PCDD/Fs Levels in Blood, Human milk and Adipose tissue of Population of Ufa, Bashkortostan.

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Introduction

Determination of background PCDD/Fs levels in blood, adipose tissue and breast milk of the population of large areas and industrial centres is carried out for the assessment of the technogenic impact on a human being. It is especially important if there is a former or a present source of PCDD/Fs emission.

Pool samples from Blood Bank taken from 50-100 people are generally used for determination of the background levels in blood of the population. Sometimes control groups are examined for comparison, in this case samples from 10-20 people may be used. Data of this kind is very important because it is used for risk assessment of dioxin load on a human being. Unfortunately, most part of this information statistically is not reliable; there are no strict rules of blood sampling. At the same time, it has been stated that PCDD/Fs content in blood depends on the donor age, diet nutrition, occupational exposure, smoking, PBF, etc. There is data on difference in kinetics of dioxin removal depending on the sex.

Data on the background level presented as the data on general population of the whole countries can not be reliably determined by random sampling and by analysis of pool blood samples of donor groups without sufficient proof of the representation for the population as a whole. A considerable difference in background levels for one and the same country depending on the sampling may serve as a proof. The level of control groups sometimes differs from the level accepted as the value for the general population by 30-50%. It is especially important for defining the trends of PCDD/Fs content in human biological tissues.

In 1960-1980 the city of Ufa, Bashkortostan, was one of the largest centres of oil-refining, petro-chemical and chemical industry, including 2,4,5-T and phenoxy herbicides production. The consequences of dioxin contamination of workers have been described earlier (1, 2, 3). In this research we have determined the background PCDD/Fs content in biological tissues of non-exposed donors in Ufa.

The background PCDD/Fs level in breast milk was determined by the recommendations of EURO/WHO. PCDD/Fs level in adipose tissue was determined as a mean value for 4 individual samples and in whole blood –as a weighted mean of 44 individual samples.

Objects and Methods

Human breast milk

In 1997 in Ufa 17 samples were taken from healthy donors living in different areas of the city including the area close to the oil-chemical complex. When sampling all requirements of the WHO methods were observed and all recommended forms were filled in. Some points are given in Table 1. Donors of the city of Ufa had no peculiarities in physiological parameters or in nutrient regime, they did not belong to any occupational risk group. 100 ml of breast milk was sampled, frozen at -18^0C and kept up to the time of analysis.

Table 1. The description of breast-milk donors groups in Ufa.

Indices	Form data	Indices	Form data
Donors quantity	17	Diet	Mixed
Average age	23.5	Diet changes	No
Average height	162	Fish consumption	Once at week
Average weight	56.4	Dairy consumption	Every day
Weight before delivery	67.5	Cheese consumption	Twice a week
Child sex	8f/9m	Meat consumption	Twice a week
Average fat content	4%	Smoking(smoked sooner)	12%

Adipose tissue

In 1996 adipose tissue was sampled from belly and breasts of 4 healthy people, clients of a Beauty clinic in Ufa. 20 g of human fat was sampled and frozen at -18^0C.

Human blood

In 1996 we for the first time determined the background level for 17 donors of Ufa, it was 20-22pg/g of blood lipids. The content of 2,3,7,8-TCDD was rather high – 12-15 pg/g of lipids (4). A good correlation with the data of A. Schecter was received by the analysis of the pool sample of 100 donors in 1992 – 23 pg TEQ/g of lipids (2). There is no more detailed data on sampling in Ufa.

In 1997 samples were taken from 44 healthy non-exposed donors with the application of the factor planning of the experiment. The following factors were used:
1) the age of donors from 5 to 70 with an interval of 10 years, 2) the sex of donors, 3) PBF (%).

Occupational exposure was preliminary excluded, diet peculiarities were not stated, all donors had been living in the city for the last 10-15 years and were practically healthy. 40 ml of whole blood were sampled and frozen at -18^0C. PCDD/Fs concentration was determined in compliance with the methods EPA 1613.

PCDD/Fs extraction from whole blood was carried out by the mixture of hexane and diethylether, from adipose tissue – by hexane – methylene chloride and from breast milk – by acetone – hexane. The measurement system consisted of a chromatograph Carlo Erba 8035, a column DB-5, 60 m, and a mass spectrometer Autospec -Ultima (6).

Results and Discussion

Table 2 gives background levels of PCDD/Fs in breast milk samples, fat and whole blood. There was not enough data for defining any peculiarities for breast milk and adipose

tissue samples and we can only state a mean level in these tissues, but for blood samples we can define the effect of accumulation depending on the age and % PBF.

For PBF calculation we use the equations given in (7). The process of dioxin accumulation was different for men and women.

TEQ (ppt)= 4.093 Age + 9.697 (for men)
TEQ (ppt)= 1.704 Age + 37.394 (for woman)
2,3,7,8-TCDD (ppt)=2.657 PBF (%)-17.255 (for men)
2,3,7,8-TCDD (ppt)=1.755 PBF (%)–32.958 (for woman).

The age peculiarities appeared to be most significant. The approximate dependence "concentration – age" was as follows:

TEQ (ppt)= 0.784 Age + 8.566
2,3,7,8-TCDD (ppt)= 0.453 Age + 1.568.

Statistically reliable increase of the concentration with the age was stated for the following PCDD/Fs isomers:

1,2,3,7,8-PnCDD (ppt)= 0.347 Age + 2.973
OCDD (ppt)= 0.102 Age + 103.0
2,3,4,7,8-PnCDF (ppt)= 0.141 Age + 13.603
1,2,3,4,7,8-HxCDF (ppt)= 0.138 Age + 8.132

For calculation of the background level of PCDD/Fs in blood for Ufa statistical data on the age of the population was used. The share of inhabitants of a certain age interval served as a weight coefficient for the calculation of the mean PCDD/Fs level in blood:

$$TEQ_{background} = \Sigma\, TEQ_i\, K_i,$$

where, n- are a number of age categories, TEQ_i - average level of TEQ for category, K_i - coefficient, reflecting i-category contribution on total city population quantity.

Weighted average value of the background level in Ufa was 17.4 pg/g of lipids for 2,3,7,8-TCDD and 35.6 pg/g of lipids for TEQ, what is more than the value given earlier in A. Schecter (2) and in our (4).

Whereas no new sources of PCDD/Fs contamination have been revealed as a result of three years of monitoring, the levels in drinking water, food and in the air of the city of Ufa today correspond to those in North America and Western Europe. The increased levels in blood and in breast milk we refer to the consequences of operation of chemical and petro-chemical plants during the 60-80s.

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Table 2. PCDD/Fs levels in whole blood, human milk and adipose tissue in general population of Ufa, Bashkortostan

PCDD/PCDF	Human blood, n=44					Breast milk, n=17					Adipose tissue , n=3			
	min	max	mediana	mean	st. dev.	min	max	mediana	mean	st. dev.	min	max	mean	st. dev.
2378-TCDD	2.5	59	17.95	21.79	13.13	5.64	24.8	14.43	14.54	6.42	3.82	15.03	8.31	5.91
12378-PnCDD	0.6	39.4	12.66	13.59	8.8	0.4	19.52	10.29	10.66	5.32	4.44	11.6	8.67	3.75
123478-HxCDD	0.6	17.2	5.33	6.56	4.78	0.1	6.4	2.31	2.57	1.52	0.84	3.59	2.23	1,37
123678-HxCDD	1	34.7	8.51	10.72	7.76	3.42	16.74	6.39	6.78	3	2.03	5.8	3.88	1.88
123789-HxCDD	0.64	19.68	4.97	5.59	3.86	1.02	3.98	1.93	2.1	0.71	0.62	3.08	1.73	1.24
1234678-HpCDD	2.5	39	18.06	17.35	9.86	3.82	48.36	7	10.27	10.36	3.1	7.9	5.80	2.45
OCDD	2	253.9	86.9	92.28	60.43	15.64	94.59	31.98	41.19	22.64	14.85	38.15	23.73	12.59
2378-TCDF	0.81	20	5.26	6.5	4.14	0.71	4.7	2.56	2.79	1.09	0.8	1.7	1.08	0.53
12378-PnCDF	0.48	31.5	7.17	10.12	8.3	0.6	22.63	1.33	2.48	5.21	0.43	0.64	0.55	0.1
23478-PnCDF	0.22	40.4	20.28	18.86	11.55	0.87	12.92	10.1	8.13	4.31	3.05	14.98	7.38	6.60
123478-HxCDF	1.4	41.59	12.56	13.77	10.25	3.25	22.28	6.02	6.6	4.33	1.91	13.9	7.21	6.11
123678-HxCDF	1.02	19.45	6.26	7.47	4.93	1.82	8.08	3.41	3.53	1.55	1.0	4.29	2.99	1.75
123789-HxCDF	0.14	23.22	3.8	5.69	4.95	0.1	1.37	0.51	0.57	0.33	0.13	0.44	0.27	0.15
234678-HxCDF	0.49	18.83	4.2	5.85	4.68	0.32	3.2	1.65	1.69	0.67	0.45	1.58	1.0	0.56
1234678-HpCDF	1.26	40.53	12.68	16.02	10.8	1.97	19.81	5.56	6.15	4.37	1.22	4.63	2.57	1.8
1234789-HpCDF	0.11	23.79	5.55	7.29	6.41	0.26	4.6	0.88	1.19	1	0.11	0.55	0.33	0.22
OCDF	0.42	95.22	17.9	26.2	24.96	0.15	12.33	3.23	4.03	3.48	0.42	1.13	0.85	0.38
TEQ	**10.1**	**98**	**39.25**	**43.49**	**22.66**	**13.04**	**45.7**	**28.5**	**26.72**	**10.59**	**10.21**	**30.44**	**18,24**	**10.74**