

Semen and Blood Dioxin and Dibenzofuran Levels in Vietnamese and Americans

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Introduction

There is concern among some US male Vietnam veterans, of whom there are almost 3 million, about health consequences of exposure to the defoliant Agent Orange, which was contaminated with 2,3,7,8-TCDD. The concerns include the potential for adverse reproductive/developmental health outcomes. Hatch and Stein hypothesized that if adverse paternal reproductive/developmental outcomes were to occur following Agent Orange dioxin exposure, they might be related to elevated dioxin levels in semen (1).

Until recently it was not technically feasible to measure dioxins in semen. We have recently published the first reports of dioxin and dibenzofuran levels in semen. The semen was collected from US Vietnam veterans (2,3). This paper extends these findings by presenting dioxin levels of semen from Vietnamese men, and by reporting the lipid content of the semen. We found elevated TCDD in the semen of these Vietnamese potentially exposed to Agent Orange, consistent with such exposure. We relate the findings in semen to findings in blood from persons residing in Vietnam and the US.

Materials and Methods

The semen samples from South Vietnam were collected in 1994 at Tan My village, Song Be Province, from 97 men, mean age 44.7 years. The village is in an area heavily sprayed by Agent Orange during the war. Semen was collected in chemically clean glass containers and frozen. Semen was thawed for pooling and then kept frozen until analyzed in Germany. Analytical methods have been described previously for other biological specimens and will not be repeated (4).

Whole blood samples from Vietnam were collected during 1991 from the South, Center, and North of Vietnam. Blood from 30 to 50 donors at each site was pooled (5).

For comparison with Vietnamese data, American blood and semen data are presented (3). Fifty Michigan Vietnam veterans were recruited to contribute blood samples during 1991 and 1992. Seventeen of these volunteered to contribute semen. Blood samples were analyzed individually. Composite semen samples were needed to provide sufficient volume for analysis. Three composites were analyzed, from 7, 6, and 4 veterans, respectively.

Results and Discussion

Of the fifty Vietnam veterans, only six had elevated blood levels of TCDD, more than 10 pg/g lipid based, consistent with exposure to Agent Orange (2). For the remaining 44 veterans, TCDD levels ranged from 0.9 to 8.3 pg/g, with a mean of 3.8 pg/g, equivalent to background level for the U.S. population. For the present comparison, the six elevated TCDD scores have been omitted so that the sample is more representative of the general population. Levels for other dioxins and for dibenzofurans are means for all fifty subjects. None of the six veterans with elevated TCDD levels were among the semen donors.

The results were converted to dioxin toxic equivalents (TEQ), using the international toxic equivalency factors. Table 1 and Figure 1 give the TEQ levels, pg/g, for the blood samples from Vietnam and the US. Means of pooled blood TCDD levels for southern and central Vietnamese are elevated, but range from a low of 2.9 to 77.0 (not shown) (5). The wide range suggests that high exposures occur mostly in areas where intense spraying of herbicides occurred. Though not shown here, 1840 ppt TCDD was measured in milk lipid from a 1970 sample of a nursing woman residing in an area (Tan Uyen village) sprayed with Agent Orange (5).

Results of analyses of pooled semen samples on a wet weight basis are shown in Table 2 and Figure 2 in parts per quadrillion. The lipid fraction was 0.12% for the Vietnamese, but was not determined for the American samples. In this study we find that the men from a southern Vietnamese village that had been sprayed with Agent Orange have semen levels of TCDD more than twice as high as the American men. Levels of other PCDD congeners and of PCDFs are higher for the Americans, consistent with exposure to PCDD/F incineration products. Total semen dioxin TEQ is nearly the same for Vietnamese and Americans.

The present study confirms our previous finding of dioxin and dibenzofuran congeners in semen and is consistent with the hypothesis that elevated TCDD can be found in semen following exposure. Further research will be needed to demonstrate whether elevated dioxin levels in semen contributes to male mediated adverse reproductive/developmental outcomes.

Acknowledgments

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Table 1. Dioxin and Dibenzofuran TEQ Levels in Blood of Vietnamese and Americans
 pg/g (ppt), lipid basis

Congener	Vietnam			USA
	Southern n = 433	Central n = 183	Northern n = 82	Michigan n = 50
2,3,7,8-TCDD	12.9	13.2	2.2	3.8*
1,2,3,7,8-PeCDD	4.0	8.2	2.1	4.6
1,2,3,4,7,8-HxCDD	0.7	1.3	0.4	0.7
1,2,3,6,7,8-HxCDD	2.9	4.6	1.3	7.2
1,2,3,7,8,9-HxCDD	0.8	1.3	0.5	1.2
1,2,3,4,6,7,8-HpCDD	0.8	0.8	0.3	1.2
1,2,3,4,6,7,8,9-OCDD	0.6	0.8	0.1	0.8
2,3,7,8-TCDF	0.2	0.3	0.5	0.2
1,2,3,7,8-PeCDF	0.1	0.1	0.1	0.1
2,3,4,7,8-PeCDF	4.2	7.5	3.8	4.4
1,2,3,4,7,8-HxCDF	2.1	6.7	2.1	1.1
1,2,3,6,7,8-HxCDF	1.3	4.0	1.1	0.6
1,2,3,7,8,9-HxCDF	0.1	0.1	0.1	0.3
2,3,4,6,7,8-HxCDF	0.2	0.3	0.2	0.3
1,2,3,4,6,7,8-HpCDF	0.4	0.8	0.5	0.2
1,2,3,4,7,8,9-HpCDF	0.0	0.0	0.0	0.0
1,2,3,4,6,7,8,9-OCDF	0.0	0.0	0.0	0.0
Total PCDDs	22.7	30.2	6.9	19.5
Total PCDFs	8.6	19.8	8.4	7.1
Total PCDD/Fs	31.3	50.0	15.3	26.6

* For TCDD values only, n=44

n.a.: not analyzed because of interference

n.d.: not detected

0.0: detected, < 0.05

Figure 1. Dioxin TEQ Levels in Blood of Vietnamese and Americans
 ppt, lipid basis

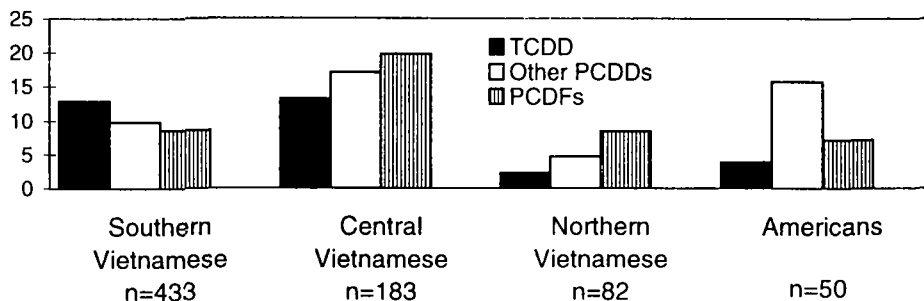


Table 2. Dioxins and Dibenzofurans in Semen of Vietnamese and of Americans
ppq, wet basis

	Measured Levels		TEQ*	
	Vietnamese n = 97	Americans n = 17	Vietnamese n = 97	Americans n = 17
2,3,7,8-TCDD	7.6	2.8	7.6	2.8
1,2,3,7,8-PeCDD	3.2	3.7	1.6	1.8
1,2,3,4,7,8-HxCDD	n.d.	3.6	0.1	0.4
1,2,3,6,7,8-HxCDD	11.3	25.3	1.1	2.5
1,2,3,7,8,9-HxCDD	4.2	7.9	0.4	0.8
1,2,3,4,6,7,8-HpCDD	31.0	86.4	0.3	0.9
1,2,3,4,6,7,8,9-OCDD	316	814	0.3	0.8
2,3,7,8-TCDF	n.d.	0.6	0.1	0.1
1,2,3,7,8-PeCDF	n.d.	1.1	0.0	0.1
2,3,4,7,8-PeCDF	2.3	3.0	1.1	1.5
1,2,3,4,7,8-HxCDF	4.0	5.5	0.4	0.6
1,2,3,6,7,8-HxCDF	2.6	5.3	0.3	0.5
1,2,3,7,8,9-HxCDF	n.d.	1.7	0.1	0.2
2,3,4,6,7,8-HxCDF	0.8	0.4	0.1	0.0
1,2,3,4,6,7,8-HpCDF	7.8	4.5	0.1	0.0
1,2,3,4,7,8,9-HpCDF	n.d.	2.0	0.0	0.0
1,2,3,4,6,7,8,9-OCDF	n.d.	217	0.0	0.2
Total PCDDs	373	944	11.4	9.9
Total PCDFs	17.5	241	2.2	3.2
Total PCDD/Fs	390	1186	13.6	13.1

*Calculated with n.d. = 1/2 limit of detection

n.a: not analyzed because of interference

n.d: not detected

0.0: detected, < 0.05

Figure 2. Dioxin TEQ in Semen of Southern Vietnamese and Americans
ppq, Wet Basis

