COMPILATION OF EU DIOXIN EXPOSURE AND HEALTH DATA: HUMAN EXPOSURE AND HUMAN LEVELS

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Introduction

The exposure of EU citizens to PCDD/Fs and related compounds has been assessed to provide a basis for the development of possible policies to control releases into the environment, in order to meet recommended guidelines for acceptable exposure. Attention has focused on the foodchain which is the most important route of human exposure to PCDD/Fs. Comparison with exposure to PCBs has been made where possible, in order to place the PCDD/F exposure in context. The data in this study have been collected through a wide ranging literature search and through many contacts within research institutions and Government Departments and Agencies

Concentrations of PCDD/Fs in Foodstuffs

Table 1 shows the availability, in the EU Member States, of data concerning the concentrations of PCDD/Fs in various foodstuffs. Finland, the Netherlands, Germany and the UK have the largest amount of numerical data, while the Spanish data set consists of a small number of samples for each food type and the Swedish data is from 1991 but is being updated. No data could be identified for Greece, Luxembourg or Portugal.

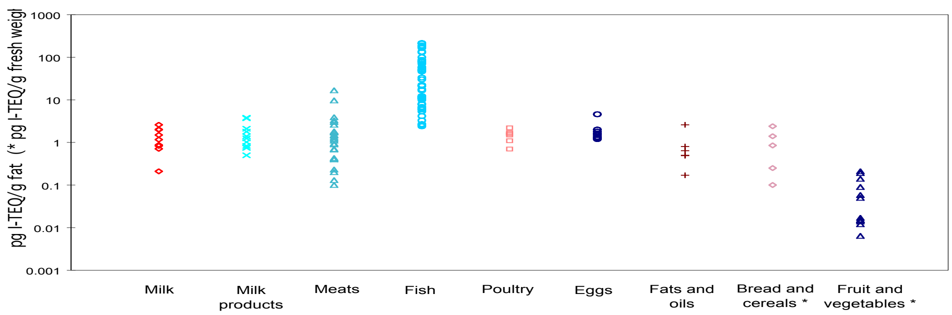
Table 1 Foodstuff concentration data availability in the EU Member States

	A	B	D	DK	E	EL	F	FIN	I	IRL	L	NL	P	S	UK
Foodstuffs in background locations															
Cows' milk		x	x	x	x			x		x		x		x	x
Dairy products			x	x	x			x	x			x		x	x
Eggs			x		x			x				x		x	x
Fish			x	x	x			x				x		x	x
Meat			x	x	x			x				x		x	x
Poultry			x		x							x			x
Fats and oils					x							x			x
Cereals					x			x				x			x
Fruits and vegetables			x		x			x	x			x			x
Fish oil dietary supplements					x										x
Foodstuffs in areas of contamination															
Cows' milk	x	x	x				x			x					x
Other							x								x
Total diet exposure estimate			x	x	x		x	x				x		x	x

A large amount of data is available on concentrations of PCDD/Fs in cows' milk. Likewise, there is relatively good coverage for dairy products, meats and fish. These are the fatty foods likely to contain higher concentrations of PCDD/Fs. Few samples of cereals, fruits and vegetables have been analysed, due to the assumption that concentrations would be insignificant as fat levels are low. However, these foods have been found to contribute significantly to exposure in some regions with high consumption rates, especially in the Mediterranean diet. Analysis of these food types is increasing, and is becoming more reliable as analytical techniques continue to improve.

Figure 1 shows the measured concentrations of PCDD/Fs in foodstuffs. It has been compiled from data on background concentrations and includes the most recent data available for each foodstuff in each country. The data points represent mean or median values for sample sets, and are given as pg I-TEQ/g fat or fresh weight according to food type. This figure does not include foods from areas of known contamination. The pattern is as expected, with foods of animal origin having higher concentrations than those of plant origin. The highest concentrations measured were in fish and meat, but these food types also show the widest concentration ranges. The fish data in particular have a very wide range because of the differences in fat content and ages of fish analysed. Fruits and vegetables have the lowest concentrations, with a mid point of 0.1 pg I-TEQ/g fresh weight. The milk and milk products, poultry and eggs have similar concentrations with mid points in the ranges of 0.75-1.7 pg I-TEQ/g fat, and the fats and oils, and bread and cereals categories have slightly lower concentrations with equal mid points of 1.2 pg I-TEQ/g fat weight and fresh weight respectively.

Figure 1 Concentrations of PCDD/Fs in foods



Total Dietary Exposure

The estimates of total dietary intake of PCDD/Fs in Table 2 have been recalculated from original data assuming an average bodyweight of 70 kg, and show a range of 0.93-3.0 pg I-TEQ/kg bw/day, with Spain having the highest exposure [1] and the Netherlands the lowest[2], albeit in different years. These estimates are therefore all within or below the range of the TDI recently recommended by the WHO, of 1-4 pg TEQ/kg bw /day[3]. However, the values in Table 2 only include exposure to PCDD/Fs, whereas the WHO TDI also includes PCBs.

Table 2 Total dietary exposure estimates across the EU

	D	DK	E	F	FIN	NL	S	UK
Year	1995	1995	1996	nd	1991	1991	1990	1992
Average total diet exposure (pg I-TEQ/day)	69.6	171	210	nd	95	65	126.5	69
Average daily exposure (pg I-TEQ/kg bw /day)	0.99	2.44	3.0	2.21 *	1.36	0.93	1.81	0.99
Daily exposure of high level consumer				5.66 *		2.3		1.5-2.2

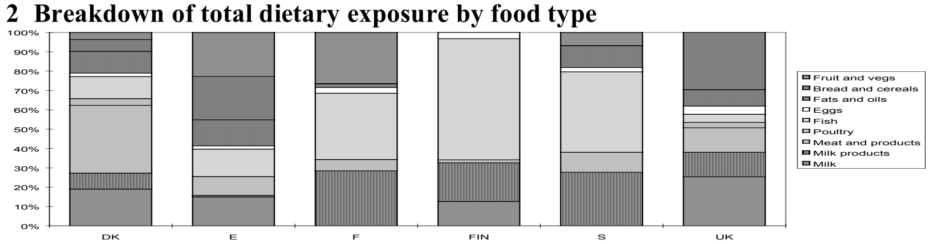
* unknown average bodyweight assumption (preliminary estimate); nd = no data available / not known

Issues of comparability of exposure estimates are important. First, the data do not all relate to the same year, and second, the estimates are calculated using different methods and with data of varying qualities. In particular, the Spanish estimate includes consumption of cereals, fruit and vegetables which contribute a total of 43% of the exposure. These foodstuffs are rarely included in PCDD/F analysis and this may partly explain the higher values calculated for Spain.

In the Netherlands[2], the UK[4] and France[5] some analysis of variations in consumption has been considered, in order to assess elevated levels of exposure in high consumers (also in Table 2).

Figure 2 shows the relative contributions of different food types to overall dietary exposure to PCDD/Fs in the countries where these data are available. The chart shows the dominance in most countries of fish, meat products, milk and milk products. Fruit and vegetables are also important in France and Spain, and cereals in the UK, although the latter data are very uncertain.

Figure 2 Breakdown of total dietary exposure by food type



For some countries data are available to compare exposure to PCDD/Fs and PCBs. In the Netherlands the contributions of these two groups to total TEQ exposure was roughly equal, with the median daily exposure of adults at 71 and 77 pg TEQ for PCDD/Fs and PCBs respectively[2]. Similar results were found in Spain, where the PCB intake contributed 48-62% of the total TEQ intake[6]. In Sweden this contribution was 49-57% of TEQ[7], and in the UK it was 38-43%[4]. The total exposures shown in Table 2 therefore represent roughly 50% of total TEQ exposure.

Variations in exposure by age have also been analysed. In general, total exposure increases with age in childhood. However, when normalised by body weight it is found to decrease with age. In relation to the Tolerable Daily Intake (TDI), which considers body weight, this implies that children may be at risk of over exposure at a young age. In the Netherlands the median intake was found to increase with age in childhood from 36.4 pg I-TEQ/day at the age of 1, to 70.4 pg I-TEQ/day at the age of 20. In adult life intake remained roughly constant[2]. In Spain a similar pattern was found, although with higher values, with an increase in daily intake from 179 pg I-TEQ at 3-6 years to 184-214 pg I-TEQ at 16-20 years[8]. However, in terms of intake per kg body weight exposure declines with increasing age. This has been shown in the UK, where those children of 1.5-2.5 years and 5-16 years having average intake ranges at 2.4-3.7 and 1.1-1.8 pg I-TEQ/kg bw/day respectively compared with adults' exposure, which was estimated at 1.0-1.5 pg I-TEQ/kg bw/day[4].

Time trend analysis was possible for Germany, the Netherlands and the UK. In the Netherlands a duplicate diets survey was undertaken in the periods 1978, 1984-1985 and 1994. A significant downward trend through time was found[2]. For Germany, the average daily intake was found to have fallen by 45% from 127 pg I-TEQ in 1989 to 70 pg I-TEQ in 1995[9]. Exposure has also fallen in the UK from 240 pg I-TEQ/day in 1982, to 125 in 1988 and has fallen further to 69 pg I-TEQ/day in 1992[10].

Human Milk and Tissue Levels

The WHO co-ordinated study of PCDD/F concentrations in breast milk was the only substantial source of comparable data on human body burden of PCDD/Fs relating to the majority of the EU Member States[11]. By definition that study considered only young women. There were very few comparable data on concentrations in children, teenagers, men or older women.

Between 1988 and 1993 the average PCDD/F concentration in breast milk in the EU decreased by around 35%, with a slightly higher decrease in rural areas and slightly lower in industrial areas. Measurements taken in Germany between 1988 and 1996 showed that the average concentrations of PCDD/Fs in the blood of adult males decreased by around 64%.

Conclusions

Large variations exist in the availability of data to assess human exposure to PCDD/Fs in individual Member States. Using the available data it has been shown that the products of fish and animal origin make the largest contribution to overall exposure, but also cereals and vegetables can contribute more than has previously been expected. Exposure has been estimated to be in the range 0.93-3.0 pg I-TEQ/kg bw/day for PCDD/Fs, which have been estimated to contribute roughly 50% of total TEQ exposure if PCBs are also included. As the recommended TDI for total TEQ is 1-4 pg TEQ/kg bw/day there may be considerable exceedances of this intake across Europe. However, human exposure to PCDD/Fs has declined in recent years and evidence shows that body burdens have also declined.

Acknowledgements

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