WHO/UNEP-COORDINATED EXPOSURE STUDY (2008-2009) ON LEVELS OF PERSISTENT ORGANIC POLLUTANTS (POPs) IN HUMAN MILK WITH REGARD TO THE GLOBAL MONITORING PLAN

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Introduction

Since the mid-eighties, the World Health Organization (WHO) has coordinated a comprehensive programme on possible health risks of polychlorinated biphenyls (PCB), polychlorinated dibenzo-*p*-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF). This programme was carried out in collaboration with other international organisations and national institutions, and concentrated particularly on the health risk of infants, due to exposure through contaminated human milk, and aiming to prevent and control environmental exposure to these chemicals. Because human milk contains many lipid soluble compounds that are also present in mother's adipose tissue, it can also be assumed that the levels of PCDD, PCDF and PCB in human milk are representative for those in plasma, serum lipid and adipose tissue. Therefore levels of these contaminants in human milk do reflect the body burden and can thus be used as an indicator for the overall exposure of the general population. The collection of human milk is a non-invasive sampling method, offering several advantages over the collection of other biological samples to assess overall human exposure. In addition, the high content of fat makes the extraction method easier and the precision of the measurements higher.

WHO has carried out a series of international exposure studies on levels of these contaminants in human milk. The first WHO-coordinated exposure study took place in 1987-1988 (1), the second round in 1992-1993 (2), the third round in 2000-2003 (3), the fourth round in 2005–2007 (4) and the fifth round in 2008-2009.

The Stockholm Convention on Persistent Organic Pollutants (POPs) (4) entered into force on 17 May 2004. As of May 2010 the Convention had 170 Parties. The objective of the Convention is to protect human health and the environment from POPs by reducing or eliminating their releases into the environment. Parties have agreed that they need a mechanism to evaluate whether this objective is achieved and the concentrations of POPs in humans and the environment are decreasing over time. According to Article 16 of the Convention, its effectiveness shall be evaluated starting four years after the date of its entry into force and periodically thereafter at intervals to be decided by the Convention of Parties (COP). A Global Monitoring Plan was established under the Convention in May 2007 along with the necessary guidance document (5). Development of this guidance document was initiated by UNEP Chemicals in 2003.

Participants in a series of meetings convened by UNEP Chemicals on this issue have consistently recommended that human milk should be one of the media to be monitored (5, 6, 7). The Conference of the Parties to the Stockholm Convention decided at its third meeting in 2007 that human milk and human blood, as well as ambient air, are the core media to be monitored under the Global Monitoring Plan. Therefore it was agreed to perform the 4^{th} and 5^{th} rounds in close collaboration between WHO and UNEP, as a joint study in support of the Stockholm Convention and funded through the Stockholm Convention Voluntary Trust Fund. With the new scope, significant modification of

the previous WHO protocol, which was limited to PCDD/PCDF and PCB only, for the collection, handling and analysis of human milk samples were necessary (8). This report presents summarized results of a global survey of the fifth round of the WHO/UNEP-coordinated exposure studies on human milk.

Materials and Methods

Protocol. Samples were collected by the participating countries following their national protocols, which dealt primarily with number and type of samples, selection of donors, collection, storage and pooling of samples, and shipping of samples to the reference laboratory. Milk from well-defined groups of 50 mothers was collected and pooled. For selection of donating mothers the following criteria were applied: a) they should be primiparae, b) healthy, c) exclusively breastfeeding one child (i.e. no twins), and d) residing in the area for about five years. For further details of the study protocol of the fourth round the reader is referred to the WHO Website (8). Samples of the fifth round were collected in 2008-2009.

Analysis. To ensure reliability of exposure data and to improve comparability of analytical results from different laboratories, the WHO has co-ordinated a number of inter-laboratory quality assessment studies. Analyses for the third, fourth and fifth round on levels of POPs in human milk were performed by the State Institute for Chemical and Veterinary Analysis of Food in Freiburg, Germany, after selection as reference laboratory (9). A rigid quality control programme is carried out on a continuous basis as described (10, 11). The rigid quality control programme is also required for performance of the tasks as the European Union Reference Laboratory for dioxins and PCBs in feed and food and as the European Union Reference Laboratory for pesticides in food of animal origin and commodities with high fat content. Details of the method for determination of organochlorine pesticides and HCB will be published separately. Limit of quantification (LOQ) for organochlorine POPs (except for PCDD/PCDF and PCB) is 0.5 µg/kg fat.

Substances to be monitored are the initial twelve POPs included under the Convention. It is recommended not only to analyse the parent POPs but also "transformation products" (e.g., DDE and DDD as DDT metabolites) or by-products (e.g., nonachlor in chlordane). The analytical details were laid down in the UNEP Guidance Document on the Global Monitoring Plan for POPs (5). However, it is recommendable to harmonize also the following analytical details:

1. The sum of parent POPs and its metabolites can be calculated based on the reported levels or after correction for molecular weight.
2. PCDD, PCDF and dioxin-like PCB are reported on the basis of toxic equivalents (TEQ) using the WHO toxic equivalency factors (12).
3. For PCDD, PCDF and dioxin-like PCB, handling of non-detected analytes is of particular importance. There are different approaches, among them the calculation of the contribution of non-detects to the TEQ as zero (lower bound concentrations) or with the LOQ (upper bound concentrations) (13). Problems of differences between lower bound and upper bound concentrations or resulting from lack of knowledge about these differences were described elsewhere (14). It was recommended that for reliable determination in the range of the usual background contamination, the difference between upperbound TEQ and lower bound TEQ should not exceed the range of 10% to 20 % for food of animal origin with a dioxin contamination of about 1 pg WHO-TEQ/g fat (only PCDD/PCDF included). Such a criterion would be of particular importance for evaluation of time trends in the key matrices of the Global Monitoring Plan.

Results and Discussion

Twenty three countries / regions (Antigua and Barbuda, Australia, Chile, Georgia, Ghana, Hong Kong SAR, India, Côte d'Ivoire, Kenya, Democratic Republic of Congo, Republic of Korea, Lithuania, Mali, Mauritius, Moldova, Nigeria, Senegal, Switzerland, Syria, Tajikistan, Tonga, Uganda and Uruguay) participated in this round of the WHO/UNEP exposure study performed in 2008-2009.

Selected results are shown in figure 1 for PCDD/PCDF as WHO-PCDD/F-TEQs, figure 2 for dioxin-like PCB (as WHO-PCB-TEQs), figure 3 for the sum DDT and its metabolites and figure 4 for hexachlorobenzene (HCB) showing the variation between countries for these POPs.

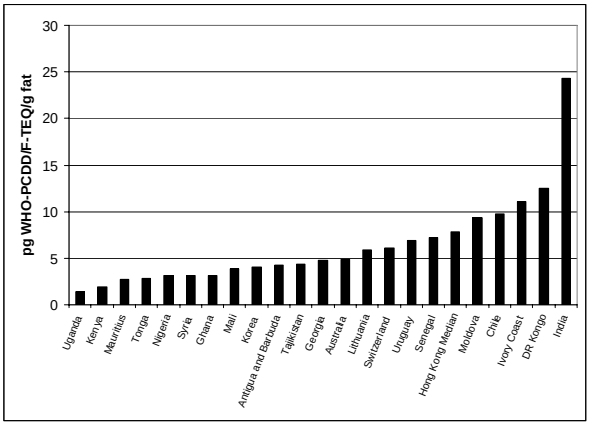

Figure 1: Results for WHO-PCDD/F-TEQ in pg/g fat in human milk

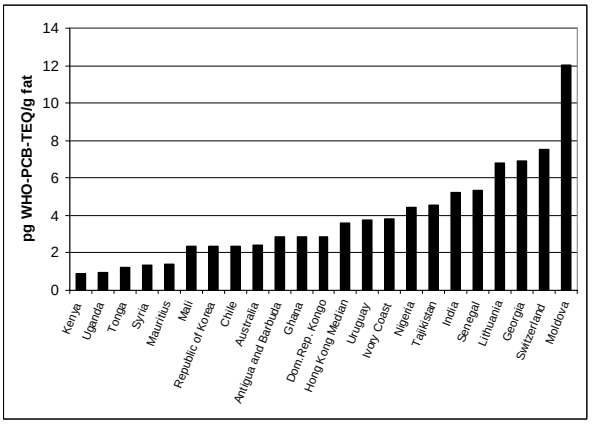

Figure 2: Results for WHO-PCB-TEQ in pg/g fat in human milk

With respect to the other POPs, aldrin is metabolized to dieldrin and was not found in human samples; dieldrin was found in the range 1.1-37.8 µg/kg fat. Chlordane (cis- and trans chlordane) is metabolized to oxychlordane, which was found between 1.2 and 12.1 µg/kg fat (below LOQ in four countries). Endrin (including endrin ketone) was not detected in any sample. Heptachlor is metabolized to heptachlorepoxide; cis-heptachlorepoxide was found in the range 0.5 to 4.1 µg/kg fat (below LOQ in seven countries)[15], whereas trans-heptachlorepoxide was not detectable. Mirex was not detectable in most cases, except in one region with levels between 1.3 and 1.8 µg/kg fat and one country with 9.8 µg/kg fat. Toxaphene (as sum of Parlar 26, 50 and 62) was not detected in about half of the countries whereas levels between 0.5 and 5.4 µg/kg fat were found in the other half.

The findings allow for priority setting among the different regions and countries. In comparison to all participating countries, higher levels of dioxin-like compounds (as TEQ) are found in Europe and one African country. Elevated PCB levels are found in Europe, whereas subtropical countries have a tendency to elevated DDT levels. In comparison to DDT, the levels of other chlorinated pesticides are generally low.

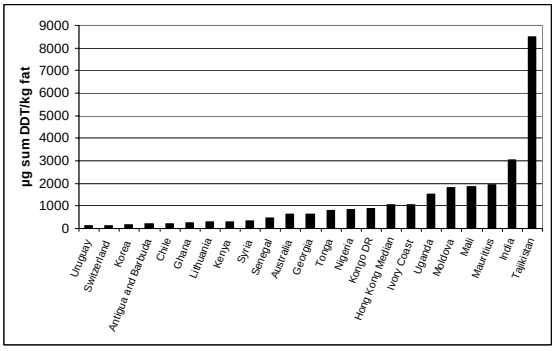

Figure 3: Results for sum DDT in µg/kg fat in human milk

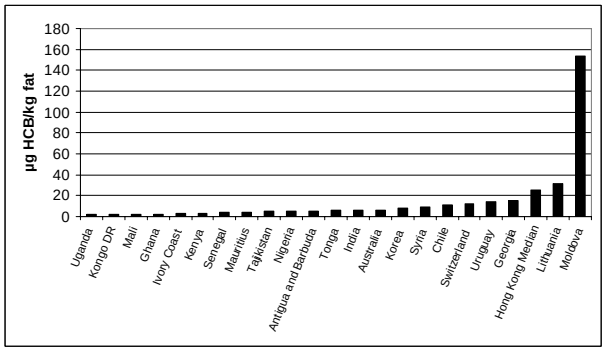

Figure 4: Results for HCB in µg/kg fat in human milk

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