FIVE YEAR FOLLOW-UP OF DIOXIN AND PCB BODY BURDEN OF RESIDENTS LIVING IN THE VICINITY OF A MSWI IN WALLONIA, BELGIUM

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Introduction

Human dioxin and PCB body burdens were investigated for the first time in Wallonia in 2000. In this first survey, higher dioxin concentrations were found in the serum of residents living in the vicinity of the municipal solid waste incinerator (MSWI) of Thumaide, by comparison with referents recruited in an unexposed area in Wallonia.[1,2] Dioxin emissions by this MSWI have now been drastically reduced in order to comply with the emission norm of 0.1 ng TEQ/Nm³. The aim of this follow-up study was to evaluate the impact of this emissions reduction, on the dioxin and PCB serum concentrations of subjects living around the incinerator and of referents, five years after the first quantifications.

Materials and Methods

The study was approved by the Ethical Committee of the University of Louvain. From the 115 volunteers studied in 2000 (52 residents living in the vicinity of the MSWI of Thumaide, recruited between February and April 2000, and 63 from the referent group, recruited between March and April 2000), we recruited 41 subjects (20 from the MSWI group and 21 from the referent group). After having given their informed consent and filled in a questionnaire, fasting serum samples were collected between October 2005 and January 2006.
In order to evaluate the dioxin and PCB body burden, the seventeen 2,3,7,8-substituted polychlorinated dibenzodioxin/dibenzofuran congeners (PCDD/Fs), the twelve dioxin-like PCBs (IUPAC no 77, 81, 126, 169, 105, 114, 118, 123, 156, 157, 167, 189) and the six indicator PCBs (ortho-PCBs; IUPAC no 28, 52, 101, 138, 153, 180) were quantified by GC-HRMS on the lipid fraction of serum.[3,4] Total serum lipids were estimated by enzymatic method. Concerning the dioxin-like PCBs, only the results of the four non-ortho-PCBs (coplanar PCBs or cPCBs; IUPAC no 77, 81, 126 and 169) are presented, since the mono-ortho PCBs were not quantified in 2000. The PCDD/Fs and cPCBs concentrations were expressed as equivalents of TCDD using the WHO-TEFs (1998). The statistical analysis was performed using the SAS software version 9.1 (Enterprise Guide, release 3.0).

Results and Discussion

From the 21 volunteers of the referent group, we excluded one subject who showed a drastic decrease of concentrations (PCDD/Fs: 76.0 pg TEQ/g fat in 2000 to 9.3 pg TEQ/g fat in 2005) as a result, most likely, of an important weight gain (20 kg). We also excluded one volunteer of the MSWI group who presented a completely abnormal increase of dioxin and PCBs concentrations in serum (PCDD/Fs: 9.2 pg TEQ/g fat in 2000 to 65.9 pg TEQ/g fat in 2005).

The 2005 mean concentrations of PCDD/Fs, coplanar PCBs and indicator PCBs of the 20 volunteers of the referent group (general population, mean age = 58.5 years) were 22.0 pg TEQ/g fat, 5.5 pg TEQ/g fat and 296 ng/g fat, respectively. It represents, by comparison with mean values observed in 2000, a decrease of 20.5%, 32.1% and 25.3%, respectively. If we take into account the bioaccumulation of these persistent compounds in the body, resulting in an increase of concentrations with age (+ 5 years), these decreases are even stronger. Indeed, after adjustment of the values observed in 2005 for the age of the volunteers in 2000, the mean PCDD/F concentration of the referent group in 2005 decreases from 22.0 pg TEQ/g fat (mean age = 58.5 years) to 19.9 pg

TEQ/g fat (mean age = 53.5 years), which means an average decrease of 28.2% by comparison with the 2000 average that was 27.7 pg TEQ/g fat.
Among the 19 volunteers of Thumaide (mean age = 58.5 years), the 2005 mean concentrations of PCDD/Fs, coplanar PCBs and indicator PCBs were 40.8 pg TEQ/g fat, 9.5 pg TEQ/g fat and 371 ng/g fat, respectively. These values correspond to mean decreases of 12.6%, 24.6%, and 24.3%, respectively, by comparison with mean values observed in 2000.

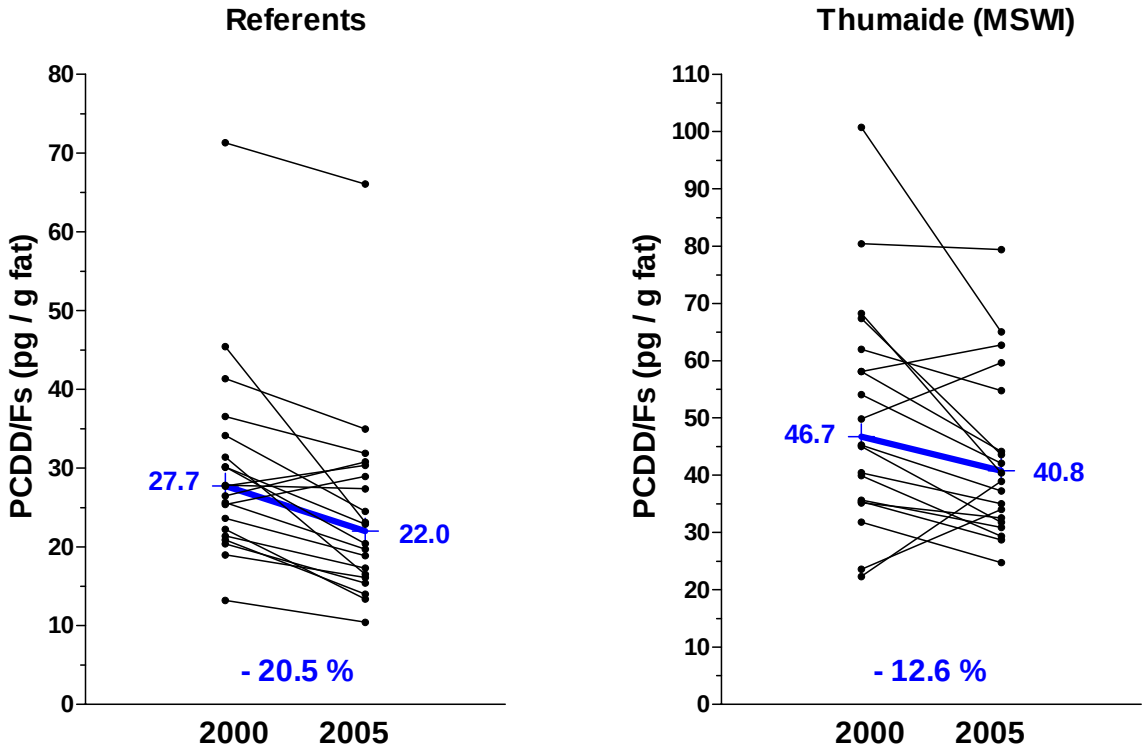

Figure 1. Temporal evolution of the dioxin (PCDD/F) concentrations between 2000 and 2005, in the MSWI group and the referent group. Geometric means are indicated, as well as the percentage of decrease.

As illustrated in Figure 1, the PCDD/F, cPCB, and indicator PCB concentrations were significantly lower in 2005 than in 2000, both in the MSWI group and in the referent group. On the other hand, the magnitude of the decreases (percentage) is not significantly different between the MSWI group and the referent group, even though the mean percentage of PCDD/F decrease appeared to be lower in the MSWI group (-12.6% rather than -20.5% in the referent group).
The percentages of decrease of PCDD/Fs were highly correlated with percentages of decrease of cPCBs ($r=0.80$; $p<0.0001$) and of indicator PCBs ($r=0.77$; $p<0.0001$), indicating a common global decrease of these different congeners.
The consumption of locally produced fats did not appear to influence significantly the percentage of decrease of dioxins and PCBs. This was evaluated by comparing, separately in the two groups, the percentage of decrease of dioxins or PCBs between subjects with low local animal fat consumption (<60g/week, n=4 in MSWI group and n=5 in referent group) and subjects with high local animal fat consumption (≥60g/week, n=12 in MSWI group and n=14 in referent group).

In order to take into account all the possible determinants of the observed variations, multiple linear regression analyses were done with, as dependent variables, percentages of variation, between 2000 and 2005, of PCDD/Fs, cPCBs, and indicator PCBs. Explanatory variables that were tested are: the age, the BMI, the gender, the group (MSWI or referent), the fat consumption, the diabetic status, the concentrations observed in 2000, and the weight difference between 2000 and 2005. It appeared from these analyses (table 1) that residence in the vicinity of the MSWI was not a significant determinant of the percentages of dioxin or PCB variations between 2000 and 2005.

Table 1. Results of the multiple linear regression analyses.

Determinant	Partial r^2	Estimate	p-value
PCDD/Fs			
Age	0.08	0.8387	0.08
Fat consumption	0.08	46.3193	0.06
Coplanar PCBs			
cPCB value in 2000	0.09	-65.06	0.07
Sex	0.14	-29.03	0.01
Age	0.08	1.048	0.05
Indicator PCBs			
Weight difference	0.30	-1.248	0.001
Age	0.07	0.515	0.07
Indic. PCB value in 2000	0.07	-34.068	0.06
Group	0.05	6.524	0.095

Conclusions

The dioxin and PCB mean concentrations observed in 2005 were significantly lower than in 2000, both in the group of residents living near the MSWI of Thumaide and in the unexposed referent group.
The mean PCDD/Fs decrease reached, after adjustment for ageing, 28.2% in five years in the general population (referent group), which is in accordance with the general decrease observed elsewhere in industrialized countries.[5-7]
The magnitude of the decreases, in terms of percentages of the values observed in 2000, was not significantly different between the exposed (MSWI) and non exposed groups. Nevertheless, even if not significant, the decrease of PCDD/Fs appeared to be lower in the MSWI group than in the referent group.
The locally produced fat consumption, in particular by the MSWI group, did not appear to influence the decrease of the dioxin and PCB concentrations.

The decrease of dioxin and PCB serum concentrations reflects a decrease of human exposure to these persistent pollutants, which is reassuring, in particular for the subjects living in the vicinity of the MSWI of Thumaide that have experienced high contaminations in the past.

Acknowledgements

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