

CONCENTRATION OF PCBs IN VARIOUS TISSUES FROM AUTOPSIES IN GREENLAND

DEWAILLY, É.^A, HANSEN, J.C.^B, PEDERSEN, H.S.^C, MULVAD, G.^C, AYOTTE, P.^A, WEBER, J.P.^D and G. LEBEL^A

^A Public Health Center - 2050, boul. René-Lévesque O., Ste-Foy, QC, G1V 2K8, Canada

^B Aarhus University - Bldg, 180, Universitetsparken, DK-8000, Aarhus C, Denmark

^C Primary Health Care Unit, Box 1001, DK 3900 Nuuk, Greenland

^D Québec Toxicology Center - 2705, boul. Laurier, Ste-Foy, QC, G1V 4G2, Canada

Introduction

The contamination of the Arctic aquatic food chain by PCBs has been described during the last decade. Native people living in the Arctic are an integral part of this food web. For cultural and economical reasons, they rely heavily on country foods for their subsistence. The daily consumption of sea mammals (seal, beluga, narwhal and walrus) was estimated to vary between 100 and 400 grams. Knowing the contamination levels reported in edible tissues of sea mammals (ppm range for PCBs) and the daily consumption rates, one would anticipate a relatively high body burden of PCBs in Inuit people. We reported in 1989 preliminary data which showed that breast milk samples collected in 1986-1987 from Inuit women from East coast of Hudson Bay (Northern Québec-Canada) contained an average PCB (Aroclor 1260) concentration of 3.6 mg/kg (lipid basis) an unusually high concentration compared to the average value of 0.77 mg/kg measured in the milk of caucasian women living in the Southern part of the Province of Québec¹. This was later confirmed by a population survey conducted in 1989-1990 in which almost all breast-feeding women (n = 107) from the Nunavik region (Northern Québec) participated.

The sum of 7 PCB congeners concentration (IUPAC no.) 118, 138, 153, 170, 180, 183 and 187 was 1052 µg/kg in milk (lipid basis) compared to 157 µg/kg in 16 pools samples used as controls (general population of Southern Québec)². Dioxins, furans and coplanar PCBs were also measured in a subsamples of the population (n= 40) showing that coplanar PCBs contributed for most of the TEQs (Toxic Equivalent Quantities relative to 2,3,7,8-TCDD).³

In addition to work conducted among the Inuit from Nunavik, PCBs have also been analyzed in the blood of 209 Inuit residents from Broughton Island. Sixty-three percent of females and males under 15 years of age and 39 % of female ages 15 to 44 exceeded the tolerable level of 5 µg/L established in Canada for PCBs (Aroclor 1254).⁴

Very few information however are available concerning the organochlorine exposure of Inuit from other circumpolar countries (Alaska/USA, Russia and Greenland). In 1979, Jensen⁵ reported PCB concentrations in adipose tissue of 27 Greenlanders aged 20-75 yr admitted for acute surgery. On a lipid basis mean concentrations of PCBs were 5.8 mg/kg

in the 22-45 yr age group (n = 17) and 8.1 mg/kg in the 46-60 yr age group (n = 10). However PCBs concentrations were calculated using Aroclor 1254 as the standard, which may underestimate total PCB concentration when high chlorinated congeners are predominant, as it is the case in the Arctic.

We report in this paper PCB concentrations in omental fat, adipose tissue, liver and brain collected during autopsies performed in Greenland.

Method

Between November 1992 and mid-october 1994, 42 autopsies were carried out at the Queen's Ingrid Hospital in Nuuk-Greenland. All samples were immediately frozen at - 80° C. Omental fat was obtained from 42 subjects, adipose tissue from 26, liver (upper right lobe) from 27 and brain from 17 subjects. Twenty-two subjects were female and 19 males (1 unknown). They originate from all Greenland regions. Various causes of death were recorded, cancer (11), cardiovascular (7), chronic bronchitis (2), violent death (8), others (13) and unknown (1). Mean age was 56.9 yr.

Samples of 1 to 2 grams were sent to the laboratory for PCB analysis and total lipid content. Fourteen PCB congeners (IUPAC nos: 28, 52, 99, 101, 105, 118, 128, 138, 153, 156, 170, 180, 183, 187) were determined by high resolution gas chromatography using an electron capture detector. Depending of the lipid content and the available quantity of tissues, detection limits varied in omental fat from 0.3 to 3.6 µg/kg, in adipose tissue from 0.3 to 0.9 µg/kg, in liver from 3 to 14 µg/kg and in brain from 3 to 8 µg/kg. All concentrations are presented on a lipid basis. Mean lipid contents were 59.6, 62.0, 4.5 and 8.3 % respectively for omental fat, adipose tissue, liver and brain. A concentration equal to half of the detection limit was assumed for non detected results.

Results

PCB mean concentrations (expressed in Aroclor 1260) was 15.7 mg/kg in omental fat, 16.9 mg/kg in adipose tissue, 12.2 mg/kg in liver and 2.0 mg/kg in brain lipids. In omental fat, all but one congeners were detected in the 42 samples. PCB 128 was detected in 35 of the 42 samples. In omental fat PCB 153, 180 and 138 were the major congeners and represented respectively 28, 20 and 19 % of the sum of the 14 congeners (6361 µg/kg).

For omental fat concentrations, no statistical differences were observed between males and females and only a slight increase with age was observed (Figures 1 and 2). The PCB congener profiles were similar in all tissues (Figure 3).

Discussion

These results clearly confirm that Greenlanders have a high PCB body burden. We found PCB (Aroclor 1260) concentrations of 15.7 mg/kg (CI 95 % 13.5-17.9) in omental fat and 17.0 mg/kg (CI 95 % 13.1-20.8) in adipose tissue.

Because of different laboratory procedures, it is difficult to compare our resulted to international data. The most recent studies on adipose tissue reported concentrations far below those observed in this study. In Ontario, a 2.1 mg/kg mean concentration has been reported in 209 adipose tissue samples collected in 1983-1984.⁶

In USA, 10 adipose tissue samples were analyzed for PCBs and a mean concentration of 1.2 mg/kg was reported.⁷ In Finland, Mussalo-Rauhamaa reported PCB concentrations of 0.26 mg/kg (whole weight basis) in adipose tissue samples from 105 subjects (surgery and autopsy). This could correspond to about 0.30 mg/kg on a fat basis.⁸

In 1991-1992 we have analyzed PCB concentrations in 17 mammary adipose tissue samples from women living in Québec City and suffering from benign breast diseases. They were used as control in a breast cancer pilot case-control study.⁹ These 17 women (mean

age 51.2 yr) had concentrations of congeners (IUPAC no: 138, 153 and 180) of 252 µg/kg (fat basis). Because these analyses have been conducted by the same laboratory, we can compare these concentrations to the 15 Greenlandic females subjects who exhibited an average adipose tissue concentration of 5051 µg/kg for the same three congeners.

Information on relative concentrations of PCBs in different organs is very limited. Hirakawa¹⁰ reported that brain concentrations of coplanar PCBs IUPAC no: 126 and 169 in brain lipids were respectively 8.3 and 1.4 ng/kg (lipid basis) compared to 141 and 103 ng/kg in adipose tissue (ratio of 1/17 and 1/73, respectively). In this study the brain/adipose tissue ratios were 1/8 and 1/9 respectively for PCB 138 and 153. These observations confirm the importance of the blood brain barrier.

Conclusion

PCB concentrations found in organs of Greenlanders are among the highest ever reported in the world. As other Inuit, Greenlanders depend on seafood and particularly sea mammals for their subsistence. These animals have accumulated PCB and other organochlorines through the food web. Evaluation of other compound concentrations (pesticides, dioxin-like compounds), hepatic cytochrome P450 activity and determination of biogenic amine neurotransmitters in the brain are ongoing.

References

1. Dewailly, É, Nantel, A., Weber, J.P. and Meyer, F. High levels of PCBs in breast mil of Inuit women from Arctic Québec. *Bulletin of Environmental Contamination and Toxicology* 1989; 43: 641-646.
2. Dewailly, É, Ayotte, P., Bruneau, S., Laliberté, C., Muir, D.C.G. and Norstrom R.J. Inuit exposure to organochlorines through the aquatic food chain in Arctic. *Environmental Health Perspectives*. 1993; 101 (7): 618-620.
3. Dewailly, É, Ryan, J.J., Laliberté, C., Bruneau, S., Weber, J.P., Gingras, S. and G. Carrier. Exposure of remote maritime populations to coplanar PCBs. *Environmental Health Perspectives*. 1994; 102(1): 205-209.
4. Kinloch, D., Kuhnlein, H. and Muir, D.C.G. Inuit foods and diet: a preliminary assessment of benefits and risks. *Science of the Total Environment*. 1992; 122: 247-278
5. Jensen, G.E. and J. Clausen. Organochlorine compounds in adipose tissue of Greenlanders and Southern Danes. *Journal of Toxicology and Environmental Health*. 1979; 5: 617-629.
6. Frank, R., Rasper, J., Smouth, M.S. and Braun, H.E. Organochlorine residues in adipose tissues, blood and milk from Ontario residents, 1976-1985. *Canadian Journal of Public Health*. 1988; 79: 150-158.
7. Holt, R.L., Cruse, S. and E.S. Greer. Pesticide and polychlorinated biphenyl residues in human adipose tissue from Northeast Louisiana. *Bulletin of Environmental Contamination and Toxicology*. 1986; 36: 651-655.
8. Mussalo-Rauhamaa, H., Pyysalo, H. and R. Moilanen. Influence of diet and other factors on the levels of organochlorine compounds in human adipose tissue in Finland. *Journal of Toxicology and Environmental Health*. 1984; 13: 689-704
9. Dewailly, É, Dodin, S., Verreault, R., Ayotte, P., Sauvé, L., Morin, J. and Brisson, J. High organochlorine body burden in women with oestrogen receptor-positive breast cancer. *Journal of the National Cancer Institute*, 1994; 86 (3): 232-234.
10. Hirakawa, H., Iida, T., Matsueda, T., Tokiwa, H., Nagata, T. and Nagayama, J. Concentrations and distribution of PCDDs, PCDFs and coplanar PCBs in various human tissues In: *Organohalogen Compounds*, Vol. 10: 93-96. Finnish Institute of Occupational Health, Helsinki 1992.

Figure 1 PCBs concentrations in omental fat according to sex

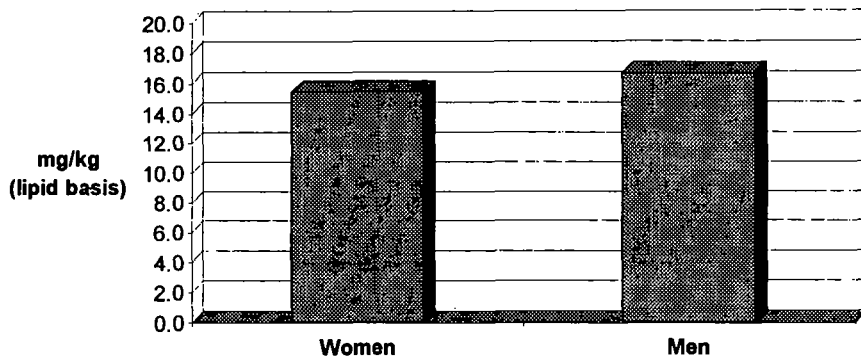


Figure 2 PCBs concentrations in omental fat according to age

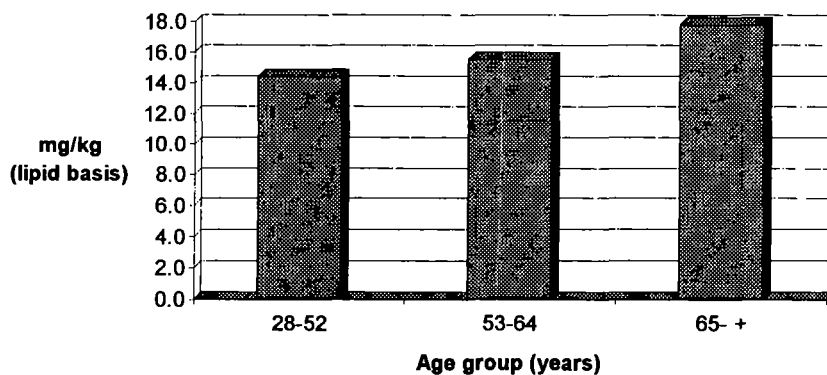
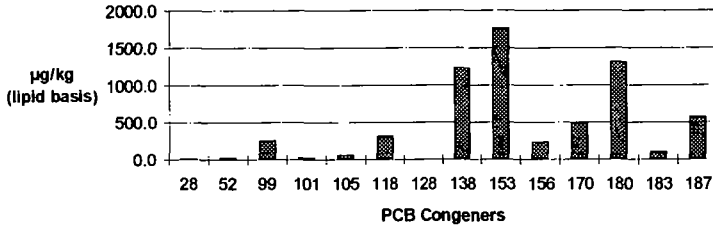
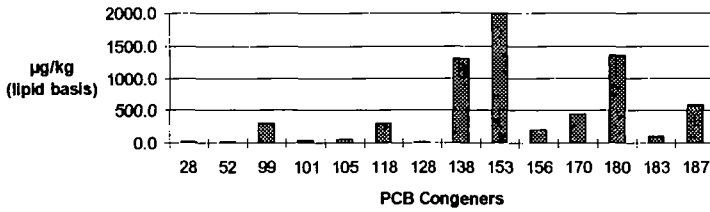


Figure 3 PCB congeners in various tissues from autopsy

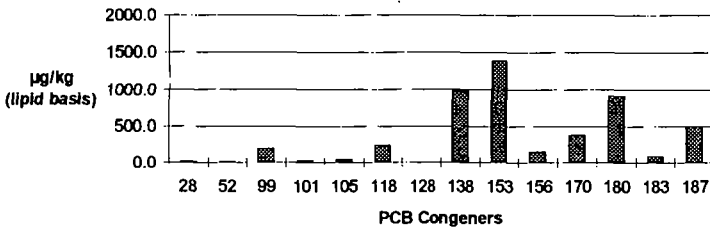
Omental Fat (n=42)



Adipose tissue (n=26)



Liver (n=27)



Brain (n=17)

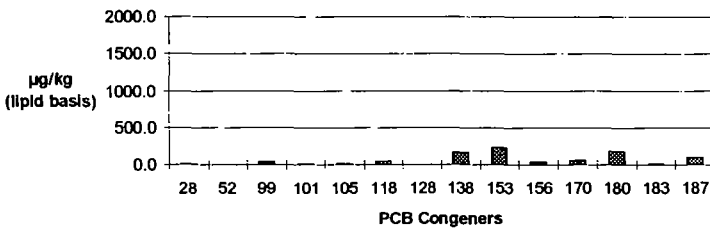


Figure 4 Correlation between concentrations of PCB (Aroclor 1260, lipid basis) in various tissues

