

# Mercury

---

## Assessing the environmental burden of disease at national and local levels

Jessie Poulin

Herman Gibb

Editor

Annette Prüss-Üstün

A Microsoft Excel spreadsheet for calculating the estimates described in this document can be obtained from WHO/PHE. E-mail contact: [EBDassessment@who.int](mailto:EBDassessment@who.int)

## WHO Library Cataloguing-in-Publication Data

Mercury : assessing the environmental burden of disease at national and local levels / Jessie Poulin, Herman Gibb. Edited by Annette Prüss-Üstün.

1.Mercury - adverse effects. 2.Mercury - toxicity. 3.Mercury poisoning, Nervous system. 4.Methylmercury compounds - toxicity. 5.Cost of illness. I.World Health Organization. II.Poulin, Jessie. III.Gibb, Herman. III.Prüss-Üstün, Annette.

ISBN 978 92 4 159657 2

(NLM classification: QV 293)

## Suggested Citation

Poulin J, Gibb H. Mercury: Assessing the environmental burden of disease at national and local levels. Editor, Prüss-Üstün A. World Health Organization, Geneva, 2008. (WHO Environmental Burden of Disease Series No. 16)

## © World Health Organization 2008

All rights reserved. Publications of the World Health Organization can be obtained from WHO Press, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland (tel.: +41 22 791 3264; fax: +41 22 791 4857; e-mail: [bookorders@who.int](mailto:bookorders@who.int)). Requests for permission to reproduce or translate WHO publications – whether for sale or for noncommercial distribution – should be addressed to WHO Press, at the above address (fax: +41 22 791 4806; e-mail: [permissions@who.int](mailto:permissions@who.int)).

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the World Health Organization in preference to others of a similar nature that are not mentioned. Errors and omissions excepted, the names of proprietary products are distinguished by initial capital letters.

All reasonable precautions have been taken by the World Health Organization to verify the information contained in this publication. However, the published material is being distributed without warranty of any kind, either expressed or implied. The responsibility for the interpretation and use of the material lies with the reader. In no event shall the World Health Organization be liable for damages arising from its use.

The named authors alone are responsible for the views expressed in this publication.

Printed by the WHO Document Production Services, Geneva, Switzerland.

## Table of Contents

Preface.....	v
Affiliations and acknowledgements.....	v
Glossary and abbreviations .....	vi
Summary.....	vii
1. Introduction.....	1
2. Sources of mercury and exposure pathways .....	2
2.1 Elemental and inorganic mercury .....	2
2.2 Organic mercury .....	3
2.3 Mercury exposure framework.....	3
3. Mercury toxicity .....	5
3.1 Elemental and inorganic mercury .....	5
3.2 Methylmercury .....	6
4. Exposure-risk relationships .....	8
4.1 Endpoints not included in the assessment .....	8
4.2 Methylmercury-induced IQ deficits .....	10
4.3 Summary .....	12
5. Exposure assessment .....	13
5.1 Measuring methylmercury levels .....	13
5.2 Determining population mercury levels .....	15
5.3 Summary .....	16
6. Disease burden methodology.....	17
6.1 Incidence of methylmercury-induced MMR .....	17
6.2 Disease burden in DALYs .....	19
7. Example disease burden estimate .....	22
7.1 Biomarker conversions .....	22
7.2 Calculating the population at risk.....	22
7.3 Estimating MMR incidence .....	24
7.4 Estimating DALYs.....	24
7.5 Summary of steps for estimating disease burden .....	24
8. Burden of disease estimates for selected populations .....	26
9. Uncertainties .....	28
9.1 Other outcomes .....	28
9.2 Model parameters.....	28
9.3 Quantitative estimation of uncertainty .....	30
9.4 Beneficial nutrients in fish and seafood .....	31
10. Research needs and recommendations.....	32
11. Disease burden and policy .....	33
References.....	34
Annex 1 List of meeting participants.....	38
Annex 2 Measuring hair mercury concentrations .....	39
Annex 3 Mercury and omega-3 fatty acid content of seafood .....	41
Annex 4 Subpopulation mercury levels .....	43
Annex 5 Calculation spreadsheet for mercury.....	60

## List of Tables

Table 1	Health effects of prenatal exposure to methylmercury.....	12
Table 2	Incremental IQ loss and percent of population shifted to MMR .....	17
Table 3	Proportion above lower bound of each hair mercury interval.....	23
Table 4	Rate of IQ loss per 1000 infants in each exposure interval .....	23
Table 5	Methylmercury exposure, MMR incidence, and DALYs for selected populations.....	26
Table 6	Values for uncertainty analyses .....	31
Table A3 –1	Mercury and omega-3 fatty acid (DHA + EPA) content of seafood.....	41
Table A4–1	Review of mercury levels by region and country, represented as concentrations in hair ( $\mu\text{g/g}$ ) .....	44
Table A4–2	Countries in WHO regional groups .....	54

## List of Figures

Figure 1	Framework for mercury exposure .....	4
Figure 2	Shift to MMR as a result of methylmercury-induced IQ loss .....	18
Figure 3	Flowchart for estimating the disease burden of methylmercury.....	25
Figure A3 –1	Mercury and omega-3 fatty acid (DHA + EPA) content of seafood.....	42

## **Preface**

The disease burden of a population and how that burden is distributed across different subpopulations (e.g. infants, women), are important pieces of information for defining strategies to improve population health. For policy-makers, disease burden estimates provide an indication of the health gains that could be achieved by targeted action against specific risk factors. The measures also allow policy-makers to prioritize actions and direct them to the population groups at highest risk. To help provide a reliable source of information for policy-makers, WHO analysed 26 risk factors worldwide in the *World Health Report* (WHO, 2002).

The Environmental Burden of Disease (EBD) series continues this effort to generate reliable information, by presenting methods for assessing the environmental burden of mercury at national and local levels. The methods in the series use the general framework for global assessments described in the *World Health Report* (WHO, 2002). The introductory volume in the series outlines the general method (Prüss-Üstün et al., 2003), while subsequent guides address specific environmental risk factors. The guides on specific risk factors are organized similarly, first outlining the evidence linking the risk factor to health, and then describing a method for estimating the health impact of that risk factor on the population. All the guides take a practical, step-by-step approach and use numerical examples. The methods described in the guides can be adapted both to local and national levels, and can be tailored to suit data availability.

This document was reviewed in Geneva at the Informal preparatory meeting for the Chemical Task Force of the Foodborne Disease Epidemiology Reference Group (FERG), held by the World Health Organization Department of Food Safety, Zoonoses, and Foodborne Diseases on 29 June 2007. For a list of invited experts and other attendees, see Appendix 1.

## **Affiliations and acknowledgements**

Herman Gibb and Jessie Poulin are from Sciences International, Alexandria, USA, and Annette Prüss-Üstün is from the World Health Organization.

We thank Lesley Onyon and Claudia Stein for their inputs and support, as well as the valuable comments from the participants of the Informal preparatory meeting for the Chemical Task Force of the Foodborne Disease Epidemiology Reference Group (FERG) held in Geneva on 29 June 2007. WHO acknowledges and appreciates the financial support for this project from the Government of Germany, Ministry for the Environment, Nature Conservation & Nuclear Safety.

## **Glossary and abbreviations**

ATSDR	Agency for Toxic Substances and Disease Registry
CI	Confidence interval
DALYs	Disability-Adjusted Life Years
DHA	Docosahexaenoic acid
EPA	Eicosapentaenoic acid
IPCS	International Programme on Chemical Safety
IOM	Institute of Medicine
IQ	Intelligence Quotient
µg	Micrograms
MMR	Mild mental retardation
NRC	National Research Council
OR	Odds ratio
PTWI	Provisional tolerable weekly intake
RfD	Reference dose
RR	Relative risk
US EPA	Environmental Protection Agency of the USA
WHO	World Health Organization
WISC	Wechsler Intelligence Scales for Children

## Summary

This document provides a review of the health effects of elemental, inorganic, and methylmercury and methods for estimating the burden of disease for methylmercury. Elemental mercury can cause a variety of health effects. Methylmercury has been associated with adult neurological problems, and there is some evidence that methylmercury exposure affects the adult cardiovascular system. However, the data for these effects are insufficient for a quantitative analysis. As a result, the quantitative aspect of this report focuses on the neurodevelopmental toxicity of methylmercury.

Cognitive deficits in infants are represented as IQ point deficits caused by prenatal exposure to methylmercury. The disease burden is assessed using the distribution of hair mercury concentrations among pregnant women or women of childbearing age as a measure of infant exposure. Although small IQ deficits may not be visible on an individual basis, they can be significant in a population with high exposure or among those affected by endemic diseases that impair neurological function. IQ deficits have the greatest population impact among children with IQ scores just above 69 points, for whom lowered IQ score would result in mild mental retardation (defined as an IQ between 50 and 69 points). The rate of mild mental retardation caused by methylmercury-related IQ loss and the resulting number of disability-adjusted life years (DALYs) lost are calculated from the exposure distribution. DALYs measure the health impact in a population as the number of healthy years of life lost based on the severity and length of the illness.

This report estimates the disease burden for several populations, including subsistence fishers, sport fishers, and indigenous communities near industrial and mining activities. The incidence rate for mild mental retardation is estimated to be as high as 17.37 per 1000 infants born among a subsistence fishing population in the Amazon, resulting in a loss of 202.8 disability-adjusted life years per 1000 infants. Due to the lack of exposure data from representative populations in the various regions throughout the world, the global burden of disease could not be estimated. Quantification of the disease burden in subpopulations for which exposure is known, however, provides an important basis for targeting populations at risk for significant health deficits.

Because elemental mercury can be transported long distances in air, regions with little or no mercury emissions may have high environmental mercury levels. Minimizing the amount of mercury emitted into the environment to reduce methylmercury concentrations in fish and seafood requires global cooperation. Furthermore, some elemental mercury is emitted as a result of natural processes (e.g. volcanoes, forest fires). Thus, reducing the consumption of seafood with high methylmercury concentrations is the most direct way to reduce the risk of methylmercury-related cognitive deficits in a highly exposed population. However, consumption recommendations must also consider the nutritional value of fish and shellfish, particularly in populations without access to alternative sources of protein. Additionally, there is evidence that omega-3 fatty acids in fish and shellfish have a beneficial effect on neurodevelopment. The risks and benefits of fish consumption depend on the amount and species of fish consumed and must be weighed carefully for each subgroup in the population.

预览已结束，完整报告链接和二维码如下：

[https://www.yunbaogao.cn/report/index/report?reportId=5\\_29399](https://www.yunbaogao.cn/report/index/report?reportId=5_29399)

