

DIOXIN TOXIC EQUIVALENTS IN WHOLE BLOOD OF AMERICAN ADULTS USING VARIOUS PROPOSED DIOXIN TOXIC EQUIVALENT FACTORS FOR PCBs

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Introduction: Total dioxin-like toxicity in humans is calculated by summing measured dioxin, dibenzofuran and polychlorinated biphenyl (PCB) congeners after multiplying by a dioxin toxic equivalency factor (TEFs).⁽¹⁻³⁾ These factors are only approximations of toxicity and are expected to change with new knowledge. Recently, the PCB TEFs changed markedly. TEFs can not be assigned to all PCB congeners, however dioxin-like PCBs can be included in the TEF scheme. Those which have either the older values proposed by S. Safe^(4,6) or the newer, WHO values,⁽⁷⁾ can be considered in total dioxin predicted toxicity and the percent contribution from PCDDs, PCDFs and PCBs can be calculated.

Results: Table I shows the mean value and range of PCDD, PCDF and coplanar, mono-ortho and di-ortho PCB TEqs in American whole blood from 44 male adults using the new WHO recommended PCB TEFs (for the congeners which have assigned values) and the former, "Safe" conservative estimates for the rest. Table II lists only totals for both "Old" and "New" toxic equivalency factors. The first two columns show totals calculated with the same seventeen PCB congeners that are detailed in Table I, the second two columns report the totals calculated only on the eight PCB congeners that are assigned values in the new WHO recommendation. Although not the ideal presentation, where all congeners shown would be assigned TEF values, the difference is illustrated, with the newer TEF values leading to less PCB TEq and a lower percent of the total compared to PCDD/Fs. Figures 1-4 demonstrate graphically the difference between total levels (in ppt, lipid) and percent of contribution.

Conclusion: The total dioxin toxic equivalents in human blood, which reflects body burden, varies according to the TEF scheme used; with the newer values, total dioxin toxicity is less than previously estimated, despite the high levels of PCBs measured in human tissue, compared to dioxins and dibenzofurans. The PCB percent contribution to the total also is less with the newer, and presumably more accurate, estimates of PCB toxic equivalents. However, as can be seen from all Figures, the dioxin-like PCBs make a substantial contribution to the total TEq.

References:

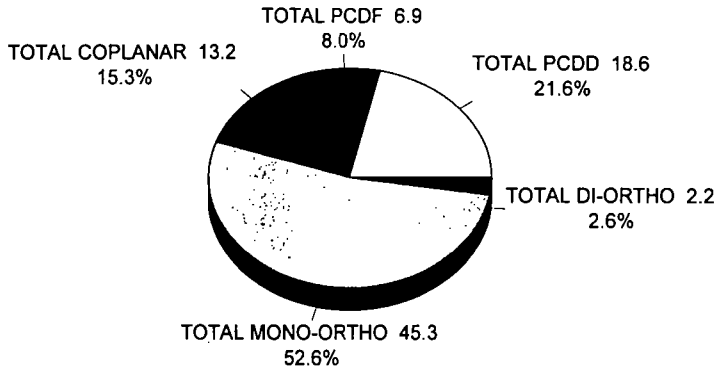
1. Pilot Study on International Information Exchange on Dioxins and Related Compounds, *International Toxicity Equivalency Factor (I-TEF) Method of Risk Assessment for Complex Mixtures of Dioxins and Related Compounds. Report Number 176*, Committee on the Challenges of Modern Society:North Atlantic Treaty Organization, 1988. pp. 1-26.
2. Pilot Study on International Information Exchange on Dioxins and Related Compounds, *Scientific Basis for the Development of the International Toxicity Equivalency Factor (I-TEF) Method of Risk Assessment for Complex Mixtures of Dioxins and Related Compounds. Report 178*, Committee on the Challenges of Modern Society:North Atlantic Treaty Organization, 1988. pp. 1-56.
3. USEPA, *Interim procedures for estimating risks associated with exposures to mixtures of chlorinated dibenzo-p-dioxins and dibenzofurans (CDDs and CDFs) and 1989 update*, Springfield, VA 22161 PB90-145756:U.S. Department of Commerce, National Technical Information Service, 1989.
4. Safe, S. Determination of the 2,3,7,8-TCDD toxic equivalent factors: Support for the use of the in vitro AHH induction assay. *Chemosphere* 16:791-802, 1987.
5. Safe, S. Development of toxic equivalency factors (TEFs) for halogenated aromatic hydrocarbons. *Organohalogen Compounds, Eco-Infoma Press, Bayreuth, Germany* 1:329-332, 1990.
6. Safe, S. Development, validation and limitations of toxic equivalency factors. *Chemosphere* 25 (Nos. 1-2):61-64, 1993.
7. Ahlborg, U.G., Becking, G.C., Birnbaum, L.S., Brouwer, A., Derks, H.J.G.M., Feeley, M., Golor, G., Hanberg, A., Larsen, J.C., Liem, A.K.D., Safe, S.H., Schlatter, C., Waern, F., Younes, M. and Yrjanheikki, E. Toxic equivalency factors for dioxin-like PCBs. *Chemosphere* 28/6:1049-1067, 1994.

BZ# PCB Congener	TEF	MEAN	RANGE	
			MIN	MAX
Coplanar				
77 3,3',4,4'-Tetra PCB*	0.0005	0.038	0.010	0.168
126 3,3',4,4',5-Penta PCB*	0.1	10.163	2.220	36.800
169 3,3',4,4',5,5'-Hexa PCB*	0.01	0.448	0.081	0.993
Mono-ortho				
28 2,4,4'-Tri PCB	0.001	7.427	0.340	66.077
74 2,4,4',5-Tetra PCB	0.001	12.693	3.009	41.443
105 2,3,3',4,4'-Penta PCB*	0.0001	0.667	0.150	3.704
118 2,3',4,4',5-Penta PCB*	0.0001	1.352	0.033	4.141
156 2,3,3',4,4',5-Hexa PCB*	0.0005	2.497	0.165	5.750
Di-ortho				
99 2,2',4,4',5-Penta PCB	0.00002	0.204	0.052	0.958
128 2,2',3,3',4,4'-Hexa PCB	0.00002	0.037	0.004	0.105
138 2,2',3,4,4',5'-Hexa PCB	0.00002	0.483	0.111	1.611
153 2,2',4,4',5,5'-Hexa PCB	0.00002	0.752	0.143	1.978
170 2,2',3,3',4,4',5-Hexa PCB*	0.00010	0.599	0.081	2.340
180 2,2',3,4,4',5,5'-Hepta PCB*	0.00001	0.182	0.042	0.418
183 2,2',3,4,4',5',6-Hepta PCB	0.00002	0.048	0.010	0.201
185 2,2',3,4,5,5',6-Hepta PCB	0.00002	0.023	0.004	0.101
187 2,2',3,4',5,5',6-Hepta PCB	0.00002	0.145	0.018	0.461
TOTAL PCDD		18.6	8.5	36.5
TOTAL PCDF		6.9	2.4	20.3
TOTAL PCDD/F		25.5	11.7	45.9
TOTAL COPLANAR		10.6	2.3	37.4
TOTAL MONO-ORTHO		24.6	6.1	80.0
TOTAL DI-ORTHO		2.5	0.6	5.3
TOTAL PCBs		37.8	10.9	108.4
GRAND TOTAL		63.3	25.9	152.3

* - WHO recommended TEFs

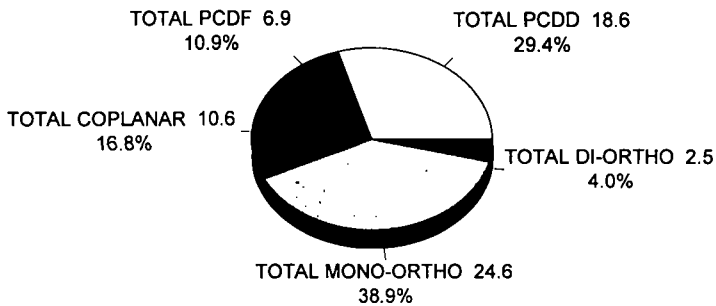
	With 17 PCB congeners		With 8 PCB Congeners	
	Old TEqs	Old & New TEqs	Old TEqs	New TEqs
Total PCDDs	18.6	18.6	18.6	18.6
Total PCDFs	6.9	6.9	6.9	6.9
Total PCDD/F	25.5	25.5	25.5	25.5
Total Coplanar PCBs	13.2	10.6	13.2	10.6
Total Mono-Ortho PCBs	45.3	24.6	25.2	4.5
Total Di-Ortho PCBs	2.2	2.5	0.5	0.8
Total PCBs	60.6	37.8	38.8	15.9
Grand Total	86.2	63.3	64.4	41.5

FIGURE 1: PCDD, PCDF, and PCB Contribution to Dioxin Toxicity - Safe's TEFs (PCBs = 17)



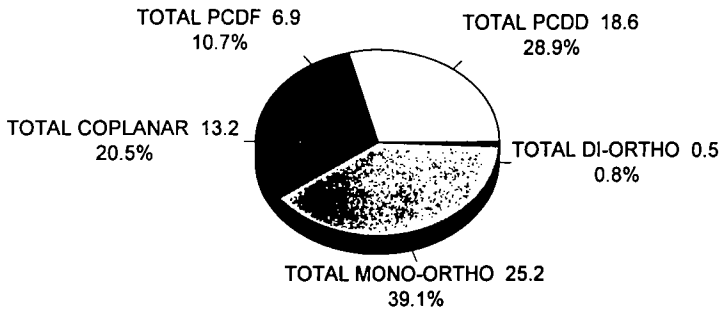
n = 44, measured values are ppt, lipid

FIGURE 2: PCDD, PCDF, and PCB Contribution to Dioxin Toxicity - A Combination of Safe's and WHO's TEFs (PCBs = 17)



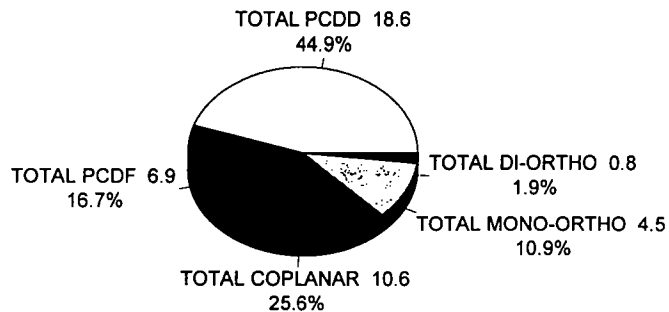
n = 44, measured values are ppt, lipid

FIGURE 3: PCDD, PCDF, and PCB Contribution to Dioxin Toxicity - Safe's TEFs (PCBs = 8)



n = 44, measured values are ppt, lipid

FIGURE 4: PCDD, PCDF, and PCB Contribution to Dioxin Toxicity - WHO TEFs (PCBs = 8)



n = 44, measured values are ppt, lipid