PCDD/F AND NON-*ORTHO* PCB BODY BURDEN OF THE GENERAL POPULATION IN WALLONIA, BELGIUM: IMPACT OF DIFFERENT SOURCES OF ENVIRONMENTAL POLLUTION

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Introduction

Since several years, there is much concern in Belgium about the potential health risks of dioxins. At the end of 80s, the dioxin exposure survey carried out by WHO showed that levels of dioxin in human milk in Belgium were amongst the highest of industrialized countries, an observation which was confirmed early 90s in the second WHO survey round[1]. The PCB/dioxin contamination incident of 1999 further increased the public concern by revealing recycling practices that might have chronically introduced PCB/dioxin in the food chain[2,3]. Given this situation, it is thus important to assess the dioxin body burden of the general population of Belgium and to identify sources of pollution contributing to the intake of dioxins (PCDD/Fs and coplanar PCBs). We report here the results of an epidemiological study conducted in Wallonia to quantify the dioxin body burden of subjects living in the vicinity of potential sources of dioxins or in a rural unpolluted area.

Methods and Materials

The study was approved by the Ethical Committee of the Catholic University of Louvain. Blood samples were obtained from a total of 257 subjects who had lived for at least 20 years in the same area. A total of 194 subjects, divided in four groups, were recruited in the vicinity of three potential sources of dioxin: (i) 58 subjects aged 25 to 67 years were living within a distance of 4 km from two iron and steel plants in the suburb of two industrial cities (Liège, n=12 and Charleroi, n=46); (ii) 52 subjects aged 26 to 71 years who were living within a distance of 1 km from the largest Belgian waste dumping site (Mont-Saint-Guibert); (iii) 33 subjects aged 33 to 65 years were recruited within a distance of 2 km from a municipal solid waste incinerator (MSWI) in an industrial area (Pont-de-Loup) and (iv) 51 subjects aged 21 to 80 years who were living within a distance of 2 km from a MSWI in a rural area (Thumaide). These subjects were compared with 63 referents aged 33 to 66 years who were living in three villages in rural areas of the Ardenne, in the South of Belgium. After having given their informed consent, the volunteers provided approximately 200 ml of blood under fasting conditions in the morning. In order to evaluate the dioxin body burden, the seventeen 2,3,7,8 substituted polychlorinated dibenzodioxin/dibenzofuran congeners (PCDD/Fs) and the four dioxin-like non-*ortho*-PCBs (coplanar PCBs or cPCBs; IUPAC n° 77, 81, 126 and 169) were quantified by GC-HRMS on the lipid fraction of serum. The results were expressed per gram fat as equivalents of TCDD using the WHO-TEFs (1998). The statistical analysis was done using the SAS software version 8.0 (Enterprise Guide, release 1.3).

Results and Discussion

The characteristics of the studied populations are given in Table 1. The five groups were well matched for gender, body mass index (BMI) and also for age with the exception of the group living around the MSWI in the industrial area who on average was younger than referents (p=0.005). The smoking and drinking habits presented also significant differences between groups.

Table 1. Characteristics of studied populations

	N	Gender (men/women)	Age[a]	BMI[a]	Tobacco[b]	Alcohol[c]
Iron and steel plant	58	26/32	52.0 (10.3)	26.6 (4.3)	56/23/21	44.8 %
Waste dumping site	52	23/29	51.9 (8.4)	24.0 (3.5)	79/17/4	38.5 %
MSWI in industrial area	33	13/20	46.1 (8.4)	27.9 (4.9)	73/12/15	21.2 %
MSWI in rural area	51	25/26	53.3 (12.5)	27.8 (4.5)	48/38/14	54.9 %
Unpolluted area	63	29/34	52.9 (7.8)	25.8 (4.1)	62/22/16	36.5 %
Total population	257	116/141	51.7 (9.8)	26.3 (4.4)	63/23/14	40.5 %

[a]Arithmetic mean (SD).
[b]Proportions (%) of non smokers / ex-smokers / current smokers.
[c]Proportions of subjects drinking more than 7 glasses of alcohol per week.
BMI, body mass index.

Table 2. Geometric mean concentrations of dioxin in blood of potentially exposed subjects and of their referents (pg-TEQ/g fat, min-max)

	N	PCDD/Fs	cPCBs	PCDD/Fs+cPCBs
Iron and steel plant	58	23.8 (5.2-57)	6.3 (1.2-37)	30.7 (7.6-84)
Waste dumping site	52	21.8 (4.1-58)	6.7 (1.1-35)	29.5 (7.9-86)
MSWI in industrial area	33	24.1 (11-113)	5.7 (0.2-20)	30.1 (13-133)
MSWI in rural area	51	37.9 (9.2-101)	10.3 (0.2-44)	48.7 (9.4-145)
Unpolluted area	63	23.9 (5.0-71)	7.0 (1.5-29)	31.3 (6.7-100)
Total population	257	25.7 (4.1-113)	7.1 (0.2-44)	32.8 (6.7-145)
Total population without the MSWI in rural area	206	23.4 (4.1-113)	6.5 (0.2-37)	30.49 (6.7-133)

Table 2 compares the geometric mean concentrations of PCDD/Fs and cPCBs in blood of the five populations. The only group with a dioxin body burden significantly different from that of referents is the group of subjects living in the vicinity of the MSWI with a rural location (p<0.0001). The four other groups studied had dioxin (PCDD/Fs, cPCBs and PCDD/Fs+cPCBs) very similar to that of referents with average values differing by less than 10% for PCDD/Fs and 20% for cPCB of the mean values of referents. The significant increase found around the MSWI in the rural area was observed for both PCDD/Fs and cPCBs and confirmed our previous observations based on a smaller group of referents[4]. The serum concentrations of PCDD/Fs and cPCBs were significantly correlated, on the total

population (r= 0.66; p<0.0001) as well as on the five different groups examined separately (r between 0.53 and 0.68, p<0.05). These findings are in good agreement with previous reports[5]. The four coplanar PCBs contribute on average to about 22 % of the total TEQ activity, a proportion which is virtually identical whether calculated on the total population (n=257, 21.6 %) or on the referents only (n=63, 22.4 %). These results were not altered after adjustment for age and BMI which were the only other variables significantly associated with dioxin body burden (see below).

A multiple linear regression analysis was performed to identify factors influencing the accumulation of dioxin in the general population. This analysis was done by excluding the group around the MSWI in the rural area whose dioxin body burden was clearly different from that of the rest of the population. We used a stepwise regression model with a significance level of 0.25 to enter the model and of 0.05 to stay in the model. The tested explanatory variables were age, BMI, gender, tobacco smoking, alcohol consumption and seafood consumption. The two variables contributing significantly to the dioxin body burden (log PCDD/Fs+cPCBs in serum, pg TEQ/ g fat) were the age (r^2=0.2, slope=0.01, p<0.0001) and the BMI (r^2=0.03, slope=0.008, p=0.0056).

In conclusion, if one excludes the subjects living in the vicinity of the MSWI in the rural area, our results show that the average dioxin body burden of different groups of the general population of Wallonia with a mean age of 46 to 53 years is around 23 pg PCDD/Fs TEQ/g fat (30 pg TEQ by adding the four cPCBs) These values were not higher and even in some cases lower than the background values reported in other industrialized countries for population groups of the same age[6-8]. If one refers to dioxin values reported in the human milk by WHO for Wallonia in 1992/1993 (20.8-27.1 pg TEQ/g fat) and if one takes into account the age difference with our population, these data also suggest that the dioxin body burden has continued to decrease in Belgium despite the recent PCB/dioxin incident.

Acknowledgments

This work was supported by the Ministry of Environment of the Walloon Region.

References

1. WHO European Center for Environment and Health (1996) Levels of PCBs, PCDDs and PCDFs in human milk. WHO-coordinated exposure study. Environmental Health in Europe Series, No.3.
2. Bernard A., Hermans C., Broeckaert F., De Poorter G., De Cock A. and Houins G. (1999) Nature 401, 231-2.
3. Bernard A., Broeckaert F., De Poorter G., De Cock A., Hermans C., Saegerman C. and Houins G (2002) Environmental Research 88; 1-18.
4. Fierens S., Mairesse H., Focant J.F., André J.E., Eppe G., De Pauw E. and Bernard A. (2001) Organohalogen Compounds 52, 334-336.
5. Longnecker MP., Ryan JJ., Gladen BC. and Schecter A.J. (2000) Arch. Environ. Health 55(3), 195-200.
6. Kiviranta H., Vartiainen T., Verta M., Tuomisto JT., Tuomisto J. (2000) Lancet 355(9218):1883-5.
7. Papke O. (1998) Environ Health Perspect.106 Suppl 2:723-31.
8. Schuhmacher M., Domingo J.L., Llobet J.M., Lindstöm G. and Wingfors H. (1999) Chemosphere 38, 1123-1133.