Risk of Cancer and Past Exposure to Municipal Solid Waste Incinerators in France

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Incinerators in France
Risk of Cancer and Past Exposure to Municipal Solid Waste

Introduction
The scientific literature showed, in occupational context, an excess of risk of certain cancers associated with strong exposures to incineration pollutants [1,2]. However, few studies have been carried out to evaluate the excess risk of cancer in the populations living near municipal solid waste incinerators (MSWI) [3-6]. Consequently, no consistent pattern has emerged on carcinogenicity of atmospheric emissions of MSWI in the general population.

Objective
The objective of this work is to estimate the association between cancer incidence and the past exposure to the atmospheric emissions of MSWI.

Methods

GENERAL DESIGN
• Retrospective ecological study
• Statistical unit: IRIS Demographic unit defined by the French National Institute for Statistics and Economic Studies (Insee) – 2000 inhabitants
• Study period: 1990 – 1999
• Population: adults above 14
• Study area: 4 French metropolitan administrative areas départements (Île-de-France, Haut-Rhin, Tarn) representing 2,272 IRIS and, over the study period, 25,000,000 person-years of observation.
• Cases: the study addressed cancers, whatever the type, and specific localizations (lung, liver, breast, soft-tissue sarcoma, leukaemia and non-Hodgkin’s lymphoma)
• Collected data on cases: gender, birth date, date of diagnosis, localization of cancer, home address the day of diagnosis (data from the cancer registry of each département). Address of each case was geocoded at the IRIS level with 99% of success in the process

EXPOSURE TO THE RISK FACTOR AND CO-FACTORS
Estimation of exposure to MSWI
• 16 municipal solid waste incinerators have been running between 1970 and 1990
• Dioxin (2,3,7,8 TCDD) was considered as a marker of emitted pollutants
• A second generation Gaussian model (ADMS 3) was used to model atmospheric dispersion and ground-level deposit
• The latency period was of 5 years for leukaemia and 10 years for the other localizations
• The index of exposure assigned to each IRIS was the median of annual cumulated deposit of dioxin (with half life of 10 years)

Confounding factors
• Urban/rural status (Insee, 1999)
• Socio-economic deprivation: score defined by a principal component analysis of several socio-economic indicators (Insee, 1990 census)
• Population density (Insee, 1990 census)
• Air pollution from traffic (NO2 air concentrations (WHO II project, 2000)
• Presence of other industries: number of industry-years (Insee, 1972 – 1984)

A Geographic Information System was developed to define exposures at the IRIS level

STATISTICAL ANALYSIS
• Poisson regression
• Generalized additive models allowing non linear associations
• Bayesian hierarchical analysis accounting for over dispersion and spatial correlation.

Results
The analysis of our data shows a positive and significant association between the index of exposure to incinerators in the 70’s and 80’s and the incidence of non-Hodgkin’s lymphoma, and, for women, all cancers and breast cancer in the 90’s. It also indicates a positive and close to significance association between liver cancer, soft-tissue sarcoma and myeloma and the exposure to MSWI. We highlight these results albeit not significant because these cancer subtypes are rare.

The table on the right presents the relative risks and their 95% confidence interval for an increase of the index of exposure from the 2.5th to the 90th percentiles of the distribution of the exposed IRIS.

<table>
<thead>
<tr>
<th>Localization</th>
<th>RR</th>
<th>CI 95%</th>
<th>p-value</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast cancer in women</td>
<td>1.09</td>
<td>[1.03 ; 1.16]</td>
<td>&lt;0.01</td>
<td>18824</td>
</tr>
<tr>
<td>All cancers in women</td>
<td>1.08</td>
<td>[1.01 ; 1.12]</td>
<td>&lt;0.05</td>
<td>59076</td>
</tr>
<tr>
<td>Non-Hodgkin’s lymphoma</td>
<td>1.12</td>
<td>[1.00 ; 1.25]</td>
<td>&lt;0.05</td>
<td>3974</td>
</tr>
<tr>
<td>Liver cancer</td>
<td>1.16</td>
<td>[0.99 ; 1.37]</td>
<td>&lt;0.10</td>
<td>2784</td>
</tr>
<tr>
<td>Soft-tissue sarcoma</td>
<td>1.22</td>
<td>[0.98 ; 1.51]</td>
<td>&lt;0.10</td>
<td>655</td>
</tr>
<tr>
<td>Myeloma</td>
<td>1.16</td>
<td>[0.97 ; 1.40]</td>
<td>&lt;0.10</td>
<td>1700</td>
</tr>
<tr>
<td>Acute leukaemia</td>
<td>1.04</td>
<td>[0.86 ; 1.25]</td>
<td>&gt;0.10</td>
<td>1338</td>
</tr>
<tr>
<td>Chronic lymphoid leukaemia</td>
<td>1.13</td>
<td>[0.91 ; 1.39]</td>
<td>&lt;0.10</td>
<td>1262</td>
</tr>
<tr>
<td>Lung cancer in women</td>
<td>1.11</td>
<td>[0.93 ; 1.33]</td>
<td>&gt;0.10</td>
<td>1983</td>
</tr>
<tr>
<td>Lung cancer in men</td>
<td>1.05</td>
<td>[0.95 ; 1.18]</td>
<td>&gt;0.10</td>
<td>1363</td>
</tr>
<tr>
<td>All cancers in men</td>
<td>1.03</td>
<td>[0.97 ; 1.09]</td>
<td>&gt;0.10</td>
<td>76047</td>
</tr>
</tbody>
</table>

Discussion
The ecological associations highlighted in our work between the risk of non-Hodgkin’s lymphoma, liver cancer and soft-tissue sarcoma and the exposure to MSWI are consistent with the results of previous epidemiological studies [3-6].

A positive association between breast cancer in women and exposure to MSWI is shown for the first time. Saintot et al [7] showed that the Val CYF1B1 allele increases the susceptibility to breast cancer in women exposed to MSWI. In addition, we note that the recent results from the Seveso women’s health study [8] showed an increase of risk of breast cancer associated with an increase in dioxin levels.

The strong associations found for all cancers and breast cancer in women may suggest an endocrine effect that increases the susceptibility to cancer in women exposed to MSWI. These results are in favor of a potential carcinogenic risk associated with residential exposure to carcinogens emitted by MSWI. These epidemiological elements need to be supported by further investigations.

STRENGTHS
• Important population size
• Data quality provided by the registries of cancer and high rate of success in geocoding home addresses
• Refined methods used to describe past exposures to MSWI emissions
• Inclusion of several confounding factors

LIMITS
Well-known biases of ecological studies (i.e. individual smoking status, people migration)
Use of recent data (air pollution, rural/urban status) to describe past exposure

References