PREVALENCE OF EXPOSURE ROUTES IN THE UNIVERSITY OF MICHIGAN DIOXIN EXPOSURE STUDY: FOOD CONSUMPTION, RECREATIONAL AND HOUSEHOLD ACTIVITIES, OCCUPATIONS AND DEMOGRAPHICS

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Introduction

The University of Michigan Dioxin Exposure Study (UMDES) was undertaken in response to concerns among the population of Midland and Saginaw counties in Michigan that dioxin-like compounds from the Dow Chemical Company facilities in Midland have contaminated soils in the Tittabawassee River flood plain and areas of the city of Midland. The UMDES was designed to answer the following questions: 1) Are dioxin levels in serum increased among people who live in the Tittabawassee River flood plain compared to people who live elsewhere in Midland and Saginaw counties in elsewhere in the state of Michigan? 2) What factors explain the variation is serum dioxin levels among the entire population?

The goal of this paper is to examine the prevalence of particular exposure pathways in the Midland/Saginaw and Jackson/Calhoun populations. Analyses of the questionnaire were done to, first, understand characteristics of the population under study in the UMDES, and second, discover possible confounders or mediators for differences across the populations of interest regarding serum dioxin levels. Methods used in data collection and analysis as well as additional study findings are reported elsewhere.[1,2,3,4,5,6]

Previous models of exposure to dioxins and dioxin-like compounds have suggested several exposure pathways including inhalation, dermal contact, and ingestion.[7,8] Since ingestion is considered the primary exposure pathway for dioxin to enter the human body in the general public,[7,8] collecting information regarding people's local food consumption becomes important in an analysis of human body burden. In addition, correlates to the amount of dioxin absorbed into the blood such as age[14], gender[13], breastfeeding[9,10], smoking status[11], occupation[12], and recreational activities must also be considered. In the UMDES, these factors were reported in the questionnaire.

Materials and Methods

The target population and methods for data collection are reported elsewhere.[1] Eligible adults completed a one hour standardized interview, administered by trained interviewers from the Survey Research Center at the University of Michigan. Data collection was conducted in two phases. Phase 1, in Fall 2004, used a paper and pencil instrument and phase 2, in Spring/Summer 2005, used a computerized questionnaire.

An important component of the questionnaire was an Event History Calendar (EHC). An EHC collects time-varying information, using cues from the respondent's lifetime to assist in recall. At the beginning of the interview, interviewers asked the respondent for their date of birth. Respondents were then asked to recall significant life events, including graduation, marriage, childbirth, starting jobs, moving houses, or any other event that was meaningful to the respondent. The interviewer recorded these events on the EHC, which also contained major national (e.g., presidents, Kennedy's assassination) and local events (e.g., Tigers winning the World Series) to help

the respondents anchor when each event occurred. Respondents were encouraged to refer to these life milestones as recorded on the EHC during the interview.

The UMDES questionnaire consisted of ten sections, each of which contained lifetime recall questions. The respondent was asked to recall possible dioxin exposure pathways over their entire lifetime in one year intervals. These pathways included a full residential history, occupations, property use, recreational activities, and consumption of meat, fish, game, eggs, dairy products, and vegetables. Basic demographic (age, gender, race, education, income) and health questions (height, weight, weight loss and gain, smoking status, childbearing and breastfeeding) were also included, as were questions to determine the eligibility of each respondent for providing blood, dust and soil samples. Items related to awareness of the UMDES and reading study materials were included in the Spring/Summer 2005 questionnaire.

The analyses for this paper are descriptive in nature. All analyses are weighted for differential probabilities of selection and adjustments due to nonresponse. Additionally, all analyses use imputed data to account for any missing data, "don't know" answers or refusals to answer questions. Standard errors are calculated to account for the complex survey design. All analyses were run using *SAS 9.1.3*.

Results and Discussion

In general, the population in the survey was aged XX, white, over/under/normal weight, and non/current/former smokers. Table 1 shows basic health and demographic characteristics for the five regions of interest in the UMDES. The mean weight loss and weight gain over the last twelve months was XX pounds and XX pounds, respectively. Approximately XX percent of women reported having breastfed their children, with XX average number of childbirths.

Table 1. 95% confidence intervals for demographic characteristics by study area, University of Michigan Dioxin Exposure Study, 2005-2006.

	Flood plain	Near Flood Plain	Plume	Other Midland/ Saginaw	Control
Mean Age					
Percent Female					
Percent White					
Percent High School Graduate or More					
Mean BMI					
Percent Current Smoker					

An important dioxin exposure pathway is ingestion. Consumption of locally grown or farmed meat, vegetables, dairy products and eggs occurred rarely/frequently in the study areas. For example, XX percent ate any beef, pork, lamb and veal home-raised in the Tittabawassee River flood plain and XX percent ate home-raised red meat from any other location. XXX percent ate vegetables from the Tittabawassee River area, either from local producers or from vegetable gardens on the respondent's property. Consumption of wild game and fish was more prevalent, with XX percent reporting having consumed any fish from the contaminated areas during the last five years. Table 2 will present selected results.

Table 2. 95% confidence intervals for food consumption patterns by study area, University of Michigan Dioxin Exposure Study, 2005-2006.

	Flood plain	Near Flood Plain	Plume	Other Midland/ Saginaw	Control
Ever ate whitetail deer or venison					
Ever ate wild turkey					
Ever ate squirrel or rabbit					
Ever ate walleye or perch from the Tittabawassee River					
Ever ate catfish from the Tittabawassee River					
Ever ate home-raised milk					

Dermal contact exposure pathways were measured through recreational activities and gardening. In general, XX percent of the population had fished in Michigan, with XX percent having fished in the Tittabawassee River, XX percent in the Saginaw River, and XX percent in the Saginaw Bay. Few people (XX%) in the study population had ever fished in the Kalamazoo River between Morrow Pond Dam and Lake Michigan. Similarly, XX percent had hunted in Michigan, with XX percent hunting in the Tittabawassee River flood plain and XX percent hunting in the areas surrounding the Saginaw River.

Table 3 examines how respondents used their current property. For example, XX percent used weed killers on their current property, XX percent burned trash or yard waste, and XX percent used a fireplace or wood burning stove. Only XX percent currently lived in a house that had caught fire while respondent lived there. In general, XXXX are activities that occur the entire time an individual lives at a residence, while XXXX occur less regularly. In addition, XX percent had a flower or vegetable garden at their current property, which did/did not vary by study area.

Table 3. 95% confidence intervals for average number of years of current property use by study area, University of Michigan Dioxin Exposure Study, 2005-2006.

Average number of years while at current residence	Flood plain	Near Flood Plain	Plume	Other Midland/ Saginaw	Control
Total years living at current residence					
Trash burning					
Use fireplace regularly					
Use weed killers					

Roughly XX percent of subjects in the Tittabawassee River flood plain were employed by Dow Chemical, compared to XX percent in the near flood plain, XX percent in the plume, and XX percent in other areas of Midland and Saginaw Counties. Few (XX percent) subjects from Jackson or Calhoun counties had ever been employed by Dow Chemical. A similar pattern holds for those who lived with a Dow employee (XX percent in the flood plain, XX percent in the near flood plain, XX percent in the plume, XX percent in other areas of Midland and Saginaw Counties and XX percent in Jackson and Calhoun Counties). XX percent of individuals who lived in the flood plain worked with dioxin-related chemicals, compared to XX percent in the near floodplain, XX percent, XX percent, and XX percent in the plume, other areas of Midland and Saginaw, and the control sites respectively.

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