



ENVIRONMENTAL FACTORS THAT EXPLAIN VARIATION IN THE UPPER PERCENTILES OF SERUM DIOXIN CONCENTRATIONS IN A COMMUNITY IN MICHIGAN, USA

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Introduction & Objectives

The University of Michigan Dioxin Exposure Study (UMDES) has collected information based on questionnaires and samples of blood, household dust and soil from selected subjects in Midland, Saginaw, Bay, Jackson and Calhoun Counties. Here we focus on serum 2,3,7,8-TCDD. The distribution of the observed serum concentrations is right skewed, with a small number of high concentration values. From a public health perspective, it is important to learn the extremes (the upper percentiles) of the serum dioxin concentration. It is also critical to learn which environmental factors can explain the variation in the upper percentiles of serum dioxin concentrations. This study seeks to estimate the upper percentiles of the serum dioxin concentrations, and better understand the environmental factors that are important in explaining the variation.

Methods

Data

- In this study, a total of 946 subjects who completed serum dioxin measurement were included. They are participants from five regions: M/S[†] Flood Plain, M/S Near Flood Plain, M/S Out Flood Plain, M/S Plume, and Jackson/Calhoun.
- The outcome of interest is 2,3,7,8-TCDD.
- Blood serum, household dust, and soil concentrations were analyzed by Alta Analytical Laboratory, Inc.
- Other exposure information was obtained from the UMDES questionnaire. It included residential history, occupations, property use, recreational activities, and consumption of meat, fish, game, eggs, milk, other dairy products, and vegetables. Basic demographic and health information was also collected.

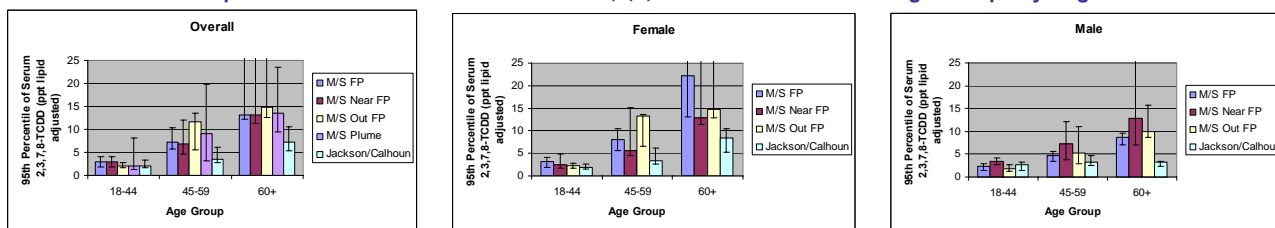
[†] M/S : Midland/Saginaw

Statistical Methods

- The study was stratified by three age groups: younger than 45, 45-59, and older than 60.
- The 95th percentiles of serum 2,3,7,8-TCDD were calculated for five regions.
- Within each age group, people were assigned into the group with high 2378-TCDD if their serum 2378-TCDD levels were greater than the 95th percentile of Jackson/Calhoun.
- Logistic regression, accounting for sample survey design information, was employed to study the environmental factors that could explain the variation of the extreme values of serum 2,3,7,8-TCDD. Models only included people older than 45 years of old.
- The final logistic models were obtained by backward selection, and stratified by gender.
- Multiple imputation techniques were employed to handle missing data.

Results

Comparisons of 95th Percentiles of Serum 2,3,7,8-TCDD Levels in Three Age Groups by Region



The group of M/S Plume was only shown in the overall population figure because of small sample sizes.

Comparison of Mean Exposure Values Between High and Normal Groups by Gender, for Age ≥ 45

Variables	Female		Male	
	Normal (n=266)	High (n=125)	Normal (n=258)	High (n=42)
Age	59.6	64.6	59.7	61.4
Body Mass Index	27.7	29.3	28.0	31.4
Months of breast feeding	7.1	3.5	----	----
Pack-years of cigarettes	13.9	7.3	18.8	9.8
Living in Midland/Saginaw (years)	26.2	51.2	35.9	52.3
Log (household dust)	0.6	0.6	0.5	0.6
Log (house perimeter soil)	0.8	1.0	0.8	0.8
Years removing shoes (0-5)	1.6	1.6	1.8	1.6
Working at Dow (years)	0.2	0.2	1.3	5.6
Meals of deer	33.6	57.0	46.0	76.6
Meals of squirrel and wild rabbit	0.5	1.2	1.7	5.6
Ever burn trash on property (Y/N)	57.1%	56.2%	54.7%	64.3%

Odds Ratios and 95% Confidence Limits from Logistic Regression Models

Domain	Variables	Female		Male	
		Odds Ratio	95% CI	Odds Ratio	95% CI
Demographics	Age (per 10 year)	1.63	(1.09, 2.43)	1.18	(0.52, 2.66)*
	Body Mass Index	1.06	(1.00, 1.12)	1.29	(1.15, 1.46)
	Breast Feeding (per month)	0.96	(0.92, 1.00)	----	----
	Pack-years of smoking cigarettes (per 10)	0.81	(0.66, 1.01)*	0.49	(0.24, 0.98)
Residence	Living in Midland/Saginaw (per 10 yrs)	1.71	(1.44, 2.04)	1.42	(1.09, 1.85)
	Food	----	----	2.78	(1.41, 5.45)
Work	Log meals of squirrel and wild rabbits	1.34	(1.03, 1.75)	----	----
	Working at Dow after 1940 (per 10 yrs)	----	----	2.33	(1.02, 5.33)
Property Use	No. years taking off shoes in the last 5 yrs	----	----	0.58	(0.41, 0.83)
	Ever burn trash on the property	2.51	(1.03, 6.10)	----	----

* not significant at p<0.05

- Figures:** In older age groups, people living in all Midland/Saginaw areas have higher upper tail values of serum 2,3,7,8-TCDD than those in Jackson and Calhoun Counties. Overall, older people have higher 95th percentiles of serum 2,3,7,8-TCDD than younger people. However, this age effect is not seen among males in Jackson/Calhoun Counties. Females over 60 in the Midland/Saginaw floodplain have the highest 95th percentile.
- Descriptive statistics:** Among people older than 45 years, 125 (32%) females are defined as having high serum 2,3,7,8-TCDD, but only 42 (14%) males are defined as high. People in the high group are older, heavier, lived in Midland/Saginaw longer, have eaten more game meat, but smoked less. In addition, females in the high group have shorter durations of breast feeding. Males in the high group have worked more years at the Dow Chemical Company. There is very little difference in household dust and soil levels between the normal and high groups.
- Logistic regression results:**
 - Females:** The odds of being in the high group are increased by higher Body Mass Index, living in Midland/Saginaw, eating deer, and burning trash. The odds of being in the high group are decreased by smoking (marginally significant) and by breastfeeding.
 - Males:** The odds of being in the high group are increased by older age, higher Body Mass Index, living in Midland/Saginaw, eating squirrel and wild rabbit, and having worked at Dow. The odds of being in the high group are decreased by smoking and by removing shoes in the home.

Conclusions

- The extreme values of serum 2,3,7,8-TCDD are higher among people who live in Midland/Saginaw than those in Jackson/Calhoun Counties.
- Among those over 45 years, people who are heavier and eat more game meat are more likely to be in the high serum 2,3,7,8-TCDD group. Moreover, the longer a person lives in Midland/Saginaw, the higher the probability he/she has extreme serum 2,3,7,8-TCDD.
- In males, working at Dow also contribute to higher odds of being in the upper tail of serum 2,3,7,8-TCDD.
- Among females, breastfeeding decreases the odds of being in the high group.

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