

SERUM PCDD, PCDF AND PCB LEVELS IN SHELEKHOV FIREFIGHTERS

Shelepchikov A.A.¹, Chernyak Y.I.², Grassman J.A.³, Brodsky E.S.¹, V.G. Jilnikov¹, E. Ya. Mir-Kadirova¹

¹ Institute of Ecology and Evolution of Russian Academy of Sciences, 33, Leninskiy prosp., Moscow, 119071, Russia;

² Institute of Occupational Health and Human Ecology, East-Siberian Scientific Center of Human Ecology, Siberian Branch of the Russian Academy of Medical Sciences, P.O. Box 1170, Angarsk, 665827, Russia;

³ Brooklyn College-CUNY, 2900 Bedford Avenue, Brooklyn, NY 11210-2889, USA

Introduction

In 1992, a disastrous fire at the "Irkutskcable" factory in the city of Shelekhov, Russia resulted in the combustion of more than 1000 tons of plastics which included polyvinylchloride. During the fire, firefighters avoided using respirators and many of them subsequently developed a complex of neurological syndromes. The high proportion of disabilities distinguishes this cohort from other firefighters in the region. Here we discuss the current level and congener pattern of PCDD/PCDFs and PCBs in the serum of the Shelekhov firefighters and two control groups.

Materials and methods

Detailed descriptions of the analytical methods and the study cohorts are provided in our previous publications and short papers from Dioxin meetings¹. Briefly, four groups of 10 men each were formed: men who never worked as firefighters (**Controls**); firefighters who developed the Shelekhov Syndrome Complex soon after their participation at the fire (**Shelekhov SC**); firefighters who participated in the Shelekhov fire but did not develop the syndromes (**Shelekhov non-SC**); firefighters who did not participate in the 1992 Shelekhov fire (**Firefighter controls**). All samples were analyzed by GC with HRMS detection.

Results and discussion:

Levels of WHO-TEQ⁰⁵_{PCDD/F} and the most distinctive congeners are shown on fig 1 and 5. The mean concentrations do not significantly differ by group. Therefore, WHO-TEQ_{DF} level in the blood of firefighters highly exposed to combustion products of chlorinated plastics in 1992 is comparable with the indices typical for working firefighters who did not participate in the fire suppression at the cable factory. Although the means of WHO-TEQ⁰⁵_{PCDD/F} for groups were not statistically different, the individual firefighter TEQs tend to be higher than the median of Group 5, the non-firefighter controls (fig. 1). The differences between the groups are more obvious when the body burden of PCDD/PCDFs is compared among the subjects (fig. 2). The mean of the control group is particularly influenced by one subject having a high body burden of PCDD/PCDF. Density of distribution analysis of the results for the remaining subjects shows that the upper limit is lower than the values obtained for 12 out of 20 Shelekhov firefighters and 4 out of 10 firefighters from Firefighter control group. The average study participant is 45 years old. When compared to the reference value for their age category (40-59 year old white non-Latin Americans), only the average geometric mean of WHO-TEQ⁰⁵_{PCDD/F+PCB} of the participants in the control group is similar². Levels of dioxin-like compounds among the firefighters are higher due to the contribution of non-dioxin-like PCBs. Both firefighters and the non-firefighter controls had high levels of PCDD/PCDF and PCBs indicating that environment contributes significantly to exposure.

1,2,3,4,6,7,8-HpCDF is the most prominent marker of human exposure to combustion products³. Elevated serum levels of 1,2,3,4,6,7,8-HpCDF indicates recent exposure since it forms in large quantities during combustion but does not bioaccumulate. These characteristics were demonstrated by the levels detected in the serum of firefighters shortly after the September 11 tragedy in World Trade Center in New York³. The concentration of 1,2,3,4,6,7,8-HpCDF measured in the blood of Shelekhov SC firefighters do not differ from the levels measured in the non-firefighter controls. However, although Shelekhov non-SC and Firefighter controls groups have similar mean concentrations, there is greater variability among the Firefighter controls. The variability of 1,2,3,4,6,7,8-HpCDF concentrations decreases in the following order: nonfirefighter controls – former firefighters – working firefighters. The resultant distribution is not changed when total body burden of 1,2,3,4,6,7,8-HpCDF is calculated for each individual (fig. 1,2).

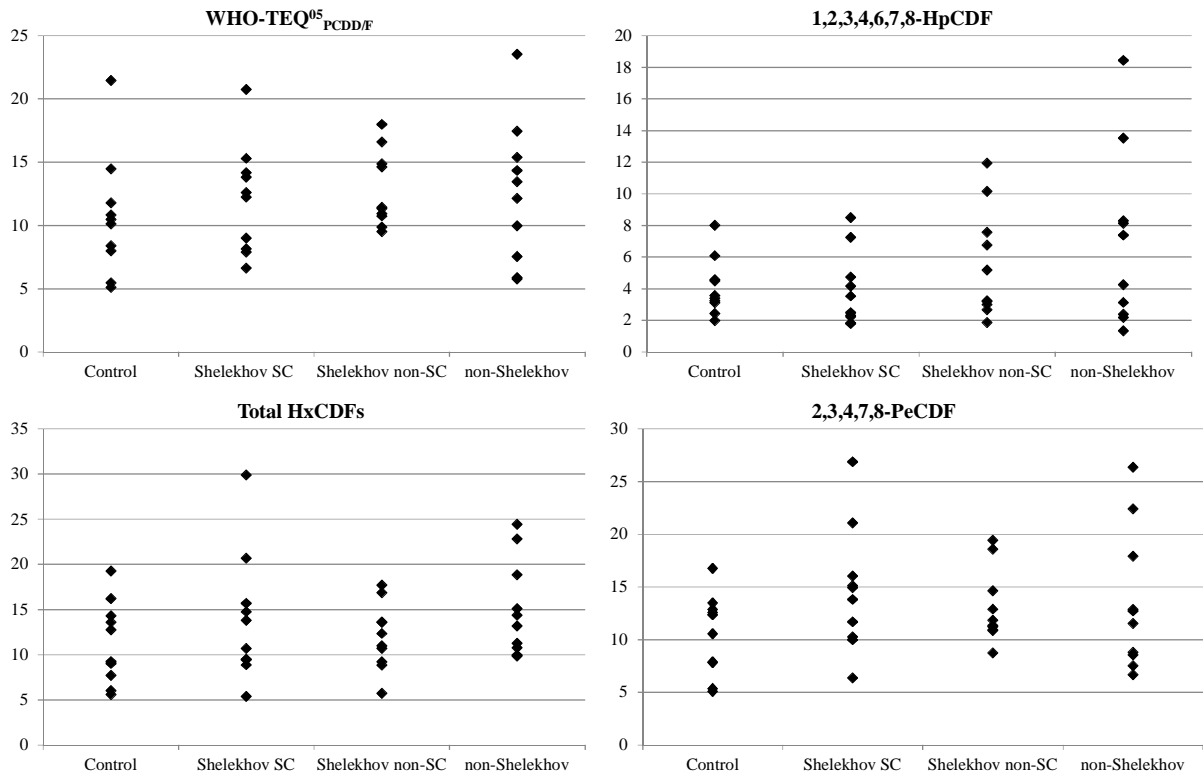


Fig. 1. Serum PCDD and PCDF levels, pg/g lipid

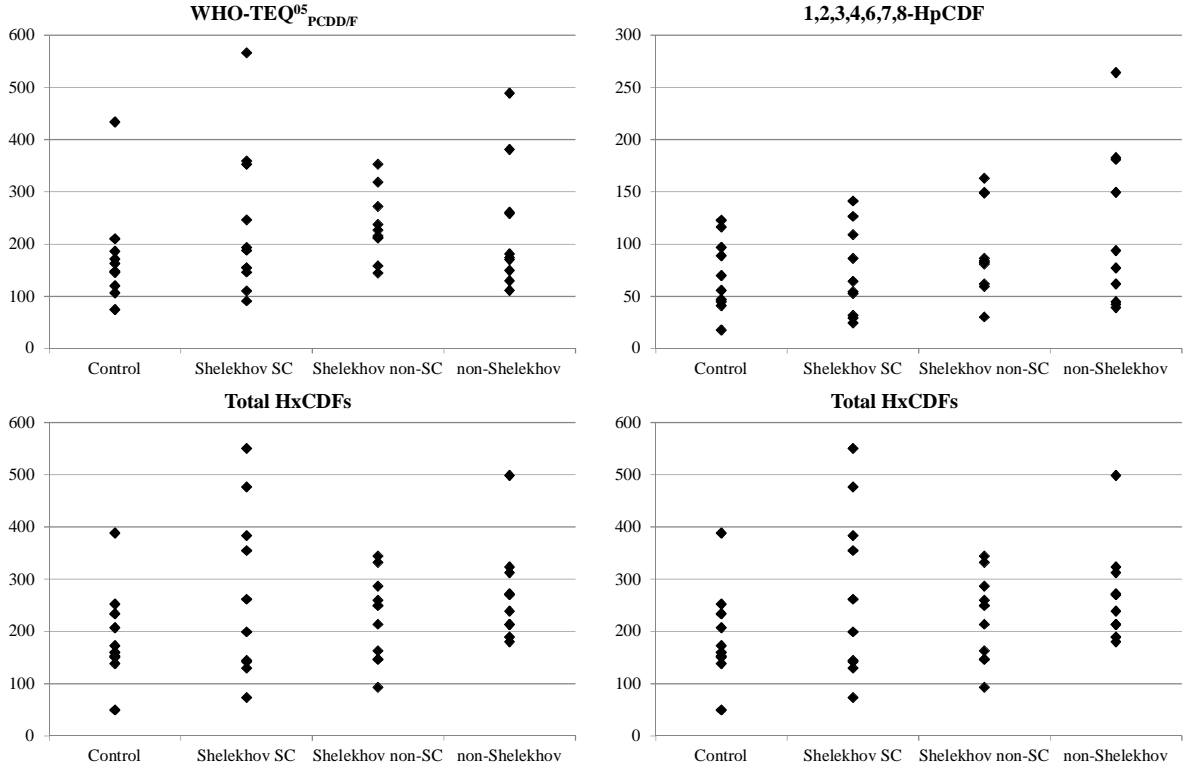


Fig. 2. Body burden PCDD and PCDF levels, ng/body

The level of dioxin-like compounds was proportional to the number of years employed as a firefighter. The contribution of firefighting as a source of exposure is supported by the observation that subjects who stopped working had lower levels of PCDD/PCDF. After cessation of work, the concentrations of these compounds show small increases consistent with those seen with aging (fig 3,4). The body burden levels for the 30 firefighters, 20 of whom participated in the fire suppression at the cable factory in Shelekhov, tends to exceed the levels of the 10 men who never worked as firefighters (fig 3).

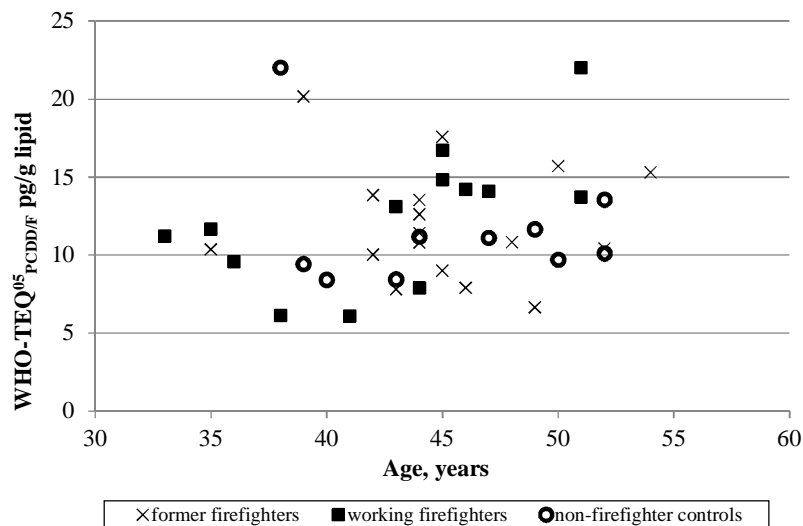


Fig. 3. Change of WHO-TEQ⁰⁵ PCDD/F concentration with age of the surveyed persons

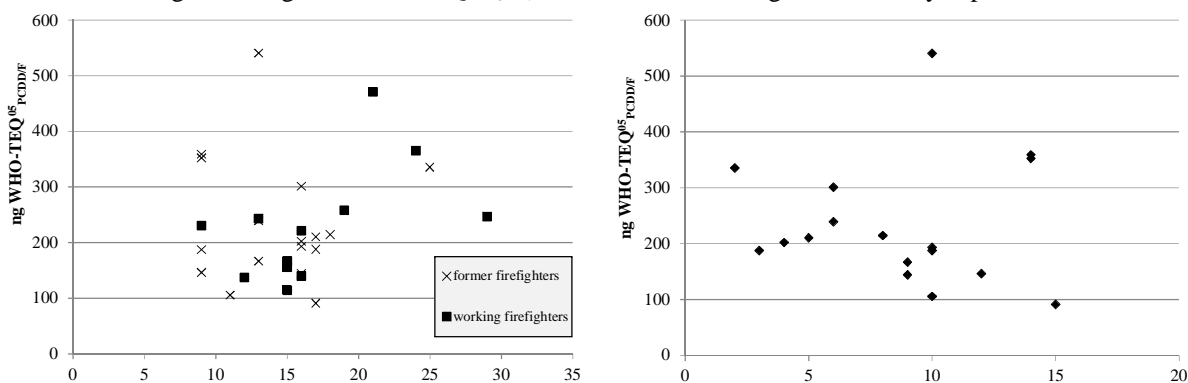


Fig. 4. Serum WHO-TEQ⁰⁵ PCDD/F by years working as a firefighter (left) – by years after cessation of work as firefighter (right).

The study shows that the PCB contribution exceeds 50% of the WHO-TEQ⁹⁸ and 40% - WHO-TEQ⁰⁵. Although PCBs can be formed during combustion, most of them are not regarded as indicators of exposure since the congener profile is not distinct from the profile occurring in common mixtures and environmental contaminants. Among dioxin-like PCBs, PCB-169 is most prominent indicator of combustion. The PCB-169 concentration in technical PCB formulas is significantly lower than PCB-126, but after combustion they are found in equal quantities⁴. We observed that the serum levels of PCB-169 was highest in the blood of Shelekhov SC firefighters whereas a wider range of values was observed amongst the non-Shelekhov firefighters compared to control group (fig. 5). This is more apparent when the body burden of PCB-169 is calculated (fig. 6). Its content in most of the former and working firefighters exceeds 90 percentile for the control group and higher levels remain after they stop working as firefighters. Therefore, PCB-169 as well as 1,2,3,4,6,7,8-HpCDF can be considered reliable markers of exposure to combustion products exposure which is supported by the lack of correlation between these congeners in the control group (fig. 7).

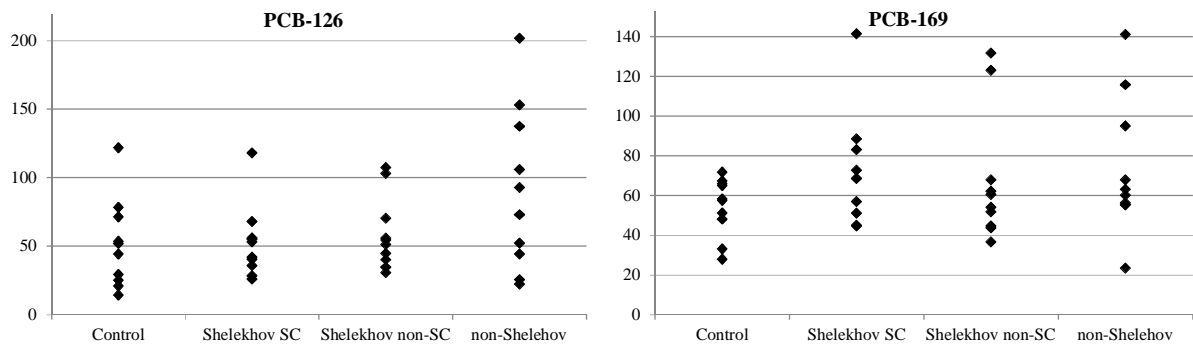


Fig. 5. Serum concentration of PCB-126 and 169, pg/g lipid

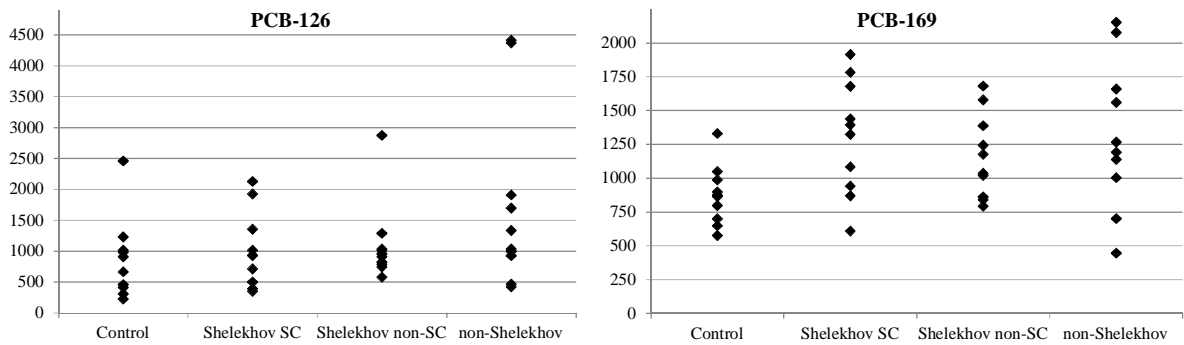


Fig. 6. Body burden PCB-126 and 169 levels, ng

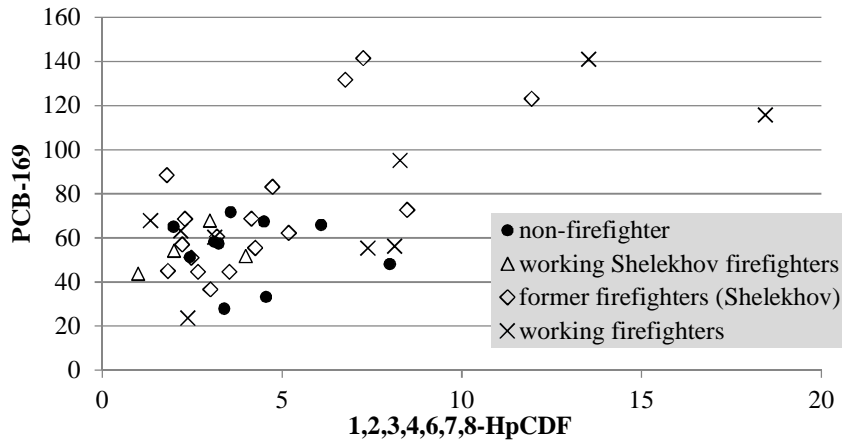


Fig. 7. 1,2,3,4,6,7,8-HpCDF vs PCB-169 (pg/g lipid)

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