



LINEAR REGRESSION MODELING TO PREDICT HOUSEHOLD DUST PCB CONGENER CONCENTRATIONS

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INTRODUCTION & OBJECTIVE

- Sampling for the University of Michigan Dioxin Exposure Study (UMDES) was conducted in 2004-2005 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
- Five regions sampled: Floodplain, Midland/Saginaw near floodplain, Midland/Saginaw out of floodplain, Midland plume, and Jackson and Calhoun Counties
- Data collected: Interview data, serum sample, household dust sample, and soil samples
- Objective: To explore what factors predict the concentrations of PCB congeners in household dust samples.**

METHODS

- Household dust sampling method:
 - Vacuum: High Volume Small Surface Sampler- cyclone and filter system
 - Protocol: Based on the American Society for Testing and Materials (ASTM) Method D 5438-00, "Standard Practice for Collection of Floor Dust for Chemical Analysis"
 - Sample locations: Living areas such as, living rooms, family rooms, dining rooms, etc.
 - Samples: One composite sample (≈10 g) per home from both hard and soft surfaces
- Statistical analysis method:
 - Linear regression incorporating sampling weights and imputed data sets
 - $\text{Log}_{10}(\text{concentration}) = \beta_0 + \beta_1(\text{factor}_1) + \dots + \beta_n(\text{factor}_n) + \text{error}$
 - Outcome variables: PCB congener concentrations
 - Predictor variables: questionnaire, field, soil, and dust loading variables
 - Final variable selection was based on backward selection techniques after testing for interactions and collinearity

RESULTS

Table 1: Significant Parameter Estimates** for Congener Concentrations in Household Dust

Predictor Variable	PCB 77	PCB 81	PCB 126	PCB 169	PCB 105	PCB 114	PCB 118	PCB 123	PCB 156	PCB 157	PCB 167	PCB 189
Soil (log₁₀ ppt)												
Concentration around house	0.371	0.376						0.496				
Max concentration on property			0.648	0.626	0.341	0.309	0.327		0.493	0.542	0.533	0.469
Region (versus Jackson/Calhoun)												
M/S floodplain***			-0.331	-0.269	-0.287	-0.311	-0.266		-0.240	-0.311	-0.240	-0.251
M/S near floodplain***		-0.183				-0.206	-0.186					
M/S out of floodplain***												
Midland plume			-0.237			-0.229						
Property Use												
Indoor/Outdoor pets (yrs*)			-0.004	-0.004								
Gardens (yrs*)	0.006		0.005	0.004								
Fire damage (yrs*)				0.108								
Work History												
Working at Dow (yrs*)	-0.008											
Indoor Conditions												
Dogs	-0.165	-0.144			-0.216	-0.216	-0.220			-0.169	-0.182	
Floor Surface												
Age of floor surface (yrs*)	0.014	0.013	0.008	0.006	0.010	0.010	0.010	0.010	0.010	0.008	0.009	0.012
High pile carpets (velvets vs. hard surface)	0.383	0.399	0.324	0.313								
Floor not replace after flood (vs. no flood)			0.345									
Dust loading or cleanliness (log g/m ²)				-0.145	-0.167	-0.180	-0.179	-0.201	-0.136	-0.157	-0.154	
Remediation												
House remediated for dioxins	0.380	0.301	0.744	0.380	0.819	0.742	0.813	0.534	0.839	0.871	0.883	0.959

*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

RESULTS, cont.

Table 2: Overall and Change in R² Values for Congener Concentrations in Household Dust

Predictor Variable	PCB 77	PCB 81	PCB 126	PCB 169	PCB 105	PCB 114	PCB 118	PCB 123	PCB 156	PCB 157	PCB 167	PCB 189
Soil Concentration around house (log ₁₀ ppt)	16.77	15.36						0.66				
Age of floor surface (yrs*)	7.60	7.05	2.49	2.56	3.05	3.26	3.21	0.66	2.83	2.04	2.61	4.10
Max soil concentration on property (log ppt)			4.73	6.45	1.72	2.03	1.69		2.65	3.02	3.00	2.45
Dogs	2.48	1.90			2.64	2.58	2.80			1.60	1.94	
Dust loading or cleanliness (log g/m ²)				2.87	1.51	1.71	1.76	0.66	0.97	1.30	1.31	
Type of carpet (pile)	1.39	1.42	1.59	1.80								
Gardens (yrs*)	1.18		0.68	1.20								
Region		0.63	1.01	0.90	0.63	0.66	0.63		0.25	0.38	0.31	0.53
House remediated for dioxins	0.09	0.06	0.32	0.15	0.26	0.21	0.26	0.66	0.26	0.28	0.31	0.39
Indoor/Outdoor pets (yrs*)			0.68	0.86								
Fire damage (yrs*)				0.48								
Working at Dow (yrs*)	0.28											
Floor replaced after flood (vs. no flood)			0.01									
Overall R² (%)	31.07	30.10	35.40	28.17	37.70	35.54	37.67	35.54	28.98	35.55	36.18	30.04

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

- 764 household dust samples were collected from the 5 regions:
 - Tittabawassee River floodplain – 205 samples
 - Midland/Saginaw near floodplain – 161 samples
 - Midland/Saginaw out of floodplain – 168 samples
 - Midland plume – 32 samples
 - Jackson/Calhoun Counties – 198 samples
- Samples were collected in 3 seasons:
 - Fall 2004 – 224 samples
 - Spring 2005 – 108 samples
 - Summer 2005 – 432 samples

CONCLUSIONS

- Higher maximum soil PCB concentrations on properties or PCB soil concentrations around the house, older floor surfaces and household remediation for dioxins were associated with higher PCB concentrations in household dust
- Across all congeners, except PCB 77 and PCB 123, Jackson and Calhoun Counties had higher congener concentrations in household dust than areas in Midland and Saginaw counties
- Owning vegetable and flower gardens (PCB77, PCB126, and PCB169), fire damage (PCB169), high pile carpet (PCB77, PCB81, PCB126 and PCB169) and floors that had not been replaced after flooding (PCB 126) were other variables associated with higher PCB concentrations
- Dust loading and dogs at the residence were associated with lower PCB concentrations for most congeners and working at Dow (ever in a lifetime) was linked to lower PCB 77 concentrations.
- Unlike the PCDDs and PCDFs, sampling season was not associated with PCB concentrations in household dust
- The backward selection model explained about 28% to 38% of dust PCB congener concentrations variations.
- Based on the change in the R² values, the PCB concentrations in the soil samples and the age of floor surface provided the greatest explanation of the variance in the models



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