Lower Risk of Cancer in the Areas Inhabited by the German Minority in the Region of Opole, Poland

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German population within the province Opole was up to 53% in the early 1950’s, 44% in the mid-1960’s, and 38% in the late 1970’s. In particular, Germans were concentrated mainly in the industrialized eastern part of the region while the surrounding rural western territories were resettled by Polish repatriates from the former territory of Poland (see geographical distribution in [2, 3]). Despite the fact that many years have passed, still a certain part of the population identifies itself as German minority. A map in figure 1 shows the areas in the Opole region in which at least 10% of the population declared being German in 2011 (according to [4]).

Since differences in the risk of cancer between these ethnic groups at the turn of the 1980’s and 1990’s have been already reported in [2, 3], it is interesting to reanalyze the present-day data. In this paper, we use geostatistical tools to estimate the risk of cancer in different spatial contexts: trends, clusters, and levels.

It is of note that, following the GLOBOCAN 2012 statistics [5], the age-standardized incidence rates per 100,000 (C00–C96 excluding C44) were higher in Germany (M = 323.7, F = 252.5) than in Poland (M = 269.2, F = 205.6). Moreover, in the band of 2008–2012, the relative rates in the Opole population were similar to the national rates: M = 1.01 (0.99–1.03), F = 0.99 (0.97–1.01).

Material

The data comprise all the cancer cases (at all sites combined) registered within the years 2008–2012, collected by the Regional Cancer Registry (RCR) in Opole. During the study period, 10,031 cancers were confirmed in men and 9,557 in women, according to the International Classification of Diseases 10th Revision (code: ’C’). A noteworthy fact is that the RCR in Opole is a member of the International Association of Cancer Registries, providing reliable information of cancer morbidity based on active registration following the Finnish Cancer Registry instructions from January 1, 1985.

The population numbers in each administrative unit were taken from the Statistical Bureau in Opole. Based on these numbers, the expected counts were calculated (offset).
Methods

The trends in particular areas (cancer growth rates) were estimated following spatiotemporal modeling as described in [6]. Such trends, which are both spatially and temporally dependent, may differ between areas. The model allows for the specification of whether the trend is above the regional level or below.

The spatial clusters of the disease were detected using a spatial scan statistics [7]. Routinely, the term ‘disease cluster’ is used if an unusually greater or smaller than expected number of cases of a disease occurs in a group of people living in close proximity and over a limited period of time.

The relative risk of cancer and the effect of the ethnical covariate were estimated based on the conditional autoregressive model [8]. In general, based on the Bayesian approach, the resulting estimators represent a weighted compromise between the standardized morbidity ratio, the overall mean relative rate, and a local mean of the relative rate in nearby areas.

The computation was performed on the WinBUGS platform [9] and with SatScan software [10].

Results

The cancer growth rates, with average values (and credible 95% intervals) for the entire region, are shown separately for men and women in figures 2 and 3, respectively. In figures 2 and 3, no steep trends in cancer risk were observed in the administrative units, oscillating by maximally ±2%, both in men and women. What is more, the insignificant average growth rates stand for stagnancy in cancer risk in the Opole region in the consecutive years 2008–2012, and the most negative growth rates were estimated for the eastern administrative units typical of the German minority areas (compare with fig. 1).

The performed geographical observation of the disease detected 4 statistically significant spatial cancer clusters in men and 2 in women (table 1).

It can be seen in table 1 that the clusters 1 and 2 are identical both in men and women with regard to the administrative units (the relative risks are also similar). Their geographical locations are presented in figures 4 and 5, respectively.

Worthy of note is the fact that the low-risk clusters (ID = 2) shown in figures 4 and 5 overlay the German minority population area (compare with fig. 1).

The spatial regression estimates for the German minority covariate in men and women are reported in table 2.
### Table 1. Cancer clusters in men and women in the Opole region (2008–2012)

<table>
<thead>
<tr>
<th>Gender</th>
<th>Cluster ID</th>
<th>Administrative unit</th>
<th>Number of cases</th>
<th>Expected cases</th>
<th>Observed/expected</th>
<th>Relative risk</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>1</td>
<td>Opole</td>
<td>1,405</td>
<td>1,186.28</td>
<td>1.18</td>
<td>1.21</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Cisek, Chrząstowice, Dobrodzierń, Gogolin, Izbicko, Jemielnica, Kolonowskie, Leśnica, Lubniany, Olesno, Ozimek, Strzelce Opolskie, Tarnów Opolski, Turawa, Ujazd, Zawadzkie, Zdzieszowice, Zębowice</td>
<td>1,755</td>
<td>2,001.40</td>
<td>0.88</td>
<td>0.85</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Kędzierzyn-Koźle</td>
<td>749</td>
<td>625.93</td>
<td>1.20</td>
<td>1.21</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Kamiennik, Nysa, Otmuchów, Paczków, Pakosławice</td>
<td>909</td>
<td>788.51</td>
<td>1.15</td>
<td>1.17</td>
<td>0.0090</td>
</tr>
<tr>
<td>Female</td>
<td>1</td>
<td>Opole</td>
<td>1,460</td>
<td>1,168.32</td>
<td>1.25</td>
<td>1.29</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Cisek, Chrząstowice, Dobrodzierń, Gogolin, Izbicko, Jemielnica, Kolonowskie, Leśnica, Lubniany, Olesno, Ozimek, Strzelce Opolskie, Tarnów Opolski, Turawa, Ujazd, Zawadzkie, Zdzieszowice, Zębowice</td>
<td>1,616</td>
<td>1,887.95</td>
<td>0.86</td>
<td>0.83</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>

**Fig. 4.** Spatial cancer clusters (at all sites combined) in men in the Opole region (2008–2012).

**Fig. 5.** Spatial cancer clusters (at all sites combined) in women in the Opole region (2008–2012).
The results given in table 2 reflect a statistically significant reduction in cancer risk in the administrative units with $\geq 10\%$ German minority; the average decrease in relative risk reaches $(1 - \exp(-0.14)) = 13\%$ in men and $(1 - \exp(-0.17)) = 16\%$ in women. The spatial models of the cancer risks are presented in figures 6 and 7.

**Table 2. Spatial regression analysis**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Regression coefficient</th>
<th>Credible 95% interval</th>
<th>p Value (one-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>-0.138</td>
<td>(-0.234, -0.042)</td>
<td>0.0028</td>
</tr>
<tr>
<td>Female</td>
<td>-0.171</td>
<td>(-0.280, -0.063)</td>
<td>0.0014</td>
</tr>
</tbody>
</table>

The results given in table 2 reflect a statistically significant reduction in cancer risk in the administrative units with $\geq 10\%$ German minority; the average decrease in relative risk reaches $(1 - \exp(-0.14)) = 13\%$ in men and $(1 - \exp(-0.17)) = 16\%$ in women. The spatial models of the cancer risks are presented in figures 6 and 7.

**Discussion**

Despite the long time that has passed since the end of World War II, the influence of the German minority on the risk of cancer is visible in the whole Opole region. What is more, the distribution of disease risk appears to be persistent since the last studies conducted in this region concerning the risk of prostate and cervical cancers at the turn of the 1980’s and 1990’s [2, 3]. All these findings may spur considerable progress in identifying etiologic risk factors and indicate potential causes. Probably, certain genetic, behavioral, nutritional, and cultural aspects may play a role in the described spatial disease patterns. On the other hand, a higher level of wealth of the German minority caused by longtime financial family connections and support of the former Western German relatives during the political/economic transformation after 1989 might also have contributed to the better quality of healthcare services. However, at this stage of research, it is impossible to precisely describe their impact on cancer occurrence. Nevertheless, to explain the difference in the risk of cancer among the ethnic groups in the region of Opole, these factors should be taken into account in future studies.

**Conclusions**

The following conclusions can be reached from this study:
- Stagnancy in the cancer risk in the Opole region has recently been observed.
- Clusters of lower risk of cancer overlay the German minority area with respect to both men and women.
- In the German-populated areas, the risk of cancer is statistically lower than in the surrounding administrative units inhabited by repatriates.
- Genetic, nutritional, or cultural aspects together with economic issues may play a role in the specified spatial disease patterns.

**Disclosure Statement**

The authors declare no conflicts of interest.
References


