



LINEAR REGRESSION MODELING TO PREDICT HOUSEHOLD DUST PCDF CONGENER CONCENTRATIONS

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INTRODUCTION & OBJECTIVE

- 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 concentrations of PCDF congeners 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: PCDF 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 TCDF	12378 PeCDF	23478 PeCDF	123478 HxCDF	123678 HxCDF	123789 HpCDF	234678 HxCDF	1234678 HpCDF	1234789 HxCDF	OCDF
Soil (log₁₀ ppt)										
Concentration around house				0.286	0.240	0.221	0.284	0.281	0.215	0.281
Concentration from garden					0.033		0.030	0.021	0.055	
Max concentration on property	0.424	0.275	0.197							
Region (versus Jackson/Calhoun)										
M/S floodplain***				-0.217			-0.178	-0.219	-0.272	-0.238
M/S near floodplain***	0.216			-0.232	-0.273	-0.195	-0.236	-0.299	-0.300	-0.284
M/S out of floodplain***	0.103						-0.066	-0.093	-0.100	-0.121
Work History										
Waste disposal, wastewater, foundry, etc (yrs*)									-0.007	-0.008
Jobs with chemicals (yrs*)		0.009						0.011		0.013
Living with a Dow worker (yrs*)			0.009							
Living with chemical co. worker (yrs*)						-0.017				
Indoor Conditions										
Cats		-0.086				-0.093				-0.100
Children in the house (yrs*)										0.005
Floor Surface										
Age of floor surface (yrs*)	0.006	0.007	0.007	0.007	0.008	0.006	0.007	0.008	0.009	
High pile carpets (velvets vs. hard surface)							0.327	0.293		
Low pile carpets (not velvets vs. hard surface)							0.233	0.188		
Floor replaced after flood (vs. no flood)							-0.149	-0.148	-0.310	
Floor not replace after flood (vs. no flood)								0.269		
Dust loading or cleanliness (log g/m ²)		-0.167		-0.109	-0.121	-0.152	-0.108	-0.116		-0.168
Sampling Season										
Spring (versus fall)									-0.140	
Summer (versus fall)		-0.195	-0.196	-0.275	-0.263	-0.324	-0.243	-0.293		-0.324
Remediation										
House remediated for dioxins		0.185			0.163				0.143	

* 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 for Congener Concentrations in Household Dust

Predictor Variable	2378 TCDF	12378 PeCDF	23478 PeCDF	123478 HxCDF	123678 HxCDF	123789 HpCDF	234678 HxCDF	1234678 HpCDF	1234789 HxCDF	OCDF
Soil Concentration around house (log ₁₀ ppt)				10.12	5.42	7.72	11.87	10.71	4.40	9.53
Sampling season		4.63	3.64	5.62	5.68	8.54	5.75	5.80		5.98
Age of floor surface (yrs*)	2.06	2.82	3.28	3.20	4.05	3.23	4.11	3.94	4.69	
Dust loading or cleanliness (log g/m ²)		3.89		1.19	1.57	2.99	1.86	1.66		1.60
Max soil concentration on property (log ppt)	6.05	2.91	1.17							
Region	1.18			0.36	0.83	0.93	0.97	1.37	1.12	1.40
Soil Concentration from garden (log ppt)					1.48		1.84	1.19	3.05	
Type of carpet (pile)							2.23	1.64		
Waste disposal, wastewater, foundry, etc (yrs*)								1.23		1.20
Cats		0.99				1.05			0.89	
Children in the house (yrs*)										1.23
Floor replaced after flood (vs. no flood)							0.03	0.02	0.04	
House remediated for dioxins		0.04			0.02			0.02		
Jobs with chemicals (yrs*)			0.45					0.57		0.60
Living with chemical co. worker (yrs*)						0.36				
Living with a Dow worker (yrs*)				0.35						
Overall R ² (%)	37.17	35.24	28.03	23.73	19.42	24.32	27.53	26.22	21.80	18.37

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

- 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

CONCLUSIONS

- Across all congeners (except OCDF), older floor surfaces were consistently associated with higher PCDF congener concentrations in household dust
- PCDF concentrations in the soil samples were associated with higher congener concentrations in household dust
- For 12378 PeCDF, 123678 HxCDF, and 1234678 HpCDF, remediation for dioxins was associated with higher congener concentrations in household dust
- For most PCDF congeners, sampling in the summer and living in Midland/Saginaw (except the Midland plume) were associated with lower congener concentrations in household dust
- Higher dust loading levels were associated with lower congener concentrations in household dust for the majority of the PCDF congeners
- The overall R² values show that the models explained about 18% to 37% of the variation in household dust PCDF congener concentrations
- Based on the change in the R² values, the PCDF concentrations in the soil samples, sampling season, and the age of the floor surface generally provided the greatest explanation of the variance in the models

Figure 1: UMDES study regions

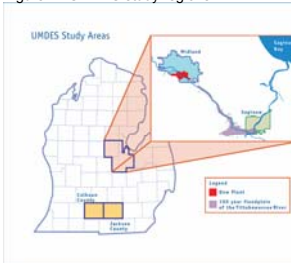


Figure 2: HVS3 vacuums used for sampling

