

HIGHLIGHTS

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In 2008, the announcement of a uranium mining project in the Sept-Îles region generated local, regional and national controversy, among other things due to fears about its impacts on health. In December 2009, the Provincial Public Health Director suggested that an inter-sector task force be set up to consider the issue in further detail and provide information for the Côte-Nord population on the health-related risks of uranium projects, based on a rigorous, objective analysis of current scientific knowledge. The Côte-Nord Regional Public Health Director asked the Institut national de santé publique du Québec (INSPQ) to carry out this analysis. Two scientific teams from the Environmental Health and Toxicology Department (Ionizing Radiation Scientific Team and Environmental Assessment Scientific Team), plus a specialist physician and epidemiologist from the Biological Risks and Occupational Health Department, were entrusted with the task of carrying out the analysis. Their mandate was to:

- Document the impacts for human health of uranium industry exploration, mining, storage, transportation and waste disposal activities, with due consideration for all exposure methods.
- Perform a feasibility study for an assessment of the toxicological and radiological risk throughout the uranium and uranium by-product production chain and, if it is deemed feasible, carry out the risk assessment.
- Document the psychological and social effects of uranium industry exploration, mining, storage, transportation and waste management activities.

To fulfill this mandate, three separate approaches were developed and applied. The methodology used and results obtained are summarized below.

1. Analysis of epidemiological data from studies of populations living near uranium mines

The task of documenting the health-related impacts of uranium industry activities began with a systematic review of the epidemiological literature. The Medline, Embase and Cochrane databases were searched using OvidSP to identify publications reporting on health impact studies in populations living near mining sites. The search produced ten original studies on links between the presence of

uranium mines and health issues in nearby populations. Since the health risks to uranium miners are already well documented, the analysis was limited to the impacts for the general population.

Each paper was assessed systematically using the epidemiological research analysis grid, and was allocated a validity score based on its external validity, methodological characteristics and funding source. Meta-analyses were carried out for some health impacts, producing an overall effect and a strength of evidence level. The strength of evidence level reflected the level of confidence (suspicion, sufficient evidence, strong evidence) in the result obtained or the inability to reach a conclusion. It was based on the effect size and an assessment of the biological plausibility, statistical accuracy, validity and consistency of the findings.

A scientific watch was subsequently instituted, as a result of which an eleventh study was added to the list. Most of these studies focused on deaths and cancer incidence, and more rarely on other causes of mortality. One of the papers examined chromosomal aberrations, and another, pregnancy outcomes. The main findings were as follows:

- For cancer deaths, meta-analyses were carried out for 13 types of cancer:
 - For lung cancer, there was sufficient evidence of no additional risk of lung cancer in women (strength of evidence level VI); in men, the higher risk of lung cancer was probably due to mining employment.
 - For leukemia, a slight increase in the risk of death was suspected (strength of evidence level III).
 - For the other 11 types of cancer, there was suspicion of no increased risk of death (strength of evidence level V), or the data were insufficient to conclude (strength of evidence level IV). Most of level IV conclusions are explained by very low validity levels.
- For cancer incidence, most of the findings were taken from one study, where only one statistically significant excess was observed: lung cancer in men, which was consistent with the findings concerning deaths from lung

cancer. A recent Ukrainian study reported statistically higher incidence levels for certain cancers, which the authors felt may have been due to a screening effect caused by earlier detection of cases among uranium workers or low radioactivity safety standards in the former Soviet Union.

- For non-cancer deaths, statistically significant excesses were observed for tuberculosis, accidents other than motor vehicles, and suicide among men. However, methodological limitations, lack of consistency and lack of biological plausibility meant that it was not possible to confirm a connection between the fact of living near a uranium mine and non-cancer deaths.
- The findings from two of the studies raised suggestions concerning abnormal responses to DNA repair and increased frequency of certain negative pregnancy issues, but the data were insufficient to conclude.

Almost all the data concerning cancer-related deaths, cancer incidence and other causes of death were taken from ecological studies that were particularly susceptible to certain types of methodological bias. As a result, the conclusions from these studies were more limited. In addition, given the large numbers of comparisons made as a result of the large number of causes of death and types of cancers studied, some associations may have been statistically significant only by chance.

In short, the findings were insufficient to assert that the fact of living near an uranium mine caused health problems. However, it is important to note that, with the exception of death due to certain types of cancer, the available data were insufficient to reach a conclusion, and further research is required.

2. Feasibility study for an assessment of the toxicological and radiological risk throughout the uranium and by-product production chain

There are no active uranium mines in the Côte-Nord region, and it was therefore not possible to produce a region-specific risk assessment. To address this, the scientific literature on risk assessments and environmental contamination from uranium mines was reviewed. Comprehensive bibliographic searches were carried out using the PubMed and Ovid interfaces. The database searches identified a

total of 243 papers, 68 of which were selected because they focused on modern uranium mine operations (i.e. the period post-1990). Of these, only 13 papers contained both field and control data, and therefore allowed for a more in-depth assessment.

Papers on risk assessments for uranium mines were limited and were often incomplete. In addition, it was difficult to identify the mine's real contribution, because in many cases regional background was not removed from the calculations. However, taking into account the limitations of the available data, the compilation led to the following observations:

- Uranium-producing regions have higher background concentrations from radionuclides and other associated chemical elements, and local populations will be exposed to higher levels of these elements. The highest radiological and chemical doses appear to be from ingestion of fish and seafood and inhalation of radon.
- The presence of a uranium mine may lead to additional exposure of local populations.
- Although the data are extremely limited, there appears to be a possibility that uranium mining generates additional exposure for the population, and that 1 mSv and IR>1 values will be exceeded (although it is impossible to state by how much).
- The data gathered are not complete enough to reach a conclusion on the area of influence of a uranium mine for radionuclides (including radon) and chemical elements.
- Upstream of these observations, one major element emerged from the study of the scientific literature: the rarity of data on regional background prior to the arrival of the uranium mine. Information on the environmental background is vital in monitoring the health of populations living near uranium mines.

3. Documentation of the psychological and social effects of uranium industry exploration, mining, storage, transportation and waste management activities

To document the potential social effects in populations living near uranium mines, a systematic literature review was carried out, based on the model used by the National Institute for Clinical Health Excellence (NICE). The search encompassed eight scientific literature databases and platforms (Ebsco, JStor, CSA, Wiley, Proquest, Current Contents, ISI and CESGLD). Other, complementary approaches were also used. A dual assessment was carried out for document relevance and quality. Fourteen texts were ultimately selected for the review. They contained findings specific to uranium mines or to the mining industry including uranium mines. The reported findings from original research (Group 1) were combined to identify the presence or absence of potential psychosocial effects. Papers from the grey literature or non-systematic literature reviews (Group 2) were unable to provide probative data, but were used to reinforce or qualify the conclusions of the Group 1 papers.

Psychological and social effects associated with uranium mines can be identified from systematic literature reviews. The findings were classified by theme, and addressed three types of effects in particular:

- Effects associated specifically with uranium mines were identified in connection with overall quality of life in the event of technological accidents. The literature on uranium mines contained no conclusions regarding other impacts on quality of life, although these elements were addressed the literature on mines in general.
- With regard to psychological health specifically in connection with uranium mines, several types of people experienced anxiety regarding radioactivity and its (real or feared) impacts. Mining processes and mining facilities, regardless of the type of mineral, also caused economic changes that had impacts on material consumption and drugs or alcohol use, and these, in turn, generated other psychological and physical impacts.
- As for aspects relating to social health, uranium mines appeared to be directly associated with alteration of the social climate and loss of public

trust in the authorities. Regardless of the type of mineral concerned, negative socio-economic impacts were observed, and were perceived as being more important than the positive impacts, given the overall duration of mining projects and their rapid growth-degrowth cycle (the boomtown effect). Social inequalities in the sharing of the costs and benefits of mining projects were also identified.

- Some social groups were found to be more vulnerable, and the Aboriginal peoples appeared to be more affected by the changes.

These findings and avenues for reflection were echoed in the general literature on the psychological and social impacts of mines. Otherwise the individual and overall limitations of the studies chosen should also be borne in mind. In particular, although the general context of the reviewed literature was consistent, differences in the social, political, economic and other contexts of the communities studied must also be taken into consideration.