DERIVATION OF PROBABILISTIC DISTRIBUTIONS FOR THE W.H.O. MAMMALIAN TOXIC EQUIVALENCY FACTORS

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Introduction

The World Health Organization (W.H.O) recently developed revised mammalian toxic equivalency factors (TEFs) for the 2,3,7,8-substituted dioxins and furans and the coplanar PCB congeners. As shown in Figures 1-3, the ranges of the relative estimates of potency (REPs) for most congeners span several orders of magnitude (usually 2-4 fold), which raises some concerns regarding the representativeness of the "point estimate" TEFs. More importantly, there appear to be significant inconsistencies in the degree of conservatism in the various TEFs. For example, some TEFs exceed the maximum value in the REP range (e.g., 1,2,3,7,8,9-HxCDD), while some TEFs are below the minimum REP value (e.g.,1,2,3,4,7,8,9-HpCDF). Also, it appears that the PCB TEFs are typically more representative of central tendencies while the PCDD/F TEFs are more representative of upper-bound values. The use of distributions to represent the TEFs , rather than point estimates, should minimize these inconsistencies and uncertainties. In this preliminary analysis, we derive TEF distributions that we believe would be suitable for use in probabilistic risk assessments.

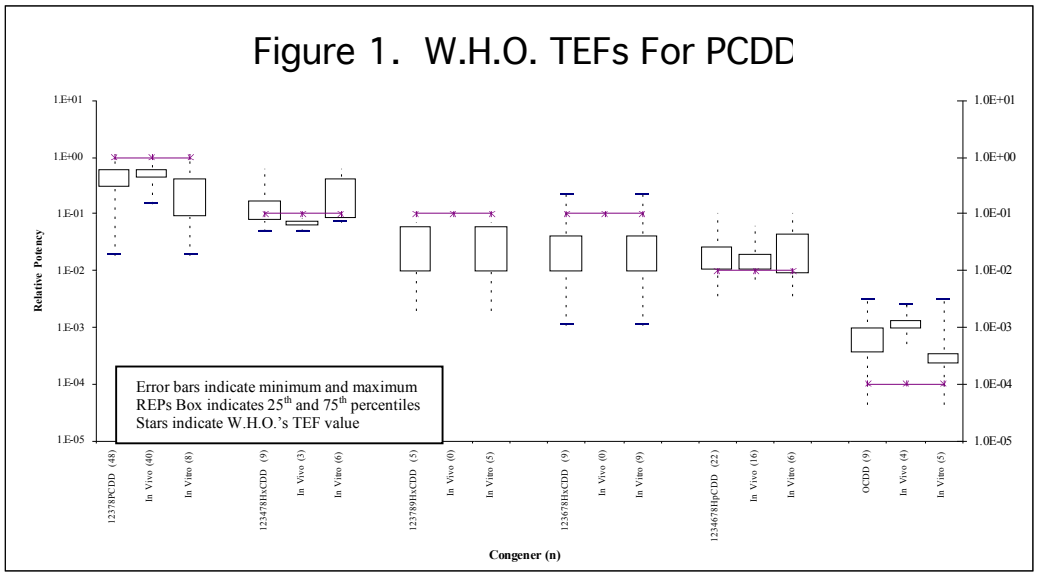
Materials and Methods

The W.H.O.'s mammalian REP database contains 936 values from published and unpublished studies. Of these, 70 values are qualified as "less than the quantitation limit"; in this analysis one-half the reported quantitation limit was substituted for these values. Thirty-eight values are qualified as "greater than the quantitation limit"; these values were not used in this analysis. Fit-testing of the congeners for which 20 or more REP values were available indicated that, of several distribution types tested (lognormal, beta, Weibull, et al.) a lognormal distribution was the best or second best fit for almost all congeners. Accordingly, lognormal probability distributions were developed for each of the PCB and PCDD/F congeners. A comparative analysis of deterministic (W.H.O. point estimate TEFs) vs. upper-bound probabilistic (95^{th} percentile using REP distributions) fish consumption risk was conducted using representative fish tissue data (point estimates) and standard conservative point estimates for body weight, exposure duration, and other exposure factors.

Results and Discussion

The comparative analysis demonstrated that the 95^{th} percentile of the probabilistic PCDD/F risk (1.8×10^{-4}) was about 3-fold greater than the deterministic PCDD/F risk obtained with the point TEFs (6×10^{-5}), while the 95^{th} percentile of the PCB probabilistic risk (5.4×10^{-4}) was almost 20-fold greater than the deterministic PCB risk (3×10^{-5}) (the 95^{th} percentiles are less than the deterministic risk when distributions are used for all exposure factors). This suggests that the W.H.O. PCDD/F TEFs are more representative of upper-bound estimates than the PCB TEFs. Use

of distributions rather than point estimates would eliminate this discrepancy and would yield risk estimates that provide for more consistent and informed decision-making.



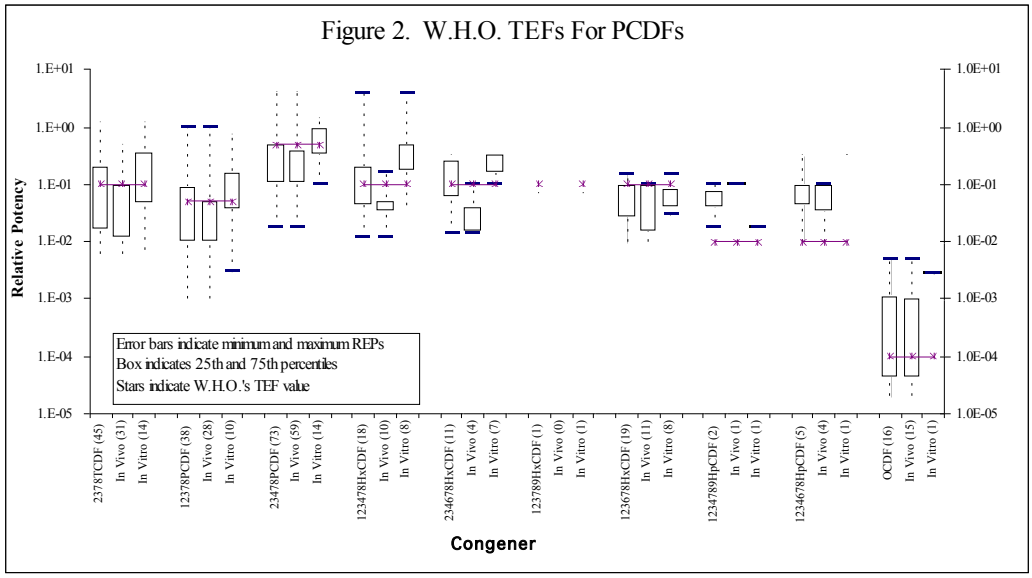


Figure 3. W.H.O. TEFs for PCBs