

The French Dioxin and Incinerators Study

Method of the Study

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Introduction

France is the European country with the highest number of municipal solid waste incinerators (about 120 units operating in 2007, 300 in 1998). However, no data was available on dioxin levels in the general population, except in maternal milk.

The French Dioxin and Incinerators Study was carried out in response to the concern of the French population who wants to know whether living in the vicinity of wastes incinerators can influence their serum dioxin levels.

OBJECTIVES

- to measure dioxin levels in serum samples collected in the populations living around various types of municipal solid waste incinerators,
- and to evaluate the contribution of the dioxins contained in locally-produced food products to these serum levels, since food is known to be the most important route of exposure.

Methods

POPULATION

The French Dioxin and Incinerators Study was carried out by the French Institute for Public Health Surveillance and the French Food Safety Agency in 8 different areas in France around municipal solid waste incinerators.

FIGURE 1 CATEGORIES OF MUNICIPAL SOLID WASTE INCINERATORS ACCORDING TO DIOXIN EMISSION / CAPACITY



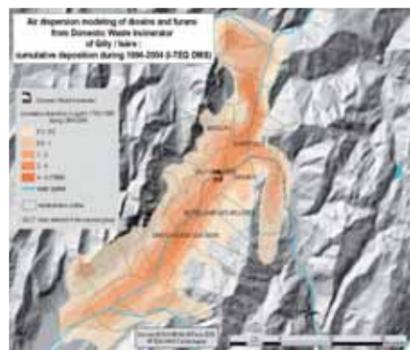
The study population was composed of 1030 adults between the ages of 30 and 65. Participants provided blood serum samples for dioxins, furans and PCBs measurement and answered face to face questionnaires.

In each of the 8 areas (Cluny, Fécamp, Gilly sur Isère, Vaux-le-Pénil, Maubeuge, Dijon, Pluzunet, Bessières) about 130 people living for at least 10 years around the incinerator, without occupational exposure, and for women without breastfeeding in the past 15 years were involved.

Exposed people were defined as living in the impact area of the incinerator's plume and not exposed people as living beyond 20 km of the incinerator and not exposed to known dioxins sources.

- In each of the exposed or not exposed study groups, the population studied was divided in two groups:
- people eating home-grown or food produced locally (poultry, meat, eggs, milk, fruit and vegetables...),
 - and people not eating home-grown or locally-produced food.

MUNICIPAL SOLID WASTE INCINERATORS



Three categories of municipal solid waste incinerators were considered:

- **four small incinerators** (<6 tons per hour) and highly polluting ones (> 10 ng/Nm²; some data > 500 ng/Nm²),
- **two large incinerators** (≥ 6 tons per hour) and highly polluting ones,
- **two large incinerators and slightly polluting ones**, which have respected environmental directives (< 0,1 ng/Nm²).

The study areas around each of these incinerators were defined using a threshold applied to the surface deposit accumulated over several years.

The deposits were estimated through a modeling of atmospheric dispersion of the municipal solid waste incinerators plume.

SAMPLING AND RECRUITMENT

In order to be eligible for participation in the survey, population was first contacted by phone after obtaining their contact details from voter lists.

Then, populations from each 8 areas were sampled using a **two-stage probability sample design, stratified by area of exposure and by consumption** or not of locally produced food.

In the first stage, households were sampled using probabilities proportional to the size of the household.

The second stage sampled people using a simple random sampling. The random sample included a single eligible adult in each household.

Each subject who was sampled was asked to complete informed consent documents and was asked to participate in an interview and blood draw close to their home (about 200 ml of blood under fasting conditions in the morning).

QUESTIONNAIRES

Subject characteristics

The physiological and socio-demographic factors include age, sex, body mass index, recent changes in body weight, study level, socio-professional category, marital status, tobacco status (smokers, ex-smokers, non smokers), grams of tobacco smoked, occupational exposure.

Food consumption

Food intake was quantified by a validated **food frequency and portions questionnaire** detailed for the food vectors for animal lipids. There were 3 questionnaires:

- the first on the **general diet** involving 109 frequencies of consumption of food products combined with several items on portions (food groups: meat (beef, pork, poultry...), fish, sea shell and shellfish, eggs, milk and dairy products, oils and fats, vegetables (leafy, roots), fruit, starchy food,
- the second on **locally-produced food diet** (132 items: frequency, portion, duration per year, etc),
- and the third on **production of cattle, poultry, eggs, milk in the area of the plume.**

Results of the food consumption were expressed in grams per day of food products or in grams per day of lipids in the food products for food from animal origin.

Environmental factors

The environmental factors studied were the length of residency since the incinerator installation, accumulated deposit at the residence measured by the dispersion models, living or not in the exposed area (under the plume), urbanism (rural, suburb, city), type and date of the household, vegetable garden (yes/no, duration of exposure to the plume, use of ashes to fertilize), barbecue, type of heating, burning, exposure to a fire, leisure, number of minutes per week in a vehicle.

Biomarkers

Exposure was assessed by serum concentrations of the 17 classical dioxins (PCDDs) and furans (PCDFs), 12 DL-PCBs and 4 marker PCBs (IUPAC 118, 138, 153, 180).

- GC-HRMS method by CART laboratory
- Blood lipids analyzed by enzymatic method
- Results expressed in WHO TEFS 1998
- Lead in blood and cadmium in urine also performed

DATA QUALITY

- Internal, external and blind quality controls were implemented to assess the performances at the various levels of concentrations found in the population.

- Two definitions of the limit of quantification (LOQ) were computed :

1- based on the EU dioxin directive 2004/44/EC

2- on levels of congeners found in the procedure blank (more restrictive LOQ).

The difference between these two definitions can be as large as one or two orders of magnitude for some congeners. However, the LOQ are still low enough to allow the quantification of the majority of the samples.

STATISTICAL ANALYSIS

To investigate whether living around the incinerator was associated with elevated blood dioxins, furans and PCBs levels, several statistical methods (univariate descriptive and multivariate analyses) were used.

The population study was selected through a stratified two stages random sampling. Therefore, sampling weights were usually used to adjust statistical analysis results. However, the results of the weighted and unweighted regression models were compared in most analyses to check their sensitivity to the over/under sampling of certain consumer profiles.

To assess the shape of the relationships between the log-transformed serum congener concentrations and the continuous explanatory factors, we used a spline regression with 3 degrees of freedom and/or analysed these factors as categorical variables.

In spite of low limit of detection, several concentrations were not detected. We therefore used either substitution method or regression model for censored data.

- High % of censored values → Tobit regression model

- Low % of censored values → Substitution method

- $X < LOD \rightarrow LOD/2$
- $LOD < X < LOQ \rightarrow (LOD + LOQ)/2$

All statistical analyses were completed using STATA, SAS and R.

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