TRENDS IN DIOXIN INTAKE AND IN HUMAN MILK LEVELS IN GERMANY

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Introduction

Polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) form as undesirable by-products in a variety of industrial and thermal processes and are ubiquitous in the environment. Especially, the 2,3,7,8-substituted congeners are very resistant to biological degradation and accumulate in the food chain and in human tissue.

Humans are exposed occurs background (environmental), accidental and occupational contamination. The major pathway of background dioxin exposure is via food, especially of animal origin. It accounts for about 90%[1]. Contamination of food results from dioxin emissions and deposition originating from e.g. combustion processes, production of halogenated chemicals or metal industry. In Germany, a set of measures and regulations have been taken for reduction and limitation of dioxin emissions into the environment and, thus, reduce the dioxin intake and the background contamination of humans[2]. Human milk is a useful bioindicator for evaluation of the background contamination. In Germany, more than 2400 human milk samples have been analysed for PCDD/PCDF since 1985. Since 1991, these data have been collected in a data bank for residues in human milk and dioxins in other human tissues established at the BgVV.

In the following an evaluation of the current dioxin intake is presented on the basis of about 3000 dioxin data from various food samples collected between 1995-99 and trends in human milk levels are discussed.

Origin of data

Food data: Most data about dioxins in food were recorded by the. Furthermore, three federal institutes associated with the Federal Ministry of Food, Agriculture and Forestry provided data on meat, milk and fish. The samples used for the calculation of the dietary intake have been collected between 1995 and 1999 and are considered representative for background contamination.

Food consumption data: The German national food consumption survey[3] served as a basis for representative data on the intake of fats from different food groups. The consumption data of more than 24000 persons were recorded with a 7-day food consumption protocol. The amounts of fat were calculated on the basis of the mean intakes for male and female consumers of 25-50 years of age.

Human milk data: In most cases the human milk samples were analysed on the request of mothers by the food control laboratories of the federal Länder (see acknowledgement). Because of the high number of samples investigated this data set should be representative and permit reliable statements on temporal trends of the background body burden of this population in Germany. Human milk samples from a defined contaminated area were analyzed by the BgVV. The human milk data were collected in the data bank for residues in human milk and dioxins in other human tissues established at the BgVV.

Results and Discussions

Trends in dioxin intakes and levels in food

For estimation of the daily intake, the representative food consumption data were combined with residue data of dioxins in food. On the basis of about 3000 data on dioxin levels in food, the current mean daily dioxin intake is 51 pg I-TEq for adults (Table 1). Related to the body weight (70 kg) this intake is 0.73 pg I-TEq per kg BW and day. Since the end of the eighties the average daily intake has decreased by 60-70 % in Germany, as shown in Table 2. The intake data and trends have been confirmed by duplicate studies[11, 12]. Similar trends have been observed in some other European countries[13].

Table 1: Calculation of the average dioxin intake in Germany (N~3000; food samples 1995-99)

	Concentration based on	Mean consumption[3] g per day	Mean I-TEq (ND=0.5LOD) pg/g	Daily intake pg I-TEq/d
Pork	fat	6.08	0.29	1.8
Beef	fat	4.23	0.66	2.8
Poultry	fat	2.25	0.58	1.3
Meat products	fat	23.0	0.41	9.3
Milk & Milk products	fat	33.9	0.58	19.7
Eggs	fat	5.1	1.16	5.8
Vegetable oil&Margarine	fat	26.1	0.02	0.5
Fish	whole weight	19.9	0.29	5.8
Fruit&Vegetable	whole weight	394	0.01	3.9
Calculated daily intake (average)				**50.9**

Table 2: Time trends of the mean daily intake of dioxins (pg I-TEq/kg BW * d) by food in Germany, based on food levels and consumption data

Year of Sampling	Remarks	Daily intake	Ref.
1986-89	22 food samples	2.3	4
1987-90	107 food samples	1.7-2	5
1986-91	>500 food samples	1.8	6
1991-95		1.47	7
1993-96	1414 food samples	0.88	8
1995	several hundred food samples	1.0	9
1995-98	several hundred food samples	0.48/0.53	10
1995-99	**about 3000 food samples**	**0.73**	**this report**

This decline did not result from changes in nutrition habits but from lower levels in food. As a result of the lower environmental dioxin levels, the levels in milk (before 1989: 1.8 pg I-TEq/g fat), beef (before 1989: 3.0 pg I-TEq/g fat) and poultry (before 1989: 2.3 pg I-TEq/g fat) decreased continuously by about 68-78% during the last 10 years. Also levels in fish decreased by about 60% during that time. However, representativity of fish sampling is problematic. In addition, other factors like changes in fishing grounds and reduction of the mean age of fish are influencing dioxin concentrations. Currently, 4 food groups account for more than 10 % each of the body burden: milk and milk products (39%), meat and meat products (30%), fish and fish products (11%), and eggs (11%), while fruits, vegetables and vegetable oils/margarine account for 9% of the dioxin intake.

In 1998, WHO derived a TDI of 1-4 pg WHO-TEq/kg BW per day for dioxins and dioxin-like PCBs[14]. In Germany, data on dioxin-like PCBs in food are rare. Data from Sweden, UK and The Netherlands demonstrate, that dioxin-like PCBs contribute to the daily intake with about 40-60%[13]. Assuming a contribution of dioxin-like PCBs of about 50%, the mean daily intake of dioxin-like compounds in Germany can be estimated to be about 1.7 pg WHO-TEq/ kg BW for adults.

Trends of background dioxin levels in human milk

The PCDD/PCDF concentrations in human milk are summarised in Table 3.

Table 3: PCDD/PCDF concentrations in human milk from Germany (pg I-TEq/g fat)

Sampling Year	N	Min	Mean	Median	95 Perc.	Max
Background contamination						
1986-1990[15]	728	5.6	30.6	29.2		87.1
1991	191	6.4	24.1	23.4	48.4	58.1
1992	171	4.9	21.0	20.6	39.2	47.8
1993	141	4.1	18.9	20.9		37.6
1994	90	6.1	17.5	17.2	36.7	43.9
1995	135	5.4	17.9	16.5	32.3	39.0
1996	81	4.9	14.0	13.7	29.6	30.5
1997	126	6.0	11.6	13.5	23.3	28.7
1998	69	4.7	12.9	12.0	23.0	28.9
Contaminated area[16]						
1990	9	36	59			86
1997	10	11	41			81

In the second half of the eighties, the mean dioxin concentrations in Germany were relatively constant at a level of about 30 pg I-TEq/g fat. This value was similar to levels found in other industrialised European countries at that time[17]. Since then, the mean PCDD/PCDF levels, the 95 percentiles and the maximum levels in human milk samples decreased by about 60% until 1998. It is important to mention that the 95 percentile of dioxin concentrations in human milk in 1998 was distinctly lower than the mean level 10 years ago. At the present time, dioxin concentrations in human milk of more than 25-30 pg I-TEq/g fat may indicate an additional exposure of the mother. The decrease of the background body burden observed in human milk from Germany within the last 10 years has been confirmed by a comparable reduction of dioxin levels in blood samples from Germany[18]. It is also in agreement with that observed in some other European countries[13].

This distinct decrease of the background body burden is in the same range as the decrease of the dioxin intake of adults and the decrease of dioxin concentrations in foods.

These results indicate that measures to reduce emissions and dioxin exposure of humans have notable effects.

Elevated dioxin levels in human milk from mothers living in a contaminated area

In a highly contaminated area elevated dioxin levels in human milk were found because some of the foods consumed there has also been produced in this area. Although the emittent - a former copper recycling plant - was closed 10 years ago, the mean value found in 1997 exceeded the mean background level by a factor of 3-4. The maximum values are in the range observed in Germany in the end of the eighties. The highest levels were found in samples from mothers who have lived for a long time near the emittent and continued to eat some food from their own gardens.

Current dioxin-intake of breast-fed babies

For breast-fed infants, an average daily dioxin intake of 57 pg I-TEq/kg body weight is calculated from the 1998 data (basis: age of the baby 4 month; mean body weight 6.5 kg; average intake of breast milk 821 ml; lipid content 3.5 %). The dioxin intake of breast-fed infants on a body weight basis is higher by 1 - 2 logs than of adults. Although the WHO-TDI of 1 - 4 pg WHO-TEq /kg BW*d is clearly exceeded during the short period of breast-feeding, the WHO working group continued to recommend breast feeding[14]. Nevertheless, further efforts to identify and minimize sources of environmental input and specific exposure paths are necessary.

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