Monitoring of Thyroid Cancer Incidence in the Vicinity of Nuclear Sites in Belgium


1. Introduction
A study has been carried out at the demand of the Belgian Minister for Social Affairs and Public Health to assess, by means of an epidemiological study at the national level, possible health effects of living in the vicinity of nuclear sites. Results presented here are part of this study.

2. Objectives
To investigate:
- Whether there is an excess in incidence of thyroid cancer within the 20km proximity area around the nuclear sites as compared to what is expected in a reference population (Outcome 1);
- Whether there is evidence for an (increasing) thyroid cancer risk with increasing 'surrogate' exposure within the 20km proximity area around the nuclear sites, i.e. (i) residential proximity to the site, (ii) prevailing wind directions, and (iii) the estimated discharges from the plants based on mathematical modelling (Outcome 2).

3. Methods
- Ecological study around the nuclear sites of Class I (highest radiological risk category).
- Reference population: Flemish population (sites of Doel and Mol-Dessel) and Walloon-Brussels-Capital population (site of Fleurus, Tihange, and Chooz).
- 20km proximity area = communes having their centroid inside circles with radius 20km centered on the nuclear sites (Figure 1).
- Single-site analyses.
- Outcome 1: Standardised Incidence Ratios (SIRs) calculated after standardisation for age and sex. + Rate Ratios calculated at the basis of Poisson Regression modelling (RRs).
- Outcome 2: Focused hypothesis tests: conditional forms of Stone’s Likelihood ratio test (Stone) and Bithell’s Linear Risk Score Tests without (LRS) and with ranks (LRS²). + Spline models used to estimate and visualise the ‘exposure’-response relations.

4. Results
Figure 2. Age- and sex-standardised rates (European Standard Rate, ESR) of thyroid cancer by year of diagnosis and region in Belgium, 2000(2004)-2008.

Table 1. SIRs and RRs of thyroid cancer for the 20km proximity area around each nuclear site.

<table>
<thead>
<tr>
<th>Nuclear site</th>
<th>O</th>
<th>E</th>
<th>SIR</th>
<th>95% CI</th>
<th>RR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chooz</td>
<td>29</td>
<td>19.76</td>
<td>1.47</td>
<td>0.93-2.00</td>
<td>1.46</td>
<td>1.02-2.10*</td>
</tr>
<tr>
<td>Doel</td>
<td>207</td>
<td>279.69</td>
<td>0.74</td>
<td>0.64-0.84</td>
<td>0.72</td>
<td>0.63-0.93</td>
</tr>
<tr>
<td>Fleurus</td>
<td>285</td>
<td>256.97</td>
<td>1.15</td>
<td>1.02-1.29*</td>
<td>1.17</td>
<td>1.04-1.33*</td>
</tr>
<tr>
<td>Mol-Dessel</td>
<td>368</td>
<td>150.01</td>
<td>2.46</td>
<td>1.93-3.13*</td>
<td>2.68</td>
<td>2.21-3.26*</td>
</tr>
<tr>
<td>Tihange</td>
<td>119</td>
<td>139.13</td>
<td>0.86</td>
<td>0.70-1.01</td>
<td>0.85</td>
<td>0.70-1.02</td>
</tr>
</tbody>
</table>

N = person-years at risk; O = Observed number of cases; E = Expected number of cases; + Rate Ratios calculated at the basis of Poisson Regression modelling (RRs).

5. Discussion and conclusion
(On the basis of the data available up to now)
1. No increased incidence of thyroid cancer around the NPPs of Doel and Tihange. For the vicinity of the French power plant of Chooz, it is impossible to draw scientific conclusions for the Belgian territory because of instability of the results.
2. For the nuclear sites of Fleurus and Mol-Dessel, a slightly increased incidence of thyroid cancer as compared to the regional average was observed, but similar and higher increased incidences were also seen at other locations without nuclear sites (Figure 5).
3. Further analyses that aimed to investigate whether there may be an increased risk of thyroid cancer with increasing surrogate exposure from the nuclear sites were hampered to a great extent by the still large geographical areas that correspond to the smallest administrative level for which health data are available in Belgium, that of communes.

Figure 3. Sensitivity analyses: RRs of thyroid cancer by increasing the circle radius (km) of the proximity area around the nuclear sites of Fleurus and Mol-Dessel. The 95% CIs are represented by the dotted lines.

Figure 4. Spline models: RRs and 95% CIs (dotted lines) of thyroid cancer within the 20km proximity area of Fleurus in function of the estimated I-131 discharge.

Figure 5. Map of Belgium depicting RRs of thyroid cancer, considering consecutively each commune in Belgium as the middle point of the proximity area (circle with radius 20km).