Environmental risks

Example of municipal solid waste incinerators

France has the largest number of municipal solid waste incinerators (MSWI) in the European Union (EU), with 128 plants counted in 2006. Substantial efforts have gone into improving them in recent years. Nonetheless, while there are no longer any MSWIs in France that do not meet European norms, many have caused significant pollution in the past.

Concern of neighbouring populations have on several occasions led the authorities to have local studies conducted to identify more in detail the risks to these populations. Gilly-sur-Isère is the best example.

Incidence study of Gilly-sur-Isère

The Rhône-Alpes regional epidemiology unit conducted this study, which took five years (2002-2006), because of severe anxiety by local residents about their health. This CIRE compared the incidence rates of cancer in the population exposed to the incinerator plume (48 000 inhabitants in 30 municipalities) with the expected rate, taking data from cancer registries as reference.

Compiling a list of all cancers in the study area between 1994 and 2002 required major health data research from multiple sources. It finally counted 2055 cancer cases, and its quality resembled the registry lists in exhaustiveness and validity. The study did not find any statistically significant excess cancer risk in the exposed area, either for all cancers or for those most often reported to be associated with exposures to incinerators or dioxins.

It quickly became clear that it would be inefficient and ineffective to conduct this type of study around each incinerator with worried neighbours. Local conditions are not always optimal. The Gilly-sur-Isère incinerator, for example, is located in a district without a cancer registry and it was therefore necessary to conduct a difficult retrospective survey to find all of the cancer cases that occurred between 1994 and 2002. Moreover, each exposed population is relatively small. The studies thus lack the power necessary to show relatively small differences in risks of exposed and unexposed populations.

In 2002, InVS and AFSSA recommended that two types of studies be performed around MSWIs: one of the dioxin burden of the local population and the other a multicenter study of cancer incidence near the facilities.

Two studies were funded through the national cancer plan.

Study of cancer and incinerators

The objective of the cancer study was to analyze the relation between cancer risk and past exposure to MSWIs for the populations living near them. In this ecological retrospective incidence study, we looked for cancer cases diagnosed during a past period (1990-1999); population exposure to MSWIs was estimated only as a function of the geographic zone of residence.

Why a study of incinerators and cancer?

Around the turn of the century, several local health crises, which received very extensive media coverage, alerted the authorities and the population to the possibility of an increased cancer risk among people living in the vicinity of incinerators: Gilly-sur-Isère, Cluny, Maincy, Nivillac, and more. The environmental pollution around these incinerators, often very high, was revealed by occasional, even one-time, measurements, because small systems were exempt from regulation at that time. A French study, performed at Besançon by J.-F Viel’s team (Floret N, Mauny F, Challier B, Arveux P, Cahn J.-Y, Viel J.-F. 2003. Dioxin emissions from a solid waste incinerator and risk of non-Hodgkins lymphoma. Epidemiology 14:392) showed an excess risk of non-Hodgkins lymphoma in the cantons (rural administrative subdivisions) exposed to emissions from the local incinerator. Since the dioxin at Seveso was classified as a confirmed carcinogen for humans by the International Agency for Research on Cancer, the risks of exposure through incinerator dust and gases to this family of substances and of the long-term effect of low doses on local residents were a legitimate question. Other pollutants emitted by incinerators might also be involved, including heavy metals, PAHs (polycyclic aromatic hydrocarbons), and dust.

Existing studies on the subject were analyzed as part of an InVS report (Incinerators and Health, InVS 2003) that concluded that the available knowledge was insufficient and that a national study was necessary. The available studies have mainly been performed on workplaces, that is, in high-exposure situations, and their results have been contradictory: some conclude that an excess risk is present, while others do not.
The geographic zones used as statistical units were census blocks, called IRIS (Ilots Regroupés pour l’Information Statistique) in INSEE terminology. A rich set of social and demographic information is available for every block, each of which has a relatively homogenous population of approximately 2000 inhabitants. Five possible confounding factors mentioned in the literature could therefore be taken into account: urban density, the urban or rural character of the place of residence, socioeconomic status, airborne traffic pollution, and industrial pollution.

The study period, that is, the period for which health data were collected, covered 1 January 1990 through 31 December 1999. The study area included four districts: Isère, Haut-Rhin, Bas-Rhin, and Tarn (figure 1). These districts were selected because they have general cancer registries old enough to cover the study period. On the other hand, 16 incinerators had emitted pollutants even before this period. This early emission period corresponded to the period of local population exposure. It was defined to make the subsequent development of cancer plausible. This exposure period ranges from 1972 at the earliest to 1985, as a function of emission dates for these different incinerators.

Due to the few number of measurement data available, it was necessary to estimate the MSWI emissions as precisely as possible to characterize exposure levels retrospectively. These estimates, based on the judgment of experts, took the technical characteristics of each incinerator into account.

Next, the dispersion of each incinerator’s plume was simulated by computer (figure 2), taking into account meteorologic and topographic indicators (roughness, relief) and using the most recent techniques (second-generation Gaussian models).

The cancer incidence rates observed in the census blocks were related to the expected reference incidence rate from cancer registry data (in the study districts, as well as in Doubs and Hérault). We compared the standardized incidence rates obtained in the census blocks with the highest, intermediate, and lowest exposure levels. Excess risks could thus be calculated according to exposure.

Overall, the study analyzed 135,567 cases of cancer in 2,272 census blocks. The early results show a statistically significant linear exposure/risk relation for some cancer sites.

The excess risk for persons living in highly exposed census blocks compared with those living in slightly exposed blocks was 6.8% for liver cancer, 1.9% for non-Hodgkin’s lymphoma, 9.1% for soft-tissue sarcoma, 2.8% for all cancers in women, and 4.9% for breast cancer. On the other hand, we found no statistical relation for lung cancer or bladder cancer (table).
The strength of this study lies in the precision of its exposure measurements with many data points collected and analyzed with the most advanced techniques for statistical modeling and taking into account the potential confounding factors that could be measured at a collective scale. The other remarkable point is the precision and reliability of the health data collected, due to the cooperation of the cancer registries and the georeferencing of cases.

By itself, an ecological study cannot establish a causal relation between exposure to incinerator fumes and the cancers mentioned. The excess risks measured are relatively low, but the study also establishes a linear exposure/risk relation, which is compatible with causality. This is the first study to show such a result for breast cancer.

It must be stressed that the risk detected reflects old exposure situations—from 1972 through 1985—not currently transposable because of the major reduction in incinerator emissions since the 1990s. Interpretation of these data requires still more analysis and cannot at this stage provide guidelines for risk management.

The "dioxin burden" study of the populations living under incinerator plumes

The objective of this study was to establish whether the populations living around MSWs had abnormally high blood dioxin levels and to analyze in detail the determinants of the dioxin burden. It was conducted in partnership with AFSSA, implemented by InVS, and coordinated locally by the regional epidemiology units.

<table>
<thead>
<tr>
<th>Sites</th>
<th>Excess risk for residents of census blocks with intermediate exposure (50th percentile) compared with the 2.5th percentile</th>
<th>Excess risk for residents of census blocks with high exposure (90th percentile) compared with the 2.5th percentile</th>
<th>P values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver cancer (both sexes)</td>
<td>6.8% (0.1–14.1)</td>
<td>9.7% (0.1–20.3)</td>
<td>p&lt;0.05</td>
</tr>
<tr>
<td>Malignant non-Hodgkin’s lymphoma (both sexes)</td>
<td>1.9% (0.0–3.8)</td>
<td>8.4% (0.2–17.2)</td>
<td>p&lt;0.05</td>
</tr>
<tr>
<td>Soft-tissue sarcoma (both sexes)</td>
<td>9.1% (1.7–20.9)</td>
<td>12.9% (2.3–30.6)</td>
<td>p=0.1</td>
</tr>
<tr>
<td>All cancers in women</td>
<td>2.8% (0.7–5.1)</td>
<td>4.0% (0.9–7.2)</td>
<td>p&lt;0.05</td>
</tr>
<tr>
<td>Breast cancer in women</td>
<td>4.8% (2.0–7.7)</td>
<td>6.9% (2.9–11.0)</td>
<td>p&lt;0.05</td>
</tr>
</tbody>
</table>

The first stage involved selecting incinerators with different emission profiles: small old incinerators that had been major polluters, large old incinerators that had been polluters, and large new incinerators that meet the new standards. Next we selected the incinerators around which we might be able to identify populations eating locally grown or raised products who might therefore have been contaminated by incinerator emissions. Food is the principal source of dioxin exposure.

Eight sites near incinerators were chosen (figure 3). For each site exposed to incinerator emissions, an unexposed site in the same region was chosen to maximize the comparability of the populations.

The "dioxin burden" study of the populations living under incinerator plumes
At each site, subjects were randomly selected, and those who agreed to participate were included. In a face-to-face interview, they answered a questionnaire about their individual characteristics, their food habits, and their domestic environment. Finally blood samples for dioxin and PCB (polychlorinated biphenyls) assays were taken and sent for analysis to the reference laboratory at the University of Liège in Belgium (CART laboratory).

Overall 1053 people aged 30-65 years participated in this study, of the 2069 randomly selected. They had to have lived in the study area for at least ten years, have no occupational exposure to dioxins and not have breast-fed (or very briefly).1

AFSSA, Aria Technology and the National Institute of the Environment and Industrial Risks (INERIS) modeled the plumes to assess incinerator exposure. The results showed that globally the mere fact of living near an incinerator did not increase blood dioxin or PCB concentrations to a statistically significant degree. Nonetheless, farmers living in exposed areas who ate fats from home-raised animals and vegetables they grew themselves had a statistically significantly higher burden than similar farmers in unexposed areas.

The principal determinant of dioxin burden related to incinerators is therefore eating local food products. On the other hand, the study did not show any difference among people who did not eat local products and therefore provided no evidence of airborne contamination.

These differences were not found around recent incinerators meeting EU standards. The results about locally grown food are consistent with the literature. They cover a more recent exposure situation than that of the cancer study, since the assays in 2005 reflect exposure during the 1990s, at a time when emissions had already been reduced.

Overall: in Gilly-sur-Isère, the overall cancer incidence is low in the study area, and the "dioxin burden" study also showed a low blood concentration. It therefore appears that in these conditions the possible contribution of the incinerator, if it exists, cannot be observed.

The cancer study showed a statistical association (exposure/risk relation) between residing under old incinerator plumes and the onset of several cancers (of the liver and the breast, as well as non-Hodgkin lymphoma and soft-tissue sarcoma). This association is expressed by significant excess risks, although they are low compared with those for many other risk factors of cancer (increased risk on the order of 5-10% for those highly exposed compared with the least exposed).

The burden study shows that the dioxin concentrations measured nowadays in the blood of persons living near incinerators are not statistically higher than in nonexposed persons. We note nonetheless that the farmers eating local animal products (meat, dairy products, eggs) and living near old highly polluting incinerators had a statistically higher blood dioxin concentration than those who were unexposed. This difference was not found around the incinerators meeting EU standards.

---

1 Breast milk is a pathway for the elimination of dioxins. Nursing mothers therefore have lower dioxin levels.