



Predictors of Serum 23478-PentaCDF Concentration in a Background Population in Michigan, USA and in a Representative USA Sample

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INTRODUCTION & OBJECTIVES

Serum dioxin concentrations were measured in two U.S. samples thought only to be exposed to background dioxin levels. Both samples were population-based: one of a 2-county area of Michigan, U.S. (the University of Michigan Dioxin Exposure Study, UMDES), and the other of the entire U.S. (the National Health and Nutrition Examination Survey, NHANES). Here we examined predictors of serum **23478-PeCDF** within both populations using regression models, accounting for complex sample design and values below the limit of detection (LOD). In addition to age and gender, the effects of body mass index (BMI), weight loss or gain, smoking, breastfeeding, race and dietary intake were also investigated.

METHODS

UMDES Sample

- Data collected in Jackson and Calhoun Counties of Michigan, USA, using a two-stage probability household sampling design.
- Eligible subjects were at least 18 years of age, lived in their current residence for at least 5 years, and provided written informed consent.
- An exposure questionnaire collected demographics, smoking and pregnancy history, occupational exposure, and food consumption.
- Serum samples were collected from subjects medically eligible to give blood as defined by the American Red Cross.
- Chemical analyses, reporting lipid-adjusted concentrations, were performed by Vista Analytical Laboratory, Inc. (El Dorado Hills, California, USA).

NHANES Sample

- The NHANES database of national health and vitality information for a sample of the U.S. population is publicly available through the U.S. National Center for Health Statistics. The NHANES data were taken from the 2001-2002 sample release.
- Serum samples were collected from medically eligible persons; a sub-sample aged ≥ 20 was selected for analysis of serum dioxins and furans.
- Chemical analyses, reporting lipid-adjusted concentrations, were performed by the Centers for Disease Control and Prevention laboratories.

Statistical Methods

- For both samples, **interval-censored regression methods** were used to handle left censoring in cases where dioxin levels fell below the LOD. In addition, the analyses incorporated the complex sample design within the model specification.
- Covariates considered included age, gender, race, BMI, BMI gain or loss in the previous year, smoking (pack-years), duration of breastfeeding, and selected interactions. In addition, food indicators and quantities (gm) were explored for beef, pork, poultry, game, fish, and dairy. Lifetime consumption data were available in UMDES, but only past 24-hour data in NHANES.
- Backward elimination was used to arrive at the final models. All analyses were performed using STATA 9.2. Regression analyses used the intreg procedure.

RESULTS

Subjects from UMDES (n=251) were slightly older than those from NHANES (n=1228) (mean (s.d.) 52.3 (15.2) vs. 49.1 (18.7), respectively). UMDES was 96% Caucasian while NHANES was 48% Caucasian/Other, 29% Hispanic, and 23% African American. Other characteristics were similar between UMDES and NHANES. Figure 1 showed the PeCDF values with model estimates by age and gender for UMDES and NHANES. Similar overall effects can be seen. The estimates from UMDES were based on larger sample volumes, which led to smaller LOD values (below LOD: UMDES 1%, NHANES 35%).

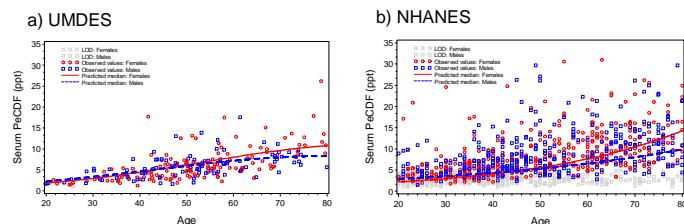


Figure 1. Plots of PeCDF data and model predicted medians by age and gender for (a) UMDES and (b) NHANES. For values below the LOD, the LOD itself is plotted (grey circles/squares).

Regression model estimates are given in Table 1.

- UMDES: Higher PeCDF was associated with older age, female gender (at older ages), and BMI loss. Lower PeCDF was associated with BMI gain, breastfeeding and smoking (until older ages).
- NHANES: Higher PeCDF was associated with older age and female gender (at older ages). Lower PeCDF was associated with BMI gain.
- The age*sex interactions are illustrated in Figs. 1a and 1b.
- The UMDES interaction between age and smoking is shown in Fig. 2a.
- The NHANES interaction between age and race is shown in Fig. 2b.
- Dietary intake was not significantly related to PeCDF in either model.

Table 1. Regression results predicting serum PeCDF concentration.

	UMDES	NHANES
	Estimate (s.e.)	Estimate (s.e.)
Age	.0255 (.0037)	.0089 (.0014)
Age ²	-.0002 (<.0001)	----
Sex (female)	.1528 (.1148)	-.2098 (.1096)
BMI	.0103 (.0038)	----
BMI loss (past yr)	.0150 (.0039)	----
BMI gain (past yr)	-.0218 (.0063)	-.0190 (.0062)
Breastfeeding (month)	-.0096 (.0023)	----
Pack-years	-.0097 (.0035)	----
Race (Hispanic) †	----	-.1734 (.0844)
Race (African American) †	----	-.1490 (.0627)
Age*Sex	.0033 (.0013)	.0047 (.0021)
Age*Pack-years	.0001 (<.0001)	----
BMI*Sex	-.0107 (.0046)	----
Age*Race (Hispanic) †	----	.0014 (.0017)
Age*Race (African American) †	----	.0031 (.0011)

† Reference group for race is Caucasian

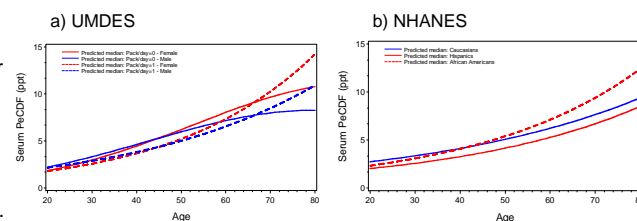


Figure 2. Plots of PeCDF model interactions for (a) UMDES and (b) NHANES.

CONCLUSIONS

These results showed generally low levels of serum PeCDF in background U.S. populations, but higher concentrations with older age. For age>60, females had higher levels than males in both UMDES and NHANES. Both samples showed lower PeCDF with BMI gain, suggesting a dilution effect. UMDES showed higher PeCDF with BMI loss. Breastfeeding was associated with lower PeCDF in UMDES. Smoking showed an interesting interaction with age: smoking was linked with lower PeCDF in middle age, but higher PeCDF at ages > 65, possibly due to liver damage from long-term tobacco use. Race effects could only be investigated in NHANES data: Hispanics showed the lowest levels of PeCDF.

Serum dioxin concentrations in exposed populations are often compared to background populations. Modeling dioxin as a function of demographic and lifestyle variables in a background population can allow background prediction in different populations.

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