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## Analytical note

The scientific journal "International Journal of Cancer," just published on its website an epidemiological study \* on the incidence of childhood leukæmia around the French nuclear power plants. This study was conducted by a team of researchers from the INSERM, in collaboration with researchers from the IRSN.

**IRSN analyses below this scientific publication.**

\* Sermage-Faure C, Laurier D, Goujon-Bellec S, Chartier M, Guyot-Goubin A, Rudant J, Hémon D, Clavel J. *Childhood leukæmia around French nuclear power plants – the Geocap study, 2002-2007*. International Journal of cancer 2012.

### **COLLABORATION BETWEEN INSERM AND IRSN IN THE FIELD OF CHILDHOOD LEUKÆMIA AROUND NUCLEAR POWER PLANTS**

IRSN addresses the issue of health risks in the vicinity of nuclear power plants since already many years, and has published several papers. In particular, the IRSN in 2008 carried out a detailed critical review of the epidemiological literature on this topic.

IRSN works in close collaboration on this topic with the team of environmental epidemiology of cancer from the INSERM (CESP UMRS1018, team 6) for over 10 years. In the early 2000 this collaboration has resulted in the first national studies on infant morbidity from leukæmia around nuclear facilities in France. This work has led to four joint publications between 2004 and 2008. **The results for the period 1990-2001 did not show any excessive risk of childhood leukæmia in the vicinity of French nuclear facilities.**

**As part of this earlier work, the contribution of the IRSN** had especially allowed the implementation of a zoning taking into account the distribution of doses to the bone marrow due to the gaseous radioactive discharges from nuclear facilities in the environment. This dose based geographical zoning represents an improvement over the simple division of facilities neighborhood in concentric circles used in most studies. This work was based on the expertise of IRSN in modeling the transfer of radionuclides in the environment. The implementation of this zoning had three objectives: 1 / define a zoning approach applicable to all sites and taking into account local characteristics (electrical power, wind rose, precipitation, level and composition of the actual gaseous releases ...) 2 / show that the output distribution does not follow for some sites by no means a concentric circle (especially for sites in the Rhone Valley or on the coast), 3 / provide an indication of the level of corresponding doses (in the order of a few thousandths of milliSievert, or about 1000 times less than those caused by natural radioactivity).

### **THE PUBLISHED STUDY**

#### ***Context***

A study published late 2007 observed an increased incidence of leukæmia among children under 5 in the vicinity of German nuclear power plants, using a population based case-control study design. INSERM had proposed to carry out a similar analysis in France, on the basis of the national population based case-control study GeoCAP to verify this observation. The objectives were: 1 / check if an excess of leukæmia appeared among children living in the vicinity of French power plants, 2 / check if

a decrease in risk appeared with distance from the plants, 3 / check points 1 and 2 by using a geographical zoning based on the distribution of doses due to gaseous discharges from nuclear power plants. The current article presents the methodology and results of this analysis.

**Material and methods**

The study included all the 2,753 childhood leukæmia cases aged up to 15 years at the end of the year of diagnosis, diagnosed between 2002 and 2007, and residing in metropolitan France. The cases were obtained from the French National Registry of Childhood Hematopoietic Malignancies (NRCH).

The study GeoCAP is an epidemiological case-control study. A set of 30,000 control addresses, 5,000 each year for the period 2002-2007, representative of the French paediatric population for those years, was randomly sampled by the National Institute for Statistics and Economic Studies (INSEE). By using the income and council tax databases the place of residence of each child was geo-located precisely. The INSEE database did not specify child gender.

The risk of leukæmia in the vicinity of the 19 French electricity generating power plants was analyzed by using two methods:

- as a classic study of incidence (estimated ratio of the observed number of cases over the expected number of cases by area, to allow comparison of results with previous studies)
- using the case-control design of the GeoCAP study (relative risk estimated from the cases and controls);

And by using two local criteria:

- Depending on the distance of residence from the site (concentric zones up to 20 km);
- Depending on the geographical zoning based on the distribution of doses due to gaseous radioactive discharges of nuclear facilities in the environment already carried out by IRSN for previous studies.

**Results**

Of the 2753 cases recorded, 99 were resident in the 20 km zone at diagnosis, and only 14 lived in the 5 km zone.

The relative risks and 95% confidence intervals estimated over the period 2002 to 2007 are:

	Geocap study	Incidence study
0-14 years - 5 km zone	1,9 [1.0;3.3]	1.9 [1.0;3.2]
0-4 years - 5 km zone	1,6 [0.7;4.1]	2.2 [1.1;4.4]

It shows an excess of cases in the 5 km zone around the sites over this period. This result was found regardless of the study protocol. It appears in all age groups considered. The observed excess is independent of the power of the nuclear plants or their location (sea or river).

The observed excess is not associated with a particular plant (persists after excluding one by one each of power plants).

This excess does not explain itself by a decrease in risk with distance: an excess appears in the 5 km zone and afterwards no excess, but no progressive decrease in risk is observed with distance.

This excess is observed only over the period 2002-2007 (and especially since the last two years 2006-2007), and no excess is observed over the whole period 1990-2007.

Over the period 2002-2007, when using the geographical zoning based on the doses due to gaseous discharges from nuclear power plants, the excess no longer appears in any of the dose based zones, and no decrease is observed with the dose category.

## **DISCUSSION**

A good agreement of results between the two types of study is shown (case-control approach and incidence study), indicating that the observed excess is not related to the methodology of analysis.

The observed excess is not specific for the age group 0-4 years. **The results therefore differ from the results of the German study in 2007 in which an excess was observed specifically for the age group 0-4 years.**

The new results are obtained over a short period of 6 years (2002-2007), and the numbers are very low, which limits the interpretation of results. They seem especially sensitive to recent years of record (2006-2007). It should be noted that throughout the period for which data are available (1990-2007), the excess is no longer observed. The results for the period 2002-2007 appear different from previous results. They must be put into perspective with other results available elsewhere, and the persistence of a potential excess risk of childhood leukæmia should be confirmed in the future. As such, these unusual results do not permit today to question the overall knowledge of the risks of childhood leukæmia around nuclear facilities.

IRSN greatly contributed to this study with its expertise in low doses, not only in the field of long-term effects of exposure to ionizing radiation, but also for the exposure characterization of the population. In particular, IRSN modeling skills have enabled the development of a geographical zoning based on the dispersion of gaseous discharges of nuclear power plants. No excess of leukæmia is observed over the period 2002-2007 when using this dose based geographical zoning. Although it is based on a rather elaborate approach (consideration of a range of 12 radionuclides, using actual release data, local weather data giving the direction and the force of winds and precipitations, modeling the transfer in the different environment compartments, consideration of different exposure pathways (inhalation, ingestion, external exposure due to the deposit, use of specific organ dose coefficients...), it must be remembered that this geographical zoning is not intended in any way to permit individual dose estimates (this would require for each individual the personal data such as gender, medical and residential history). The zoning simply offers a better approach taking into account the specific characteristics of the sites, and in that sense, represents a real improvement over the use of simple concentric circles. **The absence of excess observed with this dose based geographical zoning is not in the favour of a link between radioactive discharges from facilities and risk of childhood leukæmia.** This difference in results between the use of simple distance or **dose based geographical zoning** illustrates again the sensitivity of results in relation with the methodological choices of analysis.

**A major limitation of this work is the lack of individual data** on residential and medical history of the children, on the course of pregnancy or parental exposure. The absence of these data limits the interpretation that is made of the results observed. However it should be noted that, the present analysis in GeoCAP also considered the proximity of power lines.

One of the strengths of the GeoCAP INSERM study is that it aims to analyze several potential environmental risk factors for childhood leukæmia (proximity of power lines, natural radioactivity, proximity of other industrial installations and proximity to roads or gas stations ...). Ultimately, this study should allow a multifactorial analysis of childhood leukæmia risks, and this will consequently contribute to improving knowledge on the causes of childhood leukæmia .

In conclusion, the study observed an excess of childhood leukæmia within 5 km around the French nuclear power plants over the period 2002-2007. This result is based on very small numbers. No excess is observed when considering a longer period (1990-2001) nor by using a geographical zoning

based on the modeling of gaseous emissions of power plants. This observation could be due to undetermined risk factors present in the vicinity of nuclear facilities. This outcome demands further research on the causes of childhood leukæmia . In addition, discussions are under way at European level on the open scientific questions on the health effects of low doses of ionizing radiation within the platform MELODI (Multidisciplinary European Low Dose Initiative, [www.melodi-online.eu/](http://www.melodi-online.eu/)). This platform includes more than fifteen European organizations specialized in radiation protection or involved in research at low doses. As part of this platform an international workshop will be organised mid-2012 jointly by IRSN and BfS (the German Federal Office for Radiation Protection), to define a common methodological basis for future studies of childhood leukæmia risk near nuclear power plants or other types of sites to be investigated, and more generally to coordinate research on explanatory factors in childhood leukæmia , which remain largely unknown today. This Franco-German initiative joined one of the conclusions of the Working Group "Nuclear installations and childhood leukæmia ," set up by the French nuclear safety authority (ASN) and conducted by Professor Sommelet.

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