Dietary dioxin and PCB exposure in a selected group of Norwegians.

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Introduction

Food is the major source of dioxin and polychlorinated biphenyls (PCB) exposure in the Norwegian population. Over the years, many analyses have been performed in foods, indicating that oily fish, crustaceans and fish liver might be the main sources of these contaminants in the Norwegian diet. However, total intake estimates have been lacking, as well as comparisons between intake estimates and body burden. The Norwegian Institute of Public Health has, in collaboration with the Norwegian Food Safety Authority and The University of Oslo, conducted three dietary surveys which focus on consumption of fish and game. These foods may contain high levels of environmental contaminants, and are thus especially important with regard to dietary exposure. Based on these surveys, the aim of this study was to estimate a dietary intake range of dioxins and PCBs and investigate if this was reflected in serum levels.

Materials and Methods

The dietary surveys were started in 1999 and the two first studies encompassed a qualitative (study A, n = 6015) and a semi quantitative (study B, n = 5002) food frequency questionnaire, focussing on consumption of seafood such as crab, flatfish, halibut, crustaceans, perch and pike, and liver and kidney from game[1]. Based on concentrations of different contaminants in the actual foods, a rough estimate of the individual intake for the participants in study B was established. Based on these estimates, 700 people among the participants of study B were invited to participate in a third study, study C. 199 persons gave informed consent and answered a 12-page semi-quantitative food frequency questionnaire. In addition, serum and urine samples were collected.

PCB concentrations have so far been determined in 114 of the serum samples. Preliminary results from analyses of these serum samples and 175 dietary intake estimations are presented here. Two-thirds of the participants were regular consumers of potentially highly contaminated foods and were especially selected to the study. The results will therefore show the upper end of the intake range which is possible through a Norwegian diet, and they will not be representative for the Norwegian population in general.

An extensive database was built comprising all available concentrations of dioxin and PCB congeners in Norwegian foods. Food frequencies were converted into consumption (grams/day) by multiplying with standard portion sizes, and dioxin and PCB intake was calculated by multiplying consumption with levels of dioxins and dioxin-like PCBs (medium bound), sum 7PCB (lower bound; PCB 28, 52, 101, 118, 138, 153, 180) and PCB153 (alone) in food.

The serum samples were extracted using solid phase extraction (Isolute 101, (200 mg) from International Sorbent Technology, Mid Glamorgan, UK) after small modifications of previously described methods[2,3]. Separation and quantitative determination of the PCBs were performed by capillary gas chromatography coupled to a mass spectrometer operated in the electron capture mode with methane as buffer gas. The PCBs were monitored on the *m/z* of their respective molecular ions, confirmed by controlling the isotope abundance ratio and the retention time, and quantified by internal standard calibration using C-13 labelled standards. The uncertainty of the analysis was found to be about 20 %. The lipid content of the serum samples was determined at The National Hospital of Norway (Oslo, Norway) according to a method described by Grimvallet al.[4].

Results and Discussion

The dioxin and PCB intake was calculated to be higher with increase in age, men (Table 1), as well as for smokers and for people living in coastal municipalities. The distributions of the intakes were skewed, and the median intake of dioxins and dioxin-like PCBs was estimated to be 11.0 pg TEQ/kg bw/week (2.4 – 65.3 pg TEQ/kg bw/week). Median intake of SUM 7PCB (Table 2) was 923 ng/day (190 – 8499 ng/day) and for PCB-153 median intake was 344 ng/day (70 – 2842 ng/day). Men had a higher intake of SUM 7PCB (p = 0.005) and PCB-153 (p = 0.003) than women. Dioxins and dioxin like PCBs showed the same tendency, but these differences were not statistically significant (p = 0.053).

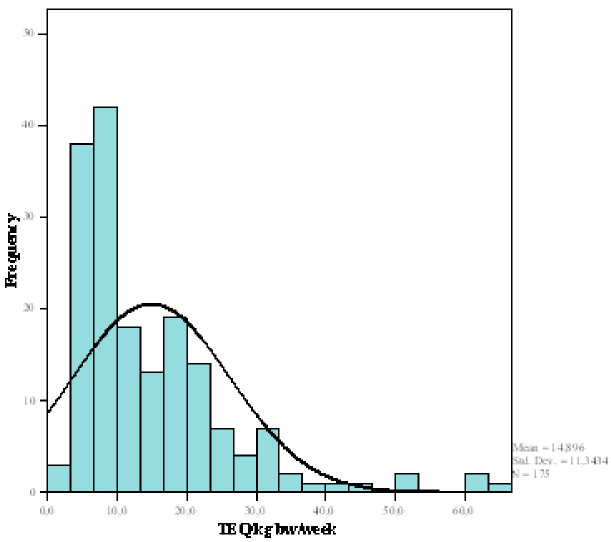

Figure 1. Histogram showing the estimated intake (pg TEQ/kg bw/week) of dioxins and dioxin-like PCBs (n =175). Median intake was 11,0 pg TEQ/kg bw/week. The solid line indicates a normal distribution.

Table 1.Dietary intake of dioxins and dioxin-like PCBs (pg TEQ/kg body weight/week).

		Dietary TEQ/kg body weight/week						
		N	Minimum	P25	Median	P75	P95	Max
Gender	All	175	2.4	6.8	11.0	19.7	36.6	65.3
	Men	80	2.4	7.3	15.3	21.9	53.1	65.3
	Women	95	2.5	6.7	9.6	17.6	31.0	51.4
Agegroup	<40	38	2.4	6.6	9.7	15.5	27.2	41.1
	40-60	73	2.8	6.6	10.0	21.0	36.6	61.5
	>60	64	4.7	7.5	13.0	20.3	36.8	65.3

Table 2.Dietary intake of SUM 7PCB (ng/day).

		Dietary PCB-Sum7 ng/day						
		N	Minimum	P25	Median	P75	P95	Max
Gender	All	175	190	612	923	1687	3122	8499
	Men	80	271	824	1461	2293	4148	8499
	Women	95	190	553	748	1310	2037	3122
Agegroup	<40	38	190	530	701	1313	2293	4148
	40-60	73	319	617	978	1807	3122	8499
	>60	64	319	762	1099	1820	3428	5213

We separated the calculated TEQ intakes according to being below or above the the tolerable intake of dioxin-like compounds of 14 pg TEQ/kg bw/week established by the EU. Seafood was the most important dietary source of dioxin- and PCB-TEQs both for those exceeding and those below this threshold level (Figure 2). Among those consuming more than 92 grams seafood pr. day (the highest tertile), 83 % exceeded the EU's threshold level.

Dietary fat and dairy products were the second largest contributor among the food groups. Among the separate foods, oily fish was the largest contributor. Seagull eggs, fish liver and roe-liver pate were the foods with the highest dioxin and PCB content pr. gram, but oily fish and roe-liver pate contributed most to high total intakes. There was a positive association between the intake of fat, vitamin D and dioxins and dioxin-like PCB.

In total, 42 % (73 persons) of the participants exceeded the international dioxin and dioxin-like PCB threshold intake levels. However, only three of these were women below the age of 40.

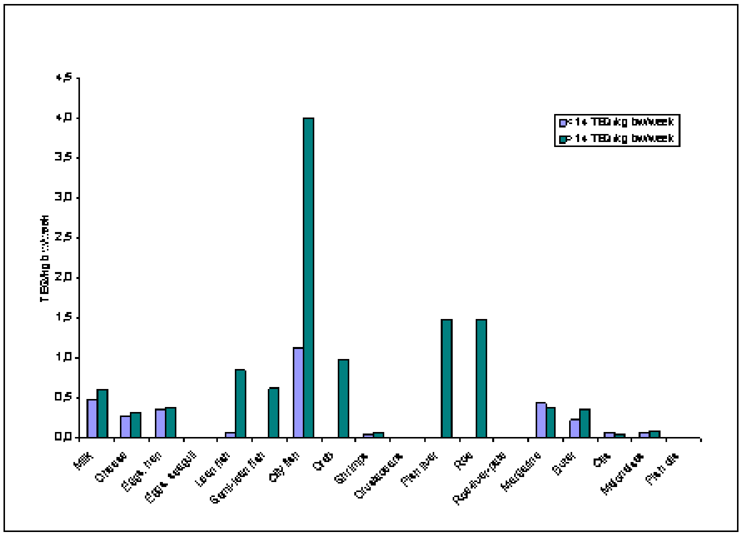

Figure 2. Contribution from different foods to the total intake of dioxins and dioxin-like PCBs for those with calculated intakes over (green) and under (blue) the TWIof 14 pg TEQ/kg body weight/week.

Serum Sum 7PCB and PCB-153 had a range of 15-1403 ng/g lipid and 5-507 ng/g lipid respectively, medians being 924 and 103 ng/g lipid. Serum levels of PCB increased with age and were higher for men than women.

The correlation between estimated dietary intakes of sum 7PCB and the corresponding serum concentrations was r = 0.483 ($p < 0,001$) for all participants (Figure 3). The serum levels were higher for older than for younger persons, probably indicating intake of more contaminated foods 10 – 20 years ago. The levels may also be affected by a general higher fish-consumption among older than younger people (data not shown). Altogether, the results indicates that our intake estimations were reasonably good, despite the limitations posed by the use of a food frequency questionnaire and the uncertainties connected to the estimation of dioxin and PCB levels in the foods.

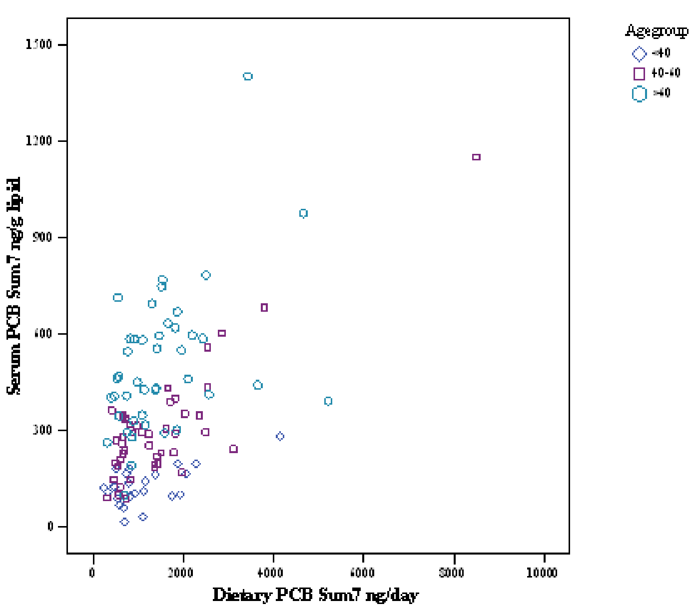

Figure 3. Scatter plot showing calculated dietary intake of sum7 (ng/day) vs. serum levels (ng/g lipid).

Conclusion

Oily fish is the greatest contributor to PCB and dioxin exposure in this group of selected Norwegians. The measured PCB serum concentrations were reasonably well predicted by the estimated intake levels.

References

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