

## Organochlorine Pesticides and PCBs in Human Adipose Tissues in Poland

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Most of the persistent organochlorine (OC) pesticides, excluding lindane, were banned in Poland in 1975/76. The first restrictions concerning the use and marketing of lindane (gamma-HCH) became effective in 1980 and were gradually extended until its agricultural use was ultimately banned in 1989. Unfortunately, there are no detailed data on the use and release of PCBs to the environment in Poland. The former studies showed that in the late seventies the concentrations of OC pesticides and their metabolites in men reached considerable high levels (Traczyk *et al.*, 1977). Despite of the restrictions or bans of these pesticides in most of the countries of the temperate climate, they still circulate in various food chains and eventually concentrate in man (Frank *et al.*, 1988, WHO, 1989).

Many authors claim an uneven distribution of the OC compounds in the population and report different levels in men and women and also some relations between OC compounds levels in fat tissues and age (Focardi *et al.*, 1986, Ferrer *et al.*, 1992). Environmental contamination also plays an important role in the magnitude of OC compounds levels in man (Luotamo *et al.*, 1991, Szymczynski *et al.*, 1986).

The aim of this paper is to present the actual concentrations of HCB, p,p'-DDT, p,p'-DDE, isomers of HCH (alpha, beta, gamma), and PCBs in human adipose tissues particularly regarding age and sex as possible factors influencing the levels of these compounds and to contribute to the general discussion on the distribution patterns of the organochlorine compounds in the population.

### MATERIALS AND METHODS

Subcutaneous adipose tissues were taken from surgically treated patients in the Warsaw's hospitals. Samples were collected between year 1989 and 1992 from men and women, aged between 10 and 80 and were stored at -20 C until analysis. The total number of analyzed samples was 277 (142 from men, and 135 from women).

OC pesticides and PCBs were determined using GLC method in conjunction with extraction and clean-up procedures. For this purpose 1.0 g of the tissue was ground

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with anhydrous sodium sulfate and extracted with n-hexane (pesticide residue grade). The extract was then concentrated and subjected to clean-up procedures by Florisil column chromatography. The eluate was used for GLC analysis of HCH, p,p'-DDT, p,p'-DDE and HCH isomers. The remaining eluate was subjected to dechlorination and oxidation followed by gas chromatography of PCBs.

Typical glass columns 180 cm long, 4 mm id, packed with 7.5% QF-1 and 3% OV-17 (9:1) on Gas Chrom Q (80-100 mesh) and gas chromatograph equipped with electron capture detector (Ni-63) were employed for determination of these compounds.

For the identification and quantification of pesticides and their isomers and/or metabolites the standard solution of HCB, HCH isomers, p,p'-DDT, p,p'-DDE, and for PCBs standard of Alocor 1254 were used. The whole procedure was checked in the international interlaboratory Analytical Quality Assurance programme for OC pesticides and PCBs organized by the National Food Administration in Sweden. The limits of determination (in mg/kg) of about 0.05 for p,p'-DDT, 0.02 for p,p'-DDE and beta-HCH, 0.01 for gamma-HCH and HCB, 0.005 for alpha-HCH, and 0.1 for PCBs are achievable using this analytical procedure.

## RESULTS AND DISCUSSION

The arithmetic means, median values, 90th percentiles and the highest values of the organochlorine compounds in human adipose tissues are presented in the Table 1. All results are expressed as mg/kg of the extracted fat.

Table 1. The concentrations of the organochlorine compounds in human adipose tissues (mg/kg of fat) (No. of samples = 277)

Compound	Mean	Median	90-th percentile	Highest value
p,p'-DDT	0.537	0.478	0.929	9.600
p,p'-DDE	5.745	4.382	10.550	35.850
alpha-HCH	0.016	- *	0.020	0.160
beta-HCH	0.228	0.120	0.500	5.097
gamma-HCH	0.074	0.030	0.120	2.727
HCB	0.310	0.120	0.640	9.020
PCBs	0.856	0.500	1.700	36.000

\* below the limit of determination

In all analyzed samples p,p'-DDT, p,p'-DDE and PCBs were always present and also occurred in the highest concentrations. As it was expected, p,p'-DDE occurred in the highest concentrations reaching as high level as 10.5 mg/kg for the 90th percentile. Much lower concentrations were found in case of HCB and beta-HCH. The remaining HCH isomers were not found above the limit of determination in the substantial fraction of the samples. These results are similar to the obtained by the authors from the Netherlands, Finland and Norway (Greve *et al.*, 1990,

Mussalo-Rauhamaa *et al.*, 1985, Skaare *et al.*, 1988) but are lower than reported from Italy (Focardi *et al.*, 1985) and Spain (Camps *et al.*, 1989).

The effect of restrictions of the use of DDT is reflected in the proportion of p,p'-DDE of the total amount of DDT which reached value of 0.91. This could be explained by the fact that the most of p,p'-DDE present in adipose tissues originate from the diet rather than from metabolism of DDT in man. Similar ratio (p,p'-DDE/DDT = 0.94) was reported by Mussalo-Rauhamaa *et al.*, (1984) in Finland.

Ferres *et al.* (1992) discussed the differences in concentrations of beta-HCH, p,p'-DDE and HCB levels in men and women. He found higher beta-HCH and HCB levels in women than in men. On the other hand, Greve *et al.* (1990) found higher levels in men for PCBs only, but this was probably due to exceptionally high values for some individual male donors. The results of this study show no statistically significant differences, although a tendency towards higher concentrations of p,p'-DDE in men is clearly visible (Table 2).

Table 2. Mean concentrations of organochlorine compounds in adipose tissues in men and women (mg/kg, S.D.)

Compound	Women (n=135)		Men (n=142)	
	Mean	S.D.	Mean	S.D.
p,p'-DDT	0.494	0.374	0.548	0.865
p,p'-DDE	4.995	3.400	6.260	5.179
beta-HCH	0.268	0.578	0.216	0.371
gamma-HCH	0.062	0.108	0.077	0.257
HCB	0.371	0.881	0.306	0.580
PCBs	0.969	3.225	0.822	0.879

Age differences were discussed by several authors who found a positive correlation between age and concentrations of persistent organochlorine compounds in human adipose tissues (Greve *et al.*, 1990, Focardi *et al.*, 1986). In order to illustrate the results obtained in this study, the levels found have been arranged in age groups, and for each age group the mean concentrations of six most predominant compounds are presented in the Table 3.

Table 3. Mean concentrations of organochlorine compounds in human adipose tissue as a function of age (mg/kg)

Age groups	n	HCB	beta-HCH	p,p'-DDE	p,p'-DDT	PCBs
<25	25	0.140	0.132	4.471	0.253	0.413
>25 - 35	40	0.150	0.133	5.410	0.384	0.411
>35 - 45	48	0.340	0.312	5.596	0.611	0.662
>45 - 55	49	0.499	0.234	5.322	0.643	1.658
>55 - 65	36	0.413	0.393	8.596	0.680	0.771
>65	30	0.391	0.283	8.424	0.812	0.901

As shown in the Table 3 the influence of age is clearly visible in HCB, beta-HCH, p,p'-DDE, p,p'-DDT, and PCBs. These results confirm the conclusions presented by the above mentioned authors who claimed the positive relationship between age and levels of these compounds in human adipose tissues. However, in this case the relationship was not statistically significant due to large differences between the individual results what is reflected by the 90-th percentiles in the Table 1. Moreover, somewhat lower concentrations observed in the oldest people may also contribute to the lack of significance. This phenomenon was also reported by Mussalo-Rauchamaa *et al.*, (1984) who found much weaker significance in case of the oldest people.

## REFERENCES

- Camps M, Planas J, Gomez-Catalan J, Sabross N, To-Figureas J, Corbella J (1989) Organochlorine residues in human adipose tissue in Spain: Study of an agrarian area. *Bull Environ Contam Toxicol* 42:195-201
- Ferrer A, Bona MA, Castellano M, To-Figureas J, Brunet M (1992) Organochlorine residues in human adipose tissue of the population of Zaragoza (Spain). *Bull Environ Contam Toxicol* 48:561-566
- Focardi S, Fossi C, Leonzio C, Romei R (1986) PCB hexachlorobenzene, and organochlorine insecticides in human fat in Italy. *Bull Environ Contam Toxicol* 36:644-650
- Frank R, Rasper J, Smout MS, Braun HE (1988) Organochlorine residues in adipose tissues, blood and milk from Ontario residents, 1976-1985. *Can J Public Health* 79:150-158
- Greve PA, van Zoonen P (1990) Organochlorine pesticides and PCBs in tissues from Dutch citizens (1968-1986). *Intern J Environ Anal Chem* 38:265-277
- Luotamo M, Jarvisalo J, Aitio A (1991) Assessment of exposure to polychlorinated biphenyls: Analysis of selected isomers in blood and adipose tissue. *Environ Res* 54:121-134
- Mussalo-Rauhamaa H, Pyysalo H, Moilanen R (1984) Influence of diet and other factors on the levels of organochlorine compounds in human adipose tissue in Finland. *J Toxicol Environ Health* 13:689-704
- Skaare JV, Tuveng JM, Sande HA (1988) Organochlorine pesticides and polychlorinated biphenyls in maternal adipose tissue, blood, milk, and cord blood from mothers and their infants living in Norway. *Arch Environ Contam Toxicol* 17:(55-67)
- Szymczyński GA, Waliszewski SM, Tuszewski M, Pyda P (1986) Chlorinated pesticides levels in human adipose tissue in the district of Poznan. *J Environ Sci Health A* 21:5-14
- Traczyk Z, Palut D, Górski T, Arczyńska E, Rutkowski W, Syrowatka T (1977) Blood levels of DDT and gamma-HCH in patients with various hematologic disorders. *Acta Med Pol* 18:139-146
- Travis CC, Hattemer-Frey HA, Arms AD (1983) Relationship between dietary intake of organic chemicals and their concentrations in human adipose tissue and breast milk. *Arch Environ Contam Toxicol* 17:475-485
- WHO (1989) Environmental Health Criteria 83. DDT and its derivatives, environmental aspects. World Health Organization, Geneva