



A follow-up investigation of homes with 'high' concentrations of PCDDs, PCDFs and dioxin-like PCBs in house dust

Alfred Franzblau¹, Lynn Zwica¹, Kristine Knutson¹, Qixuan Chen¹, Shih-Yuan Lee¹, Biling Hong¹, Peter Adriaens¹, Avery Demond¹, David Garabrant¹, James Lepkowski¹, William Luksemburg², Martha Maier², Timothy Towey³

¹University of Michigan, Ann Arbor, Michigan, USA; ²Vista Analytical Laboratory, El Dorado Hills, California, USA; ³Limno-Tech, Ann Arbor, Michigan, USA

Introduction and Objective

- Few studies have measured PCDDs, PCDFs and/or dioxin-like PCBs in house dust.
 - No study has attempted to obtain and analyze house dust samples from a large, representative sample of homes most of which are not suspected of contamination.
 - The University of Michigan Dioxin Exposure Study (UMDES) was designed to determine whether PCDDs, PCDFs, and dioxin-like PCBs in soil and/or house dust are related to or explain serum levels of these contaminants, with adjustment for other known risk factors (i.e., diet, occupation, age, BMI, etc.).
 - The UMDES measured the levels of the World Health Organization 29 dioxin congeners with consensus TEFs in serum, soil and house dust from a random sample of the population in five study areas
 - The distribution of TEQs in house dust is skewed, with a small number of high or 'outlier' values.
- Objective: To explore what may explain high or 'outlier' TEQ values in house dust**

Methods

- Eligibility Criteria:** To be eligible to participate in the follow-up study, a person must have:
 - been a participant in the UMDES (Full UMDES study protocols available at www.sph.umich.edu/dioxin/protocol.html)
 - permitted collection of a sample of house dust for chemical analyses and received results of chemical analyses
 - had a total TEQ in house dust that was more than 2.5 standard deviations above the mean of the log-transformed data
 - Determination of 'outlier' status was based on calculation of the TEQs using the 1997 TEFs
 - All TEQ results shown have been re-calculated using the 2005 TEFs
- Interviewing eligible participants with high household dust TEQs:**
 - Open-ended questions
 - Question topics:
 - House characteristics - age of house, age of carpets/rugs, fireplace use, trash burning, flooding, remediation, professional cleaning, etc.
 - Characteristics/habits of occupants of the house - ages of occupants, pets, smoking habits, occupations and hobbies of all residents, etc.
 - Other items of potential interest - treated wood in/around house, potted plants in house
- In four cases non-dust materials (cigarette ashes, burnt wood, carpet pad sample, wood from a deck) were sent for chemical analyses
- This study was reviewed and approved by the University of Michigan Health IRB.

Results

- 764 house dust measurements from the five regions sampled in the UMDES
 - 20 house dust results met the statistical criterion (> 2.5 SD)
 - 13 of the 20 subjects had elected to receive results (see Table 1)
 - interviews were completed with all 13 eligible subjects
- For the 764 house dust measurements:
 - Mean TEQ = 36.7 ppt
 - Median TEQ = 16.2 ppt

Location Key

FP: Tittabawassee River floodplain
Near FP: Near-floodplain of the Tittabawassee River
MS: Elsewhere in Midland and Saginaw counties
PL: Midland plume area downwind from the historic incineration activities of the Dow plant
JC: Jackson and Calhoun counties that served as a control area

Table 1: Baseline Concentrations of PCDDs, PCDFs, and dioxin-like PCBs in House Dust (picograms/gram of house dust dry weight)

Case Number/Location	1-FP	2-JC	3-JC	4-JC	5-MS	6-MS	7-MS	8-FP	9-JC	10-MS	11-JC	12-MS	13-FP
2,3,7,8-TCDD	0.22**	0.12**	0.21**	0.28**	0.78**	4.06	5.82	2.83	0.27**	1.4**	2.37	0.48	0.74**
1,2,3,7,8-PeCDD	0.44**	0.45**	1.03	1.07**	9.27	3.68	13.2	5.8**	0.76**	6.16	7.32	3.36	4.41
1,2,3,4,7,8-HxCDD	0.71	6.46	1.43	4.05	19.2	4.02	37.4	16.3**	23.3	20.1	46.9	105	3.36**
1,2,3,6,7,8-HxCDD	4.97	129	12	35.4	107	12.2	397	59.5	521	533	1460	2120	13200
1,2,3,7,8,9-HxCDD	2.41	20.3	4.24	8.91	47.1	2.36	157	16.8**	90.1	133	230	438	2230
1,2,3,4,6,7,8-HpCDD	194	2650	319	1080	6950	340	23800	2420	38300	27700	77700	97100	17000
OCDD	943	11400	1960	7610	47700	3020	152000	19200	198000	176000	274000	223000	21500
2,3,7,8-TCDF	4.87	4.92	4.13	4.43	8.8	49.9	26.8	991	0.75	19.3	5.6	4.45	2.94
1,2,3,7,8-PeCDF	5.03	3.02	2.23	2.65	5.41	19.4	16	579	1.78	16.4	3.72	3.5	2.53
2,3,4,7,8-PeCDF	57.4	32.7	22.6	10.9	12.6	63.7	27.4	512	3.36	105	14.4	16.2	3.17
1,2,3,4,7,8-HxCDF	90.6	85.7	12.9	30	18.5	34.9	28.6	401	20.7	512	41.5	206	13
1,2,3,6,7,8-HxCDF	39.5	39.7	5.79	20.5	36.3	15.5	33.9	105	52.9	221	31.9	81.5	27.2
1,2,3,7,8,9-HxCDF	9.57	15	2.37	0.59**	4.59	6.56	7.44	78.7	0.77**	57.1	8.82	43.4	0.78**
2,3,4,6,7,8-HxCDF	17.3	23.3	4.56	8.45	29.2	12.9	32.7	73.1	45	83.7	57.7	134	31.8
1,2,3,4,6,7,8-HpCDF	39.3	219	49.7	131	541	88.1	472	1220	2040	800	2560	3230	1240
1,2,3,4,7,8,9-HpCDF	10	40.2	4.75	8.7	26.9	11.6	26.3	64.3	53.3	131	205	333	13
OCDF	33.8	689	108	252	1920	164	713	1840	6520	1940	7930	8950	1160
PCB 81	87.5	84.5	4970	173	253	5480	168	87.4	3.33	178	43.9	30	8.07
PCB 77	2510	2380	85800	5520	9040	91500	3370	1710	77.8	5400	1250	525	190
PCB 126	820	600	1520	1750	1340	2580	140	91.9	7.7	2010	174	22.1	11.1
PCB 169	21.9	16.9	3.92	47.2	31.6	6.16	9.78	1.26**	1.48	87.7	7.46	1.29	1.92
PCB 105	245000	381000	244000	115000	12400	234000	45600	12400	515	661000	43800	3930	1630
PCB 114	14800	36000	19500	6710	496	24800	2760	828	27.2	51900	2050	271	95.8
PCB 118	532000	608000	362000	357000	22800	315000	110000	27700	1200	1170000	86500	9540	4230
PCB 123	6480	13600	13800	4450	387	19800	1810	1160	30.7	26700	1400	348	58.5
PCB 156	121000	189000	13600	48000	3600	14800	10300	4470	167	471000	15600	1140	1170
PCB 157	27100	42300	2910	11500	957	4110	3240	927	29.8	124000	3240	256	121
PCB 167	38900	62700	4100	16800	1200	4670	3580	1640	73.5	193000	4850	463	432
PCB 189	4270	8060	1040	1880	136	579	445	850	25.7	45500	698	68.7	245
Total TEQ (ppt)	150	176	199	224	268	334	408	411	544	824	1110	1400	1750

*All concentrations below the Limit of Detection (LOD) were substituted with LOD/2

Conclusions

- Outliers were located in all regions except the plume and near floodplain. The largest number was from Jackson/Calhoun (n=5 out of 13).
- The congeners contributing most to the TEQ among outliers varied, with some cases dominated by PCDDs (n=6), PCDFs (n=1) and PCBs (n=6), respectively.
- Many homes with 'high' soil contamination did not have correspondingly 'high' dioxin levels in house dust (not shown)*.
 - Occupant factors that may have contributed to these contrasting relationships between soil and house dust contamination are unclear (e.g., outdoor pets, taking off shoes inside the home, presence of children, etc.).



- Soil contamination appeared to be a dominant factor for contamination of house dust in a minority of outlier cases* (see cases 4 and 8).
- In one case it was possible to identify a likely source of contamination of house dust from a source inside the home (case 10 – carpet and/or pad).
- Cigarette ash has a low TEQ (see case 7) and appears to not be an important contributor to the dioxin contamination of house dust.
- Even recently constructed homes can have high dioxin contamination in house dust (see case 13).
- In two cases (cases 1 and 5) residents had occupations that may have afforded opportunity for exposures to dioxin-like chemicals and secondary contamination of house dust, however, the congener profiles in house dust in these 2 cases did not appear to differ conspicuously from other cases in which there was no suspicious occupational history.
- A remote structural fire did not appear to be contributing factor to current elevation of dioxins in house dust (see case 11).
- In most cases the dominant source(s) of house dust contamination in homes with 'outlier' values were not related to adjacent soil; in many or most such cases the source(s) of contamination are unknown, but may be related to uncharacterized sources within homes.

*Details are available in *Organohalogen Compounds Vol 69 (2007)*

Financial support for this study comes from the Dow Chemical Company through an unrestricted grant to the University of Michigan.