SERUM 2,3,7,8-TCDD CONCENTRATION IN A MICHIGAN, USA POPULATION WITH NO UNUSUAL SOURCES OF EXPOSURE

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The University of Michigan Dioxin Exposure Study

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Outlines

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Introduction – Background

- The University of Michigan Dioxin Exposure Study (UMDES) was conducted in response to concern that people's body burdens of dioxin-like compounds might be elevated in Midland and Saginaw counties, Michigan, because of environmental contamination from the Dow Chemical facilities in the City of Midland and sediments in the Tittabawassee River flood plain.

- To assess whether the serum dioxin-like compounds levels are elevated among residents in Midland/Saginaw, they were compared with background serum dioxin concentrations in other areas of Michigan, where there are no known unusual sources of dioxin exposure.

Introduction – Goal

- The present study quantifies the background concentrations of 2,3,7,8-TCDD in serum from residents of Michigan, who live in areas with no unusual sources of exposure.

- The mean, median, 75th percentile, and 90th percentile of these serum TCDD levels were estimated as a function of age and sex to control for confounding by these factors.

Study Population

- Population in Jackson and Calhoun counties, Michigan, were selected as the control population.
  - It was similar to the Midland and Saginaw counties in terms of demographics, urban/rural distribution, and industry – except that there is no major source of dioxin-like compounds as the Dow Chemical Company.
  - In order to be eligible for participation in this study, the Jackson/Calhoun residents were required to be 18 years or older and to have lived in their current residence for at least five years.
  - The samples were collected in summer 2005, and a total of 251 residents have serum 2,3,7,8-TCDD measures.
  - The mean age was 49 years and the mean body mass index (BMI) level was 28. The sex distribution of the study population was 59% female and 41% male, and the population was predominantly non-Hispanic whites (90.8%).

Problem and Solution

- One limitation of the Jackson/Calhoun data is that relatively few participants (n=20) were older than 75 years, especially males (n=3). As a result, estimating age- and sex-specific upper percentiles was problematic in this group.

- A substantial data set on serum TCDD levels in adults aged 20 to 85 years exists in the 2001-2002 National Health and Nutrition Examination Survey (NHANES).

- Our goal was to use information from the NHANES data, especially from people older than 75, to improve our estimates of the age- and sex- adjusted summary measures of serum TCDD concentrations in the Jackson and Calhoun population.

Flow Chart of the Statistical Analysis

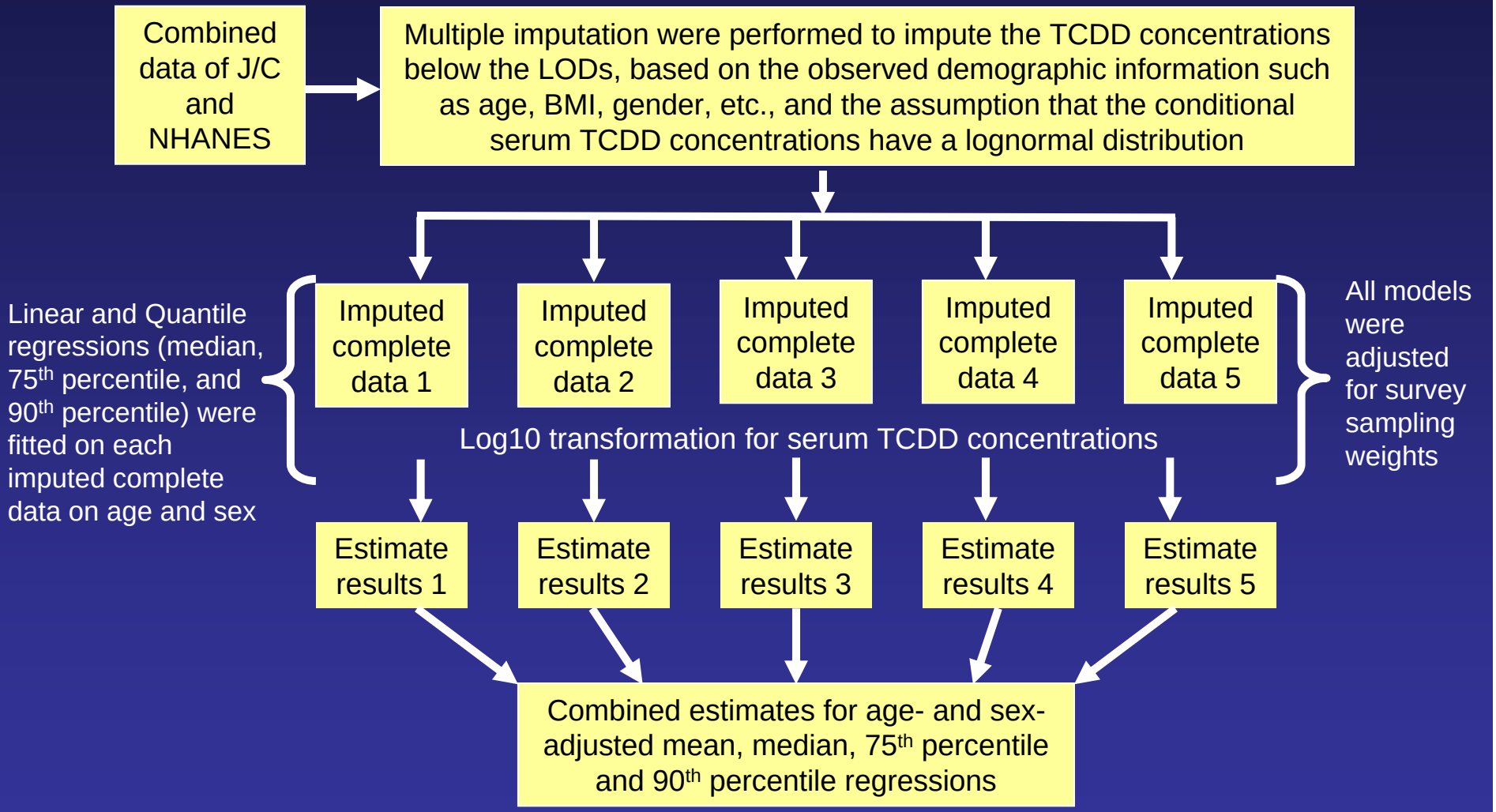


Table 1: Results of mean and quantile regressions of base 10 logarithm of serum TCDD concentrations

Factor	Mean regression	Median regression	75th percentile regression	90th percentile regression
Intercept	0.110 ***	0.153 ***	0.334 ***	0.412 ***
Age-50 (years)	0.020 ***	0.020 ***	0.016 ***	0.017 ***
Gender (Male=1)	-0.094 ***	-0.098 **	-0.111	-0.033
source (NHANES=1)	-0.139 **	-0.202 ***	-0.123	0.098
(Age-50)*Gender	-0.005 *	-0.006 *	-0.007 **	-0.005
(Age-50) * Source	-0.003	-0.003	0.002	0.0002
Gender*source	-0.040	-0.005	-0.038	-0.184

Results are reported as estimate + P-value
***P-value<0.01; **P-value<0.05; *P-value<0.1

How to Use the Results in Table 1

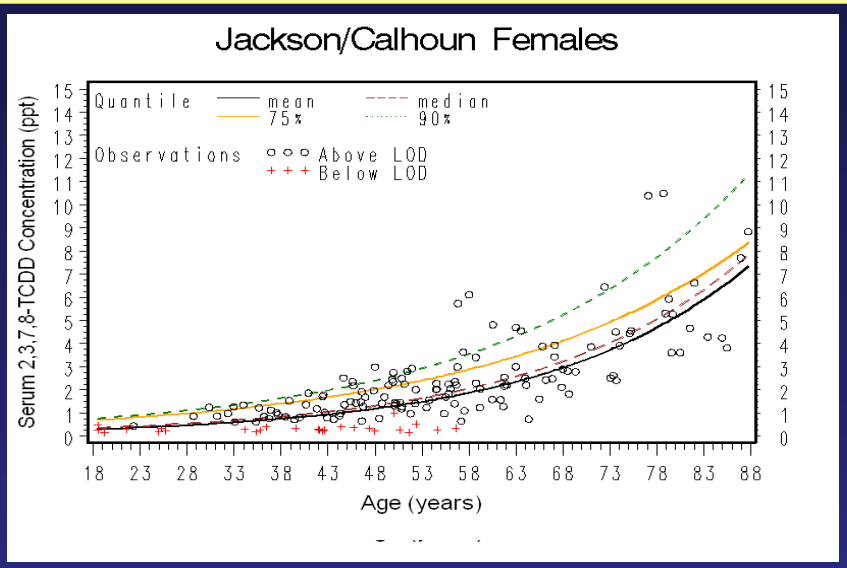
- Any age- and sex-specific background predicted serum TCDD concentrations can be obtained from the regression results in Table 1.
  - For example, the predicted 90th percentile serum TCDD concentration for a Jackson/Calhoun resident is

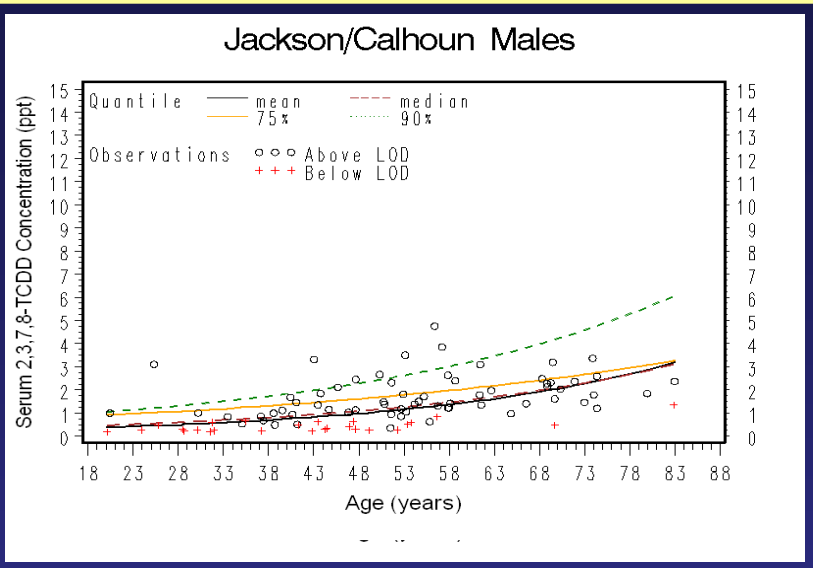
$$\hat{P}_{90} = 10^{(0.412+0.017\times(age-50)-0.033\times sex-0.005\times(age-50)\times sex)}$$

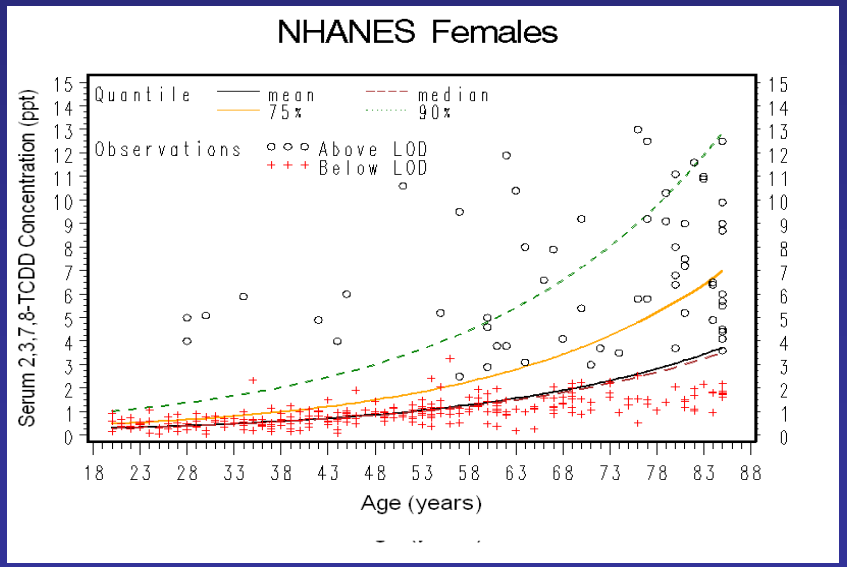
  - And for a resident aged 50 from Jackson/Calhoun

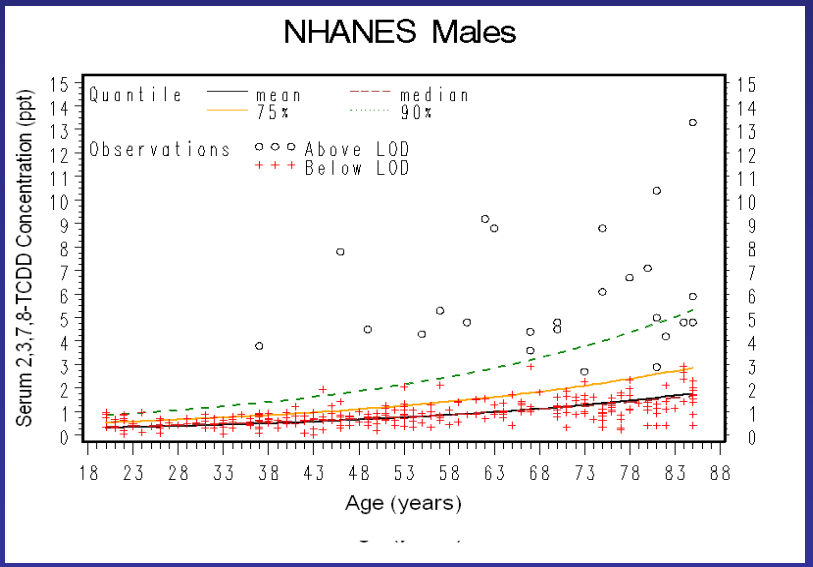
Units = ppt	Mean	Median	75th percentile	90th percentile
Woman	$10^{0.110}$=1.29	$10^{0.153}$ = 1.42	$10^{0.334}$ = 2.16	$10^{0.412}$ = 2.58
Man	$10^{0.110-0.094}$=1.04	$10^{0.153-0.098}$=1.14	$10^{0.334-0.111}$=1.67	$10^{0.412-0.033}$=2.39

Prediction of the age- and sex-specific mean, median, 75th percentile, and 90th percentile of TCDD levels









Discussion

- Serum TCDD concentrations increase with age, and females increase faster than males as age rises. Thus, the age- and sex-specific serum TCDD measures in the reference population are appropriate for comparisons to other populations, especially for comparing populations with different age and sex structures.

- The Jackson/Calhoun population is similar to the general US population (in the NHANES study) for serum TCDD exposure. This implies that the Jackson/Calhoun population is a valid reference population for comparisons of the serum TCDD concentrations to the other populations in Michigan and perhaps in the U.S.

Discussion (Cont.)

- For each resident in Midland/Saginaw, we can compare the serum TCDD level to the background level of people of the same age and sex in Jackson/Calhoun to see whether their serum TCDD level are elevated.
- With multiple quantile curves, different researchers can define different age-specific-quantile/mean curves as their reference levels according to their research interests.
- These methods and results have wide application in studies of concentrations of toxins in human serum and in environmental samples.

Future work

- The World Health Organization (WHO) 29 list of dioxins, furans, and PCBs congeners and TEQ will be analyzed using quantile regression models on age and sex as we have done for 2,3,7,8-TCDD.

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