

Impact of iron and steel industry and waste incinerators on human exposure to dioxins, PCBs and heavy metals: results of a cross-sectional study in Belgium

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Introduction

An epidemiological study was carried out in 2000/2001 in Wallonia, Belgium, to quantify the dioxins (PCDD/Fs), polychlorinated biphenyls (PCBs) and heavy metals in subjects living in the vicinity of a municipal solid waste incinerator (MSWI) or a sinter plant and compare them to levels in a rural unpolluted area.

Materials and methods

A total of 142 volunteers living around these facilities were recruited. Fifty-one subjects aged 21 to 80 years were living within a distance of 2 km from a MSWI in a rural area (Thumaide). Thirty-three subjects aged 33 to 65 years were recruited within a distance of 2 km from a MSWI in an industrial area (Pont-de-Loup). Fifty-eight subjects aged 25 to 67 years were living within a distance of 4 km from two iron and steel plants in the suburbs of two industrial cities (Liège, n=12 and Charleroi, n=46). These subjects were compared with 63 controls from an unpolluted area in the Ardenne (Belgium).

Figure 1: Localisation of the facilities



- 1: MSWI 1 (Thumaide, rural area)
- 2: MSWI 2 (Pont-de-Loup, industrial area)
- 3: Sinter plants (Charleroi and Liège)
- 0: Referents (Ardenne)

The volunteers provided approximately 200 ml of fasting blood and a urine sample. We quantified serum concentrations of dioxins (17 PCDD/Fs congeners), coplanar PCBs (IUPAC n° 77, 81, 126 and 169) and 12 PCB markers (IUPAC n° 3, 8, 28, 52, 101, 118, 138, 153, 180, 194, 206 and 209). We also measured three heavy metals: urinary cadmium (Cd), urinary mercury (Hg) and blood lead (Pb).

Results

The mean concentrations of pollutants in blood or urine in the different groups are given in Table 1. Results are similar after adjustment for confounding factors (age, sex, body mass index, fat consumption, tobacco consumption or alcohol consumption).

The mean Cd, Hg and Pb concentrations of exposed subjects were not significantly increased in comparison with referents.

By contrast, whilst no increase was found in residents around the MSWI in the industrial area or the sinter plants, subjects living around the MSWI in the rural area had on average significantly higher serum levels of dioxins and coplanar PCBs than referents.

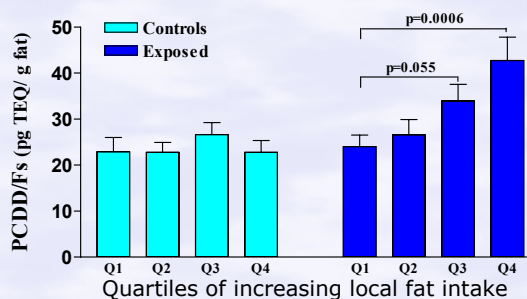
Table 1: Concentrations of pollutants in blood or urine

	Referents n=63	MSWI 1 n=51	MSWI 2 n=33	Sinter plants n=58	Total n=205
Dioxins and polychlorinated biphenyls					
PCDD/Fs (pg TEQ/g lipids)	23.9 [5.0-71]	37.9* [9.2-101]	24.1 [11-113]	23.8 [5.2-57]	26.8 [5.0-113]
Coplanar PCBs (pg TEQ/g lipids)	7.0 [1.5-29]	10.3* [0.2-44]	5.7 [0.2-20]	6.3 [1.2-37]	7.2 [0.2-44]
PCDD/Fs+cPCBs (pg TEQ/g lipids)	31.3 [6.7-100]	48.7* [9.4-145]	30.1 [13-133]	30.7 [7.6-84]	34.7 [6.7-145]
Σ12 PCB markers (ng/g lipids)	418.3 [141.5-764.1]	450.4 [122.9-1275]	374.8 [194.3-818.3]	404.5 [124.8-909.4]	416.3 [122.9-1275]
Heavy metals					
Cd urine (µg/g creatinine)	0.49 [0.13-2.17]	0.62 [0.20-1.95]	0.43 [0.07-2.78]	0.49 [0.06-4.46]	0.51 [0.06-4.46]
Hg urine (µg/g creatinine)	1.95 [0.52-6.17]	1.80 [0.79-18.8]	2.11 [0.95-10.35]	1.79 [0.5-6.12]	1.89 [0.5-18.8]
Pb blood (µg/L)	45.8 [5.00-164]	43.3 [11.0-149]	39.4 [17.0-123]	42.2 [12.0-190]	43.1 [5.00-190]

Geometric mean [min-max]. *p value < 0.05.

A two-way ANOVA on age-adjusted dioxin levels revealed a significant interaction between residence around incinerators and the consumption of fat from local origin, especially from bovine and poultry products. Whereas dioxin levels in referents did not vary with local animal fat consumption, dioxin levels in subjects living around the incinerators increased proportionally to their intake of local animal fat, almost doubling in subjects with the highest fat intake (figure 2).

Figure 2: Increase in dioxin body burdens with local fat consumption



Conclusions

- Human exposure to emissions from MSWIs can increase dioxin and coplanar PCB body burden of residents.
- This increase is dependent of the consumption of animal products from the local food chain.
- This increase is likely to occur only when dioxin emissions exceed 5 ng TEQ/Nm³. This threshold is largely above emission standards currently in force in most countries (between 0.1 and 1 ng TEQ/Nm³).

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