HUMAN EXPOSURE TO DIOXINS FROM CLAY: A CASE REPORT

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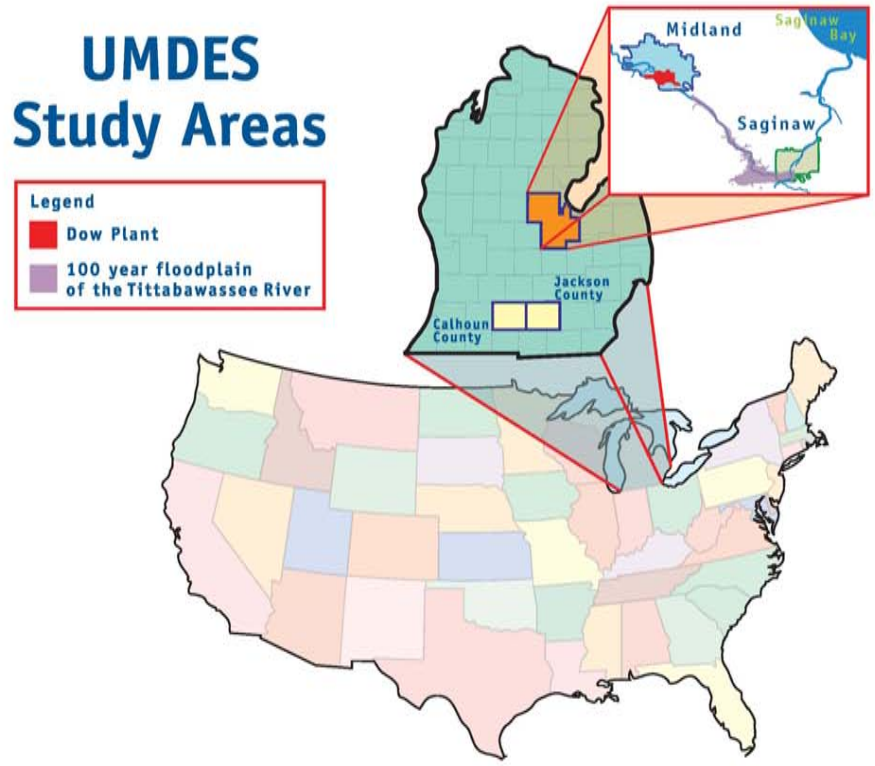
HUMAN EXPOSURE TO DIOXINS FROM CLAY

- For most people the dominant source of exposure to dioxin-like compounds is food (>90%), primarily via consumption of dairy, meat, and fish products.
- Additional circumstances of exposure that can be significant in selected subpopulations include:
  - occupational exposures
  - consumption of fish or game from contaminated regions
  - residing in the vicinity of waste incinerators

HUMAN EXPOSURE TO DIOXINS FROM CLAY

- The 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, body mass index, etc.).
- Analyzable serum samples were obtained from 946 randomly selected participants.
- Eligible subjects also had the same congener analyses performed on soil samples from around their homes (n=766) and on house dust sampled from inside homes (n=764).
- Full details on study methods and protocols are described elsewhere (http://www.sph.umich.edu/dioxin/protocol.html)

HUMAN EXPOSURE TO DIOXINS FROM CLAY



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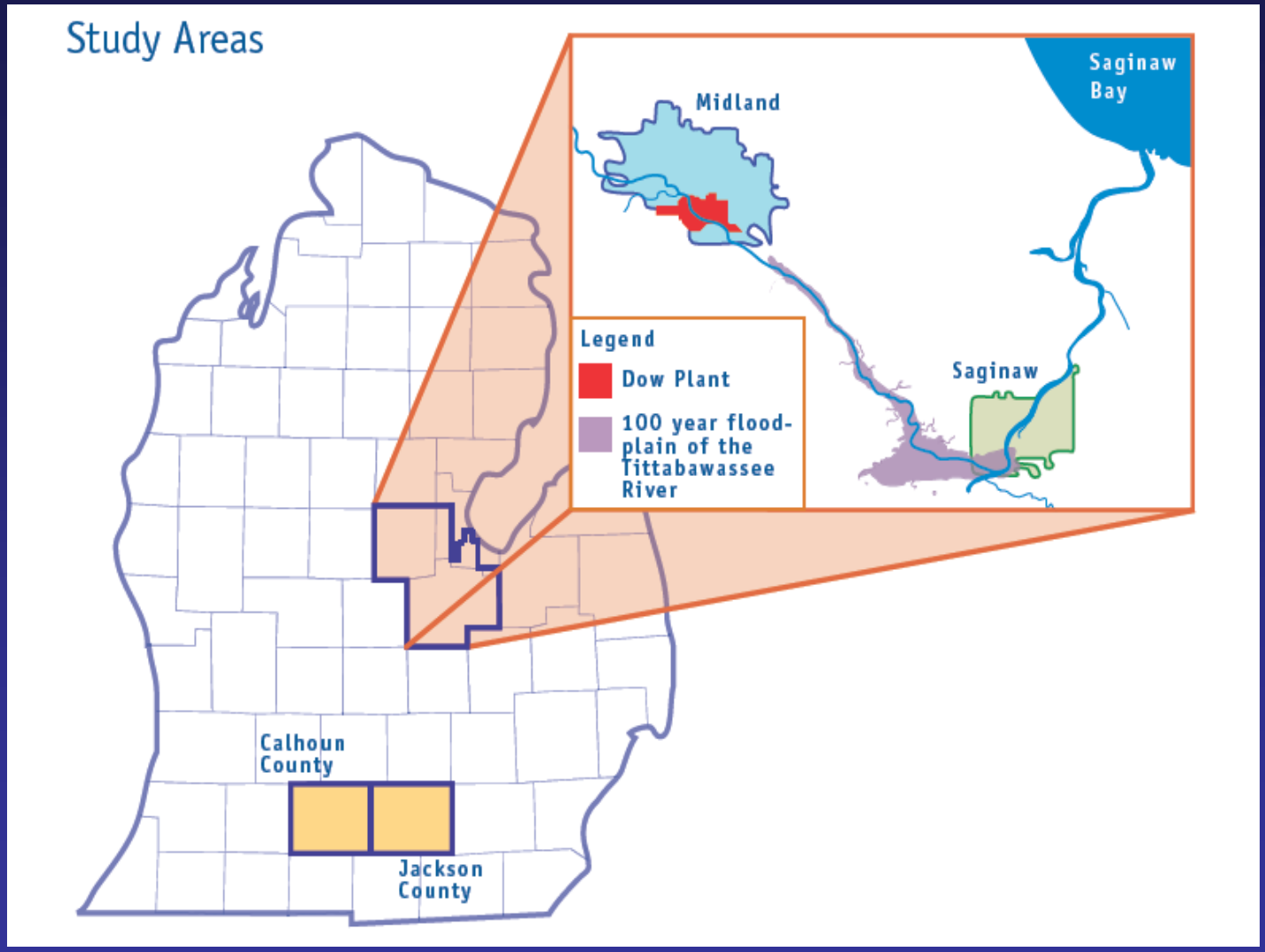
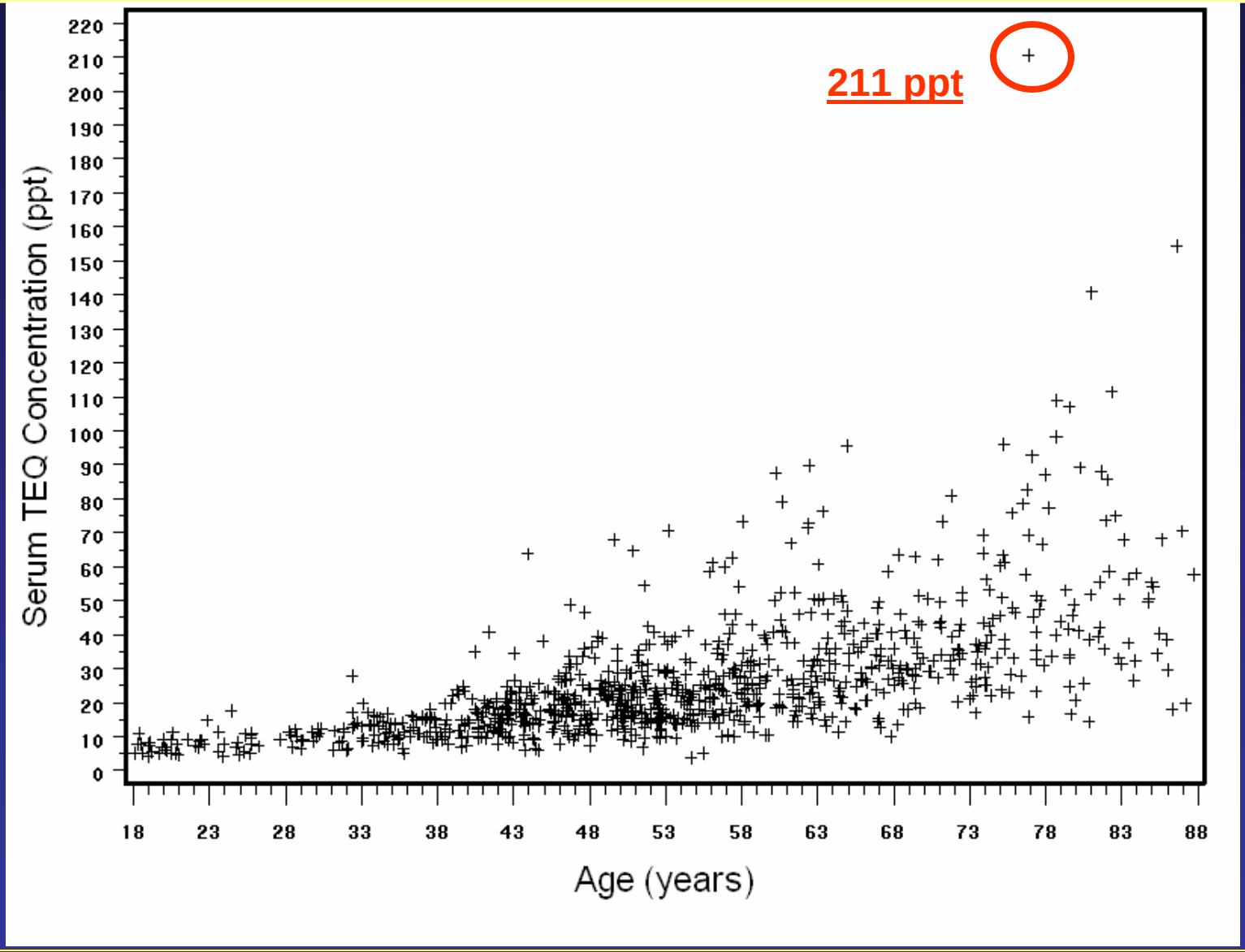


HUMAN EXPOSURE TO DIOXINS FROM CLAY

- The median serum TEQ (based on 29 congeners and using the 2005 WHO TEFs) in the study group was 25-30 ppt.
- The highest TEQ was 211 ppt.
- We report results of further investigations into why the subject with the highest serum TEQ had elevated levels of dioxins in her serum.

HUMAN EXPOSURE TO DIOXINS FROM CLAY



HUMAN EXPOSURE TO DIOXINS FROM CLAY

- Description of the index case:
  - Female; 77 years old; never smoked; no recent weight change
  - No history of occupational exposure to dioxins
  - No consumption of wild game since childhood
  - Modest consumption of sport-caught fish; stopped 13 years before the study; denied ever eating fish from the Tittabawassee or Saginaw Rivers
  - No gardening or consumption of vegetables from her property
  - Never resided near industrial incinerators

HUMAN EXPOSURE TO DIOXINS FROM CLAY

- Description of the index case (continued):
  - Had lived along the Tittabawassee River for almost 30 years, downstream from the Dow plant located in Midland, Michigan.
  - She had been very involved in ceramics as a hobby from the early 1960's up to about the mid 1990's.

HUMAN EXPOSURE TO DIOXINS FROM CLAY

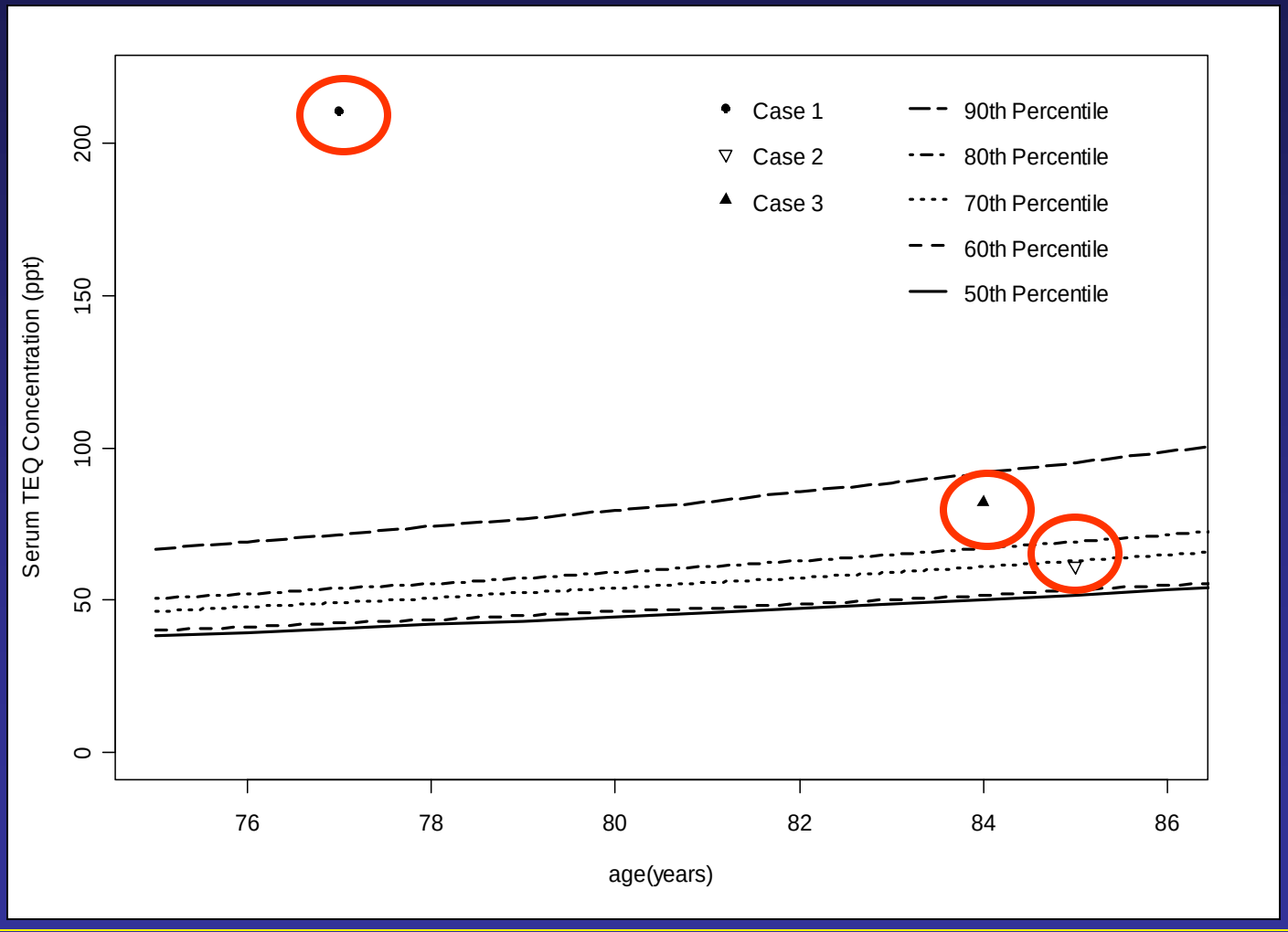
- Description of ceramics activity of index case:
  - She purchased clay in liquid form ("slip") and poured this into plaster molds to harden
  - No additions to clay except distilled water
  - Rough edges of dried pieces were smoothed with a wet sponge or by sanding
  - She never used gloves, respirator or other PPE
  - Pottery was fired in one of 3 un-vented electric kilns in the basement of her home (1800^{o}F, cone 6)
  - Along with friends, she performed ceramics work on average about 3 afternoons or evenings per week for about 3 decades

HUMAN EXPOSURE TO DIOXINS FROM CLAY

- Description of ceramics friends:
  - Case 2 (age = 85) and Case 3 (age = 83)
  - No history of occupational exposures to dioxins; never resided along Tittabawassee River, or near incinerators; never ate sport caught fish or wild game; never smoked; no recent weight change
  - The manner, time frame, frequency and duration of ceramics work was approximately the same as for the index case, except each had only one kiln, these were located in garages, not in the basement or elsewhere inside their homes, and they were used less frequently

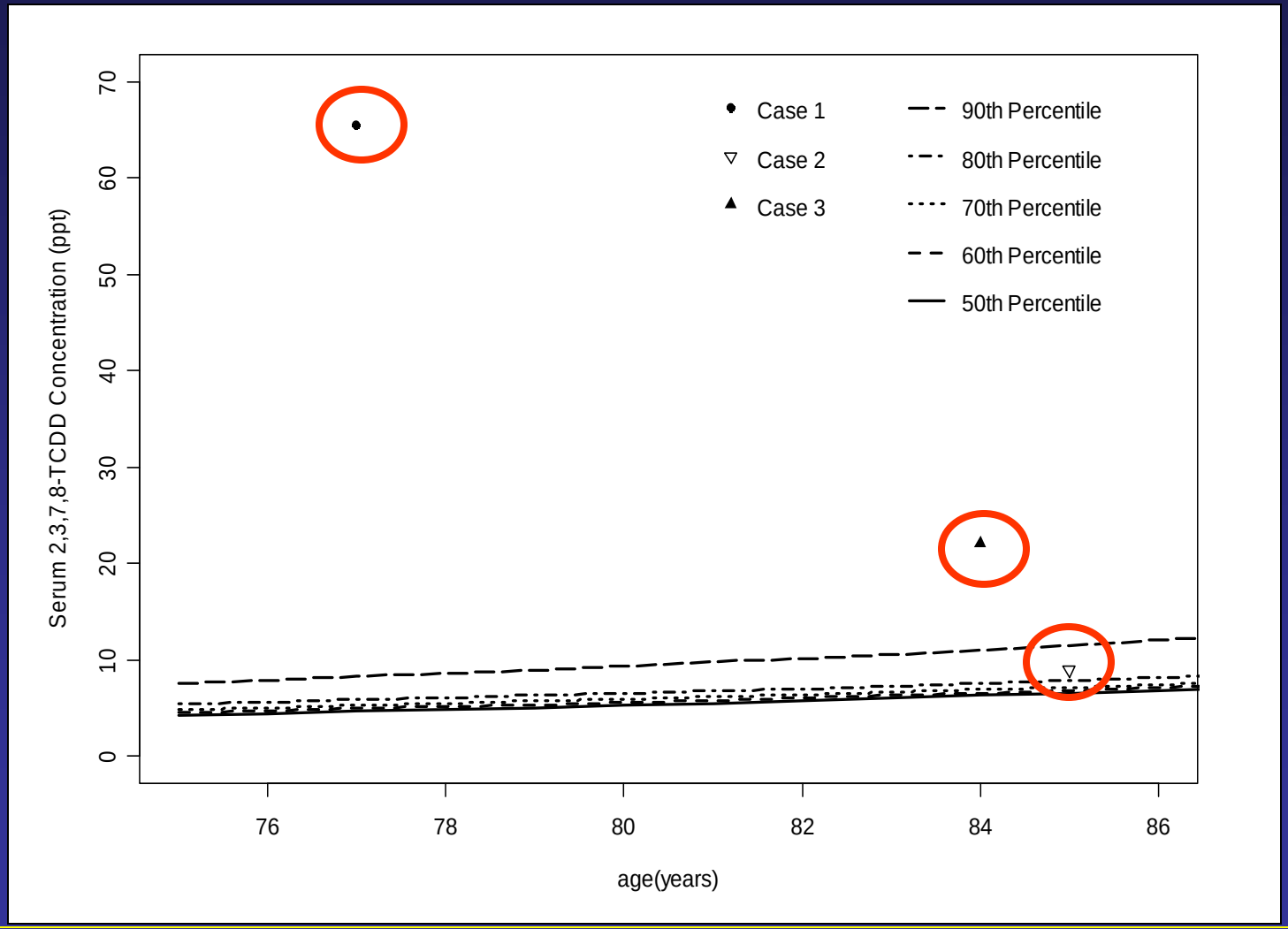
HUMAN EXPOSURE TO DIOXINS FROM CLAY

Serum TEQ for Cases with Quantile Curves Based on Female Controls from Jackson and Calhoun Counties



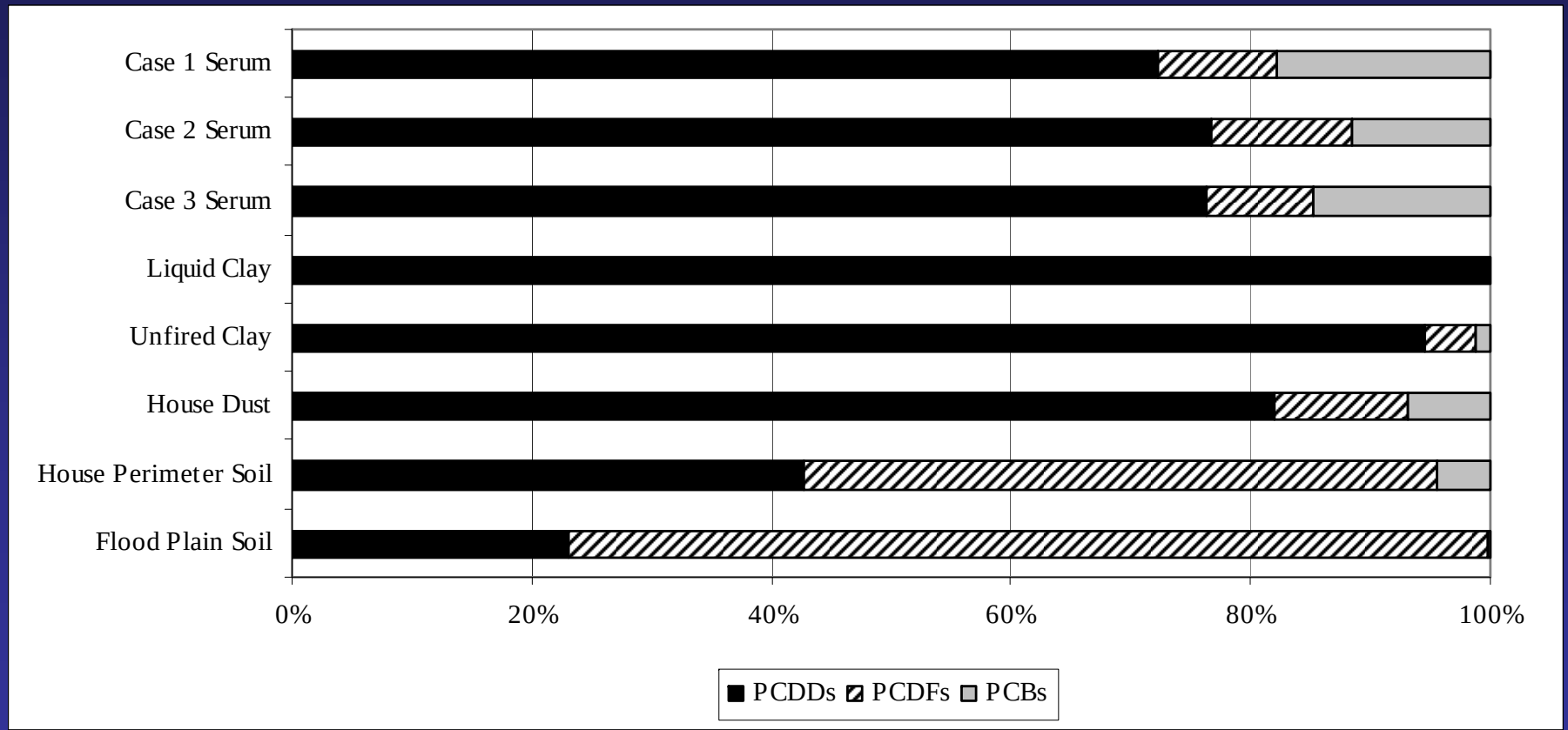
HUMAN EXPOSURE TO DIOXINS FROM CLAY

Serum 2,3,7,8-TCDD for Cases with Quantile Curves Based on Female Controls from Jackson and Calhoun Counties



HUMAN EXPOSURE TO DIOXINS FROM CLAY

Relative Contribution of PCDDs, PCDFs and dioxin-like PCBs to TEQ for Serum, Clay, House Dust and Soil Results



HUMAN EXPOSURE TO DIOXINS FROM CLAY

- Most of the TEQ for the cases is attributable to PCDDs, not PCDFs or PCBs.
- The liquid clay and unfired clay used by the cases is contaminated with PCDDs (similar to previously published results for ball clay), with only low levels of PCDFs, while the soil, particularly from the flood plain, is dominated by furans.
- The high PCDD/PCDF ratio suggest that the dioxin contamination in the clay, and not the dioxin contamination in soil from the index case's property, was the dominant source of dioxin contamination in the subject's serum.

HUMAN EXPOSURE TO DIOXINS FROM CLAY

- Possible exposure pathways from clay:
  - direct absorption of dioxins through the skin while handing liquid clay or unfired ceramics
  - inhalation of dioxins volatilized when ceramic pieces were fired in the un-vented kilns
  - ingestion of clay or clay particles that landed on food items in the home or during food handing
  - inhalation of clay dust from handling and sanding unfired ceramic items
  - inhalation of clay dust that became mixed with house dust

HUMAN EXPOSURE TO DIOXINS FROM CLAY

- Cases 2 and 3 are approximately the same age as Case 1, and handled clay in a manner that was similar to Case 1, but their TEQ and specific congener levels in serum were dramatically lower compared to the index case.
- The major distinction appears to be that Cases 2 and 3 each had only one kiln, and these were located in garages, not in the basement or elsewhere inside the living space of their homes.
- These results suggest that inhalation of dioxins volatilized when ceramic pieces were fired in the un-vented kilns in the basement of the home was the dominant route of exposure for Case 1.
- The fact that Cases 2 and 3 had above-average TEQ and specific congener levels in their serum (e.g., 2,3,7,8-TCDD after adjustment for age), could be due to their more limited exposure to kilns, and/or a limited role for exposure from direct handing of clay materials

HUMAN EXPOSURE TO DIOXINS FROM CLAY

- Our subjects reported that they purchased clay from regional retail sales outlets, but the precise geological source of the clay used by our subjects is not known.
- The magnitude of the public health significance of our findings is not clear, but the number of people exposed to dioxins in clay could vary considerably. We do not know what fraction of clays used by schools in art classes, ceramics enthusiasts, professional potters or in commercial operations is contaminated with dioxins, and the extent of the contamination may vary.
- Further investigations are warranted to better determine routes of exposure, in particular to confirm whether volatilization of dioxins during firing is the most important route of exposure, and also to determine the extent of dioxin contamination of clay used by ceramicists and in commercial operations.

HUMAN EXPOSURE TO DIOXINS FROM CLAY

- Related posters will be on display during Poster Session B, Wednesday and Thursday
  - Poster P-285: A FOLLOW-UP INVESTIGATION OF HOMES WITH 'HIGH' CONCENTRATIONS OF PCDDS, PCDFS AND DIOXIN-LIKE PCBS IN HOUSE DUST
  - Poster P-293: CASE STUDY OF RESIDENCES WITH ANOMALOUS SOIL CONCENTRATIONS OF PCDDS, PCDFS AND PCBS IN A COMMUNITY IN MICHIGAN, USA

HUMAN EXPOSURE TO DIOXINS FROM CLAY

Questions?

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Concentrations of PCDDs and PCDFs in Serum, House Dust, Soil, and Clay, and Published Concentrations for Ball Clay (parts per trillion)

Compound	Serum Case 1	Serum Case 2	Serum Case 3	House Dust	House Perimeter	Flood Plain	Liquid Clay	Unfired Clay	Fired Clay	Clay Mixture*	Unfired Clay*	Fired Clay*
2,3,7,8-TCDD	65.4	9	22.1	2.49	2.67	65	31	5.34	0.05	191	212	0.1
1,2,3,7,8-PeCDD	59.8	17	18.4	2.85	2.52	10.6	85	46.1	0.15	155	157	0.4
1,2,3,4,7,8-HxCDD	30.8	12.1	17.5	5.98	2.42	8.7	86.5	44.7	0.14	32	30	0.4
1,2,3,6,7,8-HxCDD	189	83.6	82.3	84.7	6.36	58.6	142	63.5	0.28	103	93	0.4
1,2,3,7,8,9-HxCDD	32.4	10.7	14.1	31	4.66	12.9	454	388	0.28	395	363	0.4
1,2,3,4,6,7,8-HpCDD	149	74.7	57.1	4620	110	652	2430	1280	1.92	1130	1080	0.4
OCDD	541	914	615	20900	851	5800	48500	18400	7.26	29700	23000	1.4
2,3,7,8-TCDF	1.09	0.264	0.716	9.96	20	836	0.07	11	0.09	ND	ND	ND
1,2,3,7,8-PeCDF	0.4	0.141	0.533	6.85	12	543	0.08	17.5	0.21	ND	ND	ND
2,3,4,7,8-PeCDF	50	12.4	13.7	7.97	13.7	442	0.07	7.88	0.13	ND	ND	ND
1,2,3,4,7,8-HxCDF	27	8.46	10	10.4	12.2	375	0.07	4.73	0.08	ND	ND	ND
1,2,3,6,7,8-HxCDF	24.7	8.56	7.96	7.73	5.36	126	0.50	5.2	0.16	ND	ND	ND
1,2,3,7,8,9-HxCDF	1.06	0	0	2.11	3.06	80.4	0.15	1.67	0.07	ND	ND	ND
2,3,4,6,7,8-HxCDF	4.23	1.63	1.33	6.79	5.85	48.7	0.1	1.7	0.13	ND	ND	ND
1,2,3,4,6,7,8-HpCDF	9.45	5.24	6.73	289	53.5	771	0.16	3.29	0.62	ND	ND	ND
1,2,3,4,7,8,9-HpCDF	0.68	0	1	9.4	3.41	65	0.07	1.94	0.08	ND	ND	ND
OCDF	2.1	1.04	1.06	636	92.6	1740	4.57	5.27	0.34	ND	ND	ND
Total TEQ (ppt)**:	211	61	82	85	18	397	223	126	0.5	419	435	<1

ND = not detected (below limit of detection); *Ferrario (2002); **TEQs based on 29 congeners using 2005 TEFs; serum results are reported on a lipid adjusted basis, all other results are reported on a dry weight basis