

## A REVIEW OF PERSISTENT ORGANIC POLLUTANTS IN VIETNAM: IMPLICATIONS FOR HUMAN EXPOSURE

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### Abstract

This paper reviews recent studies on the contamination by persistent organic pollutants (POPs) in humans from Vietnam and its possible implications on human health. Elevated DDT concentrations were found in breast milk of women living around the open dumping sites in both Hanoi and Hochiminh City. These levels are among the highest values reported for countries surveyed in Asia-Pacific region, suggesting recent human exposure to DDT and the potential risk for breast feed children. People living in an extremely poor condition in and around open dumping sites from Asian countries including Hanoi and Hochiminh City, Vietnam have been exposed to elevated levels of dioxins and related compounds. Intakes of dioxins by breast-fed children of people living in such dumping sites in Vietnam and other Asian developing countries well exceeded the Tolerable Daily Intake (TDI) values proposed by WHO, suggesting potential health effects of dioxins on these people. Interestingly, intake of dioxins via soil ingestion and dermal exposure estimated for children were notably higher than those for adults, indicating higher risk for children in dumping sites. Further studies should be focused on the potential impacts of open dumping sites on the ecosystem and human health, particularly by toxic chemicals such as dioxins and related compounds.

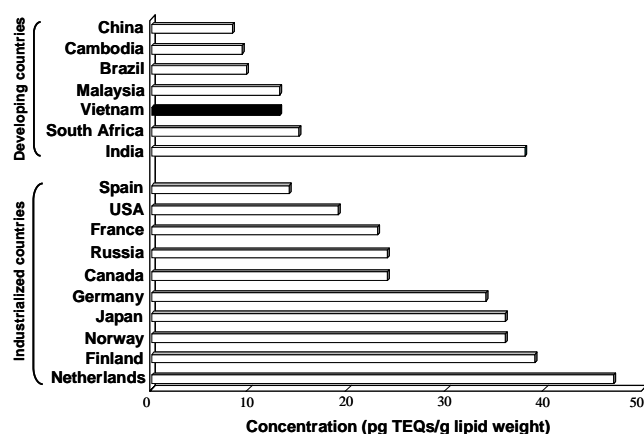
### Introduction

Toxic effects of persistent organic pollutants (POPs) on ecosystems and human health are among the most critical issues which have received considerable attention during the past four decades. Although the extent of contamination by POPs has been predominant in industrialized nations, an increasing number of recent investigations have highlighted the role of the Asia-Pacific region as a potential emission source of these chemicals, particularly to the pristine areas such as the Arctic and the Antarctic<sup>1</sup>. Despite the fact that POPs residue levels tend to decrease significantly in developing countries, the developing world, particularly the Asia-Pacific, could continue to be a potential source of POPs in future. This paper compiles results of the recent investigations on human exposure to various groups of POPs such as organochlorine (OC) pesticides, PCBs and dioxins and possible implications of the magnitude of contamination on human health. Residue concentrations of POPs in human samples, particularly breast milk collected from Vietnam are reviewed to understand the status of contamination and the possible toxic implications for human health.

### Status of contamination

Recent study conducted in 2000/2001 provided extensive data on human exposure from Vietnam. Breast milk of 96 nursing women living near the dumping sites of municipal wastes in Hanoi and Hochiminh City, the two biggest metropolitan cities in Vietnam were analyzed for OC pesticides and PCBs<sup>2</sup>. Elevated DDTs concentrations in breast milk were observed in both Hanoi (mean: 2100 ng/g lipid wt; range: 480-6900 ng/g lipid wt) and Hochiminh City (mean: 2300 ng/g lipid wt; range: 440-17000 ng/g lipid wt), suggesting recent human exposure to this pesticide in Vietnam. These levels are among the highest ranks for the developing countries as well as developed nations<sup>2</sup>. This fact raises concern over the possible toxic impacts on human health.

To understand the degree of human exposure to dioxins and dibenzofurans (PCDD/Fs) in open dumping sites, their residue levels in breast milk were also examined<sup>3</sup>. Mean PCDD/F concentration in breast milk from women living near dumping sites in Hanoi was 51 pg/g lipid wt (6.0 pg/g TEQs), range: 18 - 120 pg/g lipid wt (2.9 - 9.3 pg/g TEQs). To understand the magnitude of contamination in human breast milk from dumping site in Asian countries including Vietnam, TEQ concentrations were compared with values reported for breast milk from general population of other countries since 1990 (Fig. 1).



**Figure 1.** Comparison of TEQs concentrations in human breast milk from different countries in the world.

TEQ levels in human breast milk from dumping sites from Hanoi, Vietnam were slightly higher than those in Philippines and Cambodia, but apparently lower than those in India. The levels are, however, still in lower rank when comparing to those reported for industrialized countries. In developed nations, residues levels of dioxins and related compounds have been decreasing because of the strict regulations on the production and usage<sup>4</sup>. On the other hand, in Asian developing countries, dioxin contamination may increase in future since there is substantial lack of proper control measures.

The release of dioxins and related compounds from various potential sources such as open dumping sites in urban and suburb areas, combustions of medical wastes in hospitals, etc should be considered as a research priority in Asian developing countries including Vietnam in future.

### Human health implications

In the perspective of human health implication, on the basis of the recent data of average seafood consumption reported by Food and Agriculture Organization of the United Nations, average daily intake of PCBs and DDTs from seafood for different countries in Asia-Pacific region was estimated. Interestingly, results showed that intakes of DDTs by Vietnamese population were apparently higher than those reported in other countries examined (Table 1).

**Table 1.** Estimated daily intakes of persistent organochlorines via mussels by different populations in Asia-Pacific region

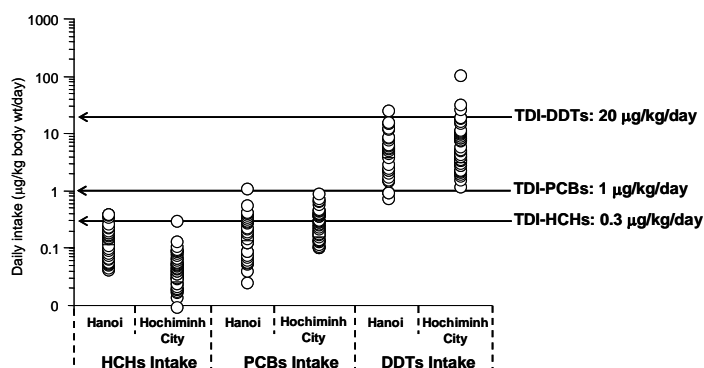
Country	Survey year	Seafood consumption <sup>a</sup> (g/person/day)	Intake of PCBs <sup>b</sup> (ng/person/day)	Intake of DDTs (ng/person/day)	Intake of HCHs (ng/person/day)
Cambodia	1998	20	15	6.6	< 0.2
China	1999-2001	71	180	17000	57
Hong Kong	1998-99	69	260	8300	14
India	1998	13	49	55	26
Indonesia	1998	52	68	52	2.1
Japan	1994	196	5900	690	63
South Korea	1998	114	420	400	30
Malaysia	1998	156	160	220	< 1.6
Philippines	1998	77	440	31	2.3
Russia	1999	54	3400	650	54
Vietnam	1997	47	66	1900	2.8

<sup>a</sup>Seafood consumption data were cited from FAO Food Balance Sheets, FAO Statistics Division, FAO 2006

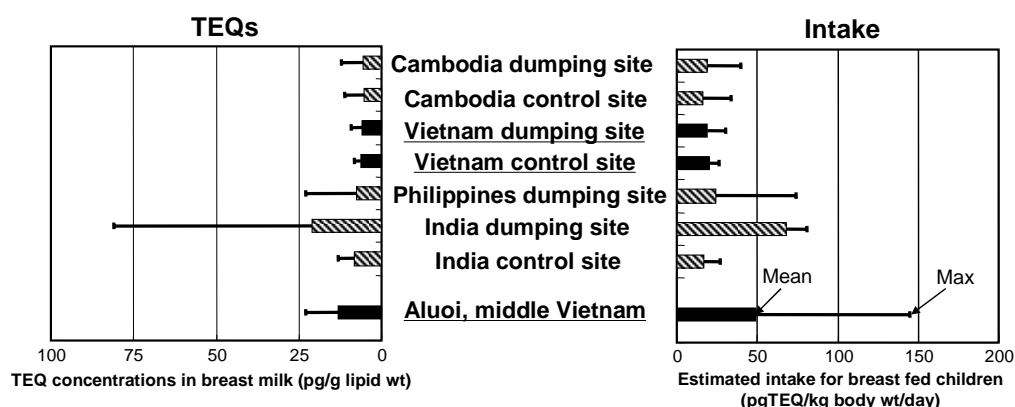
<sup>b</sup>Intakes were estimated on the basis of residue concentrations in mussels (Asia-Pacific Mussel Watch Program) reported by Monirith *et al.* (2003)<sup>5</sup>

In addition to the elevated exposure of DDT via seafood to Vietnamese general population, certain cohorts living near the municipal dumping sites may be at a higher risk by the toxic substances: dioxins and dibenzofurans. A methodical approach was developed to evaluate the risk of exposure to PCDD/Fs via soil ingestion and dermal absorption<sup>6</sup>. Intakes of dioxins were estimated to be the highest in people of Philippines, followed by Cambodia, India, Hanoi (North Vietnam), and Ho Chi Minh City (South Vietnam). Intakes of PCDD/Fs by the people living near dumping sites were about 2 to 200-fold greater than those for the people in control sites, and thus emphasizing greater health risk threatening these people. Interestingly, the estimated intakes of dioxins via soil ingestion and dermal exposure for children were higher than those for adults, suggesting greater risk of dioxin exposure for children in dumping sites<sup>6</sup>. Further investigations should be focused on children and infants as they are the most susceptible group and have higher exposure levels to dioxins.

**Figure 2.** Estimated daily intakes of persistent organochlorines by infants from Hanoi and Hochiminh City, Vietnam in comparison with the Tolerable Daily Intake (TDI) proposed by Health Canada



To understand the magnitude of exposure to POPs by infants living in and around open dumping sites in Vietnam, the daily intake (DI) of OC insecticides, PCBs and PCDD/Fs (TEQs) were estimated on the basis of residue concentrations in breast milk<sup>2,3</sup>. The estimated daily intakes of DDTs, HCHs and PCBs in comparison with the tolerable daily intake (TDI) values proposed by Health Canada<sup>7</sup> are illustrated in Fig. 2. Although intakes of OCs by most infants were below the TDI values, intakes by some individuals were close to or exceeded the guidelines. Particularly, a few individual samples from Hochiminh City had the intakes of DDTs exceeding the TDI value (20 µg/kg body wt). This result may raise greater concerns on infant health because they are sensitive to environmental contaminants.



**Figure 3.** TEQ concentrations and estimated intakes of PCDD/Fs for breast fed children from dumping sites and control sites in Asian countries, and in Aluoi Valley, an area of Agent Orange spraying during American War

The intakes of PCDD/Fs by breast fed children estimated on the basis of residues in breast milk of women living in open dumping sites in Asian countries are given in Fig. 3. The intakes estimated for Vietnamese were comparable to those in Cambodia but lower than in the Philippines and India<sup>3</sup>. However, it is important to note that these intakes are well exceeded the TDI value of 4 pg TEQ/kg body wt. This result highlights the risk for breast fed children living in open dumping site from Asian developing countries. On the other hand, the intakes estimated for children living near the hot spot of dioxin contamination due to the past usage of Agent Orange in southern Vietnam are still very high even after the end of Agent spraying almost 3 decades ago<sup>8</sup>. Thus, Vietnam could serve as suitable location for future research on possible toxic effects of dioxins on wildlife and humans due to the unique situation where both current and historical dioxin contamination exist implicating potentially exposed population.

### Acknowledgements

This study was supported by grants from the Environmental Science and Technology in the Core University Program between Japan Society for the Promotion of Science (JSPS) and National Center for Natural Science and Technology, Vietnam (NCST), Research Revolution 2002 (RR2002) of Project for Sustainable Coexistence of Human, Nature and the Earth (FY2002) and 21<sup>st</sup> Center of Excellence (COE) Program from the Ministry of Education, Culture, Sports, Science and Technology, Japan.

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