Dioxin body burden in women with long term residency near and away from major chemical industries in Teesside, UK

Tanja Pless-Mulloli[1], Richard Edwards[2], Denise Howel[1], Olaf Paepke[3], Thomas Hermann[0]

[1]University of Newcastle upon Tyne, Newcastle, UK
[2]University of Manchester, Manchester, UK
[3]ergo Forschungs Gesellschaft, Hamburg, Germany

Introduction

Retrospective exposure assessment poses a major challenge for environmental epidemiology studies. Body burden measures may act as markers for long-term exposure if biomarkers can be found with sufficiently long half lives in the human body. Some studies of human exposures have reported data from exposures over several years and before and after sources started production (1-3), however none have investigated the usefulness of such approach when exposure is estimated over more than a decade. Whilst for the general population food intake forms the major source of long term dioxin exposures other occupational and environmental sources can contribute to elevated body burdens. The UK has rich data sets for dioxin levels in food, but no body burden data are yet available for a general population sample.

We tested the hypothesis that women with long term residence close to an industrial complex have a higher body burden and a distinct pattern of dioxins, furans (PCDD/F) and polychlorinated biphenyls (PCBs). We estimated exposure by recording residential history and food intakes and compared this information with body burden measurements as proxy for all forms of exposure.

Method

Design:
We carried out an observational study of 20 women living near (0.1-2.7km) and 20 women living distant (5-40 km) from an industrial complex on Teesside, UK.

Subjects and setting:
Subjects were recruited from participants in a case-control study of residential exposure to air pollution and lung cancer. Residences were assigned to exposure zones: A=near, B=intermediate (no subjects from zone B are included in this body burden study), C= distant from industry. The definition of zones was informed by land-use surveys, dispersion modelling and monitoring. This documented that exposures to air pollution in Zone A had been much higher than in the other zones

in the past and until the 1980s. We recruited 20 women from zone A (10 cases and 10 controls) and 20 from zone C (10 cases and 10 controls) sequentially between January 2000 and December 2003. Women with weight loss of ≥ 3.5kg over last 3 months or who had lived for less than 20 years consecutively in their current zone were excluded.

Data collection:
Information on: occupational exposure (defined as years spent in jobs considered to have a possible or probable increased risk of lung cancer); residential history; current and past consumption of local animal and vegetable produce; number and length of breast feeding periods; current and typical diet; and self-reported height and weight was collected with an administered questionnaire by a research nurse at the time of the collection of the blood sample. Whole blood (40-60ml) was analysed for PCDD/F and PCBs.

Data analysis:
We report results in ng/kg on lipid base. The means dioxin levels were compared in Zone A & C: bootstrap confidence intervals were calculated in those cases when the distributions were non-Normal. Further comparisons were made using stepwise multivariate linear regression after adjusting for covariates. These were agreed a priori based on known determinants of dioxin/furan levels identified from the literature (age, age-squared, body-mass-index, cumulative dietary intake of eggs, fish, meat and dairy products, breast feeding duration, and occupational exposure. Other covariates were of interest (e.g. years of consumption of animal produce from zone A, years since last breast feeding period) but very few women had breastfed at all making it impossible to include the variable in the multivariate analysis. The analysis of congener patterns was carried out by descriptive statistics, principal components analysis and multivariate analysis of variance (MANOVA) using log-ratio transformations (4).

Ethics:
The protocol for this study was approved by the local research ethics committee. Participants gave informed consent and were fed back results if this was requested.

Results

Table 1 shows the characteristics of the study population.

The mean age of participants from Zone A was 62.5 years, the mean age of participants from zone C was 65.3 years. Participants in Zones A and C were similar with regards to their age, body mass index, breast feeding, and occupational exposure. Lifelong consumption of dairy products and eggs were similar in both zones, however meat consumption was slightly higher in Zone C than in zone A, whilst fish consumption was slightly higher in Zone A than in Zone C. Zone A residents were more likely to report regularly consuming local animal produce from Zone A, although this was only five individuals, four of whom had eaten such produce regularly for less than five years in total. The population of this study was older than populations in most previous population based studies. The mean duration of residence was 47.3 years for zone A residents and 40.5 years for zone C residents.

Table 1 Characteristics of the study population

	Zone A (near industry)		Zone C (distant from industry)	
Number	20		20	
	Mean	Median	Mean	Median
Age [years]	62.5	65.0	65.3	67.0
Body mass index [kg/m]	28.7	27.9	27.9	28.7
Breast feeding [months]	3.3	0	4.5	0
Lifelong dietary consumption of [number of portions x 1000]				
Meat	16.0	16.7	18.3	19.1
Fish	6.0	5.3	4.4	5.0
Dairy products	39.3	40.4	41.8	40.8
Eggs	8.9	5.9	8.6	5.9
Occupational exposure [years]	1.6	0	1.0	0
Continued residence in last Zone [years]	47.3	45.5	40.5	38.0
Total residence in last zone [years	52.6	49.0	44.2	40.5

Table 2 shows selected results of the body burden of dioxins and PCBs in zones A and C.

Table 2 Body burden of PCDD/F and selected PCBs in Zones A and C in ng/kg lipid base

	Zone A (near industry)	Zone C (away from industry)	Difference in means (95% CI)
Number	20	20	
	Mean		
WHO-TEQ (DF+PCB)	45.3	48.6	-3.3 (-13.2 to 6.7)
WHO-TEQ (D)	20.7	21.6	-1.0 (-5.3 to 3.4)
WHO-TEQ (F)	8.4	9.1	-0.7 (-2.7 to 1.3)
WHO-TEQ (DF)	29.1	30.8	-1.7 (-8.0 to 4.6)
WHO-TEQ (PCB)	16.3	17.9	-1.7 (-5.9 to 2.6)
2378-TCDD	4.0	4.1	-0.2 (-1.2 to 0.8)
PCB 118	13993	18357	-4364 (-10878 to 1345
PCB 156	13180	12973	-208 (-2569 to 2984)
PCB 118:156	1.2	1.4	-0.2 (-0.7 to 0.3)

DF=dioxin/furan, D=dioxin, F=furan

We found no significant difference in mean body burden for any of the indicators between zones A and C participants. However, the data was consistent with either a large or a zero difference for some variables. In multivariate linear regression no significant differences were found in any mean body burden measures between participants form zones A and C, after adjusting for potential confounders

All congener patterns were consistent with an urban background pattern. The average congener profile for those congeners where less than one third of samples were below detection limits is given in Table 3. Further analyses were only performed on the 10 congeners below.

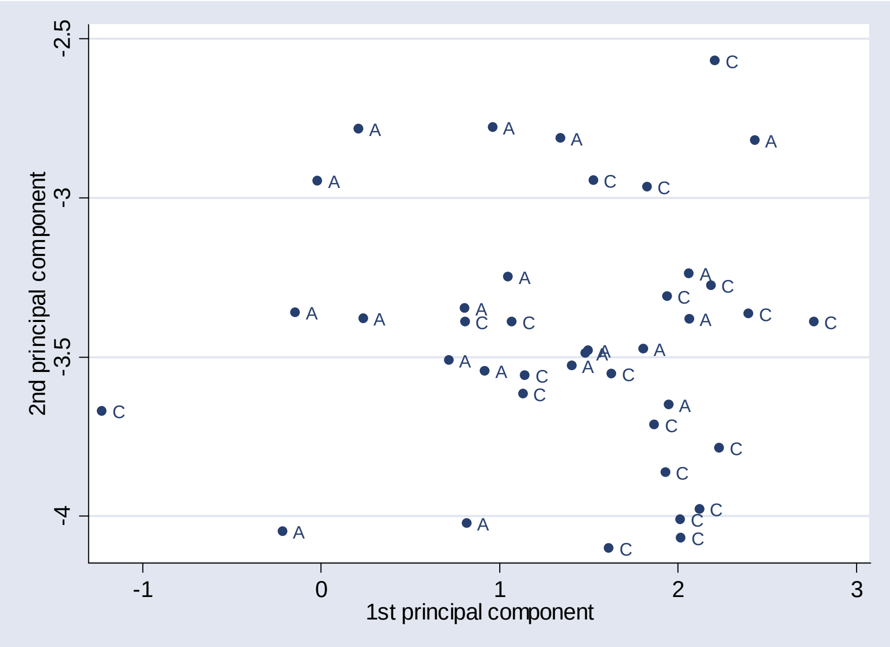
Table 3 Dioxin/furan congener profiles in residents of Zone A (near industry) and zone C (away from industry)

Congener	Zone A (%)	Zone C (5)
D2378	0.53	0.78
D12378	1.45	2.13
D123478	1.27	1.55
D123678	6.19	8.25
D123789	0.84	0.93
D1234678	3.93	3.18
OCDD	82.23	77.93
F23478	1.88	2.66
F123478	1.03	1.43
F123678	0.73	0.99

N.B. F2378, F12378, F123789, F1234789 below detection limits for >90% samples
F234678, F1234678 below detection limits for >33% samples

The first two principal components retained 88% of the sample variation. The plot (Figure 1) showed that there was some tendency for samples in Zone A and C to differ in profile, but the hypothesis that the mean vectors were equal in samples from Zone A & Zone C was tested via MANOVA and could not be rejected (p=0.33).

Figure 1 **Principal components plot for samples from residents of Zones A and C**



Discussion

This was a population-based study with much detail on residential and food consumption information. It presents the first population based dataset of body burden data for the UK. The levels in this elderly female population were comparable with background levels reported for other industrialised parts of the world (5, 6).

The hypothesis, that long term residents close to an industrial complex have a higher body burden and a distinct pattern of dioxins, furans (PCDD/F) and polychlorinated biphenyls (PCBs) was not upheld in this setting. The body burden of these biomarkers were not a useful indicator for long term residential exposure in this setting.

There were several possible explanations for the lack of difference between levels in subjects living near and far from the industrial complex. One possible explanation was that the intake of PCDD/F and PCB via background food consumption was such a dominant source of exposure that impacts from local industrial sources were undetectable if they existed. Alternatively and /or additionally differential exposures due to proximity of residence near industry may only have occurred in the more distant past, with more recent exposure experience similar due to changes in emissions and industrial processes. Finally, dioxin exposure as opposed to air pollution exposure, which we knew to be different in the past, may have been similar in Zone A and Zone C residents.

References

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