

THE MAPPING OUT OF ENVIRONMENTAL LEVELS OF DIOXIN  
CONTAMINATION BY USE OF POOLED WHOLE BLOOD  
THROUGHOUT A COUNTRY: VIET NAM, A CASE STUDY

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### INTRODUCTION

We extend our previous work on fat tissue, blood and milk collected in almost 50 locations throughout Viet Nam by reporting dioxin (PCDD) and dibenzofuran (PCDF) levels on 15 analyses of pooled blood comprised of 2,000 human samples. Viet Nam exhibits a unique human tissue dioxin pattern that is especially conducive to mapping out environmental levels of dioxins and dibenzofurans.<sup>1,2</sup> Agent Orange, a phenoxyherbicide mixture of half 2,4-D and half 2,4,5-T (contaminated with 2,3,7,8-TCDD), was heavily sprayed only over jungle and cropland between 1962 and 1970 in 10% of the south and central parts of Viet Nam. Both elevated 2,3,7,8-TCDD, partially from Agent Orange, and also an industrial contamination pattern with higher chlorinated dioxins, are seen in the south only. Blood from northern Viet Nam is characterized by much lower human tissue levels of dioxins resulting from less industrialization and the absence of Agent Orange spraying. The higher dioxin body burden consistently found in persons from south and central Viet Nam and lower levels from the north suggest that health studies on these large populations may yield important information concerning the health effects of the dioxins.

### METHODS

Samples of whole were collected in 1990-91 at regional hospitals from adult patients. The specimens were frozen immediately and kept frozen until analysis. Analytical methods will not be repeated here.<sup>3</sup>

### RESULTS AND CONCLUSIONS

Tables I and II present the results of 15 pooled analyses from different locations in Vietnam. Table I clearly shows a difference in human 2,3,7,8-TCDD blood levels between four locations in central Viet Nam, where Agent Orange was sprayed, and two specimens from Hanoi in the north, which was not sprayed. TCDD levels from the central locations range from 9.5 to 18 ppt in blood lipid, whereas the northern specimens range from not detected with a detection limit of 2.4 to 2.9 ppt lipid. As seen in Table II, some specimens

from the south show even higher levels of 2,3,7,8-TCDD, up to 32 ppt, on a lipid basis. The low 3.4 ppt of TCDD from the Ho Chi Minh City (Saigon) sample was taken from relatively young women at the Obstetrics and Gynecological Hospital.

Consideration of the total dioxin "Toxic Equivalents," (TEQ) using current estimates of toxicity,<sup>4,6</sup> indicates a general pattern of industrial contamination in the southern and central regions with total dioxin and dibenzofuran TEQs ranging from 16 to 77 ppt, compared with 12 and 18 ppt from the two northern Hanoi pooled specimens.

By using pooled blood, it is possible to more rapidly and economically obtain average dioxin levels in these populations.<sup>7</sup> This provides population-based exposure indices for future health studies relating levels of dioxins to health effects, and will improve the quality of such studies by providing accurate and direct estimates of dioxin exposure and body burden. The human tissue levels of TCDD from Agent Orange by geographical area is also of considerable interest to American Viet Nam veterans and veterans from other countries who may have been exposed to Agent Orange. Recent studies showing a causal relationship between certain types of cancer and exposure to dioxins or phenoxyherbicides clearly demonstrate the importance of further research in Vietnam.<sup>8-14</sup>

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**TABLE I**  
**CHLORINATED DIOXINS, DIBENZOFURANS AND DIOXIN TOXIC EQUIVALENTS IN POOLED BLOOD FROM CENTRAL AND NORTHERN VIETNAM, 1987-91 (PPT, LIPID)**

Location	CENTRAL				NORTH	
Province	Quang Tri	Thua Thien	Da Nang		Hanoi	
Hospital	Quang Tri N=50	Hue N=50	A Luoi N=33	Da Nang N=50	Oncology N=50	Hospital #103 * N=32
2,3,7,8-TCDD	9.5	11	15	18	2.9	<2.4
1,2,3,7,8-PnCDD	14	15	ND(2.2)	30	4.1	4.2
1,2,3,4,7,8-HxCDD	9.0	23	ND(1.8)	15	4.6	2.3
1,2,3,6,7,8-HxCDD	36	53	11	73	13.7	13
1,2,3,7,8,9-HxCDD	6.6	19	ND(4.1)	22	4.2	5.7
1,2,3,4,6,7,8-HpCDD	78	101	21	93	33.5	13
OCDD	614	773	127	1278	161	87
2,3,7,8-TCDF	3.0	2.3	<6.8	<6.0	5.9	2.6
1,2,3,7,8-PnCDF	ND(1.8)	4.8	ND(2.1)	ND(3.1)	2.5	<1.1
2,3,4,7,8-PnCDF	8.5	20	3.0	24	7.0	8.6
1,2,3,4,7,8-HxCDF	36	89	21	108	29.7	6.5
1,2,3,6,7,8-HxCDF	21	61	11	57	14.1	6.4
1,2,3,7,8,9-HxCDF	ND(1.6)	ND(1.0)	ND(1.6)	ND(1.2)	ND(1.0)	ND(1.1)
2,3,4,6,7,8-HxCDF	ND(1.2)	3.6	ND(1.0)	6.3	2.4	1.8
1,2,3,4,6,7,8-HpCDF	61	84	23	117	68.9	12
1,2,3,4,7,8,9-HpCDF	ND(2.5)	ND(4.2)	ND(2.5)	ND(5.7)	< 5.5	<1.2
OCDF	ND(9.9)	ND(6.5)	ND(12)	ND(13)	5.9	<3.0
Total PCDD	767	995	174	1529	224	126
Total PCDF	130	265	61	315	139	41
Total PCDD/Fs	897	1260	235	1844	363	167
PCDD TEQ	23	30	17	46	8	6
PCDF TEQ	11	27	6	31	10	6
PCDD/F TEQ	34	57	23	77	18	12

Totals are rounded. ND = not detected, with detection limit in brackets. For TEQ calculation and total PCDD/F, ND or < contributes half to detection limits. \* See reference #2.

**TABLE II**  
**CHLORINATED DIOXINS, DIBENZOFURANS AND DIOXIN TOXIC EQUIVALENTS IN POOLED BLOOD FROM SOUTHERN VIETNAM 1987-91 (PPT, LIPID)**

Province	Ho Chi Minh City		Dong Nai			Tay Ninh		Song Be	
Hospital	Tu Du Ob/Gyn N=50	Cho Ray N=50	Dong Nai * N=33	Bien Hoa N=50	Tri An N=50	Tay Ninh N=50	Tan Bien N=50	Song Be City N=50	Tan Uyen N=50
2,3,7,8-TCDD	3.4	10.8	12	28	12	6.8	5.3	9.0	32.0
1,2,3,7,8-PnCDD	8.8	8.8	14	10	3.4	2.8	10.3	14.8	10.3
1,2,3,4,7,8-HxCDD	7.5	5.8	14	11	ND(2.2)	5.2	7.3	10.3	7.4
1,2,3,6,7,8-HxCDD	29	26.6	52	25	13	16	41.3	57.5	45.3
1,2,3,7,8,9-HxCDD	8.6	6.3	15	6.1	7.1	6.5	10.9	15.4	10.0
1,2,3,4,6,7,8-HpCDD	97	80.4	176	90	24	45	108.5	114.2	90.3
OCDD	933	627	1655	685	226	600	838	703	564
2,3,7,8-TCDF	4.6	4.0	3.9	ND(1.2)	3.0	1.8	2.1	2.4	1.7
1,2,3,7,8-PnCDF	3.2	2.5	2.9	3.0	ND(1.0)	ND(1.0)	1.7	3.8	1.4
2,3,4,7,8-PnCDF	21	10.7	22	8.0	2.1	3.7	6.9	17.9	7.7
1,2,3,4,7,8-HxCDF	14	18.3	27	23	8.9	7.5	15.8	64.0	27.5
1,2,3,6,7,8-HxCDF	11	10.2	27	13	3.8	5.3	9.8	36.7	15.8
1,2,3,7,8,9-HxCDF	ND(1.4)	ND (1.0)	ND (1.2)	ND (2.9)	ND (1.0)	ND(1.0)	ND (1.0)	1.7	ND (1.0)
2,3,4,6,7,8-HxCDF	3.3	1.7	5	ND(1.9)	ND(1.0)	ND(1.1)	1.3	7.9	3.8
1,2,3,4,6,7,8-HpCDF	22	29.9	31	28	11	8.0	41.6	117.4	71.1
1,2,3,4,7,8,9-HpCDF	2.6	< 6.0	2.7	ND(5.5)	ND(2.0)	ND(2.9)	< 4.6	13.7	< 6.9
OCDF	ND(5.5)	3.7	11	ND(10)	ND(4.0)	ND(6.9)	3.7	4.9	3.5
Total PCDD	1087	766	1938	855	286	682	1021	924	759
Total PCDF	82	84	133	75	29	26	85	270	136
Total PCDD/Fs	1169	850	2071	930	315	708	1107	1194	895
PCDD TEQ	14	21	31	39	16	12	18	27	45
PCDF TEQ	14	9	18	8	3	4	7	22	10
PCDD/F TEQ	28	30	49	47	19	16	25	48	55

Totals are rounded. ND = not detected, with detection limit in brackets. For TEQ calculation and total PCDD/F, ND or < contributes half to detection limits. \* See reference #2.