DIOXIN AND DIBENZOFURAN LEVELS IN THE BLOOD OF EXPOSED MALE AND FEMALE RUSSIAN WORKERS WITH CHLORACNE AS COMPARED TO CONTROLS

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INTRODUCTION

Three male and four female chemical workers were exposed to dioxins at a factory in Ufa, Russia, approximately 22 years prior to blood collection in 1991 and analysis in 1992. In 1969, five of the seven (three male and two female), were diagnosed with chloracne after manufacturing 2,4,5-trichlorophenoxy-acetic acid at the Agrochemical complex in that city. This is the first known example of female occupational exposure to 2,3,7,8-TCDD resulting in chloracne. These workers exhibit elevated values of 2,3,7,8-TCDD ranging from 36 to 291 parts per trillion (ppt), with a mean of 185 ppt. We compare the dioxin and dibenzofuran levels and dioxin toxic equivalents of these workers with that of non-exposed Russians and calculate half-lives and estimated body burden in 1969. We also measured the coplanar PCBs in these workers and believe this to be the first measurement of such in blood of Eastern Europeans.

METHODS

The whole blood samples from UFA were analyzed by the addition of ^{13}C-labelled PCDDs/PCDF/coPCBs, ethanol and aqueous ammonium sulfate, extracted twice with hexane. The hexane extracts were washed with water, dried, and evaporated to dryness to determine the extractable lipid content of the samples (all values are expressed on a lipid basis). The extracts were then defatted with concentrated sulfuric acid, cleaned up successively with acid/base silica, Florisil, and carbon columns. Determination was by GC-MS on a DB-5 capillary column at 10K mass resolution using the isotope dilution internal standard method.[1] Controls were analyzed by methods previously referenced.[2]

RESULTS AND DISCUSSION

The dioxin, dibenzofuran, and PCB results are shown on Table I. Dioxin toxic equivalents (TEQ) are calculated using current estimates of toxicity.[3-5] All of the workers sampled demonstrate elevated 2,3,7,8-TCDD twenty-two years after initial exposure, ranging from 36 to 291 ppt, lipid, with a mean of 185. Five of the workers developed chloracne in 1969. However, one of these has the lowest 2,3,7,8-TCDD blood concentration of the group while two workers with higher levels did not display chloracne. Therefore, while the presence of chloracne indicates dioxin exposure, its absence does not preclude such exposure as noted previously by many authors, ourselves included,[6] and by Mocarelli, Patterson, et al.[6]

Table II illustrates our estimations, using 5 and 10 year half-lives, of the 2,3,7,8-

TCDD blood levels, 2,3,7,8-TCDD body burden, and total PCDD/F TEQ of these workers in 1969.

This incident offers the opportunity to study possible differences between men and women in their response to dioxins since some of these occupationally exposed women developed chloracne, demonstrating genetic sensitivity to dioxins. Information concerning levels of dioxins related to many endpoints including cancer in women and adverse reproductive effects may also be studied from this group. Until now, studies of U.S. and European dioxin exposed workers usually involved males only. Environmental exposures of women to dioxins have occurred in the south of Vietnam, from Agent Orange;[2,8] from the Yusho and Yu-Cheng incidents where food was cooked in rice oil contaminated with PCBs and PCDFs;[9,10] and in Seveso, Italy where an accident resulted in a cloud of toxic material containing 2,3,7,8-TCDD being released over a large area.[7]

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TABLE I
DIOXIN, DIBENZOFURAN LEVELS AND TOXIC EQUIVALENTS IN BLOOD LEVELS OF 7 UFA FACTORY WORKERS

Sample #/Sex	TEQ	General Population N=68	#1 (M)	#2 (M)	#3 (M)	#4 (F)	#5 (F)	#6 (F)	#7 (F)
Chloracne (Y/N)			Y	Y	Y	N	N	Y	Y
2378-TCDD	1	4.4	36	165	287	96	134	291	287
12378-PnCDD	0.5	8.8	19	31	36	61	54	71	70
123478/123678-HxCDD	0.1	10.6	8.8	14	22	32	33	28	21
123789-HxCDD	0.1	2.3	ND(3)	ND(7)	ND(8)	ND(9)	ND(10)	ND(9)	ND(8)
1234678-HpCDD	0.01	13.5	3.9	14	15	15	25	26	38
OCDD	0.001	85.2	55	131	153	114	190	196	161
2378-TCDF	0.1	2.3	ND(3)	ND(4)	ND(3)	ND(2)	ND(4)	ND(5)	ND(5)
12378-PnCDF	0.05	ND(1.09)	ND(2)	ND(2)	ND(2)	ND(3)	ND(2)	ND(3)	ND(3)
23478-PnCDF	0.5	9.9	18	14	23	22	28	35	53
123478/123678-HxCDF	0.1	13	17	19	28	24	44	27	26
234678-HxCDF	0.1	1.3	ND(5)	ND(8)	ND(5)	ND(4)	12	6.8	ND(5)
1234678-HpCDF	0.01	6.1	12	15	27	30	36	26	29
OCDF	0.001	<8*	ND(10)	11	13	ND(10)	22	28	28
Total PCDDs		125	124	359	517	323	441	617	581
Total PCDFs		37	57	66	97	86	145	127	143
Total PCDD/Fs		162	181	425	614	409	586	744	724
Total TEQ		17	58	193	323	145	185	352	355
3,3',4,4'-TCB (77)	0.01	NA	ND(90)	ND(180)	ND(190)	ND(120)	ND(780)	ND(250)	ND(200)
3,3'4,4'5-PnCB (126)	0.1	NA	69	170	183	108	ND(100)	254	260
3,3'4,4'5,5'-HxCB (169)	0.05	NA	63	36	104	93	81	68	69

Data for General population from Russia from Baikalsk and St. Petersburg NA= not available ND= not detected *=N=8

TABLE II
2,3,7,8-TCDD LEVELS AND TOXIC EQUIVALENTS CALCULATED FOR TIME OF EXPOSURE WITH 5 AND 10 YEAR HALF LIVES FOR SEVEN RUSSIAN FACTORY WORKERS

Sample#/Sex	General Population	#1 (M)	#2 (M)	#3 (M)	#4 (F)	#5 (F)	#6 (F)	#7 (F)
TCDD (PPT)								
Present	4.1	36	165	287	96	134	291	287
Assuming 5 year halflife	-	760	3481	6055	2025	2827	6140	6055
Assuming 10 year halflife	-	165	757	1318	441	616	1336	1318
BODY BURDEN OF TCDD (UG)*								
Present		0.675	3.1	5.4	1.6	2.2	4.7	4.7
Assuming 5 year halflife		14.2	65.3	113.5	32.9	45.9	99.8	98.4
Assuming 10 year halflife		3.1	14.2	24.7	7.2	10.0	21.7	21.4
TOXIC EQUIVALENTS								
Present	17.5	58	193	323	145	185	352	355
Assuming 5 year halflife	-	782	3509	6091	2074	2878	6201	6123
Assuming 10 year halflife	-	187	785	1354	490	667	1397	1386

* = Body burden calculated assuming 25% fraction lipid, a 75 kg body weight for males, and 65 kg body weight for females. Samples collected in 1991, analyzed in 1992, calculations assume initial exposure occurred 22 years ago. Totals are rounded. Calculations assume that only 2378-TCDD differed in blood levels at the time of exposure, 22 years ago.