



The University of Michigan Dioxin Exposure Study: A follow-up investigation of cases with high serum concentrations of 2,3,4,7,8-pentaCDF

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Introduction

The study was motivated because of concerns about human exposure to dioxin-contaminated sediments in the Tittabawassee River (TR). Most of the total toxic equivalency (TEQ) in TR sediments is due to two furan congeners, 2,3,7,8-TCDF and 2,3,4,7,8-pentaCDF. Only the latter congener has a prolonged serum half life in humans (~7.8-10 years) and thus it can serve as a biomarker of exposure.

Methods

Eligible subjects were required to be at least 18 years old, and to have lived in their homes for at least 5 years. The main study involved an hour-long interview and obtaining blood, house dust and soil samples for chemical analyses from eligible subjects. 946 subjects from five Michigan counties provided blood samples (including 251 from Jackson and Calhoun Counties, the control area of the study) that were analyzed for 29 PCDDs, PCDFs and PCBs by Vista Analytical Laboratory (El Dorado Hills, California). The goal was to re-interview the top 15 subjects, i.e., those with the highest studentized residuals above the mean (after adjustment for age, age², and BMI) of the control population. When a subject refused or could not be contacted, the next highest subject was contacted. Serum results are reported in parts per trillion (ppt) on a lipid adjusted basis and soil results are reported in ppt on a dry weight basis. All TEQ values are calculated with the 29 dioxin-like congeners, using WHO 2005 TEFs.

Results & Conclusions

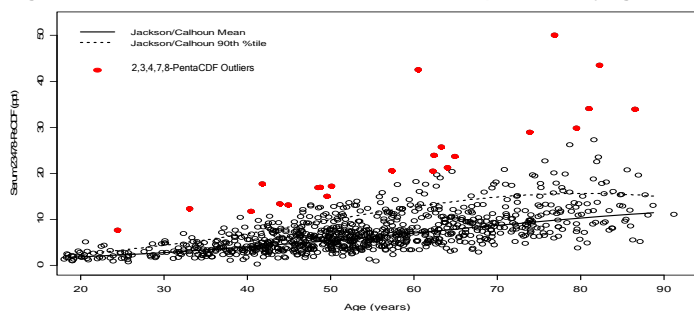
Seventeen of the 23 subjects with the highest serum concentrations of 2,3,4,7,8-pentaCDF agreed to be re-interviewed. The serum levels of 2,3,4,7,8-pentaCDF for the 23 subjects ranged from 7.66 ppt to 50 ppt (or, 2.42 to 4.29 studentized residuals above the mean of the control population after correction for age, age², and BMI – see Figure 1 and Table 1). The mean, median, 95th percentile and maximum for serum 2,3,4,7,8-pentaCDF in the control population of the study were 6.0 ppt, 5.4 ppt, 13.0 ppt, and 26.2 ppt, respectively.

Table 1: Selected data for the 23 2,3,4,7,8-pentaCDF outliers

Case No.	Serum TEQ	Serum 2,3,4,7,8-PentaCDF	Serum PentaCDF S.R.	% of TEQ from PCDDs	% of TEQ from PCDFs	Location of Residence	Reported Flood Plain Food Consumption
1	52.5	42.5	4.29	56.9	31.8	TRFP	Meat, Vegetables, Game
2	211	50.0	3.76	72.2	9.9	TRFP	None Reported
3	20.3	17.7	3.58	40.0	48.5	J/C	None Reported
4	19.7	12.3	3.35	62.0	26.7	TRFP	Flood plain vegetable stand
5	112	43.5	3.24	71.9	14.7	TRFP	None Reported
6	38.0	16.9	2.96	67.6	19.4	OMS	No Contact
7	39.0	17.0	2.95	60.2	20.0	NFP	Sport fish
8	76.3	25.7	2.94	65.2	16.7	NFP	None Reported
9	89.9	23.9	2.88	44.4	13.2	TRFP	Sport fish
10	17.8	7.66	2.88	51.2	26.3	NFP	No Contact
11	23.9	17.2	2.84	47.2	32.7	TRFP	None Reported
12	42.8	20.6	2.82	63.4	22.5	TRFP	No Contact
13	63.8	13.4	2.73	27.7	9.1	NFP	No Contact
14	95.6	23.7	2.69	44.8	10.6	NFP	Personal vegetable garden
15	141	34.1	2.69	59.6	11.3	TRFP	Sport Fish, Game
16	69.5	28.9	2.67	64.6	17.3	NFP	None Reported
17	35.1	11.7	2.66	63.5	19.6	NFP	None Reported
18	38.0	13.1	2.58	59.1	23.5	TRFP	No Contact
19	68.0	15.0	2.58	55.8	13.2	NFP	Sport Fish, Game
20	71.4	20.5	2.56	36.8	11.6	OMS	Flood plain vegetable stand
21	50.5	21.2	2.48	58.3	22.4	TRFP	Personal vegetable garden
22	107	29.8	2.44	80.3	11.9	OMS	No Contact
23	154.4	33.9	2.42	54.4	10.6	NFP	None Reported
Jackson/Calhoun Median	18.5	5.4	-	64.8	16.3	-	-

SR, Studentized Residuals after adjustment for age, age², and BMI; TRFP, Tittabawassee River Flood Plain; NFP, Near Tittabawassee River Flood Plain; OMS, Other Midland/ Saginaw County; J/C, Jackson or Calhoun Counties

Figure 1: UMDES serum concentrations of 2,3,4,7,8-pentaCDF by age



Ten of the 23 outliers lived on the TR flood plain (TRFP). Nine of 17 outliers who were interviewed reported eating meat, vegetables, wild game, and/or sport caught fish from the TR or flood plain soils from the TR. Case 1 reported a unique history of personally raising beef and vegetables on his property in the flood plain for a number of years – this case is described in more detail elsewhere. In addition to residing in Jackson/Calhoun Counties and having no exposure to the contamination in the TRFP, case 3 is unique for having the highest proportion of TEQ due to PCDFs (48.5%) among all subjects in the UMDES.

Living in the TRFP, or in nearby areas of Midland and Saginaw (M/S) counties, appears to be associated with elevated levels of 2,3,4,7,8-pentaCDF in serum for these outlier cases. It is possible that foods from the flood plain were consumed, but that subjects were unaware of the origin of foods they ate (e.g., foods purchased in local grocery stores may have been grown in the TR flood plain). Case 3 suggests that there are other important sources of exposure to furans, particularly 2,3,4,7,8-pentaCDF, aside from the contamination in the TRFP.

Overall, among cases with outlier concentrations of 2,3,4,7,8-pentaCDF in serum, the excess percent contribution of PCDFs to the serum TEQ among M/S outliers is modest.

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