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Press release

Pesticides and their effect on health

An Inserm group of experts

Since the eighties, epidemiological research has been looking into how pesticides are involved in several pathologies in persons who are exposed to these substances in the course of their work, in particular cancerous pathologies, neurological pathologies and reproductive disorders. These investigations have highlighted the potential effects of even low levels of exposure during the sensitive periods of development (in utero and during childhood).

In this context, the DGS (Direction Générale de la santé – the public health authority) asked Inserm to draw up a list of scientific publications that could be used to corroborate the health risks involved in occupational exposure to pesticides, in particular in agriculture and on the effects of early exposure of the foetus and young children.

In reply to this request, Inserm got together a multidisciplinary group of experts in which epidemiologists specialising in environmental health or occupational health worked alongside biologists specializing in cellular and molecular toxicology.

According to international scientific publications issued over the last 30 years and analysed by these experts, there appears to be a positive link between occupational exposure to pesticides and certain pathologies in adults: Parkinson's disease, prostate cancer, hematopoietic cancers (non-Hodgkin's lymphoma, and multiple myeloma). Furthermore, exposure to pesticides during the prenatal and postnatal periods and in infancy appears to be a particularly risk for the development of the child.

Pesticides: definitions, use and exposure routes

The term 'pesticide' comes from the Latin 'Pestis' (plague) and Caedere (to kill), and encompasses a large number of widely varying substances that act on living organisms (such as insects, vertebrae, worms, plants, fungi and bacteria) in order to destroy, control or limit them.

There is currently a huge variety of pesticides (around 1000 active substances have already been commercialized, with 309 phytopharmaceutical substances already authorized in France). They vary according to their targets, their modes of action, their chemical class or their persistence in the environment.

- Targets: these include herbicides, fungicides, insecticides, etc.
- There are nearly 100 chemical families of pesticide: organophosphates, organochlorides, carbamates, pyrethrinoids, triazines, etc.
- There are almost 10 000 commercially available formulations of the active substance plus different types of additive (liquid, solid, granules, powders, etc.).
- Pesticides can remain present in the environment from a few hours to several years. They are transformed or degraded into numerous metabolites. Certain of these, such as organochlorides, persist for years in the environment and end up in the food chain.

For the purposes of this study, the term 'pesticide' refers to all active substances, independently of regulatory definitions.

Pesticides: what are they used for?

In France, very little quantitative data are available for each type of use. Most of the tonnages (90%) are used for agriculture, but other professional sectors are also concerned: road, garden and park maintenance, the industrial sectors (production, wood treatment), use for human and veterinary health care purposes, vector control (mosquitoes), pest control, etc. We can also add domestic uses to this list (plants, animals, disinfection, gardening, wood).

In France, fungicides represent almost half of the tonnages. 80% of the tonnages of pesticides are used to treat straw cereals, corn, colza and vines. The most commonly sold contain sulphur or glyphosate as the active substance.

Sources of exposure:

Pesticides are present everywhere in the environment. They are present in the air (indoors and outdoors), in water (underground, surface water, coastal waters), in the ground and in foodstuffs (including commercialized bottled water).

In professional environments, the dermal route is the main type of exposure (roughly 80%). Exposure through the respiratory tract occurs in specific application circumstances (during fumigation or when used in closed spaces). Exposure can occur at different times: during handling, preparation, application, cleaning or re-entry (tasks carried out in areas treated with pesticides), but the worst exposure occurs when preparing spray solutions or mixtures or

when re-entering already treated areas. For the general population, the oral route is often considered as the main cause of exposure via foodstuffs.

Pesticides and cancers

The group of experts targeted 8 cancer sites: 4 hematopoietic cancers, plus prostate cancer, testicular cancer, brain tumours and melanomas. Most of these sites had been identified in previous meta-analyses as being potentially linked to exposure to pesticides, generally without any distinction having been made between the active substances involved.

□ Prostate cancer

According to available publications, there is a greater risk to farmers, workers in pesticide manufacturing plants and rural populations (between 12 and 28%, depending on the population). Some active substances have been specifically documented: chlordecone among the general population and carbofuran, coumaphos, fonofos and permethrin among the populations working in associated professions. All these substances are currently prohibited. For certain of them, a higher risk was observed among farmers who had previous family histories of prostate cancer.

□ Hematopoietic cancers

According to available publications, there is a higher risk of non-Hodgkin's lymphomas and multiple myelomas for workers exposed to pesticides in the farming and non-farming sectors. Organophosphates and certain organochlorides (lindane, DDT) are thought to be the cause. Although these results are not as convergent, a higher risk of leukaemia cannot be ruled out.

As for the other cancerous sites concerned, it is very difficult to carry out an overall analysis of all the studies. There are several reasons for this: they may occur less frequently (testicular cancer, brain tumours and Hodgkin's disease), or other factors may lead to confusion (for example, exposure to UVs in the farming population, since UV exposure is a well-known risk factor for melanomas).

Pesticides and neurodegenerative diseases

The group of experts concentrated on 3 neurodegenerative diseases: Parkinson's disease, Alzheimer's disease and amyotrophic lateral sclerosis, and on cognitive disorders, that could be early signs of or be associated with certain neurodegenerative diseases.

□ Parkinson's disease

An increased risk of developing Parkinson's disease was observed in persons who were exposed to pesticides in the course of their work. The connection was particularly marked in the case of persons exposed to insecticides and herbicides. Up until now, no connection has been proven with fungicides, however there have been fewer studies on this subject.

The results are more contrasted for the other neurodegenerative diseases. For example, in the case of Alzheimer's disease, the results from the cohort studies are convergent and reveal that there is a higher risk when the case-control studies are less robust. As for amyotrophic lateral sclerosis, the lack of study data makes it impossible to draw conclusions.

Several reviews and a recent meta-analysis have confirmed the adverse effects of exposure to pesticides in the work place, in particular the effect of organophosphates on cognitive functioning. This effect seemed to be clearer for a person having suffered from previous acute intoxication.

Effects on pregnancy and the development of the child

There now exist numerous epidemiological studies that suggest there is a connection between prenatal exposure to pesticides and the development of the child, both in the medium and long term.

□ Effect of occupational exposure during the prenatal period

Publications suggest that there is a significant increase in the risk of foetal deaths (miscarriages) and an increased risk of congenital malformations when the mother has been exposed in her work place. Other studies suggest adverse effects on fine motor skills, visual acuity, or even short-term memory during the development of the child. Finally, the recent meta-analyses have highlighted a significantly higher risk of leukaemia and brain tumours.

□ Effects of residential exposure during the prenatal period (surrounding environment or domestic uses)

Several case-control and cohort studies show an increased risk of congenital malformations in children born to women living in the vicinity of an agricultural area or involved in the domestic use of pesticides (cardiac malformations, neural tube defects, hypospadias).

Low birth weight, neurodevelopmental disorders and a significant increase in the risk of leukaemia have also been reported.

Pesticides and fertility

The link between certain pesticides (in particular dibromochloropropane) that are no longer used and adverse effects on male fertility has been clearly established, but many uncertainties remain as to pesticides currently in use.

The link between pesticides and female infertility is not well known and needs more in-depth study.

Biological mechanisms

Current publications are insufficient to accurately identify the cellular and molecular mechanisms involved in pathologies that are potentially linked to exposure to certain pesticides. However, certain modes of action of these substances corroborate the epidemiological data. For example, oxidative stress seems to play a major part, in the case of Parkinson's disease. DNA damage, disturbances in certain signalling pathways (likely to cause a disturbance in cell proliferation or cell death), or alterations to the immune system are all indicative of the effects of pesticides on health.

The problem of pesticide mixtures

Populations are permanently exposed to low doses of pesticides and numerous other substances that contaminate the environment. These mixtures of pesticides and other substances could lead to health risks that are difficult to predict at the current time, and this makes the problem of mixtures and low doses a major issue for research and evaluating dangers.

Experts are pointing out that the fact of being unable to come to a conclusion does not necessarily mean that there is no risk.

If certain substances are blamed, it is merely because they have been studied more often than others (in particular, in the United States context); many active substances have not been subjected to epidemiological studies.

Recommendations

The recommendations highlight the need for a better understanding of old and new data concerning populations exposed either directly or indirectly to pesticides in the work place.

The recommendations also draw attention to the critical exposure periods (development periods), both in working environments and in the general population.

Multi- and trans-disciplinary research must be consolidated in order to allow more rapid characterisation of the potential dangers presented by the active substances in pesticides.

Group of experts and authors

Isabelle BALDI, Equipe Santé Environnement, Centre de recherche Inserm U 897 and Ghislaine BOUVIER, Laboratoire Santé Travail Environnement, Isped, Université Victor Segalen, Bordeaux

Sylvaine CORDIER, Inserm U 1085, Institut de recherche sur la santé, l'environnement et le travail, Irset, Université de Rennes 1, Rennes

Xavier COUMOUL, Inserm UMR-S 747, pharmacologie, toxicologie et signalisation cellulaire Université Paris Descartes, Paris

Alexis ELBAZ, Inserm U 1018, Centre de recherche en épidémiologie et santé des populations, Villejuif

Laurence GAMET-PAYRASTRE, Toxalim (Research Centre in Food Toxicology), UMR 1331 Inra/INP/UPS, Toulouse

Pierre LEBAILLY, Groupe régional étude CANcer, Grecan, EA1772, Centre François Baclesse, Caen

Luc MULTIGNER, Inserm U 1085, Institut de recherche sur la santé, l'environnement et le travail, Irset, Université de Rennes 1, Rennes, Pointe à pitre.

Roger RAHMANI, Toxicologie cellulaire, moléculaire et génomique, Toxalim, UMR 1331, Institut Inra de Sophia Antipolis, Nice

Johan SPINOSI, InVS, Umrestte, Université Claude Bernard Lyon 1, Lyon

Geneviève VAN MAELE-FABRY, SSS/IREC/LTAP (Louvain Center for Toxicology and Applied Pharmacology), Université catholique de Louvain, Bruxelles

Press contact

presse@inserm.fr

Tel : 01 44 23 60 97