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Axmon, Anna; Rignell-Hydbom, Anna

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+46 46-222 00 00

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Association between biomarkers of exposure to persistent organochlorine compounds (POCs)

Anna Axmon*, Anna Rignell-Hydbom

Department of Occupational and Environmental Medicine and Psychiatric Epidemiology,
Institute of Laboratory Medicine, University Hospital, SE-221 85 Lund, Sweden

*Corresponding author. Tel +46-46-173960. Fax +46-46-173669. E-mail

anna.axmon@med.lu.se

Abstract

Serum concentrations of CB-153 and p,p'-DDE were assessed for 354 men and women from the Swedish Fishermen's Families Cohort, and were found to correlate very well (Pearson's $r=0.72$). In this particular cohort the main source of exposure to persistent organochlorine compounds are consumption of contaminated fatty fish. High correlations between total PCB/CB-153 and p,p'-DDE have also been found in other population with similar exposure, but not in populations whose major source of exposure to persistent organochlorine compounds is not necessarily through the consumption of contaminated sea food. The authors suggest that when investigating a possible relation between exposure to persistent organochlorine compounds and different health outcomes in populations with exposure similar to the Swedish Fishermen's Families Cohort, there may be no need to analyze more than either CB-153 or p,p'-DDE.

Key-words: PCB, DDE, correlation, fish consumption

Persistent organochlorine compounds (POCs) including polychlorinated dibenzo-p-dioxins (PCDDs), dibenzofurans (PCDFs), polychlorinated biphenyls (PCBs) and dichloro-diphenyl-trichloro-ethane (DDT) are global environmental contaminants. Two of several common traits among these chemicals are their lipophilicity, and their low metabolization rate, causing biomagnification in the food chain and bioaccumulation in individuals. In several parts of the world, different populations have been exposed to mixtures of POC in such a way that it is impossible to determine the exact compounds included in the exposure. These populations include consumers of fatty fish from the Baltic Sea (Svensson et al., 1991; Asplund et al., 1994; Ahlborg et al., 1995) and the Great Lakes on the border of the US and Canada (Cordle et al., 1982; Sonzogni et al., 1991). In order to investigate possible health effects of such exposure, it is possible to use measures of exposure such as years of fish consumption, or amount of fish consumed. However, a biomarker for exposure is obviously to be preferred as proxy measure. The PCB congener 2,2',4,4',5,5'-hexachlorobiphenyl (CB-153) has been suggested to be an appropriate biomarker of exposure to POC since it is well correlated with the total POC derived TEQ in plasma (Brouwer et al., 1995). 1,1-Dichloro-2,2-bis (*p*-chlorophenyl)-ethylene (*p,p'*-DDE), the major metabolite of DDT, is also considered a suitable biomarker for these chemicals (Sjödén et al., 2000).

From studies on reproductive outcomes among men and women who consume large amounts of fatty fish from the Baltic Sea (the Swedish Fishermen's Families Cohort), 354 samples of lipid-adjusted serum concentrations of CB-153 (26-1460 ng/g lipid) and *p,p'*-DDE (7-2251 ng/g lipid) were available (men, *n*=189; women, *n*=165). A high correlation was found between the two biomarkers (Pearson's *r*=0.72). Furthermore, when trichotomizing both biomarkers into equally sized groups (*n*=118 in each group), the agreement between the categories for CB-153 and the categories for *p,p'*-DDE was high (Table 1), with 65% of the observations ending up in the same category regardless of which biomarker was used, and

only two percent having high exposure to one chemical and low to the other. The rank augmented correlation coefficient (Svensson, 1997) was very high ($r_a=0.97$), and there was no systematic change in neither position nor concentration. Moreover, in previous studies on the Swedish Fishermen's Families Cohort, several outcomes have been analyzed using both CB-153 and p,p'-DDE as measures of exposure. These studies have found similar risks associated with CB-153 and p,p'-DDE with respect to outcomes such as sperm quality (Rignell-Hydbom et al., 2004), and fertility and miscarriages (unpublished data).

Consumption of fatty fish from the Baltic Sea is one of the major sources of POC exposure in the general Swedish population. Hence, a similar association between CB-153 and p,p'-DDE as that found in the Swedish Fishermen's Families Cohort, was found in a group of 205 Swedish women chosen as controls in a population-based case-control study of organochlorines and endometrial cancer (Pearson's $r=0.65$ for the log-transformed concentrations)(Glynn et al., 2003). Furthermore, a high correlation was also found between total PCB (sum of 89 congeners) and DDE among 538 men and women who consumed large amounts of fish caught in the Great Lakes (Pearson's $r=0.72$ for the log-transformed concentrations)(Hanrahan et al., 1999), although the correlation between total PCB and DDE (i.e. not log-transformed) was slightly lower (Pearson's $r=0.52$) in the subgroup of women who had given birth (Weisskopf et al., 2005). Among a group of pregnant Inuit women, who represent a population that relies on marine food, high correlations between CB-153 and p,p'-DDE was found in cord blood (Pearson's $r=0.89$; $n=98$) as well as in breast milk (Pearson's $r=0.87$; $n=116$)(Muckle et al., 2001).

In studies investigating populations whose major source of POC exposure is not necessarily consumption of contaminated sea food, PCB and DDE seem to be less correlated: The Pearson correlation coefficient between p,p'-DDE and Aroclor 1260 was 0.61 in 536 women who had delivered in randomly selected hospitals in the Quebec province (Dewailly et

al., 1996). Furthermore, among 212 male partners of subfertile couples in USA, the correlation between CB-153 and p,p'-DDE was found to be between 0.3 and 0.4 (Hauser et al., 2003).

Although several studies have assessed concentrations of both total PCB/CB-153, and p,p'-DDE, only a few have presented the correlation between these biomarkers for POC. However, the available results suggest that the correlation may be high in populations which are exposed mainly through the consumption of polluted fatty fish, such as fish from the Baltic Sea or the Great Lakes. In populations with other sources of exposure, the correlation may not be as pronounced.

Our conclusion is thus, that when investigating a possible relation between POC exposure and different health outcomes in populations whose main exposure source is contaminated fatty fish, there may be no need to analyze more than either CB-153 or p,p'-DDE. However, this does not rule out that analysis of e.g. hydroxylated PCBs with other biological and toxicological properties can contribute to further understanding of exposure-response associations. We encourage others who have measured CB-153 and p,p'-DDE in human populations to report the correlation between these two biomarkers to either support or disagree with our conclusion.

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Table 1. Agreement between the biomarkers 2,2',4,4',5,5'-hexachlorobiphenyl (CB-153) and p,p'-dichloro-diphenyl-dichloro-ethylene (p,p'-DDE) in human serum.

		CB-153 (ng/g lipid)		
		Low <112.9	Medium 112.9 – 186.8	High > 186.8
p,p'-DDE (ng/g lipid)	Low < 141.0	85	32	1
	Medium 141.0 – 256.9	27	59	32
	High > 256.8	6	27	85