HALF-LIVES OF DIOXINS, FURANS, AND PCBS AS A FUNCTION OF AGE, BODY FAT, BREASTFEEDING, AND SMOKING STATUS

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OBJECTIVE

Provide a method of half-life adjustment that is based on relevant individual characteristics

INTRODUCTION

To understand the effects of past intake of polychlorinated dibenzodioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and polychlorinated biphenyls (PCBs) on current serum concentrations, it is necessary to know the half-life of each congener at each age of a person's life. Inter-individual half-life variation can be partially attributed to certain individual characteristics, including age, body fat, smoking status, and time spent breastfeeding a child. With a quantitative method of adjusting for these characteristics, half-lives, and therefore exposures, can be more accurately estimated.

METHODS

- Measured and modeled data were used to examine the relationship between the half-lives of 29 congeners in humans and the factors that affect their length.
- Reference half-life values for an adult and for an infant were used to produce a continuous interpolation of the half-life as a function of age, of percent body fat, and of total body fat.
- Correction factors for the effect of breastfeeding a child and for smoking were introduced.

RESULTS

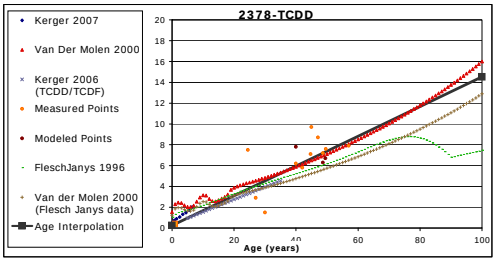

Figure 1 . Half-life (in years) vs. age (in years) for 2378-TCDD

There is a positive nearly linear association between age and half-life. This may indicate a direct relationship between age and half-life, or age may incorporate the effect of other parameters, such as the change in percent body fat with age.

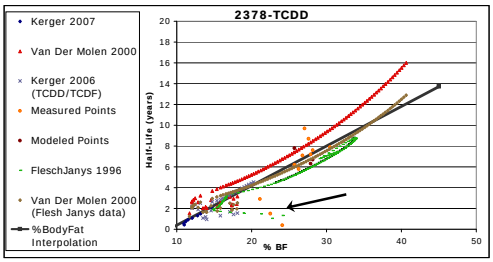

Figure 2. Half-life (in years) vs. percent body fat 2378-TCDD

Half-life increases with percent body fat at older ages, but not at younger ages (shown by the arrow on figure 2). Because of this, the relationship between percent body fat and half-life could be useful for correcting the half-life for a given age, but cannot be used to represent every stage of an individual's life.

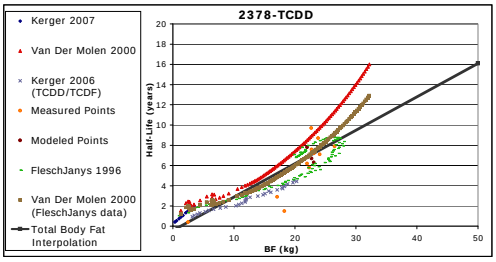

Figure 3. Half-life (in years) vs. body fat (in kg) 2378-TCDD

Using absolute body fat rather than percent body fat better accounts for the effect of dilution found in children. The two points well below the curve correspond to acute poisoning of two females with high concentrations of TCDD.

We propose a strategy for determining the half-lives of the 29 congeners in an individual that is based on the relationship of half-life and age.

We use the reference values given in Milbrath *et al.*, and add a correction for percent body fat for a given age.

$$\tau_{1/2}(age_i, smoke_i, \%bf_i)_i = \left(\beta_{0(age)} + \beta_{age} \cdot age_i\right) \cdot SF_i \cdot \frac{\%bf_i^{2005}}{\%bf_{ref(age_i)}^{2005}}$$

The decay rate (k_i) is calculated as a function of the half-life and the number of months spent breastfeeding a child.

$$k_i = \frac{ln(2)}{\tau_{1/2}} + k_{breast} \cdot t_{breast}$$

An alternative strategy could be based on a linear relationship with absolute body fat, but this requires further validation.

CONCLUSIONS

- When the equation with age was tested against the Flesch-Janys regression, a similar response was obtained over a wide range of ages and percent body fat.
- There is not sufficient data to test the equation based on total body fat, and this approach requires further validation.
- The described equations represent a simple and relatively consistent approach that can be used to determine individual half-lives for numerous dioxin, furan, and PCB congeners.

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