



LINEAR REGRESSION MODELING TO PREDICT HOUSEHOLD DUST PCDD CONGENER CONCENTRATIONS

Shih-Yuan Lee¹, Lynn Zwica¹, Kristine Knutson¹, Biling Hong¹, Qixuan Chen¹, Timothy Towey², Brenda Gillespie¹, Avery Demond¹, Peter Adriaens¹, James Lepkowski¹, Alfred Franzbalu¹, David Garabrant¹

¹University of Michigan, Ann Arbor, Michigan, USA; ²LimnoTech, Ann Arbor, Michigan, USA

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 PCDD 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
 - $\log_{10}(\text{concentration}) = \beta_0 + \beta_1(\text{factor}_1) + \dots + \beta_n(\text{factor}_n) + \text{error}$
 - Outcome variables: PCDD 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	2378 TCDD	12378 PeCDD	123478 HxCDD	123678 HxCDD	123789 HxCDD	1234678 HpCDD	OCDD
Soil							
Concentration around house (log ₁₀ ppt)	0.261	0.239	0.207	0.363	0.352	0.302	0.352
Region (versus Jackson/Calhoun)							
M/S floodplain***				-0.193		-0.212	-0.164
M/S near floodplain***		-0.116		-0.277	-0.174	-0.289	-0.209
M/S out of floodplain***							
Midland plume	0.481						-0.239
Property Use							
Indoor/Outdoor pets (yrs*)	-0.005				-0.003		
Gardens (yrs*)		0.003					
Trash burning (yrs*)	0.003		0.004		0.003	0.006	0.005
Work History							
Waste disposal, wastewater, foundry, etc (yrs*)					-0.004	-0.005	-0.006
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						
Indoor Conditions							
Children in the house (yrs*)				0.006	0.003		
Smoking in the house (pk-yrs)							-0.004
Floor Surface							
Age of floor surface (yrs*)		0.008	0.011	0.011	0.011	0.010	0.009
High pile carpets (velvets vs. hard surface)		0.402	0.436	0.450	0.551		
Low pile carpets (not velvets vs. hard surface)		0.330	0.364	0.416	0.515		
Floor replaced after flood (vs. no flood)			-0.199				
Floor not replaced after flood (vs. no flood)				0.407	0.287	0.469	0.356
Dust loading or cleanliness (log g/m ²)	-0.162	-0.133	-0.124	-0.206	-0.153		-0.132
Sampling Season							
Summer (versus fall)	-0.139	-0.129		-0.252	-0.194	-0.290	-0.200
Remediation							
House remediated for dioxins	0.305	0.215					

*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

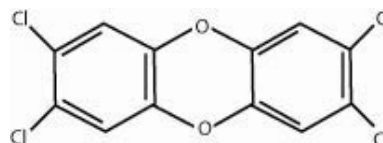
Predictor Variable	2378 TCDD	12378 PeCDD	123478 HxCDD	123678 HxCDD	123789 HxCDD	1234678 HpCDD	OCDD
Soil Concentration around house (log ₁₀ ppt)	9.98	6.76	4.52	7.14	7.50	5.59	11.80
Age of floor surface (yrs*)		5.52	8.01	4.72	6.81	3.81	4.32
Dust loading or cleanliness (log g/m ²)	3.67	3.40	2.27	3.39	2.73		1.62
Sampling season	3.66	2.62		3.68	3.85	3.05	2.71
Type of carpet (pile)		3.25	2.75	1.52	3.32		
Region	3.53	1.34		0.87	0.50	1.56	0.85
Trash burning (yrs*)	0.50		0.99		0.70	1.27	1.06
Children in the house (yrs*)				1.704	0.86		
Indoor/Outdoor pets (yrs*)	1.30				0.61		
Floor replaced after flood (vs. no flood)			0.02	0.02	0.01	0.03	0.02
Waste disposal, wastewater, foundry, etc (yrs*)					0.52	0.34	0.81
House remediated for dioxins	0.09	0.07					
Gardens (yrs*)		0.87					
Living with a Dow worker (yrs*)	0.71						
Smoking in the house (pk-yrs)							0.58
Water activities in contaminated area (days*)	0.57						
Working at a chemical company other than Dow (yrs*)	0.29						
Overall R² (%)	41.27	24.58	18.24	19.46	25.98	16.81	23.81

* 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

- Compared to Jackson and Calhoun Counties, the TCDD concentrations in household dust were higher in the Midland plume, while 123678 HxCDD, 1234678 HpCDD, and OCDD were all lower in the Midland/Saginaw floodplain or near floodplain areas
- Across all congeners, higher PCDD soil concentrations around the house were strongly associated with higher dust concentrations after controlling for all other important covariates
- In general, older floor surfaces, carpeted floor surface, flooring not replaced after flooding and trash burning on the property were associated with higher dust PCDD congener concentrations while dust loading and sampling in summer (versus fall) were related with lower dust concentrations
- For 2378 TCDD, working at other chemical companies, living with Dow workers, doing water activities in contaminated areas and houses that had been remediated for dioxins were also associated with higher dust TCDD level
- Other variables linked to dust PCDD congener concentration included, smoking at the house, owning vegetable/flower gardens, having pets, working in waste disposal, wastewater, foundries etc.
- According to overall R² values, variables in the backward selection regression models described about 41% of the variation in 2378 TCDD concentration in household dust and 17% to 26% of the variation for other PCDD congeners
- Among all variables, change in R² values suggested that soil congener concentration, age of floor surface, dust loading, and sampling season, provided the greatest explanation of variance in the models



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