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# Persistent organic pollutants in 9/11 world trade center rescue workers: Reduction following detoxification

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**Abstract**

Exposure to toxins following the September 11, 2001 attack on and collapse of the World Trade Center (WTC) is of particular concern given the ultra fine particulate dust cloud, high temperature combustion, and months-long fire. Firefighters, paramedics, police and sanitation crews are among the approximately 40000 personnel who labored for weeks and months on rescue and cleanup efforts. Many of the rescue workers have subsequently developed symptoms that remain unresolved with time. This study characterizes body burdens of polychlorinated biphenyls (PCBs), polychlorinated dibenzofurans (PCDFs), and polychlorinated dioxins (PCDDs) in rescue workers and citizens exposed following the WTC collapse. Our research includes a pilot evaluation of a detoxification method aimed at reducing toxic burden. Many congeners were found at elevated levels, in ranges associated with occupational exposures. Post-detoxification testing revealed reductions in these congeners and despite the small study size, some reductions were statistically significant. Health symptoms completely resolved or were satisfactorily improved on completion of treatment. These results argue for a larger treatment study of this method and an overall treatment approach to address toxic burden.


*Keywords:* Environment; Exposure; Dioxin; Dibenzofuran; PCB; Treatment

## 1. Introduction

Rescue workers present at the World Trade Center (WTC) following the September 11, 2001 terrorist attacks were exposed to large quantities of dust, smoke and fumes from the building's collapse and subsequent fire. The fire at the WTC site burned for months. Firefighters, paramedics, police and sanitation crews were among the approximately 40000 personnel who labored for weeks and months in the immediate vicinity of the WTC. Personal Protective Equipment (PPE) use was inconsistent (Kipen and Gochfeld, 2002), and contaminant exposure occurred in a number of ways including dermal absorption and inhalation.

Many of the rescue workers developed persistent coughs, headaches, memory disturbances and other symptoms while working on the site. Two and a half years later, these symptoms persisted (Prezant et al., 2002). USEPA measured levels of benzene, dioxins and polychlorinated biphenyls (PCBs) in air and found these levels were elevated in the weeks after the collapse. (Litten et al., 2003) Dioxins slowly returned to normal background levels after three months. (Litten et al., 2003) The New York (NY) Department of Environmental Conservation (DEC) analyzed dust/ash samples collected nearby the WTC site.

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The purpose of this study was two-fold: 1. To characterize body burdens of polychlorinated biphenyls (PCBs), polychlorinated dibenzofurans (PCDFs), and polychlorinated dioxins (PCDDs) in exposed rescue workers and citizen. 2. A pilot evaluation of a treatment method aimed at reducing toxic burden.

## 2. Methods and materials

Seven men who were present at the WTC collapse and involved in the rescue and cleanup effort received treatment at the New York Rescue Workers Detoxification Project in April 2004 and agreed to participate in this study. Five were employed by the New York Fire Department (FDNY), one was a volunteer rescue worker and one worked at the nearby at the NY Stock Exchange. All were at the site the day of and several weeks after the collapse when exposure would have been the highest. The rescue workers used little or no protective respiratory gear during the WTC cleanup and all currently live or work in New York. The average age was 44 (range is 37–53).

These individuals volunteered to have their blood drawn to measure the levels of polychlorinated biphenyls (PCBs), polychlorinated dibenzofurans (PCDFs), and polychlorinated dioxins (PCDDs). Fifty milliliters of whole blood was drawn in chemically cleaned glass containers prepared by the analytic laboratory with anticoagulant with Teflon® tops containing no paper products. Blood was frozen and sent frozen on dry ice to Germany for polychlorinated dioxin and furan analysis at ERGO Laboratory, a World Health Organization certified dioxin laboratory. Analysis was performed by gas chromatography/high-resolution mass spectrometry by methods previously described (Päpke et al., 1989). Measured levels were converted to dioxin toxic equivalents (TEQ) using the 1998 WHO toxic equivalency factors (TEFs) (Van den Berg et al., 1998).

These subjects also participated in a series of testing including thorough medical examination, structured health and symptom questionnaires, and neurophysiological testing.

All tests, evaluations, and sample collections were repeated approximately one month after initial testing in order to provide a comparison. Following the second period baseline evaluation, the study subjects enrolled in the detoxification treatment regimen developed by Hubbard, which included exercise, sauna bathing and vitamin and mineral supplements developed to reduce the adverse effects of chemical exposures. (Schnare et al., 1982; Tretjak et al., 1990) On completion of treatment, all subjects had their blood drawn for post-treatment evaluation.

## 3. Results

The measured dioxin, dibenzofuran, and PCB congener levels and TEQ for each subject before and after detoxification is presented in Table 1. Prior to detoxification treatment, five rescue workers (HB50605, WB5005, WB8008, WB9009, WB13013) had elevated levels of 2,3,3′,4,4′-PeCB (105), 2,3′,4,4′,5-PeCB (118) and/or 2,3,3′,4,4′,5-HxCB (156). Patient H 5-0605 was a firefighter who we initially tested in May 2003. Pre treatment, total mono-ortho PCB blood levels ranged from 19 ppb to 404 ppb (WHO-TEQ 8.2–133.3) with a geometric mean of 41 ppb (WHO-TEQ of 29.3). Pre-treatment, total non-ortho PCB blood levels ranged from 43 ppt to 328 ppt (WHO-TEQ 3.9–111.9), with a geometric mean of 81.8 ppt (WHO-TEQ of 13.1).

Table 2 displays the mean and median difference for each congener following detoxification. The $p$-value is calculated using the Wilcoxon singed-rank test, which is a non-parametric test that uses ranks of the data consisting of matched pairs. By using ranks, this test takes the magnitudes of the differences into account. Due to the small sample size, we cannot assume normality of the data. A non-parametric test is the best test for our study. The means and medians listed in Table 2 are for the differences between the congener before and after detoxification. Therefore, a positive score reflects a mean/median where the average levels of dioxin, dibenzofuran and PCBs dropped, while a negative score reflects where the average levels increased.

Following detoxification, calculated WHO-TEQs for mono-ortho PCB blood levels decreased by an average 65%, as shown in Fig. 1. Measured levels ranged from 15 ppb to 302 ppb (WHO-TEQ 3.6–133.3) with a geometric mean of 32 ppb (WHO-TEQ of 8). Non-ortho WHO-TEQs averaged a 57% decrease as shown in Fig. 2. Measured levels ranged from 33 ppt to 229 ppt (WHO-TEQ 1.6–17).

Mono-ortho and non-ortho PCB levels in rescue workers were measured twice in one month prior to detoxification to determine the change in levels, or the lack thereof, with the absence of treatment. As shown in Fig. 3, during this one-month period of no treatment, PCB mean concentration levels had a 4% insignificant increase. In contrast, all rescue workers had measurable decreases in these PCBs following treatment. Brominated dioxins, brominated dibenzofurans, and polybrominated diphenyl ether congeners were at low levels or below the limit of detection (data not shown).

Subjects reported a similar pattern of health complaints and manifested symptoms including respiratory impairment, mental/emotional distress (two met PTSD criteria), decreased sensory systems, chronic muscle and joint pain, gastrointestinal disorders, and skin rashes. These symptoms were completely resolved or were satisfactorily improved on completion of treatment. The neurophysiological test results also improved. Fig. 4 shows the change in mean severity of self-reported symptoms as measured by a questionnaire.

## 4. Discussion

In view of the documented persistence of adverse health effects in individuals exposed during the collapse of the WTC, it is important to not only document symptoms and possible causes but to identify workable treatment

Table 1
Measured dioxin, dibenzofuran, and polychlorinated biphenyl levels[a] before and after treatment of WTC-exposed individuals, NY 2004

| Identification | WTC002 | | WTC005 | | WTC006 | | WTC009 | | WTC011 | | WTC013 | | H50605 [b] | | Comparison NHANES III | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Congener | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post | L.O.D. | 75th |
| 2.3.7.8-Tetra-CDD | 1.9 | 1.3 | 3.2 | 2.1 | 2.2 | 1.8 | 1.4 | 1.7 | 3.0 | 1.4 | 1.6 | 1.6 | 2.6 | 2.0 | 4.8 pg/g | n.d. |
| 1.2.3.7.8-Penta-CDD | 5.3 | 4.1 | 7.1 | 7.0 | 8.1 | 7.3 | 5.8 | 7.1 | 4.1 | 3.5 | 4.1 | 5.7 | 6.3 | 6.2 | 5.3 | n.d. |
| 1.2.3.4.7.8-Hexa-CDD | 4.0 | 3.5 | 6.5 | 5.6 | 6.1 | 4.8 | 5.8 | 6.3 | 2.4 | n.d.(2) | n.d.(4) | n.d.(4) | 6. | 9.6 | | |
| 1.2.3.6.7.8-Hexa-CDD | 31 | 29 | 38 | 35 | 49 | 44 | 33 | 40 | 20 | 14 | 15 | 16 | 41 | 36 | 7.5 | 36.1 |
| 1.2.3.7.8.9-Hexa-CDD | 2.8 | 3.4 | 5.6 | 5.9 | 5.1 | 6.2 | 4.0 | 5.8 | 5.4 | 3.4 | n.d.(3) | n.d.(3) | 5.6 | 6.3 | 7.6 | n.d. |
| 1.2.3.4.6.7.8-Hepta-CDD | 26 | 27 | 56 | 54 | 48 | 42 | 51 | 63 | 21 | 26 | 24 | 25 | 47 | 55 | 24.7 | 61.9 |
| OCDD | 94 | 95 | 272 | 250 | 437 | 426 | 195 | 242 | 66 | 79 | 134 | 114 | 186 | 251 | 145 | 445 |
| 2.3.7.8-Tetra-CDF | n.d.(1) | n.d.(1) | 1.2 | 1.2 | n.d.(1) | n.d.(1) | n.d.(1) | n.d.(1) | n.d.(1) | n.d.(1) | 1.3 | 1.4 | 1.3 | 1.4 | 4.6 | n.d. |
| 1.2.3.7.8-Penta-CDF | n.d.(1) | n.d.(1) | 1.3 | 1.3 | n.d.(1) | n.d.(1) | n.d.(1) | n.d.(1) | n.d.(1) | n.d.(1) | 1.1 | 1.1 | 1.9 | 1.9 | 5 | n.d. |
| 2.3.4.7.8-Penta-CDF | 3.4 | 4.0 | 10.3 | 9.8 | 7.7 | 7.9 | 4.7 | 6.0 | 3.5 | 2.9 | 6.6 | 6.3 | 9.1 | 10 | 4.8 | n.d. |
| 1.2.3.4.7.8-Hexa-CDF | 4.3 | 4.7 | 9.2 | 8.8 | 8.2 | 6.8 | 7.3 | 7.3 | 3.8 | 4.2 | 6.0 | 6.6 | 10.4 | 13 | 4.7 | n.d. |
| 1.2.3.6.7.8-Hexa-CDF | 3.2 | 3.4 | 7.0 | 7.1 | 7.5 | 6.6 | 3.9 | 6.1 | 2.3 | 3.3 | 4.8 | 5.6 | 7.2 | 10 | 4.8 | n.d. |
| 1.2.3.7.8.9-Hexa-CDF | n.d.(1) | n.d.(1) | n.d.(1) | n.d.(1) | n.d.(1) | n.d.(2) | n.d.(1) | n.d.(2) | n.d.(2) | n.d.(2) | n.d.(3) | n.d.(3) | n.d.(5) | n.d.(5) | 4.6 | n.d. |
| 2.3.4.6.7.8-Hexa-CDF | 1.4 | n.d.(2) | 3.5 | 2.7 | 2.3 | 1.5 | 2.5 | 2.1 | 1.6 | n.d.(1) | 5.4 | 5.4 | 2.1 | 6.0 | 4.8 | n.d. |
| 1.2.3.4.6.7.8-Hepta-CDF | 3.1 | 2.7 | 4.8 | 5.5 | 5.7 | 6.5 | 5.9 | 8.3 | 3.6 | 5.0 | 5.7 | 4.4 | 6.1 | 6.8 | 5.2 | n.d. |
| 1.2.3.4.7.8.9-Hepta-CDF | n.d.(2) | n.d.(1) | n.d.(1) | n.d.(2) | n.d.(1) | n.d.(3) | n.d.(1) | n.d.(2) | n.d.(2) | n.d.(3) | n.d.(5) | n.d.(5) | n.d. | n.d.(8) | | |
| OCDF | n.d.(4) | n.d.(3) | n.d.(3) | n.d.(5) | n.d.(3) | n.d.(10) | n.d.(4) | n.d.(5) | n.d.(6) | n.d.(11) | n.d.(22) | n.d.(24) | n.d. | n.d.(33) | 12.6 | n.d. |
| 3,3',4,4'-TCB (77) | n.d.(14) | n.d.(24) | n.d.(13) | n.d.(17) | n.d.(12) | n.d.(22) | n.d.(18) | n.d.(27) | n.d.(17) | n.d.(23) | n.d.(26) | n.d.(28) | 68. | n.d.(31) | | |
| 3,4,4',5-TCB (81) | n.d.(2) | 2.6 | 2.5 | 3.8 | n.d.(2) | 2.4 | 2.4 | 4.6 | n.d.(3) | 3.3 | 5.2 | 9.0 | 12.0 | 9 | 25.8 | n.d. |
| 3,3',4,4',5-PeCB (126) | 23 | 28 | 44 | 41 | 64 | 65 | 41 | 44 | 20 | 14 | 36 | 39 | 197 | 163 | 9 | n.d. |
| 3,3',4,4',5,5'-HxCB (169) | 21 | 28 | 23 | 23 | 48 | 49 | 26 | 43 | 23 | 16 | 31 | 28 | 51 | 56 | 9.9 | n.d. |
| 2,3,3',4,4'-PeCB (105) | 1203 | 1006 | 7908 | 5222 | 537 | 443 | 4050 | 3626 | 1881 | 1184 | 1782 | 1886 | 41765 | 31469 | 6400 | n.d. |
| 2,3,4,4',5-PeCB (114) | 675 | 581 | 1906 | 1380 | 1253 | 1000 | 980 | 887 | 771 | 500 | 1236 | 1289 | 17746 | 13986 | 6400 | n.d. |
| 2,3',4,4',5-PeCB (118) | 6153 | 4955 | 31225 | 22656 | 4665 | 3266 | 20163 | 16772 | 9408 | 5355 | 10062 | 9705 | 207921 | 152910 | 6400 | 14700 |
| 2',3,4,4',5-PeCB (123) | 232 | 234 | 492 | 556 | 283 | 227 | 245 | 421 | 149 | 174 | 310 | 373 | 1900 | 2853 | | |
| 2,3,3',4,4',5-HxCB (156) | 8045 | 6807 | 6987 | 4598 | 9759 | 7214 | 6478 | 6403 | 7501 | 4290 | 9977 | 9371 | 95751 | 66304 | 6400 | n.d. |
| 2,3,3',4,4',5'-HxCB (157) | 1596 | 1548 | 1396 | 1086 | 2042 | 1606 | 1480 | 1523 | 1550 | 1003 | 2485 | 2293 | 18706 | 16126 | 6400 | n.d. |
| 2,3',4,4',5,5'-HxCB (167) | 756 | 798 | 2029 | 1601 | 1096 | 911 | 1683 | 1802 | 1047 | 2123 | 1918 | 1867 | 18881 | 16344 | 6400 | n.d. |
| 2,3,3',4,4',5,5'-HpCB (189) | 531 | 629 | 475 | 430 | 952 | 955 | 594 | 790 | 523 | 413 | 846 | 738 | 2324 | 2336 | | |
| Total PCDDs/PCDFs | 180 | 177 | 424 | 396 | 587 | 562 | 320 | 395 | 136 | 142 | 210 | 193 | 333 | 416.1 | | |
| Total non-ortho-PCBs | 44 | 58 | 70 | 68 | 112 | 116 | 70 | 91 | 43 | 33 | 72 | 76 | 328 | 229 | | |
| Total mono-ortho-PCBs | 19191 | 16558 | 52417 | 37530 | 20587 | 15623 | 35673 | 32223 | 22832 | 15042 | 28616 | 27521 | 404994 | 302328 | | |
| Total WHO-TEQ PCDDs/PCDFs | 13.9 | 12 | 23.1 | 21 | 22.4 | 21 | 15.8 | 19 | 12.7 | 9.1 | 13 | 14 | 21 | 22 | | |
| Total WHO-TEQ non-ortho-PCBs | 8.4 | 3.1 | 13.8 | 4.3 | 14.0 | 7.0 | 11.3 | 4.8 | 8.4 | 1.6 | 3.9 | 4.2 | 111.9 | 17 | | |
| Total WHO-TEQ mono-ortho-PCBs | 22.3 | 5.2 | 37 | 6.4 | 36.5 | 5.4 | 27.1 | 6.6 | 21 | 3.6 | 8.2 | 7.8 | 133.3 | 67 | | |

[a] Values in pg/g (ppt), lipid based; Samples from Human Blood.
[b] Patient H 5-0605 blood tested in 5/2003 [firefighter sent us his PCB value of 32ppb (Webb and McCall) on 1/9/02].
NHANES III data from Second National Report on Human Exposure to Environmental Chemicals. US Dept of Health and Human Services NCEH Pub. No. 02-0716 March 2003.

Table 2
Mean and median differences for PCDDs, PCDFs and PCBs following detoxification

| Congener | Mean difference | Median difference | (*p*-value) |
|---|---|---|---|
| 2.3.7.8-Tetra-CDD | 0.57 | 0.60 | 0.06 |
| 1.2.3.7.8-Penta-CDD | −0.02 | 0.10 | 0.94 |
| 1.2.3.4.7.8-Hexa-CDD | 0.14 | 0.51 | 0.56 |
| 1.2.3.6.7.8-Hexa-CDD | 1.65 | 2.57 | 0.38 |
| 1.2.3.7.8.9-Hexa-CDD | −0.37 | −0.61 | 0.44 |
| 1.2.3.4.6.7.8-Hepta-CDD | −2.70 | −1.38 | 0.38 |
| OCDD | −10.48 | −0.99 | 0.69 |
| 2.3.7.8-Tetra-CDF | −0.03 | 0.00 | 0.5 |
| 1.2.3.7.8-Penta-CDF | −0.001 | 0.00 | 0.99 |
| 2.3.4.7.8-Penta-CDF | −.23 | −0.24 | 0.58 |
| 1.2.3.4.7.8-Hexa-CDF | −0.32 | −0.37 | 0.47 |
| 1.2.3.6.7.8-Hexa-CDF | −0.32 | −0.37 | 0.47 |
| 1.2.3.7.8.9-Hexa-CDF | * | * | * |
| 2.3.4.6.7.8-Hexa-CDF | 0.15 | 0.75 | 0.44 |
| 1.2.3.4.6.7.8-Hepta-CDF | −0.62 | −0.70 | 0.22 |
| 1.2.3.4.7.8.9-Hepta-CDF | * | | * |
| OCDF | * | * | * |
| 3,3′,4,4′-TCB (77) | 9.71 | 0.00 | 0.99 |
| 3,4,4′,5-TCB (81) | −1.66 | −2.19 | 0.16 |
| 3,3′,4,4′,5-PeCB (126) | 4.39 | −1.31 | 0.69 |
| 3,3′,4,4′,5,5′-HxCB (169) | −2.76 | −0.73 | 0.47 |
| 2,3,3′,4,4′-PeCB (105) | 2041.47 | 423.78 | 0.05 |
| 2,3,4,4′,5-PeCB (114) | 706.42 | 253.28 | 0.03 |
| 2,3′,4,4′,5-PeCB (118) | 10568.20 | 3391.45 | 0.02 |
| 2′,3,4,4′,5-PeCB (123) | −175.35 | −63.00 | 0.08 |
| 2,3,3′,4,4′,5-HxCB (156) | 5644.41 | 2388.82 | 0.02 |
| 2,3,3′,4,4′,5′-HxCB (157) | 581.48 | 310.29 | 0.03 |
| 2,3′,4,4′,5,5′-HxCB (167) | 280.59 | 51.00 | 0.58 |
| 2,3,3′,4,4′,5,5′-HpCB (189) | −6.55 | −2.96 | 0.99 |
| Total PCDDs/PCDFs | −12.86 | 3.03 | 0.94 |
| Total non-ortho-PCBs | 9.61 | −4.00 | 0.81 |
| Total mono-ortho-PCBs | 19640.66 | 4963.62 | 0.02 |

Wilcoxon Rank Test.

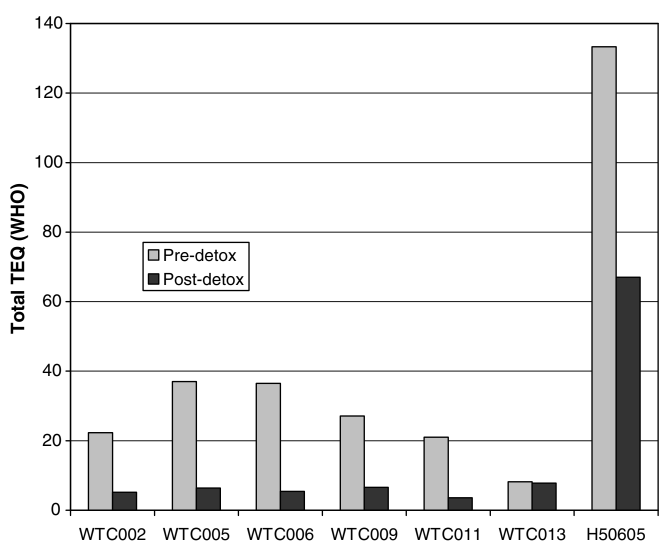


Fig. 1. Changes in Blood Total WHO-TEQ Mono-Ortho PCB Levels with Detoxification.

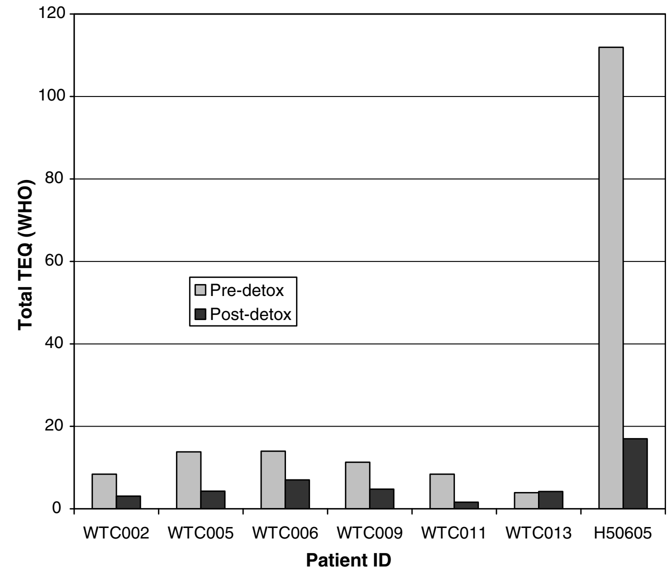


Fig. 2. Changes in Total WHO-TEQ Non Ortho PCB Levels with Detoxification.

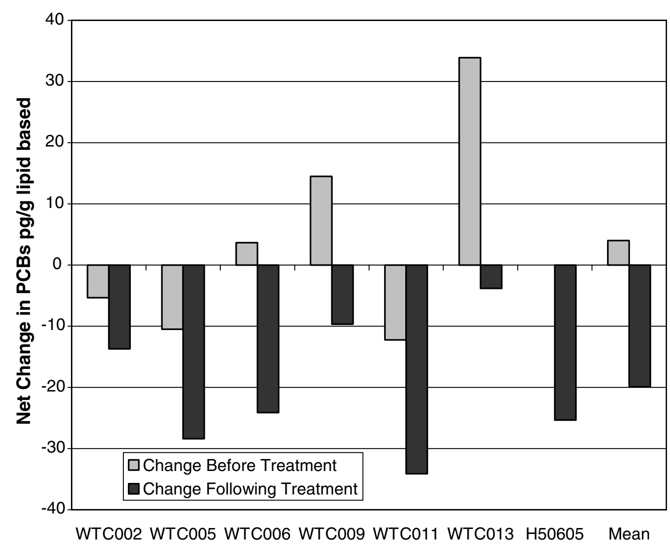


Fig. 3. Change in Mono-Ortho PCB Levels with Treatment Compared with One Month of No Treatment.

modalities. The purpose of characterizing the levels of these compounds was to determine whether compounds of this class could be detected in this population this long after exposure. Additionally, assuming detection, we wanted to know whether their levels could be reduced by detoxification treatment. It is useful to have a marker compound for use in future studies that plan to evaluate the use of this treatment method.

This was a complex exposure involving many different compounds and under many different circumstances. Various reports suggest that PCBs, PCDDs, PCDFs and brominated flame retardants were not above background in the dust at the WTC site when tested 5–6 days after the attack. However the large volume of polybrominated biphenyls and brominated diphenyl ethers could have led to significant ambient exposure during the first few days after the colapse (Lioy et al., 2002). These compounds have

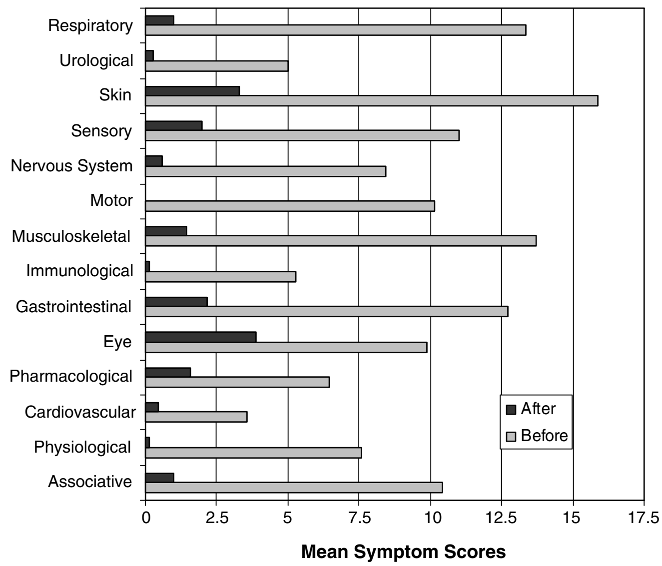


Fig. 4. Self Reported Symptom Severity Before and After Detoxification.

long half-lives. (Schecter et al., 2002a; Schecter et al., 2002b) It is unclear why PCBs but not PCDDs, PCDFs or brominated flame retardant levels were elevated, despite previous positive findings in chemical workers decades after exposure. (Sullivan and Krieger, 1991) We can only measure elevated levels of PCBs and dioxins in the human body if uptake increases body burden significantly. For comparison: the intake via food ranges between 50 and 100 pg TEQ/day. A typical air concentration may be at 0.05 pg TEQ/$m^3$. Even at a 1000 times elevated air concentration, 24 h inhalation (20 $m^3$) adds "only" 1000 pg to the body burden (equivalent to about 10 days additional uptake from food).

The elevated concentrations of the PCB congeners found in some rescue workers appear to be consistent with the several dozen firefighters tested by FDNY and noted to have elevated PCB levels above 12 PPB (as reported by Medilabs, Valley Cottage NY – under contract with the New York City Fire Department Medical Department.). This level was found by using the Webb and McCall technique, which averages 6 ppb in the general population. These levels are considerably higher than would be expected in the general population, and consistent with levels seen in occupational exposure to PCBs. (Edelman et al., 2003) A particular firefighter (Patient HB50605) provided us with results of two prior FDNY-ordered PCB tests (based on Arochlor 1260, Webb and McCall technique). Test results were 32 ppb on January 9th, 2002 and 13 ppb on September 9th, 2002. He had his blood drawn and it was analyzed for dioxin, dibenzofuran and PCB at ERGO laboratory on May 2003 (Table 2). Using a more reliable and sensitive technique, his levels measured 416 ppb (WHO-TEQ 133.3). This firefighter (Patient H 5-0605) had also worked on the day of and several days following the collapse.

A study by Edelman et al, reports an unanticipated increase in heptachlorodibenzodioxin and heptachlorodibenzofuran, associated with exposure from the WTC collapse (Edelman et al., 2003). However, the authors do not presume the exposure to be from the WTC collapse alone.

The symptoms presented by the seven men in this group matched the pattern seen in studies of WTC-exposed populations. (Levin et al., 2004) A 2003 Mt. Sinai/NIOSH/CDC analysis of 250 WTC screening program participants document that approximately half of the sample had persistent WTC-related pulmonary, ENT and/or mental health symptoms that persisted a year following exposure (Grandjean, 2003). The persistent symptomatology and its successive improvements with detoxification is consistent with medical records from the nearly 400 WTC-exposed men and women who completed detoxification treatment.

This pilot study is limited by its small sample size. No relationships can be inferred between the PCB contamination found and the observed symptoms, or between reduction in these levels and the improvements following treatment. However, it is interesting that studies evaluating the adverse effects of high levels of PCB exposure commonly list neurologic, (Chen et al., 1985; Chia and Chu, 1984) immune and neuroendocrine effects (Carpenter, 1998), neurobehavioral effects, (Brown and Nixon, 1979; Schantz et al., 2001) rashes and acne, nausea and other gastrointestinal problems (Agency for Toxic Substances and Disease Registry (ATSDR, 2000)). Occupational studies suggest that exposure to PCBs may also cause irritation to the nose and lungs, blood and liver changes, fatigue, and depression. Furthermore, previous studies of PCB-exposed firefighters have demonstrated neurologic symptom improvement on completion of this treatment. (Kilburn et al., 1989) Prior studies using this method of detoxification showed reduced body burden of PCBs, PBBs and chlorinated pesticides (Schnare et al., 1984). The data presented here will be used for a larger subsequent study where correlations may be further tested. Even three years after the WTC attacks, thousands of exposure victims continue to have persistent illness. New approaches to this public health predicament are urgently needed.

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