

Dioxin exposure in the Midland-Saginaw, Michigan population

David H. Garabrant, MD, MPH

Emeritus Professor of
Occupational Medicine and Epidemiology
The University of Michigan School of Public Health
Ann Arbor, Michigan 48109-2029

**The University of Michigan Dioxin Exposure Study (UMDES)
Presentation to the Saginaw-Tittabawassee Rivers
Contamination Community Advisory Group**

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Team, past and present

- **School of Public Health**

David Garabrant, MD, MPH
Alfred Franzblau, MD
Olivier Jolliet, PhD
Lynn Zwica, MS, MS
Kristine Knutson, MPH
Elizabeth Hedgeman, MS, MPH
Camelia Sima, MS
Qixuan Chen, MS
Biling Hong, MA
Shih-Yuan Lee, MS
Chiung-Wen Chang, MA, MS
Xiaohui Jiang, MS
Jinkyung Ha
Meghan Milbrath
Yvan Wenger, MS
Sharyn Vantine
Wei Hao, MA

- **Center for Statistical Consulting and Research**

Brenda W. Gillespie, PhD
Scott Swan, MS
Danielle Gwinn

- **College of Engineering**

Peter Adriaens, PhD, PE
Avery Demond, PhD, PE
Tim Towey, MS
Shu-Chi Chang, PhD
Hoa Trinh, MS

- **Institute for Social Research**

James Lepkowski, PhD, MPH
Barbara Lohr Ward, MBA
Kathy Ladronka
Kristen Olson, PhD
Jennifer Sinibaldi, MS

- **Contractors**

Vista Analytical Labs
Environ
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Regional Medical Labs



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The University of Michigan has complete independence to design, carry out, and report the results of the study.

The investigators report to an independent Scientific Advisory Board: Dr. Linda Birnbaum, NIEHS; Dr. Marie Sweeney, NIOSH; Prof. Ronald Hites, Indiana University; Dr. Paolo Boffeta, Mount Sinai School of Medicine.



The UMDES

Full descriptions of the UMDES methods, datasets, results, and publications are available at our website:

www.umdioxin.org

This presentation focuses on the role of dioxin contamination in soil and house dust in relation to the body burden of dioxins.



The UMDES

We undertook The University of Michigan Dioxin Exposure Study (UMDES) in response to concerns that the dioxin-like compound contamination from the Dow Chemical Company facilities in Midland, Michigan have led to an increase in residents' body burdens of dioxins, furans and PCBs.

Our goals were to -

1. Determine whether residents experience increased exposure to the elevated dioxin-like compounds in the environment
2. Identify the completed pathways of exposure
3. Communicate our results to involved communities



Study design

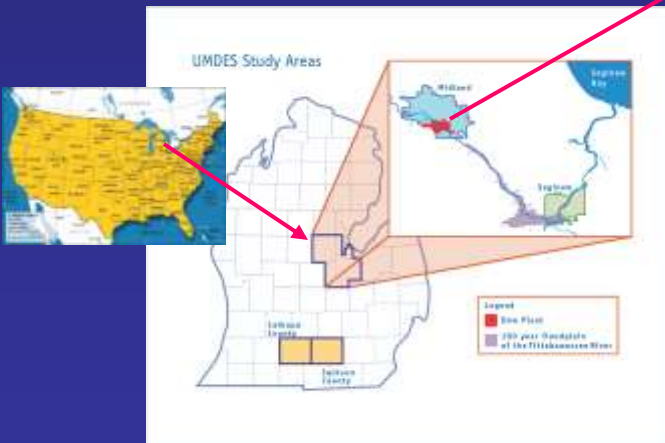
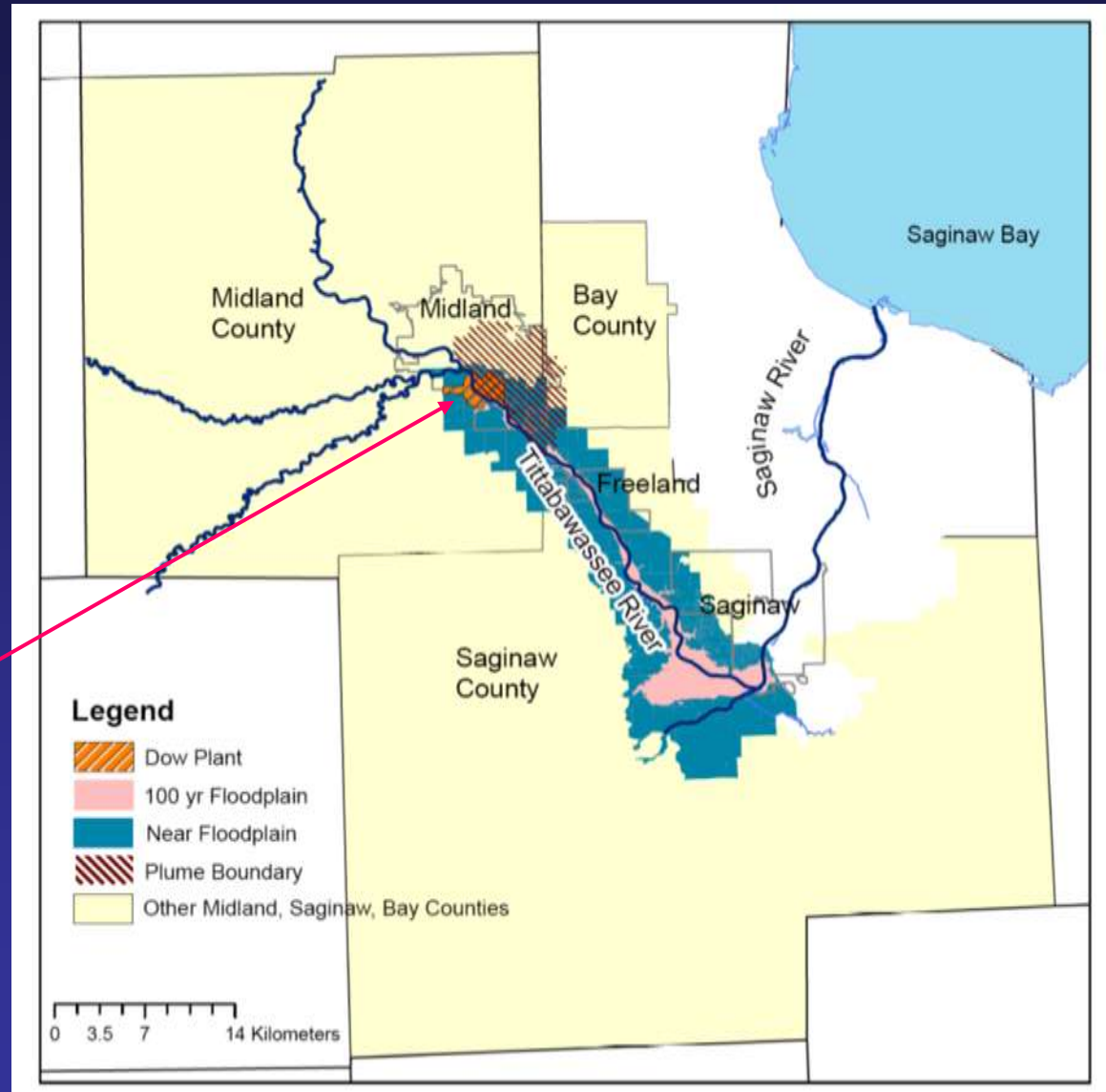
Our sample design was a stratified, multistage area probability sample of households and persons. Adults over the age of 18, who had lived in their current residence continuously for at least five years, were eligible to participate (only one person per household).

Area of residence was further stratified into regions:

- The Floodplain of the Tittabawassee River
- The Near Floodplain
- The Midland Plume – downwind of the Dow plant
- Other Midland/Saginaw – not near the rivers or Dow
- For comparison, Jackson/Calhoun Counties

Five study populations: 4 in Midland/Saginaw and 1 referent area.

1. Tittabawassee River Flood Plain (M/S FP)
2. Near Flood Plain (M/S near FP)
3. Midland Plume (M/S Plume)
4. Other Midland/Saginaw (M/S Other)
5. Jackson/Calhoun counties (J/C) (referent population 200 km away)



Information collected from each study participant.

Current (Production)
Version

For Office Use Only

The University of Michigan Dioxin Exposure Study

The University of Michigan
Survey Research Center
Institute for Social Research

Sample ID Number:
--

Interviewer Label:

1. Interviewer's ID No.: _____
2. Date Iw Began: _____
3. Date Iw Completed: _____
4. Length of Iw: _____


The following statement must be read to all respondents

Your participation in this project is completely voluntary. Even though informed consent document, you may decide to leave the study at any time without penalty or loss of benefits to which you may otherwise be entitled. Your participation will have no impact on your employment. You may skip or not answer any survey question that makes you feel uncomfortable without study compensation.

- Interview
- Blood sample
- Household dust
- Soil samples



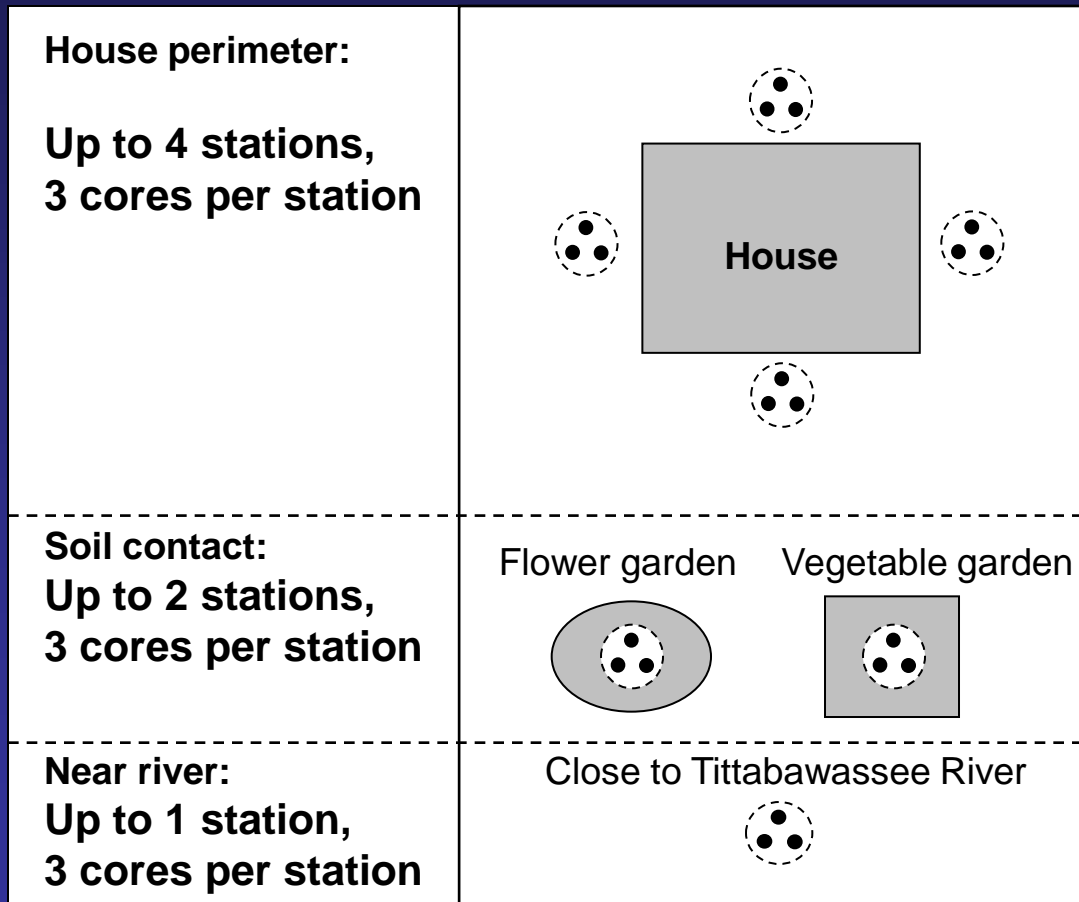
University of Michigan Dioxin Exposure Study



Respondent Booklet

Investigation of Soil Concentrations

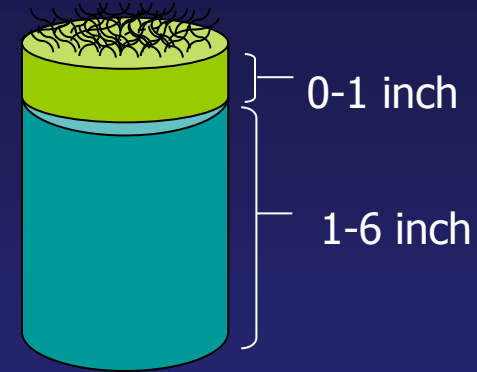
Soil samples were taken at various locations on participants' property



Investigation of Soil Samples



- Cores were extruded, separated into two strata and the vegetation removed



- Strata were composited

House perimeter:	0-1 inch, 1-6 inch
Near river:	0-1 inch, 1-6 inch
Garden:	0-6 inch



- Composites were sent to Vista Labs for analysis for WHO (2005) 29 congeners by HRGC/HRMS



Participation (N) by Region

	Floodplain	Near Floodplain	Midland Plume	Other Midland/Saginaw	Jackson/Calhoun	Total All Regions
Interviews	326	264	71	304	359	1,324
Blood	251	197	48	199	251	946
Dust	207	159	37	163	198	764
Soil	203	164	37	168	194	766
All 4	195	156	35	162	183	731



Serum and Soil Results – TEQ (ppt) by Region

Serum

Zone	N	Mean	Median	75 th	95 th	Min	Max
Overall	946	23.9	19.6	29.2	58.6	3.8	211
M/S FP	251	26.4	23.2	32.9	52.5	4.7	211
M/S Near FP	197	25.6	21.9	32.4	62.9	4.2	154
M/S Other	199	26.9	20.7	32.4	62.7	4.1	107
M/S Plume	48	21.4	16.8	20.9	63.3	3.8	79
Jackson/Calhoun	251	21.3	18.5	25.3	46.5	4.7	109

Serum TEQ is the lipid-adjusted WHO 2005 TEF-weighted average of 29 dioxin congeners

Soil

Zone	N	Mean	Median	75 th	95 th	Min	Max
Overall	766	14.3	4.5	10.3	59.4	0.4	2300
M/S FP	203	56.5	11.4	35.4	223	1.1	1880
M/S Near FP	164	52.0	3.9	10.4	103	0.8	2300
M/S Other	168	13.5	5.3	13.2	59.4	0.8	158
M/S Plume	37	109	58.2	112	257	6.3	746
Jackson/Calhoun	194	6.9	3.6	7.6	22.6	0.4	186

Soil TEQ is the house perimeter 0-1 inch stratum (dry-weight) WHO 2005 TEF-weighted average of 29 dioxin congeners



House Dust Results – TEQ (ppt) by Region

Zone	N	Mean	Median	75 th	95 th	Min	Max
Overall	764	36.7	16.2	29.7	126	1.4	1750
M/S FP	207	38.9	16.4	36.3	108	2.3	1750
M/S Near FP	159	16.5	11.3	20.1	41.7	1.4	189
M/S Other	163	35.0	17.6	28.5	87.7	1.6	1400
M/S Plume	37	38.8	31.3	41.8	90.7	8.2	334
Jackson/Calhoun	198	38.8	13.8	32.2	177	2.1	1110

House dust TEQ is the (dry-weight) WHO 2005 TEF-weighted average of the 29 dioxin congeners



Final Regression Model for Serum TEQ

1. Our analyses explain most of the variation in blood TEQ concentrations. (Total adjusted R^2 for the TEQ model: 69%.)
2. The overwhelming bulk of the variation in blood levels is due to demographic factors (age↑, sex (F↑), BMI↑, breast feeding↓, smoking ↓)
3. Contamination in soil from around the house and house dust are not significant in the model
4. Merely living on contaminated soil or with contaminated house dust does is not a significant pathway of exposure



Final Model for Serum TCDD

1. The overwhelming bulk of the variation in blood levels is due to demographic factors (age ↑, sex (F ↑), BMI ↑, breast feeding ↓, smoking ↓).
2. Contamination in soil from around the house and house dust are not significant in the model.
3. Merely living on contaminated soil or with contaminated house dust does is not a significant pathway of exposure.
4. Living in Midland/Saginaw prior to 1980 was an important predictor of blood TCDD.



Final Model for Serum TCDD - 2009

Research

The University of Michigan Dioxin Exposure Study: Predictors of Human Serum Dioxin Concentrations in Midland and Saginaw, Michigan

David H. Garabrant,¹ Alfred Franzblau,¹ James Lepkowski,² Brenda W. Gillespie,³ Peter Adriaens,⁴ Avery Demond,⁴ Elizabeth Hedgeman,¹ Kristine Knutson,¹ Lynn Zwica,¹ Kristen Olson,^{2,5} Timothy Towey,⁴ Qixuan Chen,³ Biling Hong,¹ Chung-Wen Chang,¹ Shih-Yuan Lee,³ Barbara Ward,² Kathy LaDronka,² William Luksemburg,⁶ and Martha Maier⁶

¹Department of Environmental Health Sciences and Risk Science Center, University of Michigan School of Public Health, Ann Arbor, Michigan, USA; ²Survey Research Center, Institute for Social Research, University of Michigan, Ann Arbor, Michigan, USA; ³Department of Biostatistics, University of Michigan School of Public Health, Ann Arbor, Michigan, USA; ⁴Department of Civil and Environmental Engineering, University of Michigan College of Engineering, Ann Arbor, Michigan, USA; ⁵Survey Research and Methodology Program, University of Nebraska-Lincoln, Gallup Research Center, Lincoln, Nebraska, USA; ⁶Vista Analytical Laboratory, El Dorado Hills, California, USA

BACKGROUND: We conducted a population-based human exposure study in response to concerns among the population of Midland and Saginaw counties, Michigan, that discharges by the Dow Chemical Company of dioxin-like compounds into the nearby river and air had led to an increase in residents' body burdens of polychlorinated dibenzofurans (PCDDs), polychlorinated dibenzofurans (PCDFs), and dioxin-like polychlorinated biphenyls (PCBs), here collectively referred to as "dioxins."

OBJECTIVES: We sought to identify factors that explained variation in serum dioxin concentrations among the residents of Midland and Saginaw counties. Exposures to dioxins in soil, river sediments, household dust, historic emissions, and contaminated fish and game were of primary interest.

METHODS: We studied 946 people in four populations in the contaminated area and in a referent population, by interview and by collection of serum, household dust, and residential soil. Linear regression was used to identify factors associated with serum dioxins.

RESULTS: Demographic factors explained a large proportion of variation in serum dioxin concentrations. Historic exposures before 1980, including living in the Midland/Saginaw area, hunting and fishing in the contaminated areas, and working at Dow, contributed to serum dioxin levels. Exposures since 1980 in Midland and Saginaw counties contributed little to serum dioxins.

CONCLUSIONS: This study provides valuable insights into the relationships between serum dioxins and environmental factors, age, sex, body mass index, smoking, and breast-feeding. These factors together explain a substantial proportion of the variation in serum dioxin concentrations in the general population. Historic exposures to environmental contamination appeared to be of greater importance than recent exposures for dioxins.

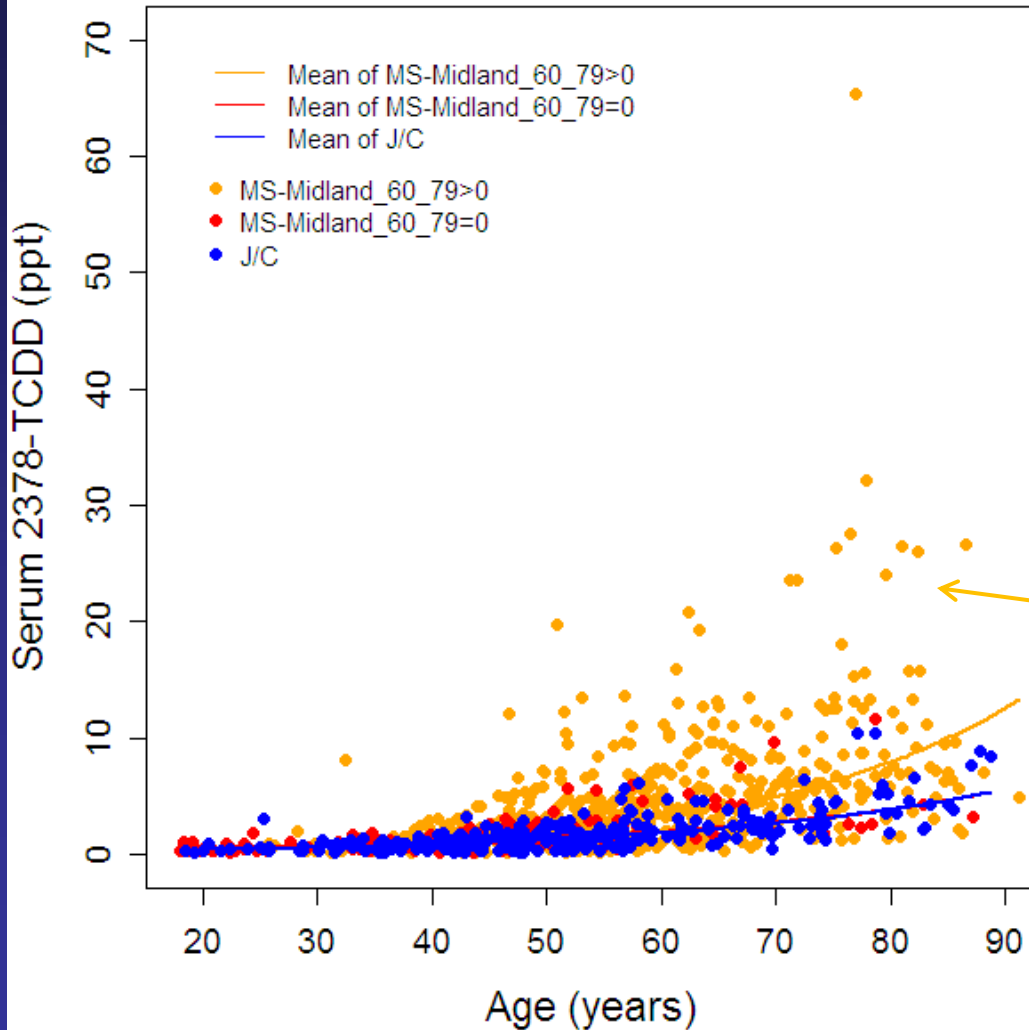
KEY WORDS: epidemiology, exposure pathways, polychlorinated biphenyls, polychlorinated dioxins, polychlorinated furans, soil contamination. *Environ Health Perspect* 117:818-824 (2009). doi:10.1289/ehp.11779 available via <http://dx.doi.org/> [Online 22 December 2008]

century, chemical waste incinerators in operation into the 1980s, and chlorophenol production between 1937 and 1980 (Burns et al. 2007). Soils in areas downwind of the Dow plant have elevated dioxin-like compounds with a congener pattern that is rich in PCDDs, and sediments in the Tittabawassee River downstream of the Dow plant have elevated levels with a congener pattern that is rich in PCDFs (Hilscherova et al. 2003). We conducted a human exposure study [University of Michigan Dioxin Exposure Study (UMDES)] in response to concerns among the population of Midland and Saginaw counties that the discharge by Dow of dioxin-like compounds into the river and air had led to an increase in residents' body burdens of PCDDs, PCDFs, and PCBs. This question is central to the discussion of the circumstances and exposure pathways by which dioxin emissions may affect the human population.

Methods

To investigate the factors that predict resi-

2378_TCDD



The **red** dots are the blood TCDD levels of people who lived in M/S when we studied them (2005) but who did not live in M/S before 1980.

The **blue** dots are the blood levels of people who lived in Jackson/Calhoun when we studied them (2005).

The **red** and **blue** lines are identical, meaning that the blood levels are identical in these two groups.

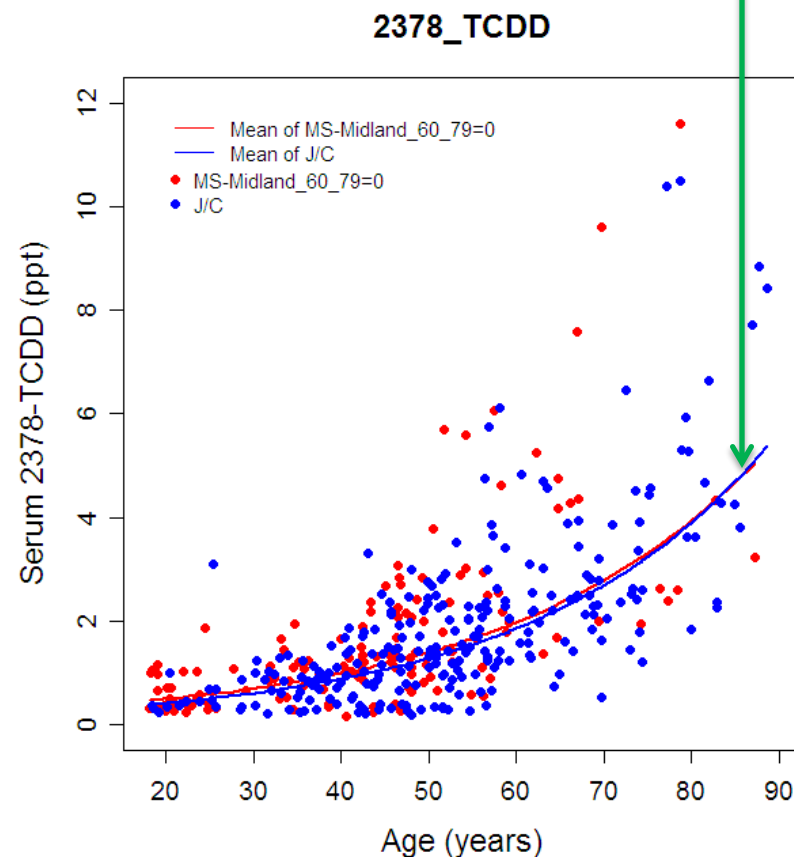
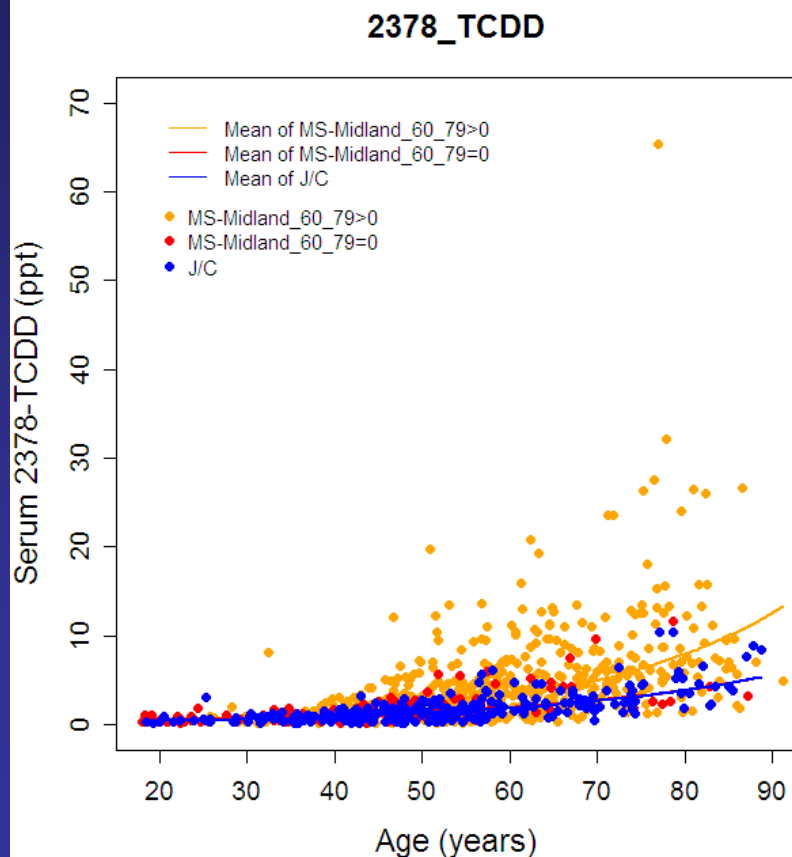
The **orange** dots are the blood levels of people who lived in M/S in 2005 and who lived here before 1980. All the high blood levels are in these people.

Once we take into account whether people lived here before 1980, there is no difference at all between Jackson/Calhoun and Midland/Saginaw blood levels.

The red dots are the blood TCDD levels of people who lived in M/S when we studied them (2005) but who did not live in M/S before 1980.

The blue dots are the blood levels of people who lived in Jackson/Calhoun when we studied them (2005).

The red and blue lines are identical, meaning that the blood levels are identical in these two groups.





The UMDES included highly contaminated properties

1. Critics have suggested that the UMDES is 'underpowered' because only 23 study participants lived on 'highly contaminated' soil (i.e., TEQ > 1,000 ppt).
2. 1,000 ppt TEQ is the current EPA preliminary remediation goal (PRG) for residential soil. EPA has proposed to lower the PRG to 72 ppt TEQ or even 3.7 ppt TEQ.
3. The TEQ is the TEF-weighted sum of 29 congeners. TEFs are related to toxicity (i.e. binding to AhR), and have nothing to do with exposure and absorption.
4. Focusing solely on TEQ may mask important exposure relationships due to the influence of the TEFs. TEFs down-weight specific congeners by as much as 3×10^{-5} .



Soil and house dust levels

The percentage of properties with soil or house dust above 1,000 ppt or above 5,000 ppt for TEQ and selected congeners

Factor	TEQ	TCDD	OCDD	PeCDF	PCB 105	PCB 118
Soil – HP top 1" > 1,000 ppt	0.03	0	18.3	0.03	12.6	23.6
Soil – maximum > 1,000 ppt	0.24	0	22.7	0.27	15.9	27.2
Soil – soil contact zone > 1,000 ppt	<0.01	0	9.71	<0.01	5.17	7.45
House Dust > 1,000 ppt	0.40	0	89.6	0	73.1	91.6
Soil – HP top 1" > 5,000 ppt	0	0	2.13	0	2.96	5.58
Soil – maximum > 5,000 ppt	0.18	0	3.11	0.2	4.58	7.13
Soil – soil contact zone > 5,000 ppt	0	0	0.87	0	0.88	1.34
House Dust > 5,000 ppt	0	0	31.6	0	26.6	53.8

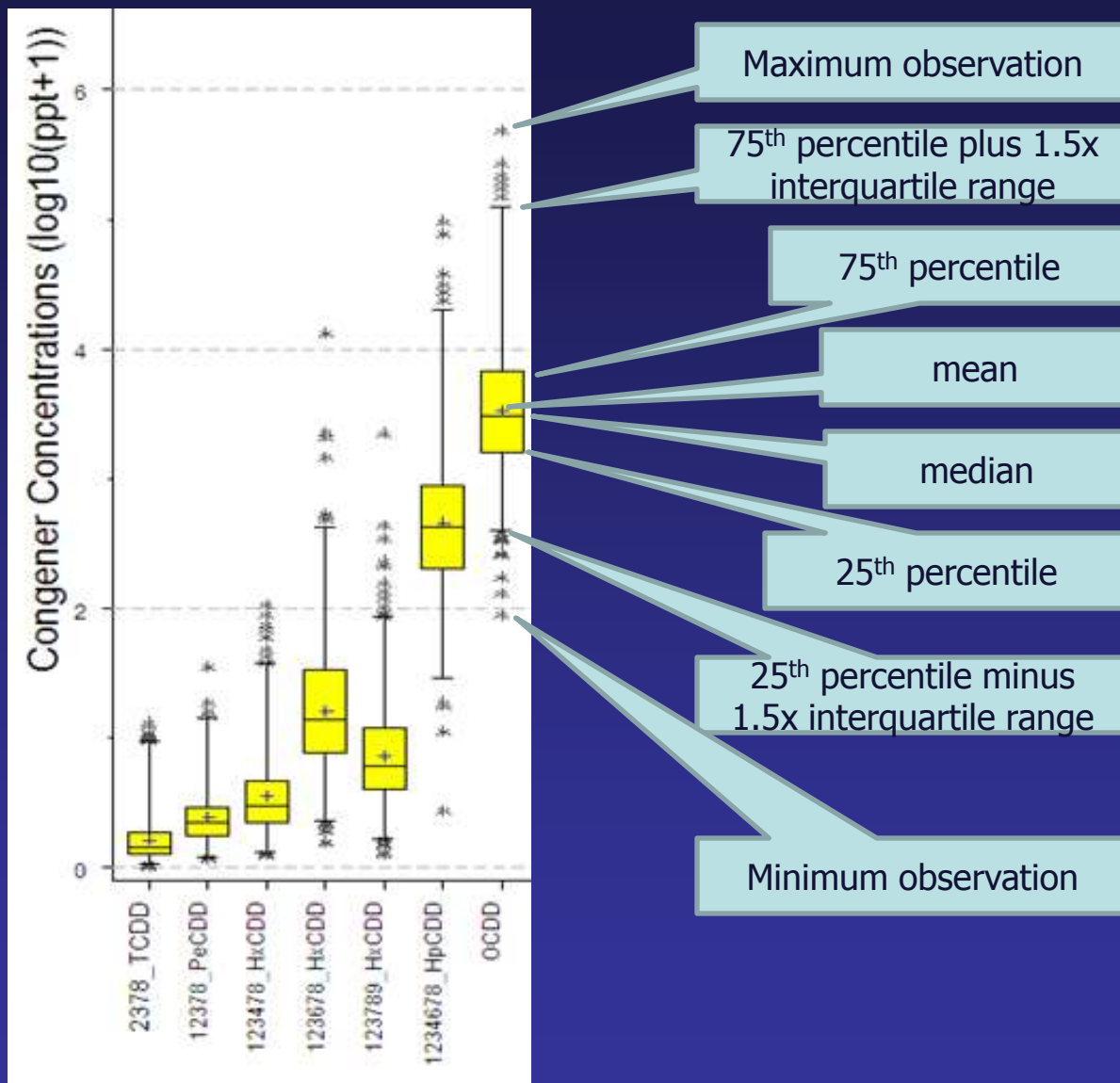


Specific congeners are more informative than the TEQ:

1. Focusing on individual congeners that are present in high concentrations in soil allows us to see whether highly contaminated soil and household dust have any relationship to blood dioxin levels.
2. There is little difference in how (and to what extent) different congeners are absorbed into the blood.
3. The congeners present in the highest concentrations are of greatest interest, irrespective of their Toxicity Equivalence Factors (TEFs).

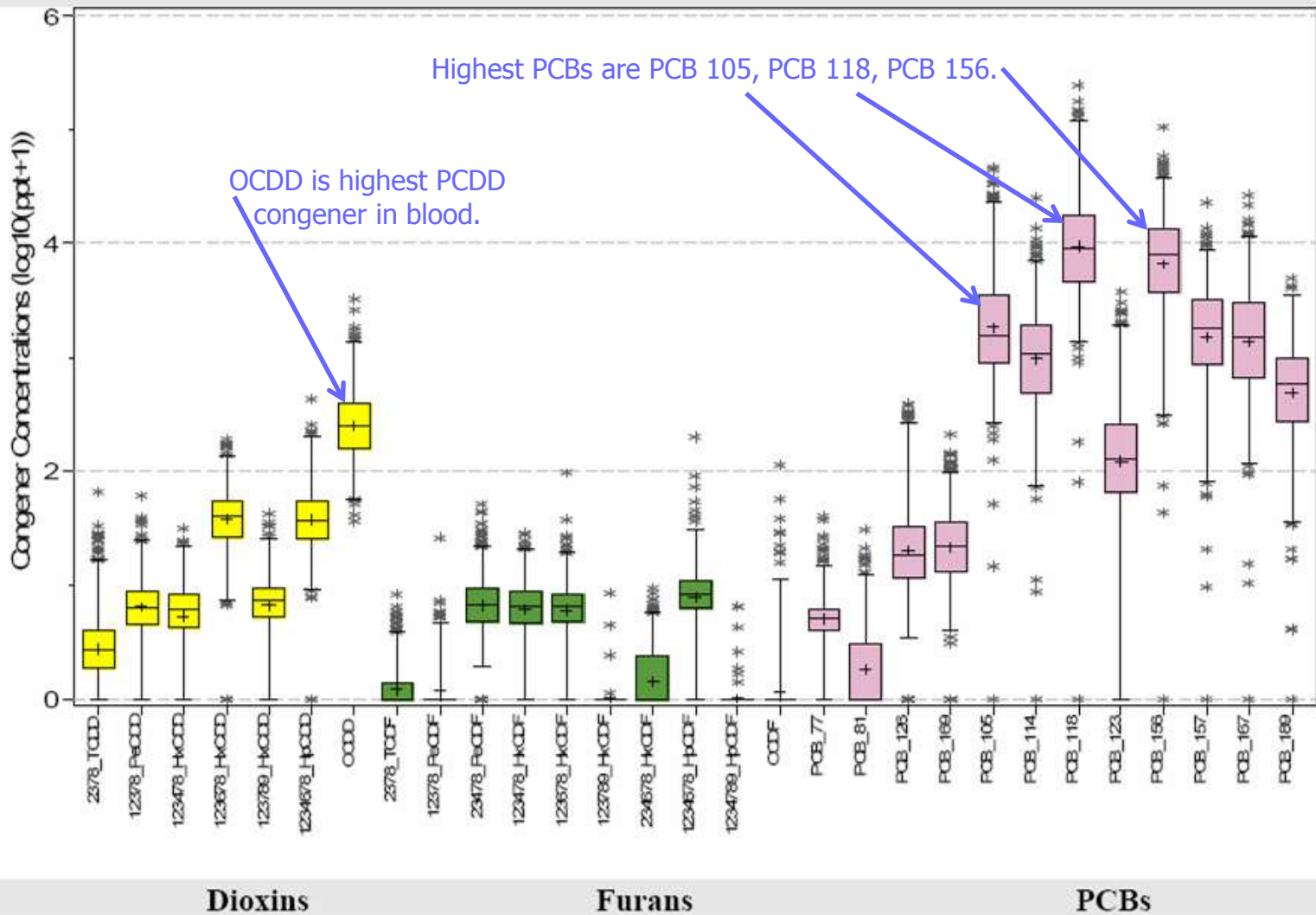
Congener	TEF
OCDD	0.0003
PCB 105	0.0003
PCB 118	0.0003

Box and Whisker plots



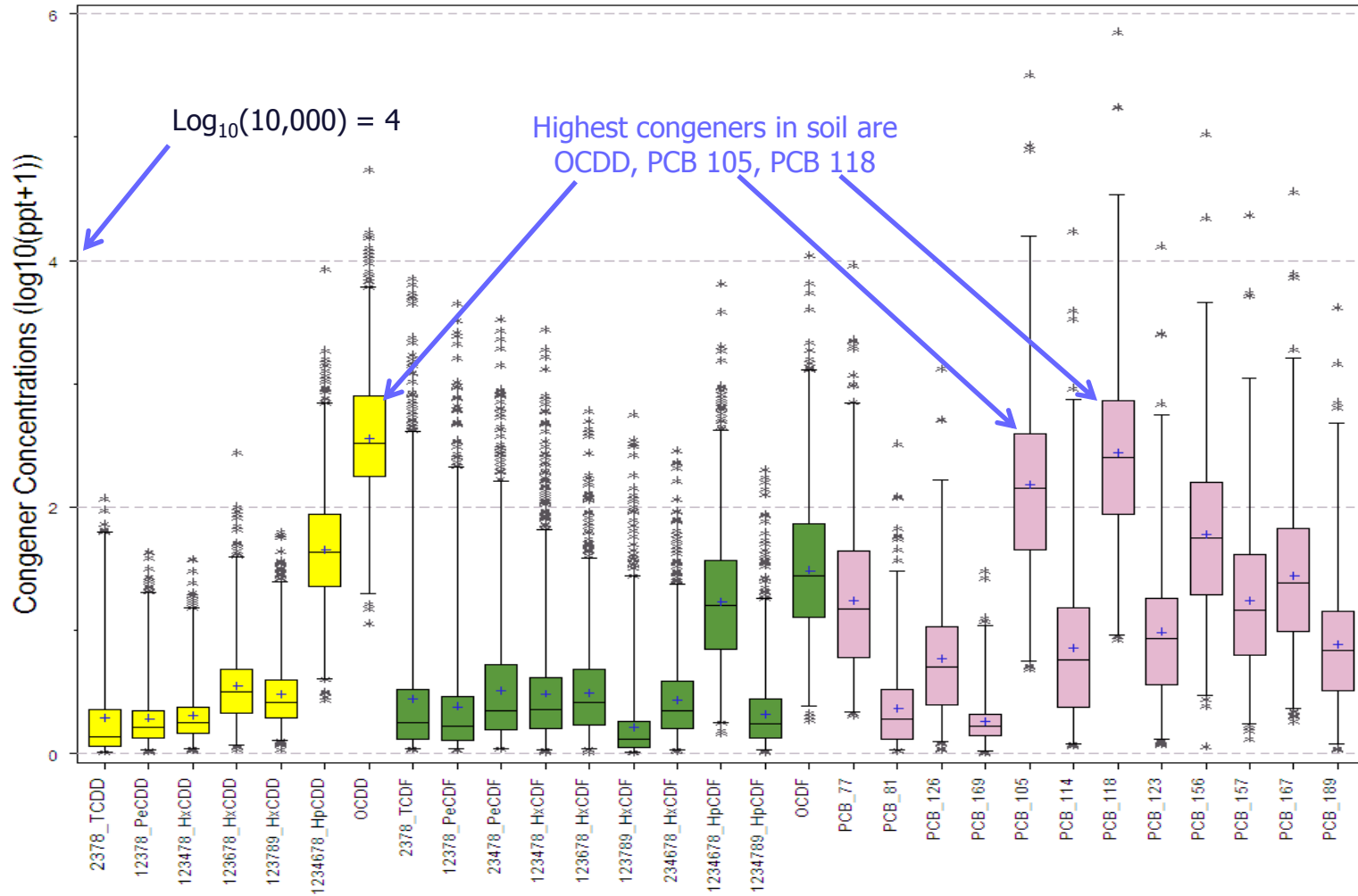


Serum PCDD, PCDF, and PCB concentrations



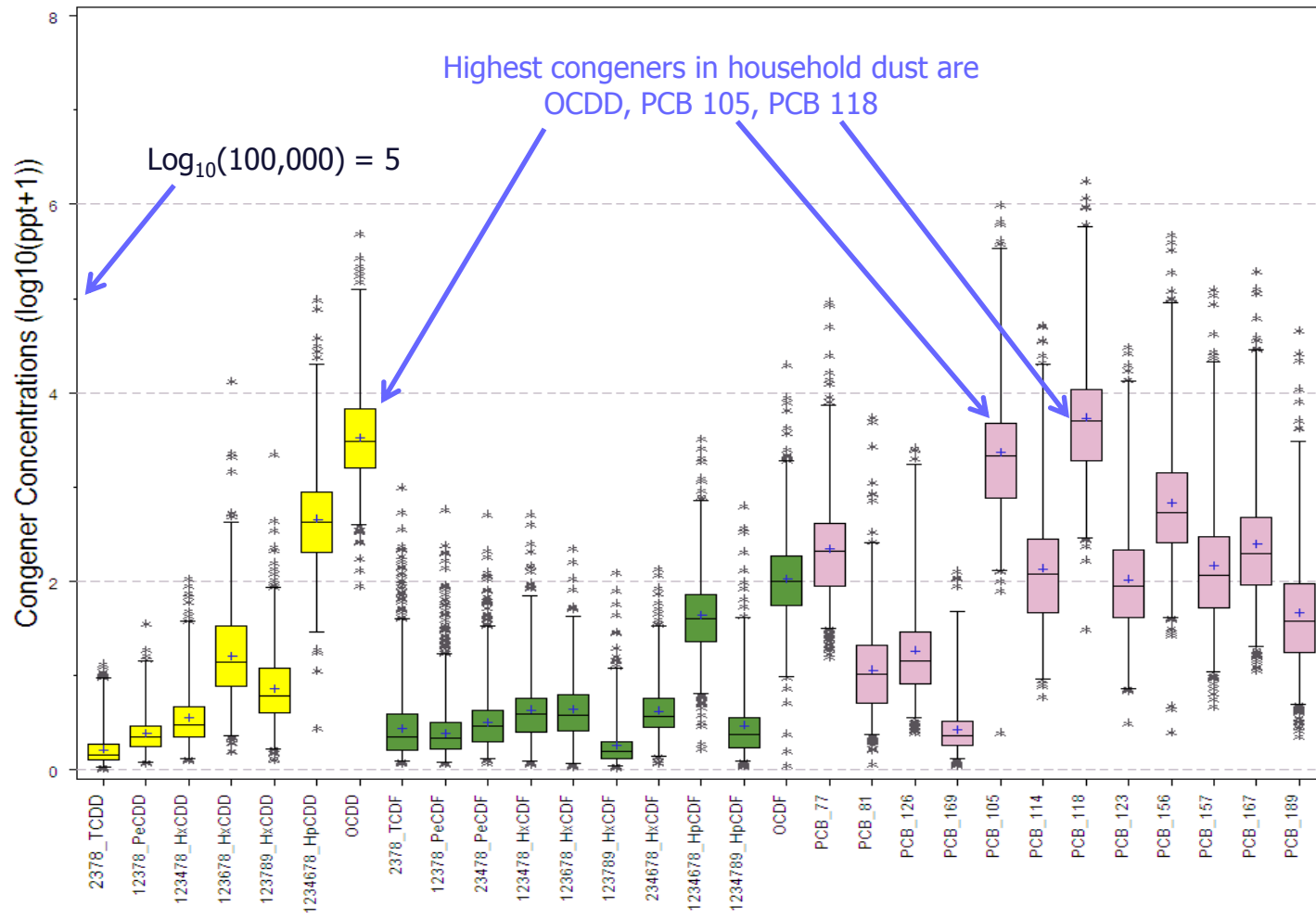


House perimeter 0-1" Soil PCDD, PCDF, and PCB concentrations





Household dust PCDD, PCDF, and PCB concentrations





Modeling Approach

In addition to TEQ, we have modeled selected congeners because they are important contributors to serum TEQ:

- 2378-TCDD
- 23478-PeCDF

Or their concentration tends to be high in serum, soil, and house dust (and they have long serum half-lives):

- OCDD
- PCB-105
- PCB-118



Impact of Soil and House Dust on Blood Levels

$$\text{Log}_{10}(\text{serum}) = \alpha + \beta_1(\text{factor 1}) + \dots + \beta_n(\text{factor n}) + \text{error}$$

Factor	TCDD	OCDD	PeCDF	PCB 105	PCB 118
Soil – HP top 1"	NS	NS	NS	@	NS
Soil – maximum	NS	NS	NS	NS	NS
Soil – soil contact zone	NS	NS	NS	@	NS
House Dust	NS	NS	NS	$\beta=0.000001^{**}$	$\beta=0.0000005^*$

NS: not significant; *p=0.008; **p=0.001

@These results are significant, but unstable (i.e., the significance depends on only one, two or three influential observations)

There is no relationship between soil dioxins and serum dioxins even when soil levels are as high as 10,000 to 50,000 ppt (as for OCDD, PCB-105, and PCB-118)



Impact of Soil and House Dust on Blood Levels

- What do the regression coefficients mean for house dust for PCB 105 and PCB 118?
- The regression coefficients for household dust indicate that increasing dust by X units multiplies serum by $10^{\beta \cdot X}$
 - $\text{Log}_{10}(\text{serum PCB 105})$ increases by 1.0 log units when dust increases by 10^6 ppt. So, serum concentration of PCB 105 is multiplied by
 - 10 when household dust increases by 10^6 ppt,
 - 1.0023 (0.2%) when dust increases by 1000 ppt.
 - $\text{Log}_{10}(\text{serum PCB 118})$ increases by 0.5 log units when dust increases by 10^6 ppt. So, serum PCB 118 is multiplied by
 - 3.16 when household dust increases by 10^6 ppt.,
 - 1.0011 (0.1%) when dust increases by 1000 ppt.

Summary Conclusions – Soil and household dust

- We found no significant relationship between contaminated soil and blood dioxin concentrations.
- EPA’s estimate based on toxicokinetic modeling of the effect of soil dioxins in this range is substantially higher than the UMDES empirical 95%ile upper bound estimate.

EPA theoretical model (appendix A, table 4, page 63)		UMDES data (results from Garabrant, 2009a)	
Description	Modeled serum dioxin TEQ	Calculated change in serum dioxin TEQ	95% confidence limits on change in serum dioxin TEQ
20 year old subject			
exposed to soil at 11.6 ppt TEQ	13.6 ppt		
soil at 223 ppt TEQ	16.5 ppt		
Difference in serum TEQ due to soil dioxins	16.5-13.6 = 2.9 ppt	-1.81 ppt	-5.40 to 1.78 ppt
40 year old subject			
exposed to soil at 11.6 ppt TEQ	16.7 ppt		
exposed to soil at 223 ppt TEQ	20.0 ppt		
Difference in serum TEQ due to soil dioxins	20.0-16.7 = 3.3 ppt	-2.22 ppt	-6.63 to 2.18 ppt
60 year old subject			
exposed to soil at 11.6 ppt TEQ	19.4 ppt		
exposed to soil at 223 ppt TEQ	22.7 ppt		
Difference in serum TEQ due to soil dioxins	22.7-19.4 = 3.3 ppt	-2.58 ppt	-7.70 to 2.53 ppt



Impact of Soil and House Dust on Blood Levels

- The regression models indicate that the UMDES data was adequate to find very small associations between household dust and PCBs.
- There was no significant relationship between soil and serum dioxins, indicating that soil exposure is not a significant exposure pathway over the range of soil concentrations (up to 50,000 ppt for some congeners).
- Moreover, we had 923 subjects who had soil concentrations under 1000 ppt TEQ and whose data is directly relevant to whether soil contamination in the range between 3.7 and 90 ppt contributes to serum dioxins. It does not contribute.
- EPA's estimate of the effect of soil dioxins in this range based on toxicokinetic modeling is outside of the UMDES 95%ile upper bound estimate.



Conclusions

- The UMDES has considerable power to detect small and/or historically remote factors that influence current serum dioxin levels
 - Residence in Midland/Saginaw during 1960's and 1970's



Conclusions

- Indirect pathways of exposure from soil through the food chain can be important, depending on behaviors (e.g., eating animals or animal products raised on contaminated soil).
- Living with contaminated house dust has very little influence on serum dioxin levels, even at relatively extreme levels of contamination.
 - There was a weak relationship for two PCBs (~1% adjusted R^2 only for PCB 105 and PCB 118).
 - There was no relationship for PCDDs or PCDFs.

Case Report: The University of Michigan Dioxin Exposure Study: A Follow-up Investigation of a Case with High Serum Concentration of 2,3,4,7,8-Pentachlorodibenzofuran

Alfred Franzblau,¹ Elizabeth Hedgeman,¹ Olivier Jolliet,¹ Kristine Knutson,¹ Tim Towey,² Qixuan Chen,³ Biling Hong,¹ Peter Adriaens,⁴ Avery Demond,⁴ David H. Garabrant,¹ Brenda W. Gillespie,³ and James Lepkowski⁵

¹Department of Environmental Health Sciences, University of Michigan School of Public Health, Ann Arbor, Michigan, USA; ²LimnoTech, Ann Arbor, Michigan, USA; ³Department of Biostatistics, School of Public Health, ⁴Department of Civil and Environmental Engineering, College of Engineering, and ⁵Institute for Social Research, University of Michigan, Ann Arbor, Michigan, USA

CONTEXT: Polychlorinated dibenzo-*p*-dioxins, polychlorinated dibenzofurans, and dioxin-like polychlorinated biphenyls that have toxic equivalency factors (TEFs) were measured in serum of 946 subjects in five Michigan counties. The study was motivated by concerns about human exposure to dioxin-contaminated sediments in the Tittabawassee River (TR). Most of the toxic equivalency in TR sediments is from two furan congeners, 2,3,7,8-tetrachlorodibenzofuran and 2,3,4,7,8-pentachlorodibenzofuran (2,3,4,7,8-pentaCDF).

CASE PRESENTATION: The individual with the highest adjusted (for age, age squared, and body mass index) serum level of 2,3,4,7,8-pentaCDF in the study (42.5 ppt) reported a unique history of raising cattle and vegetables in the floodplain of the TR. Interviews and serum samples were obtained from the index case and 15 other people who ate beef and vegetables raised by the index case. 2,3,4,7,8-pentaCDF in beef lipid was estimated to have been more than three orders of magnitude greater than background (1,780 vs. 1.1 ppt). The mean, median, and 95th percentile for serum 2,3,4,7,8-pentaCDF in the study control population were 6.0, 5.4, and 13.0 ppt, respectively, and were 9.9, 8.4, and 20.5 ppt among beef and vegetable consumers, respectively. Back extrapolation for the index case suggests that his increase in serum concentration of 2,3,4,7,8-pentaCDF above background may have been as high as 146 ppt.

DISCUSSION: Consumption of beef and/or vegetables raised on dioxin-contaminated soil may be an important completed pathway of exposure.

RELEVANCE TO PUBLIC HEALTH PRACTICE: Animals and crops should not be raised for human consumption in areas contaminated with dioxins.

KEY WORDS: dioxins, food, furans, pathway of exposure, polychlorinated biphenyls. *Environ Health Perspect* 118:1313–1317 (2010). doi:10.1289/ehp.0901723 [Online 23 April 2010]

tissues, 2,3,4,7,8-pentaCDF can serve as a biomarker of remote exposure to contaminated TR sediment. One individual with the highest adjusted serum level of 2,3,4,7,8-pentaCDF in the UMDES [42.5 ppt lipid adjusted, or 4.29 studentized residuals above the log-normalized mean of the control population after adjusting for age, age squared, and body mass index (BMI)] reported a unique exposure history that involved consuming homegrown beef and vegetables raised in the TR FP.

In this report, we have described this person's serum results and the results of a follow-up investigation that involved friends and family members who also reported regularly eating the beef and vegetables that were raised on this individual's property.

The UMDES used a two-stage clustered random sampling design to recruit subjects from five counties in the State of Michigan (USA). Eligible participants were required to be at least 18 years old and to have lived in their homes for at least 5 years. For the main study, eligible subjects were interviewed for

Case Report: Human Exposure to Dioxins from Clay

Alfred Franzblau,¹ Elizabeth Hedgeman,¹ Qixuan Chen,² Shih-Yuan Lee,² Peter Adriaens,³ Avery Demond,³ David Garabrant,¹ Brenda Gillespie,² Biling Hong,¹ Olivier Jolliet,¹ James Lepkowski,⁴ William Luksemburg,⁵ Martha Maier,⁵ and Yvan Wenger¹

¹Department of Environmental Health Sciences, and ²Department of Biostatistics, University of Michigan School of Public Health, Ann Arbor, Michigan, USA; ³Department of Civil and Environmental Engineering, University of Michigan College of Engineering, Ann Arbor, Michigan, USA; ⁴Institute for Social Research, University of Michigan, Ann Arbor, Michigan, USA; ⁵Vista Analytical Laboratory, El Dorado Hills, California, USA

CONTEXT: For the general population, the dominant source of exposure to dioxin-like compounds is food. As part of the University of Michigan Dioxin Exposure Study (UMDES), we measured selected polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and dioxin-like polychlorinated biphenyls (PCBs) in serum of 946 subjects who were a representative sample of the general population in five Michigan counties.

CASE PRESENTATION: The total toxic equivalency (TEQ; based on 2005 World Health Organization toxic equivalency factors) of serum from the index case was 211 ppt on a lipid-adjusted basis, which was the highest value observed in the UMDES study population. This subject had no apparent opportunity for exposure to dioxins, except that she had lived on property with soil contaminated with dioxins for almost 30 years, and had been a ceramics hobbyist for > 30 years. Soil from her property and clay that she used for ceramics were both contaminated with dioxins, but the congener patterns differed.

DISCUSSION: The congener patterns in this subject's serum, soil, and ceramic clay suggest strongly that the dioxin contamination in clay and not soil was the dominant source of dioxin contamination in her serum.

RELEVANCE TO PUBLIC HEALTH PRACTICE: It appears that ceramic clay, in particular the process of firing clay with unvented kilns, can be a significant nonfood and nonindustrial source of human exposure to dioxins among ceramics hobbyists. The extent of human exposure from ceramic clay is unclear, but it may be widespread. Further work is needed to more precisely characterize the routes of exposure.

KEY WORDS: ball clay, clay, dioxins, furans, human exposure, polychlorinated biphenyls. *Environ Health Perspect* 116:238–242 (2008). doi:10.1289/ehp.10594 available via <http://dx.doi.org/> [Online 5 October 2007]

exposures via the food chain, we are not aware of any reports that document ball clay as a direct source of human exposure to PCDDs, PCDFs, and/or dioxin-like PCBs.

The University of Michigan Dioxin Exposure Study (UMDES) was designed to determine whether PCDDs, PCDFs, and dioxin-like PCBs (hereafter collectively referred to as “dioxins”) 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.). The study was undertaken in response to concerns among the population of Midland and Saginaw Counties that dioxin-like compounds from the Dow Chemical Company facilities in Midland, Michigan, have contaminated areas of the City of Midland and sediments in the Tittabawassee River flood plain. The study measured the serum levels of the World Health Organization (WHO) 29 dioxin congeners with consensus toxic equivalency factors (TEFs) in a random sample of the population in the study regions (Van den



Conclusions

- These results apply to persons age 18 and older
 - Small children could not be studied since the volume of blood (80 mL) required to achieve necessary limits of detection (~ 1 ppt) was not ethically possible given the technology available at the time.
- We examined the relationship between serum dioxins and soil dioxins among young adults (ages 18-25), some of whom had lived on highly contaminated properties as children. There was no relationship between soil and serum dioxins for any congener in this group.



UMDES publications

Apparent Half-Lives of Dioxins, Furans, and PCBs in Fat

National Institute of Health
NIH Public Access
Author Manuscript

Published Online First
Geostrophology
in the Study

Pierre G. Chang,¹ Gillespie,² 2. Dignost, Arthur, M., 3. Ceaver, 4. School, 5. Institute

Abstract
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The University of Michigan Dioxin Exposure Study: Methods for Assessing Dioxin and PCB Exposure

David H. Garabrant,¹ Avery Diamond,¹ Kristin Olson,² 2. Department of Biostatistics, University of Michigan, Ann Arbor, Michigan, USA; ³ Department of Environmental Health Sciences, University of Michigan, Ann Arbor, Michigan, USA

Background: The United States has a large number of dioxin-like compounds (DLCs) in the environment. The University of Michigan Dioxin Exposure Study (UMDES) is a population-based study of dioxin and PCB exposure in the Ann Arbor, Michigan area.

Methods: We conducted a cross-sectional study of 1,000 subjects in the Ann Arbor, Michigan area. We measured dioxin and PCB levels in urine, blood, and breast milk.

Results: We found that dioxin and PCB levels in urine, blood, and breast milk were significantly higher in subjects living near the Dow Chemical Company facility in Midland, Michigan.

Conclusions: Our study provides the first comprehensive assessment of dioxin and PCB exposure in the Ann Arbor, Michigan area.

Keywords: dioxin, PCB, exposure, Michigan, UMDES

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The University of Michigan Serum Dioxin Concentration Study

David H. Garabrant,¹ Alfred Franzblau,² Elizabeth Hodgson,³ Bling Hong,⁴ and Martha M. Fenn,⁵ 1. Department of Biostatistics, University of Michigan, Ann Arbor, Michigan, USA; 2. Department of Environmental Health Sciences, University of Michigan, Ann Arbor, Michigan, USA; 3. Department of Environmental Health Sciences, University of Michigan, Ann Arbor, Michigan, USA; 4. Department of Environmental Health Sciences, University of Michigan, Ann Arbor, Michigan, USA; 5. Department of Environmental Health Sciences, University of Michigan, Ann Arbor, Michigan, USA

Background: The University of Michigan Dioxin Exposure Study (UMDES) is a population-based study of dioxin and PCB exposure in the Ann Arbor, Michigan area.

Methods: We conducted a cross-sectional study of 1,000 subjects in the Ann Arbor, Michigan area. We measured dioxin levels in serum.

Results: We found that dioxin levels in serum were significantly higher in subjects living near the Dow Chemical Company facility in Midland, Michigan.

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Keywords: dioxin, serum, exposure, Michigan, UMDES

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dioxin, serum, exposure, Michigan, UMDES

Introduction
The University of Michigan Dioxin Exposure Study (UMDES) is a population-based study of dioxin and PCB exposure in the Ann Arbor, Michigan area.

Estimation of Background Serum 2,3,7,8-TCDD Concentrations By Using Quantile Regression in the UMDES and NHANES Populations

Yuhan Chen,^{1,2} David H. Garabrant,^{3,4} Elizabeth Hodgson,⁵ Madhav K. J. A. Little,⁶ 1. Department of Environmental Health Sciences, University of Michigan, Ann Arbor, Michigan, USA; 2. Department of Environmental Health Sciences, University of Michigan, Ann Arbor, Michigan, USA; 3. Department of Environmental Health Sciences, University of Michigan, Ann Arbor, Michigan, USA; 4. Department of Environmental Health Sciences, University of Michigan, Ann Arbor, Michigan, USA; 5. Department of Environmental Health Sciences, University of Michigan, Ann Arbor, Michigan, USA; 6. Department of Environmental Health Sciences, University of Michigan, Ann Arbor, Michigan, USA

Background: The University of Michigan Dioxin Exposure Study (UMDES) is a population-based study of dioxin and PCB exposure in the Ann Arbor, Michigan area.

Methods: We used quantile regression to estimate background serum 2,3,7,8-TCDD concentrations in the UMDES and NHANES populations.

Results: We found that background serum 2,3,7,8-TCDD concentrations were significantly higher in subjects living near the Dow Chemical Company facility in Midland, Michigan.

Conclusions: Our study provides the first comprehensive assessment of background serum 2,3,7,8-TCDD concentrations in the UMDES and NHANES populations.

Keywords: 2,3,7,8-TCDD, background, exposure, Michigan, UMDES, NHANES

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Keywords
2,3,7,8-TCDD, background, exposure, Michigan, UMDES, NHANES

Introduction
The University of Michigan Dioxin Exposure Study (UMDES) is a population-based study of dioxin and PCB exposure in the Ann Arbor, Michigan area.

Estimating Population Distributions When Some Data Are Below a Limit of Detection by Using a Reverse Hierarchical Cluster Analysis of Polychlorinated Dioxins and Furans in Michigan, USA, Soils: Evaluation of Industrial and Background Congener Profiles

Timothy P. Yorky,¹ Shi-Chang Chang,² Avery Diamond,³ David H. Garabrant,⁴ James L. Fisher,⁵ 1. Department of Environmental Health Sciences, University of Michigan, Ann Arbor, Michigan, USA; 2. Department of Environmental Health Sciences, University of Michigan, Ann Arbor, Michigan, USA; 3. Department of Environmental Health Sciences, University of Michigan, Ann Arbor, Michigan, USA; 4. Department of Environmental Health Sciences, University of Michigan, Ann Arbor, Michigan, USA; 5. Department of Environmental Health Sciences, University of Michigan, Ann Arbor, Michigan, USA

Background: The University of Michigan Dioxin Exposure Study (UMDES) is a population-based study of dioxin and PCB exposure in the Ann Arbor, Michigan area.

Methods: We used reverse hierarchical cluster analysis to estimate population distributions of polychlorinated dioxins and furans in Michigan, USA soils.

Results: We found that polychlorinated dioxins and furans in Michigan, USA soils were significantly higher in subjects living near the Dow Chemical Company facility in Midland, Michigan.

Conclusions: Our study provides the first comprehensive assessment of polychlorinated dioxins and furans in Michigan, USA soils.

Keywords: polychlorinated dioxins, furans, Michigan, USA, soils, UMDES

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Introduction
The University of Michigan Dioxin Exposure Study (UMDES) is a population-based study of dioxin and PCB exposure in the Ann Arbor, Michigan area.



UMDES Scientific Presentations

126 presentations at scientific meetings throughout the world.



