Samples	Mean Hg (mg/kg)	Median Hg (mg/kg)	Maximum (mg/kg)	Minimum (mg/kg)
Tuna	7	0.4004	0.4126	0.8425	0.0867
Humpback Red Snapper	19	0.1607	0.1510	0.2575	0.0635
Bigeye Scad	20	0.0358	0.0272	0.0884	0.0149
Prawn	1	0.0081	0.0081	0.0081	0.0081

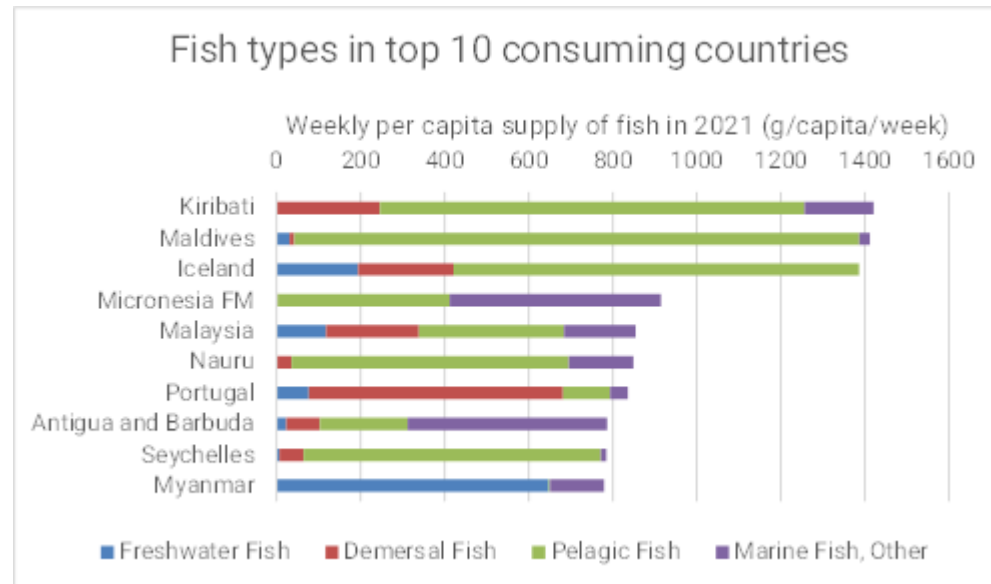
Reference Values

- Fish is the main source of methylmercury for humans
- Mercury levels in fish differ in different fish species
- Usually, pelagic and demersal species contain higher level of mercury than freshwater and marine (coastal/reef) species
- Guideline values for different fish species are presented in the table:

Issued	Target	Parameter	Type	Value mg/kg
FAO and WHO (2018)	Alfonsino	MeHg	Maximum level of whole commodity fresh or frozen (in general after removing the digestive tract)	1.5
	Marlin			1.7
	Orange roughy			0.8
	Pink cusk-eel			1.0
	Shark			1.6
	Tuna			1.2
USEPA (2001)	Fish	MeHg	Human health criteria	0.3
USFDA (2000)	Fish, shellfish, crustaceans, other aquatic animals (fresh, frozen or processed)	MeHg in edible portion	Action level	1.0
EU (2006)	Fishery products and muscle meat of fish excluding species listed below except for the followings: brown meat of crab, head and thorax meat of lobster and similar large crustacean	Total Hg	Maximum level in food stuff	0.5
	Muscle meat of fish (species defined*)	Total Hg		1.0
MOHLWJ (1973)	Fish and shellfish except for the followings: Tuna (tuna, swordfish, bonito), Freshwater fish, Demersal fish (sting fish, alfonsino, sablefish, red queen crab, ivory shell, sharks)	Total Hg	Provisional standard	0.4
		MeHg (reference value)		0.3

Fish Consumption in Maldives

- Maldives is one of the **largest fish consumers**
- Fish consumption contributes around **71% of the animal-source protein** intake of the population's diet – the **highest in the world** (Bennett et al. 2018)
- Fish type consumed is predominantly pelagic species (e.g., **tuna**, salmon)



UN Food and Agriculture Organization (2021)



Hair Survey

Survey title: Preliminary assessment of mercury exposure level for citizens in the Maldives due to high-level fish consumption in daily diet

- The first human biomonitoring survey in Maldives for Mercury
- Survey is funded by the UNEP Mercury Project and executed by the Ministry of Climate Change, Environment and Energy of Maldives
- Survey was approved by Maldives National Health Research Council
- Hair samples were collected from all seven districts of Maldives
- Samples were analysed by the Asian Institute of Technology, Thailand via Cold Vapor Atomic Absorption Spectrometry

Hair Sample Collection

- **Stratified random sampling** approach used
- **100** samples collected (**preliminary** study): 100 samples (25% of effective sample size of a full-scale study, an underpower probability of 35% or in other words 65% power). This is appropriate for a preliminary study as according to Tseng and Sim's (2021) suggested rule of thumb, preliminary studies should have a power of at least 60%.
- **Exclusion criteria:** subjects who have not lived in the region for 3 consecutive years, subjects with dyed/bleached/permed hair, vegetarians, and subjects who are smokers, cosmetic skin whitening product users
- Subjects are equally selected by gender (50:50), by age range (20 subjects each from age groups: 19 or below, 20-29, 30-39, 40-49, and 50 or above)
- **Challenge** encountered while sampling: cultural/religious taboos against giving hair = delays in sample collection

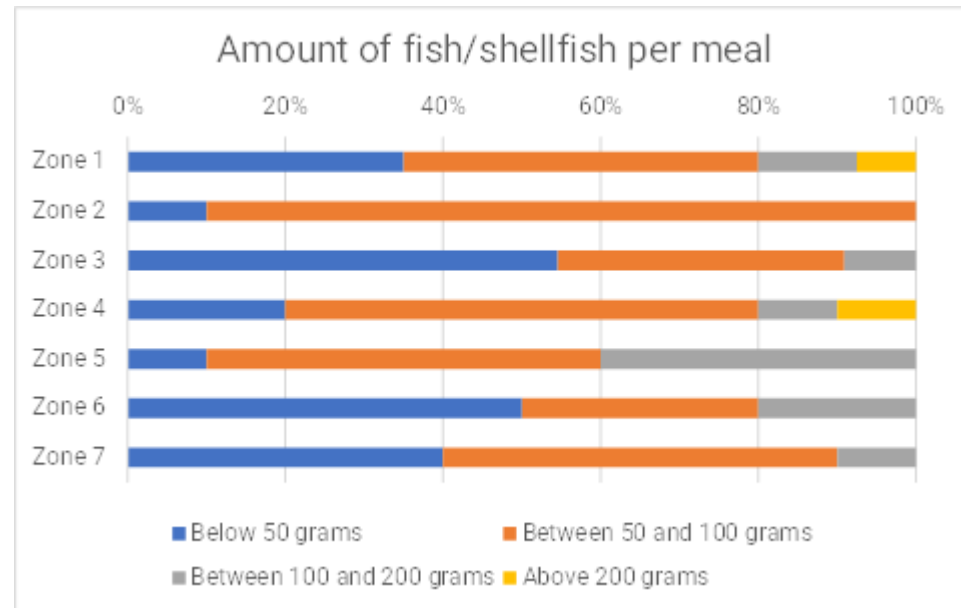
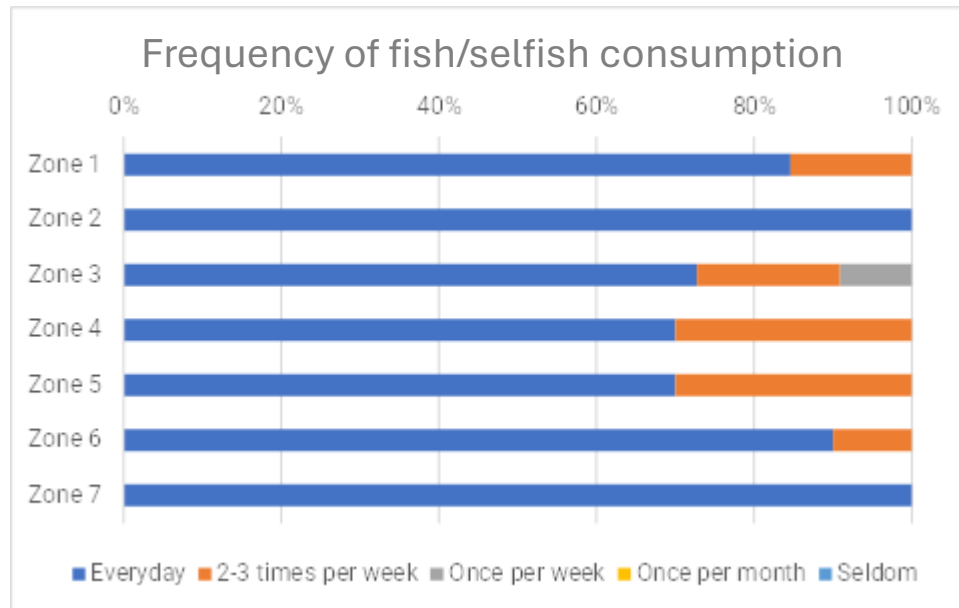
Age Group	Age	Gender		Total
		Male	Female	
1	19 or below	10	10	20
2	20-29	10	10	20
3	30-39	10	10	20
4	40-49	10	10	20
5	50 or above	10	10	20
Total:				100

Zone #	Region	Male	Female	Total Sample
1	North Central Province	20	20	40
2	Upper North Province	5	5	10
3	North Province	5	5	10
4	Central Province	5	5	10
5	South Central	5	5	10
6	Upper South Province	5	5	10
7	South Province	5	5	10
Total:				100

Fish Consumption: Survey Results

Results from the survey:

- Significantly large portion of the population **consumes fish every day**. The amount per meal is moderate in most cases but some participants consume over 100 grams per meal which might result in excessive intake of methylmercury
- There was a significant preference for **medium/small size tuna** (e.g. bonito/skipjack) followed by **canned** fish (usually has skipjack and yellowfin tuna) followed by **large varieties of tuna** (e.g. bigeye and bluefin)



Hair Mercury Levels

- Results not yet publicized
- The average value was 3.68 mg/kg

Hair Mercury Levels by Age

- Results not yet publicized
- The hair mercury levels increased along with increase of age
- Age group of 50 or above shows much higher mercury level than those in other age groups

Hair Mercury Levels by Zone

- Results not yet publicized
- **Zone 7** is significantly higher than the other zones
- 100 % of the survey participants in zone 7 stated that they **eat fish everyday**

Hair Mercury Levels vs Fish Consumption

- Results not yet publicized
- There is a clear increasing trend in mercury levels with the increased frequency of fish consumed
- No significant differences were observed for the amount of fish consumed per meal (difficult for subjects to estimate weight of fish retroactively)

Reference Values

WHO reference values were used for this study

Benchmark dose / NOAEL		Uncertainty factor	Guideline
WHO (2007)	14 mg/kg maternal hair on child neurodevelopment.	6.4	2.2 mg/kg*
Japan (2005)	11 mg/kg maternal hair on child neurodevelopment.	4	2.8 mg/kg
USA (2001)	46-79 µg/L maternal blood (equivalent to 11-20 mg/kg hair) on child neurodevelopment.	10	1.1-2.0 mg/kg

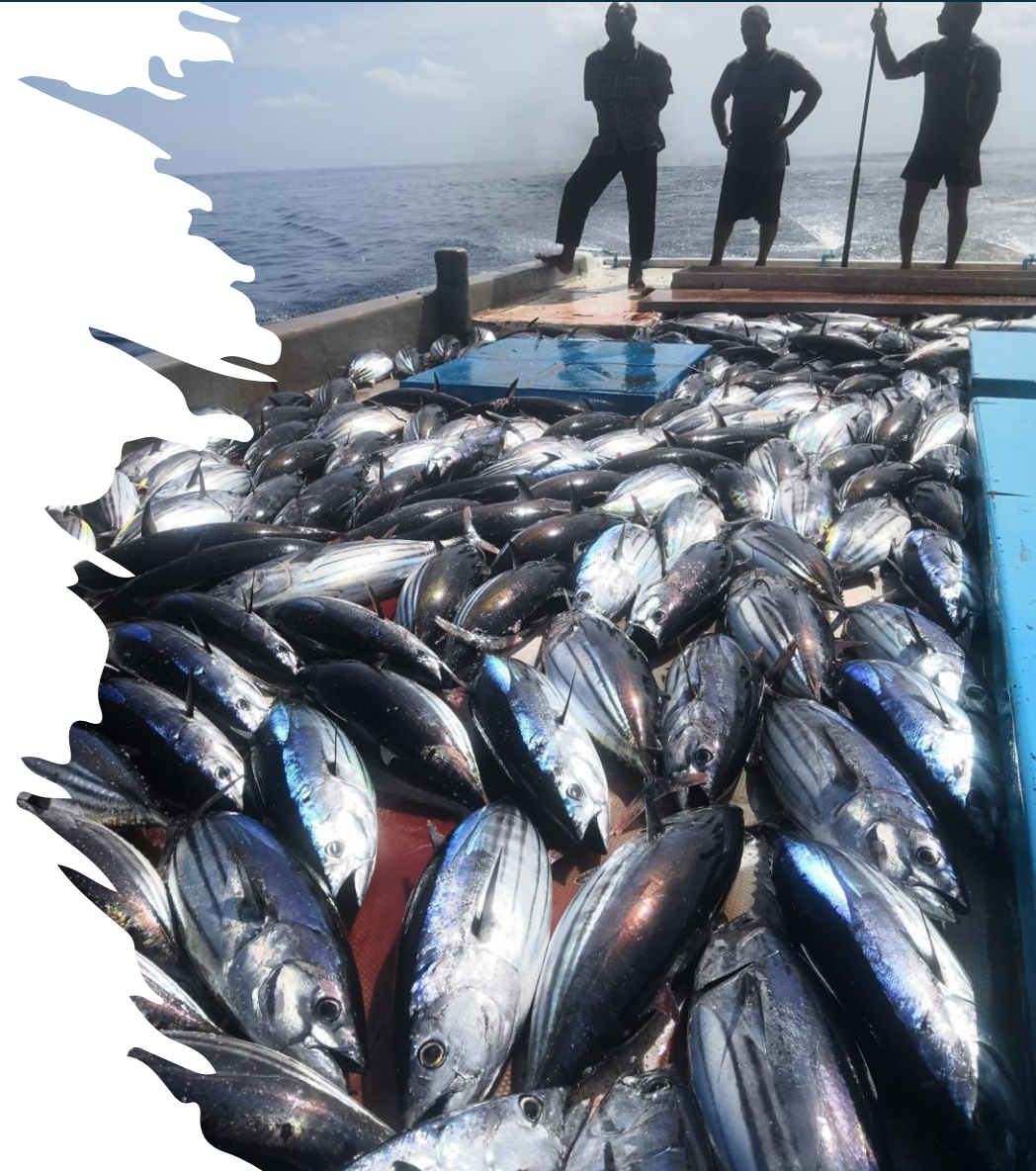
*: Intakes of up to about two times higher than the value would not pose any risks of neurotoxicity in adults.

Hair Mercury Levels Against WHO Ref

- Results not yet publicized

Conclusion

- Heavy reliance on fish as a protein source
- Monitoring of mercury in fish is limited: some fish samples analysed by NHL exceeded the recommended values
- Approx. 1/3 of participants had hair mercury levels that exceeded WHO reference value
- 2/3 women in childbearing age exceeded the WHO reference values
- Need for mercury related awareness, dietary interventions
- Need for further studies: targeting regions with higher fish consumption, targeting high risk age groups, health correlation studies



Thank You