



Linear regression modeling to predict household dust TEQ and TCDD concentration

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Introduction and Objectives

- > The University of Michigan Dioxin Exposure Study (UMDES) was conducted to determine the factors that explain variation in serum congener levels of PCDDs, PCDFs, and PCBs and to quantify how much of the variation each factor explained
- > As part of the UMDES, household dust samples were taken from 5 regions in Michigan (Figure 1):
 - Tittabawassee River floodplain
 - Midland/Saginaw near floodplain
 - Midland/Saginaw out of floodplain
 - Midland plume – downwind of Dow Chemical Co.
 - Jackson and Calhoun Counties – control group
- > Other data collected includes questionnaire data, serum samples, and soil samples
- > **Objective: To explore what factors predict the TEQ and TCDD concentration in household dust samples**

Methods

- > Household dust sampling:
 - Household dust samples were collected from eligible UMDES participants using a High Volume Small Surface Sampler, HVS3 (Figure 2)
 - Samples were collected from both hard and soft surfaces in living areas with high potential for human contact (living rooms, family rooms, dining rooms, etc.)
 - One composite sample was collected per home - samplers attempted to collect 10 grams of house dust
 - The sampling protocol was based on the American Society for Testing and Materials (ASTM) Method D 5438-00, "Standard Practice for Collection of Floor Dust for Chemical Analysis"
- > Linear regression modeling:
 - $\log_{10}(\text{concentration}) = \beta_0 + \beta_1(\text{factor}_1) + \dots + \beta_n(\text{factor}_n) + \text{error}$
 - Outcome variables: TEQ and TCDD concentration
 - TEQ calculated based on WHO 2005 TEFs
 - Predictor variables: questionnaire, field, soil, and dust loading variables
 - Final variable selection was based on backward selection techniques after testing for interactions and collinearity

Figure 1: UMDES study regions

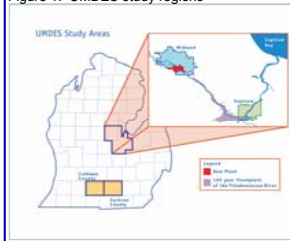


Figure 2: HVS3 vacuums used for sampling



Results

- > 764 household dust samples were collected from the 5 regions (Figure 1):
 - Tittabawassee River floodplain – 205 samples
 - Midland/Saginaw near floodplain – 161 samples
 - Midland/Saginaw out of floodplain – 168 samples
 - Midland plume – 32 samples
 - Jackson and Calhoun Counties – 198 samples
- > Samples were collected in 3 seasons:
 - Fall 2004 – 224 samples
 - Spring 2005 – 108 samples
 - Summer 2005 – 432 samples
- > Mean age of the floor surfaces sampled was 12.2 years

Table 1: Significant parameter estimates**

Predictor Variable	TEQ	2378 TCDD
Soil (log₁₀ ppt)		
Concentration around house	0.336	0.261
Region (versus Jackson/Calhoun)		
M/S floodplain***	-0.288	
M/S near floodplain***	-0.326	
M/S out of floodplain***	-0.167	
Midland Plume	-0.191	0.481
Property Use		
Indoor/Outdoor pets (yrs*)		-0.005
Weed killers (yrs*)	-0.005	
Trash burning (yrs*)	0.004	0.003
Work History		
Working at a chemical company other than Dow (yrs*)		0.010
Living with a Dow worker (yrs*)		0.012
Recreational Activities		
Water activities in contaminated area (days*)		0.000
Floor Surface		
Age of floor surface (yrs*)	0.009	
Flooring not replaced after flooding (vs. no flood)	0.411	
Dust loading or cleanliness (log g/m ²)	-0.148	-0.162
Sampling Season		
Summer (versus fall)	-0.264	-0.139
Remediation		
House remediated for dioxins	0.149	0.305

* Years/days in which the subject lived at the sampled residence

** All parameter estimates are significant at alpha = 0.05 level

*** M/S – Midland/Saginaw

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Results, cont.

Table 2: Overall and change in R² values

Predictor Variable	TEQ	2378 TCDD
Soil Concentration around house (log ₁₀ ppt)	10.67	9.98
Dust loading or cleanliness (log g/m ²)		3.67
Age of floor surface (yrs*)	5.54	
Sampling season	4.83	3.86
Region	2.62	3.53
Dust loading or cleanliness (log g/m ²)	2.41	1.30
Trash burning (yrs*)	1.05	0.71
Weed killers (yrs*)	1.00	0.57
House remediated for dioxins	0.07	0.46
Flooring not replaced after flooding (vs. no flood)	0.03	0.29
Overall R² (%)	25.05	0.09
		Overall R² (%)
		41.27

* Years/days in which the subject lived at the sampled residence

Conclusions

- > For both the TEQ and 2378-TCDD models, **soil concentration from around the house** was the most important predictor in household dust concentrations – it explained the most variation in the models. Higher soil concentrations were associated with higher household dust concentrations
- > Other important predictors of household dust TEQ were:
 - **Age of floor surface** – Older floor surfaces were associated with a higher TEQ
 - **Sampling season** – Sampling in the summer (versus the fall) was associated with a lower TEQ
 - **Region** – Living in any of the Midland/Saginaw regions was associated with a lower TEQ
 - **Dust loading** – Higher dust loading levels were associated with a lower TEQ
- > Other important predictors of household dust 2378-TCDD concentrations were:
 - **Dust loading** – Higher dust loading levels were associated with lower 2378-TCDD concentrations
 - **Sampling season** – Sampling in the summer (versus the fall) was associated with lower 2378-TCDD concentrations
 - **Region** – Living in the Midland Plume region (compared to living in the Jackson/Calhoun) was associated with higher 2378-TCDD concentrations
 - **Indoor/Outdoor pets** – Pets were associated with lower 2378-TCDD concentrations
- > **Remediation for dioxins and trash burning** were associated with higher TEQ and 2378-TCDD concentrations in household dust

Additional Information

- > Data for 28 other dioxin congeners can be found on our study website at www.umdioxin.org