Consumption of crabs and body burden of PCDDs/PCDFs: A study of male crab consumers from a polluted fjord area in Norway.

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Introduction

A magnesium production plant, situated in the inner part of the Frierfjord in Southern Norway, forms considerable amounts of organochlorine compounds (OCs). The main components penta- and hexachlorobenzene, octachlorostyrene, PCBs and PCDDs/PCDFs have been regularly monitored in sediment and marine organisms at various distances from the source [1,2,3]. The emissions of OCs from the Mg-plant have declined dramatically in two steps (1975 and 1990) due to waste water treatment, and this has been followed by reduction in the contamination of recipient organisms [4]. Nevertheless, levels in marine biota found today still exceed those from diffuse polluted areas by a factor of 2 - 40 [2]. Therefore, restrictions in commercial fishing and recommendations concerning limited consumption of fish and shellfish, established for the contaminated area in 1989, are still valid.

The area, however, is popular for recreational purposes and it is known that some residents catch and consume considerable amounts of local fish and shellfish. During summer and autumn the crab species *Cancer pagurus* is a popular food item in this area. These crabs have been shown to contain high levels of OCs revealing the characteristic pattern of the Mg-process [5]. The aim of the present study was to investigate the relations between consumption of crabs from the Friefjord area and the levels and patterns of PCDDs/PCDFs and PCBs in blood from men living in this area.

Methods

Study Groups. Twenty-four male consumers of locally caught crabs were recruted non-randomly through announcement in local newspapers and other media. The male referents were drawn randomly from the Register of Population. All study participants were administered a questionnaire designed to obtain information on their potential occupational and environmental exposure to PCDDs/PCDFs and PCBs. Venous blood was drawn from each participant after overnight fasting and the samples were kept frozen at -20°C until analysed.

Analyses of Blood Samples. Extraction of whole blood samples was performed after a method described by Päpke et al. [6] using partitioning of 40 mL of blood samples on diatomaceous earth (Hydromatrix, Varian SPP) and elution of the fat fraction with n-heptane/isopropanol (3:2, v/v). The amount of extracted lipid was determined gravimetrically. 2,3,7,8-

substituted PCDDs and PCDFs and non-ortho PCBs were determined by HRGC-HRMS after clean-up as described elsewhere [7]. Mono- and multi-ortho PCBs were extracted by the same method using 15 mL of whole blood. 17 PCB congeners were determined by HRGC-ECD after clean-up by concentrated sulfuric acid and chromatography on basic alumina.

Results and Discussion

The crab consumers were divided into two groups according to their crab intake (Table 1). There were no significant differences in age of the subjects in the different groups, and no correlation was found between the age and the level of PCDDs and PCDFs in blood. Parallel to the differences in crab intake, there was a slight, non-significant increase in the mean fish intake.

Table 1. Characteristics of the Study Groups.

	Referents n=10	Moderate intake n=15	High intake n=9
Age (years)	46.7 (41-50)	45.33 (40-54)	46.22 (41-52)
BMI (kg/m^2)	25.4 (22.2-30.7)	26.2 (21.7-32.7)	27.3 (21.5-30.9)
Crab intake (nrs./year)	0	20.5 (10-50)	89.4 (>50-150)
Fish intake (meals/week)	1.1 (0.5-2.5)	1.4 (0.25-2.5)	1.8 (0.5-3.5)

There was a pronounced difference in the blood levels of many PCDDs/PCDFs in the three study groups, especially for the dibenzofurans which are characteristic for the pollution of the fjord area and which are also found at high levels in the crabs [5] (Fig.1).

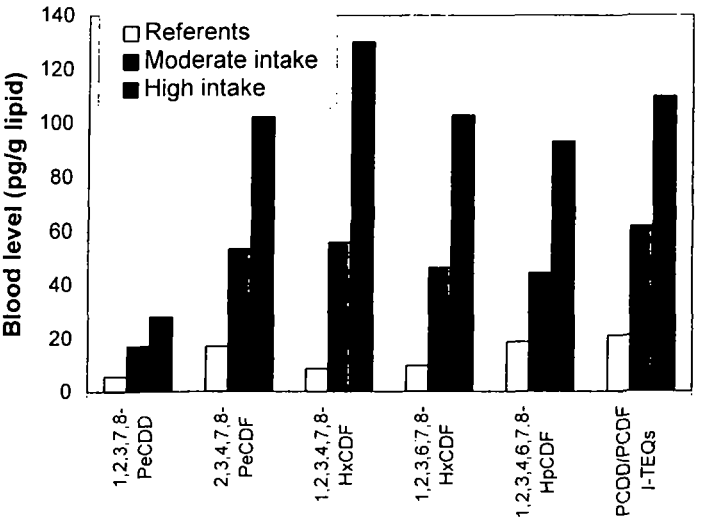

Figure 1. Mean levels of selected PCDDs/PCDFs in whole blood of subjects consuming various amounts of crabs.

The PCDD/PCDF related TEQs for our reference group was comparable with recent results reported for the general population in Germany [8]. The mean blood level in our high-consumer group, expressed as TEQs, was about five times higher.

Much smaller, increases were observed for levels of several PCB congeners in the blood of the high-intake group compared to the referents. No significant correlation was found between the levels of sum PCBs and the crab intake. Interestingly, PCB-209, which is the dominant PCB congener found in the crabs [3], is not represented to a great extent in the blood of the crab consumers. This could be due to limited bioavailability.

Significant associations were also observed when correlating the individual number of crabs consumed per year and the corresponding blood levels of several PCDDs/PCDFs, especially 2,3,4,7,8-PeCDF, 1,2,3,4,7,8-HxCDF (Fig.2), and 1,2,3,6,7,8-HxCDF and total TEQs.

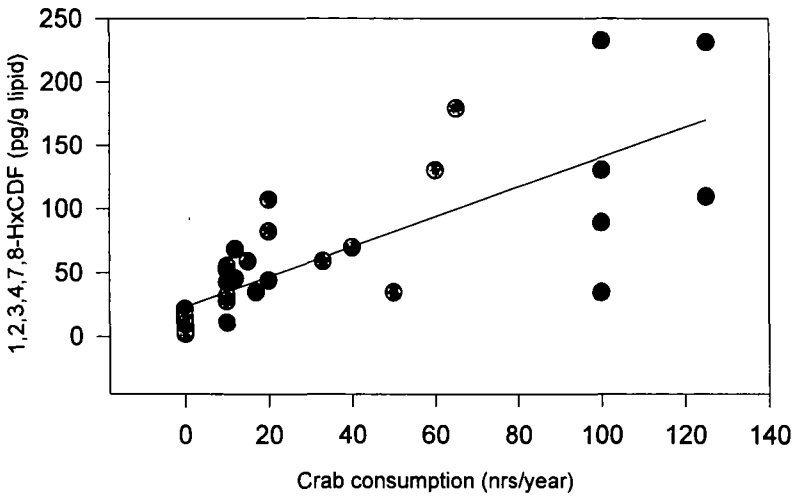

Figure 2. Whole blood levels of 1,2,3,4,7,8-HxCDF (pg/g lipid) according to reported crab consumption in 33 subjects.

Using body mass indices (BMI) and age, the body fat fraction of each subject was estimated according to an empirical formula derived by Deurenberg [9]. On this basis, the average weekly PCDD/PCDF intake of each individual subject was calculated assuming a single compartment model, first order kinetics and an average half-life of 7 years. The mean weekly intakes were 11, 30 and 47 pg TEQ/kg b.w. for the referents, moderate- and high-intake groups, respectively compared to the tolerable weekly intake of 35 pg TEQ/kg b.w. proposed by a Nordic Expert Group [10] (Fig. 3).

Conclusions

Consumption of crabs from a polluted fjord area is a major source of exposure to PCDDs/PCDFs among male hobby fishermen: There is a strong correlation between the measured blood levels of PCDDs/PCDFs and the reported crab consumption. The characteristic PCDF profile found in the waste water from the Mg-plant and in the crabs is reflected in the blood of crab consumers. Calculated weekly exposures show that about half of the crab consumers exceeded the Nordic tolerable intake of 35 pg TEQ/kg b.w./week.

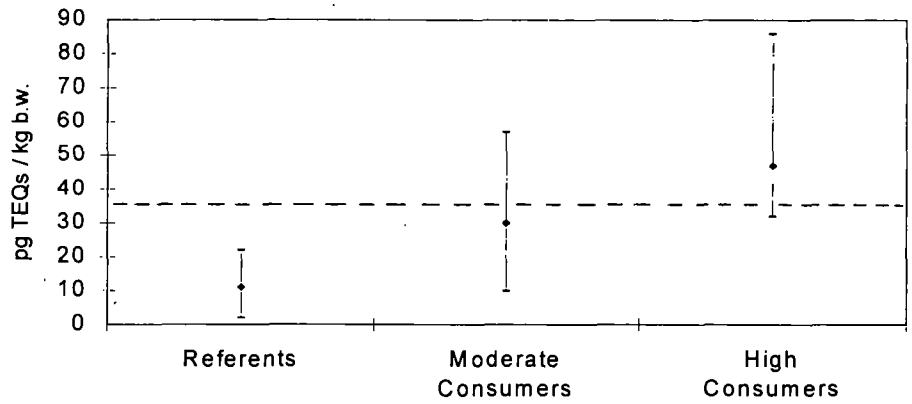

Figure 3. Calculated weekly intake of PCDDs/PCDFs in crab consumers and referents.

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