

PCDDS, PCDFS AND PCBS LEVELS IN BLOOD OF THE SCHELEKHOVO POPULATION, THE IRKUTSK REGION, RUSSIA

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Introduction

Schelekhovo, the center of Irkutsk Region is located about 20 km north of Irkutsk and has more than 54,000 inhabitants. There are several facilities being potential sources of dioxins and related compounds in Schelekhovo. Irkutsk aluminum (“IrkAZ”) and Irkutsk cable (“Irkutskcable”) factories, “Silicon” factory, factory produced ferro-concrete builds, thermoelectric power station and etc. In addition, in December 1992 there was a fire at the Irkutsk cable factory. During the fire about 600 tons of polyvinylchloride granules and about 100 tons of polyvinylchloride sheeting burned. Our previous investigation of PCDD/Fs and PCBs levels in adipose tissue¹ and the investigation of other scientists of PCDD/Fs and PCBs levels in blood^{2,3} of expose firemen did not show high values (26.3 pg PCDD/F TEQ/g lipids + 26.4 pg PCB TEQ/g lipids¹, 20 pg PCDD/F+PCB TEQ/g lipids² and 28.1 pg PCDD/F TEQ/g lipids + 27.2 pg PCB TEQ/g lipids³, accordingly). Looking at the environment collaborators from NPO “Tayfun” indicated the finding of elevated levels of dioxins and related compounds in under layer of snow around the factories after the fire incident⁴. These elevated values were connected with the constant emissions of Irkutsk aluminum factory located nearby⁴. Our study of PCBs levels in snow from Schelekhovo in 1994 and 1996⁵ registered total PCB levels similar to 1992.

The aim of this study is to present data on PCDDs, PCDFs and dioxin-like PCBs levels for residents of Schelekhovo and for workers of Irkutsk cable factory (“Irkutskcable”), Irkutsk aluminum factory (“IrkAZ”) and factory “Silicon” located in this city.

Methods and materials

The blood sample of residents of Schelekhovo was collected in the center of blood transfusion in the Central Regional Hospital of the Schelekhovo area in 2000. Blood of workers of the plants “Irkutskcable”, “IrkAZ” and “Silicon” were sampled at the facilities during annual medical examinations. The detail description of investigated cohorts is presented in table 1. The cohorts investigated show similar figures with respect of age, BMI and residential time in Schelekhovo. In addition, the mean working time at the facilities of the 5 groups is quite similar. The duration of the inhabitancy of people in cohorts in Schelekhovo amounts at the average of 24 to 31 years.

After collecting the blood the samples were stored below – 18 °C. Pooling of the blood samples was performed in the laboratories in Irkutsk. For analysis, the samples have been shipped from Russia to Germany in frozen status by an international courier service to the ERGO laboratory in Hamburg.

The analytical methods used are validated and successfully applied by participation at international quality control studies.^{5,6}

HUMAN EXPOSURE II

Table 1. Age, BMI and the duration of living in Schelekhovo of participants of the study groups

| # | Cohorts | Age | BMI kg/m ² | The duration of working at plant, years |
|----|--|-----------|-----------------------|---|
| 1. | Residents of Schelekhovo, female, n=50 | 41.0±10.3 | 25.1±3.3 | — |
| 2. | Workers of “Silikon”, male, n=20 | 47.6±4.1 | 25.3±3.0 | 16.2±4.6 |
| 3. | Workers of “IrkAZ”, electrolysis department, male, n=20 | 48.4±5.1 | 26.9±3.4 | 21.5±9.4 |
| 4. | Workers of “IrkAZ”, technical service, male, n=17 | 48.0±5.9 | 25.0±3.5 | 23.3±7.3 |
| 5. | Workers of “Irkutskcable”, not having contact to PVC, male, n=25 | 48.2±8.0 | 24.3±3.1 | 21.7±6.7 |
| 6. | Workers of “Irkutskcable” having contact to hot PVC, male, n=10 | 47.9±6.0 | 23.7±1.9 | 22.4±6.6 |

Results and Discussion

Results of this investigation are presented in table 2 and fig. 1. Toxic equivalents were calculated using the WHO - TEF model. Total PCDD/F and PCB TEQ levels vary from 39.1 to 64.6 pg TEQ/g lipids. The maximum TEQ level was found for workers cohort (# 5) of Irkutsk cable factory without having contact to PVC. Lower level could be found for the cohort of workers (# 6) taking part in the formation of cables and having contact to hot PVC, namely in worse condition than cohort # 5. The same phenomenon was found for two cohorts of workers from Irkutsk aluminum factory. Workers taking part in electrolysis process show a lower TEQ level than workers from the technical service. We can suggest that this phenomenon is due to amplified requisition to accident prevention for people working in adverse conditions. On the other hand the slightly higher value of group #4 can be due to possible contact with electrical equipment containing PCB during repair of equipment. The TEQ levels of cohort # 2 and other groups investigated are quite similar to the TEQ level of the group of residents (# 1) contaminated only by background exposure. This control group did not work at the industry. In all cases the PCB TEQ levels were about twice as higher than PCDD/F TEQ levels. The PCDD and PCDF TEQ levels found in this study are comparable to other groups from previous investigations for the population of the Irkutsk Region ^{1,2,3,7} and for Germany ⁸. An exception is the population of Usol'e-Sibirskoe population showing higher values ^{1,7}

The PCB TEQ levels are similar or a little higher than those from other settlements of the Irkutsk Region (with the exception of Usol'e-Sibirskoe). In this investigation we analyzed all 12 dioxin-like PCB congeners while in previous studies only 3 or 6 congeners have been analyzed. It has to be noted here that PCB TEQ levels in human tissues obtained in our investigation now and previously are higher than PCB TEQ levels in populations of other regions.

The congener pattern of PCDDs, PCDFs and PCBs found in this study are generally similar to pattern found for the Irkutsk Region population. On the other hand the PCB congeners pattern in human samples from Schelekhovo and other settlements show increased PCB levels if compared to values reported for other industrialized areas like Germany ⁸ as presented in Fig.1.

This phenomenon confirms our suggestion regarding the presence of an unidentified source for PCBs in the Irkutsk Region.

Table 2. PCDDs, PCDFs and PCBs levels in blood of residents and workers from Schelekhovo (pg/g lipids).

| | # 1* | # 2 | # 3 | # 4 | # 5 | # 6 |
|--------------------------------------|-----------|-----------|------------|-------------|-----------|-----------|
| PCDDs/PCDFs | | | | | | |
| 2,3,7,8-TCDD | 3.9 | 5.3 | 4.1 | 4.7 | 6.8 | 4.4 |
| 1,2,3,7,8-PeCDD | 3.5 | 3.2 | 2.2 | 2.5 | 4.2 | 4.1 |
| 1,2,3,4,7,8-HxCDD | 3.1 | n.d.(1.8) | 1.9 | n.d. (1.3) | 2.7 | n.d.(1.3) |
| 1,2,3,6,7,8-HxCDD | 4.0 | 5.6 | 3.8 | 4.4 | 4.4 | 4.8 |
| 1,2,3,7,8,9-HxCDD | 2.1 | 1.5 | 1.3 | 1.2 | 1.9 | 2.0 |
| 1,2,3,4,6,7,8-HpCDD | n.d.(6.6) | 10.0 | 4.0 | 6.6 | 5.7 | n.d.(4.5) |
| OCDD | 90.5 | 95.4 | 46.6 | 61.4 | 48.9 | 44.0 |
| 2,3,7,8-TCDF | n.a. | n.d.(1.6) | n.d. (1.4) | n.d. (1,6) | n.d.(1.5) | n.d.(1.7) |
| 1,2,3,7,8-PeCDF | 1.0 | n.d.(1.0) | n.d. (1.0) | n.d. (1.0) | n.d.(1.0) | n.d.(1.0) |
| 2,3,4,7,8-PeCDF | 8.4 | 13.6 | 9.0 | 9.4 | 14.0 | 9.3 |
| 1,2,3,4,7,8-HxCDF | 12.0 | 16.4 | 9.8 | 12.6 | 15.0 | 10.0 |
| 1,2,3,6,7,8-HxCDF | 5.6 | 5.7 | 4.4 | 4.1 | 6.3 | 4.6 |
| 1,2,3,7,8,9-HxCDF | n.d.(3.7) | n.d.(1.6) | n.d. (1.6) | n.d. (2.1) | n.d.(1.9) | n.d.(1.9) |
| 2,3,4,6,7,8-HxCDF | n.d.(3.0) | n.d.(1.9) | n.d. (1.8) | n.d. (2.0) | 1.9 | n.d.(2.0) |
| 1,2,3,4,6,7,8-HpCDF | 10.2 | n.d.(5.5) | n.d. (5.0) | n.d. (5.7) | n.d.(5.4) | n.d.(5.8) |
| 1,2,3,4,7,8,9-HpCDF | n.d.(2.9) | n.d.(1.9) | n.d. (1.7) | n.d. (1.9) | n.d.(1.8) | n.d.(2.0) |
| OCDF | n.a. | n.d.(13) | n.d. (12) | n.d. (13.9) | n.d.(13) | n.d.(14) |
| Non-ortho and mono-ortho PCBs | | | | | | |
| PCB-77 | n.d.(91) | n.d.(59) | n.d (54) | n.a. | n.d.(58) | n.a. |
| PCB-81 | 13 | 7 | 3 | 5 | 10 | 6 |
| PCB-126 | 202 | 127 | 86 | 143 | 136 | 102 |
| PCB-169 | 53 | 95 | 70 | 81 | 102 | 70 |
| PCB-105 | 14684 | 13598 | 9492 | 10840 | 15230 | 7601 |
| PCB-114 | 3409 | 4723 | 3036 | 3762 | 5448 | 3485 |
| PCB-118 | 52714 | 50854 | 33102 | 40322 | 63937 | 28709 |
| PCB-123 | 1299 | 1325 | 778 | 1176 | 1302 | 611 |
| PCB-156 | 14346 | 27625 | 17914 | 21113 | 29645 | 28278 |
| PCB-157 | 2717 | 5207 | 3734 | 4379 | 5630 | 5442 |
| PCB-167 | 3589 | 4032 | 2608 | 3241 | 4921 | 3128 |
| PCB-189 | 1004 | 1260 | 924 | 1154 | 1302 | 1259 |
| Total PCDD/PCDF | 144,2 | 156,8 | 87 | 106,8 | 111,9 | 83,2 |
| Total non-ortho-PCB | 268 | 229 | 160 | 229 | 248 | 178 |
| Total mono-ortho-PCB | 93760 | 108624 | 71588 | 85986 | 127414 | 78511 |
| PCDD/F TEQ-WHO | 14.5 | 18.4 | 12.9 | 14.2 | 21.3 | 15.2 |
| PCB TEQ-WHO | 37.9 | 39.2 | 26.1 | 35.1 | 43.2 | 33.4 |
| PCDD/F+PCB TEQ-WHO | 52.4 | 57.6 | 39.1 | 49.3 | 64.6 | 48.6 |

n.d. - not detected, limit of detection (LOD) in (), n.a. - not analyzed. * - # according the table 1.

HUMAN EXPOSURE II

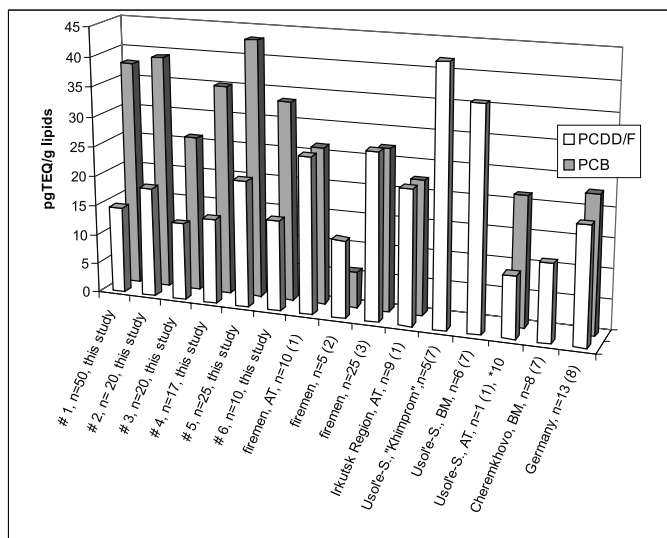


Figure 1. Comparison of PCDD/F, PCB TEQ levels in blood of residents and workers from Shelekhovo, firemen taking part in the extinction of the fire of “Irkutskcable” in 1991, and residents and workers from other settlements of the Irkutsk Region and from Germany. Values are given in pg TEQ/g lipids. AT: adipose tissue, BM: breast milk. *10: concentration multiply by 10.

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