

PREDICTORS OF HOUSEHOLD DUST CONCENTRATIONS OF PCDDs, PCDFs, AND PCBs IN A COMMUNITY IN MICHIGAN, USA

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Introduction

“Dioxins” or dioxin-like compounds are a family of structurally related chemicals including polychlorinated dibenzodioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs). The University of Michigan Dioxin Exposure Study (UMDES) 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 have resulted in contamination of soils in the Tittabawassee River flood plain and areas of the City of Midland and that people’s body burdens of PCDDs, PCDFs and PCBs may be elevated because of the environmental contamination. A central goal of the UMDES is to determine the factors that explain variation in serum congener levels of PCDDs, PCDFs, and PCBs, and to quantify how much variation each factor explains. Household dust was considered an exposure variable of interest so it was sampled in each residence in which an eligible participant resided. The descriptive statistics, distributions, and congener patterns of the household dust concentration and loading data have been described elsewhere.¹ The goal of this report is to describe which factors explain variation in the household dust levels measured in the UMDES and to quantify how much variation each factor explains.

Materials and Methods

Five populations were studied in the UMDES. A random sample from each population was selected. The five populations were:

- Residents of Midland and Saginaw Counties who reside in the flood plain of the Tittabawassee River between the Dow Chemical plant in Midland and the confluence of the Tittabawassee and Shiawassee rivers in Saginaw (M/S FP)
- Residents of Midland, Saginaw, and Bay Counties who reside in census blocks adjacent to the flood plain of the Tittabawassee River between the Dow Chemical plant in Midland and the confluence of the Tittabawassee and Shiawassee Rivers in Saginaw (M/S Near FP)
- Residents of Midland, Saginaw and Bay Counties who do not reside in the flood plain of the Tittabawassee or Saginaw Rivers or the confluence flood plain of the Shiawassee River (M/S Out FP)
- Residents of Midland, Saginaw and Bay Counties who reside in the plume of the former Dow Chemical plant incinerator (M/S Plume)
- Residents of Jackson and Calhoun Counties, Michigan (Jackson/Calhoun)

All five populations were sampled using a two-stage area probability household sample design. In order to be eligible for participation in household dust sampling, subjects had to have lived in the residence at least five years and be the owner of their residence. A more detailed description of the populations and respondent selection methodology is reported elsewhere.²

Dioxin exposure study in Midland, MI

Household dust sampling was conducted in the home of each eligible respondent following their consent. The sampling protocol was based, with minor modifications, on the American Society for Testing and Materials (ASTM) method "Standard Practice for Collection of Floor Dust for Chemical Analysis".³ The sample was taken from sampling locations that presented the highest potential for human contact with household dust and dirt. The locations were generally a frequently occupied living space (e.g., living or family room) and a high traffic hallway or pathway. Samples were taken from both hard and soft surfaces and were not taken of undisturbed dust in generally inaccessible areas.

The sample was obtained from designated sampling areas within each sampling location. Sample areas were selected based on the representativeness of the area of the location and the amount of accessible space the area provided. A High Volume Small Surface Sampler (HVS3) was used to collect the sample. The HVS3 is a vacuum cleaner equipped with a cyclone and a fine-particle filter capable of capturing 99.95% of particles above 0.3 μm aerodynamic mean diameter. The sampling technicians attempted to collect a minimum of 10 grams of total dust in order to yield analytical detection limits equal to or less than 1 part per trillion (ppt). If the amount of dust collected from the initial sampling area within each location was not sufficient, secondary areas were marked and sampled as needed. Bulk dust and filter samples were combined resulting in one household dust sample per sampled residence. Samples were transported on ice to a dedicated 4° C cooler before being delivered to the analytical laboratory for analysis. Analyses were performed by Alta Analytical Laboratory, Inc. (El Dorado Hills, California, USA) for the WHO designated 29 PCDD, PCDF, and PCB congeners⁴ using US EPA methods 8290⁵ and 1668⁶.

To test for potential effects of household and property variables on household dust PCDD, PCDF, and PCB levels, regression models for left-censored data, with survey sample weights, were employed using the entire UMDES dataset and all geographic regions. Both Stata⁷ and SAS⁸ statistical software packages were utilized to complete the analyses. Potential predictive variables for household dust levels include property soil levels of PCDDs, PCDFs, and PCBs as well as selected variables from the respondent questionnaires and household dust sampling field data sheets. Questionnaires and field data sheets were completed at each sampled residence. Questionnaire data of predictive interest includes household resident occupations and habits as well as residence use. The data collected on the field data sheets included the date, time, and sampling team as well as the sampling locations, indoor conditions, surface types, equipment settings, total area sampled and total sampling time. Each field data sheet also included a labeled diagram of all sampled locations. Samplers also noted whether there was a wood-burning fireplace near the sampling location, whether there were any household pets at the residence, and whether the sampling location had been flooded and if so, when.

Results and Discussion

Results and discussion will not be available until after complete study results have been presented to the affected communities in August of 2006.

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Dioxin exposure study in Midland, MI

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