

# Soil Chemical Pollution and Aggressive Pathologies

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*Maintaining the soil in optimal parameters is vital for mankind, given its essential role in providing the alimentary base, as well as its extremely slow formation and regeneration (hundreds or thousands of years). The direct and indirect pollution of the soil and especially its chemical pollution represent a corollary of other types of pollution, given that it is produced by solid, liquid and gaseous residues. It may be involved in a wide range of diseases (respiratory, cardiovascular, digestive, renal, haematological, osteoarticular, neurological) of allergic, infectious, degenerative or neoplastic nature, from infancy to the old age. Although there are natural causes of soil pollution (e.g. volcanic eruptions), most pollutants come from human activities, which are the most incriminated in its pollution, degradation and erosion at an accelerated pace. The growing concern of all nations for the adoption of measures to limit the chemical pollution of the soil is partially found so far in viable and effective solutions intended to combat soil contamination and degradation and ensure its restoration. Chemical industrialization leads to technical and scientific progress, but at the same time it can develop related pathologies, which means that the role of the occupational health physician is essential in ensuring prophylaxis and the early detection of occupational diseases. Besides that, the role of the pediatrician is equally precious for the detection of specific diseases caused by chemical pollutants to children, because they will develop into adults with pathological stigma. The chemical pollution of the soil is a major challenge for ecologists, given that it is an important risk factor for many types of afflictions. It requires maximum attention from civil society, health care professionals and government institutions. The specialist in occupational medicine, as well as the pediatrician bear an essential responsibility in both, prevention and treatment.*

*Keywords: chemical pollution of the soil, occupational medicine, occupational diseases, preventive, pediatrician*

The health of planet Earth is an essential responsibility of mankind, with an impact on the increase of current pathologies, even greater for future generations.

The state of human health is closely related to the degree of chemical pollution of the soil.

Since ancient times, people have been concerned for the composition of the soil. Thus, Moses (1400 B.C.) instructed people to evaluate properly the soil, where they would settle. Hippocrates (400 B.C.) draws attention to the idea that soil can influence people's health, an idea that has developed up to the present day [1].

In the context of the specialty known as Occupational Medicine, there should be a complex approach to occupational toxicity at the workplace, together with the knowledge of external environmental conditions. Regardless of its form, pollution aggravates occupational diseases, leading sometimes to their progressive evolution and a reserved prognosis.

## *Epidemiology of Pollution*

It seems that the inhabitants of Asia and Africa have the highest risk of pollution, keeping in mind that, just in 2015, 2.5 million people died in India. In the second place is China, a country where 1.8 million people died, followed by Bangladesh, Pakistan, North Korea, South Sudan and Haiti. Epidemiological research has taken into account the level of soil, water and air pollution, indicating that 92% of people who lost their lives come from middle-income countries [2].

A study published in October 2017 in the Lancet medical journal issues an alarm signal regarding the effects of pollution on humanity, stating that 9 million people have lost their lives due to pollution and 6.5 million of them have died from air pollution [3].

In Europe, industrialization and chemicalization have led, in the last 200 years, to an increase in soil pollution with different pollutants that have a severe impact on human health. Along with chemical soil pollution, explosive industrialization has also caused air and water pollution. Chemicals such as pesticides, lead, asbestos, DDT and chlorofluorocarbon, represent some historical examples of general pollution and acute or chronic intoxication. It is difficult to assess and quantify the effects of chronic exposure at lower doses than those considered toxic, for instance in the case of people living in or near a contaminated area. In this case, it is not possible to apply the traditional approach, by studying one single variable (a single polluting substance), given that there are many pathogenic links with an impact on health, which act complexly and synergistically. It is considered that every person on Earth is currently contaminated and that every human body has at least 200 synthetic chemical substances. Every year we add new chemicals to those, to which we have already been exposed [4].

We should also remind the role of solar-terrestrial activity in the triggering of acute coronary heart events in some patients [16].

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### Types of Soil Pollution

There have been described two types of soil pollution: direct and indirect pollution. Direct pollution comes from industrial and domestic waste, along with the use of chemical fertilizers and pesticides in agriculture. Indirect pollution of the soil comes from the dust and harmful gases in the atmosphere, which are dissolved by the rain and are deposited in the soil. The wind transports the pollutants from one place to another, as well as infiltration waters, which transport the polluting agents to the depths, and polluted rivers that infest irrigated and flooded surfaces. Once soil contamination exceeds a certain threshold, that soil is considered *dead from a functional point of view* and it is a dramatic phenomenon. Contamination with heavy metals and many organic substances is virtually irreversible [2,4,5].

### Experimental part

#### Main soil pollutants

#### Organic pollutants

There are 8-16 thousand organic compounds, natural or derived from human activities. There will be presented below some of the main organic pollutants and chemicals identified by WHO as the most aggressive against health.

Out of the 8-16 million organic compounds, natural or derived from human activities, 40,000 are present in our daily lives. After 50 years of research, we know details of the biodegradation mechanisms of only approximately 900 of them.

Among the most aggressive we should mention: polychlorinated *biphenyls* (PCB or PCB), *polybrominated biphenyls* (PBB) *poly-chloro-dibenzofurans*, *polycyclic aromatic hydrocarbons*, *organochlorinated and organophosphorus pesticides and organic fuels (especially gasoline)* [4-6].

#### Pesticides

Professional poisoning with pesticides may occur to farmers and it is conditioned by the way of penetration and the time of exposure. At the same time, we must highlight the chronic intoxication that may occur also to people, who excessively consume certain kinds of food that contain pesticide residues (fruits, vegetables) [1,2].

#### Organochlorine pesticides

They are mainly represented by DDT, which has been widely used to combat insects, but has been banned in industrialized countries since 1970. Its main disadvantage consists in its chemical stability, as well as in the retention and accumulation effect in the soil, food and human body. Over time, it has been determined that some chemical substances resulting from its decomposition cause endocrine and carcinogenic disorders.

Since 2004, the *Stockholm Convention* banned its use in agriculture all over the world, but it is still used to combat insects that are vectors of contagious diseases (malaria, typhus) [1,2,4].

#### Organophosphorus pesticides

Although they were initially promoted as more environmentally friendly than organochlorinated pesticides, it was later determined that they have several negative effects: impairment of the cholinesterase function, impairment of glucid, lipid and protein metabolism and increase in the oxidative stress.

The most commonly used is glyphosate, while others are: malathion, parathion and dimethoate.

The negative effects of exposure to these substances have been proven in clinical trials. They consist in an increase in the risk of: cardiovascular diseases, metabolic disorders, neurological disorders, reproductive system disorders and lymphomas [1,2,4-6].

#### Initium

Ametoctradin: A fungicide of the Pyrimidylamine/Triazolopyrimidine class

The product is controversial, because it is considered toxic to the human body; it is carcinogenic, affects the reproductive system and may develop neurotoxicity and acute toxicity. Gheorghe Mencinicopschi (former Director of the Food Research Institute of Bucharest) shows that 1 gram of Initium introduced into the body requires a year for its elimination. The daily ingestion of this product can completely prevent its elimination.

Romania was the first country in the world to authorize the use of fungicides based on INITIUM, which, according to the German company BASF, will enable vine growers to obtain faster high-quality production.

The German company indicated that besides the product containing Initium intended for grapes, which is available in Romania under the name of Enervin from 2010, there has also been authorized the use of Zampro, an Initium-based fungicide for special potato, tomato, cucumber and onion cultures. Extremely toxic Initium-based products (which the company claims to have a low toxicity) shall be added to others, such as the newly launched Cabrio Top, a complex fungicide for grapes.

Together with Enervin, Cabrio Top will become an important product in the field of grape protection in Romania. At the same time, Initium-based products are approved first in the Netherlands and the UK and, after that, in other European countries [5-7].

#### Inorganic pollutants

Metals: Cd, Cr, Cu, Hg, Mn, Ni, Pb, V, Zn; Metalloids: As, Bo, Sb; Nonmetals: Se Actinide: U; Halogens: I, F

Some are considered toxic at any concentration (Hg, As, Tl), while others are considered toxic, only if they exceed a certain concentration (B, Cl, Cu, Fe, Mn, Mo, Zn). Organometallic compounds that are extremely toxic (methyl-mercury) can also be formed.

Some of these elements are necessary for the health, given that they are beneficial, when administered in the food or well-dosed in nutritional supplements. Some of them (Cd, Pb, Hg) have no biological function and are toxic to humans.

#### Arsenic pollution (As)

In Bangladesh, around 43,000 people die annually due to the contamination of water with large quantities of naturally occurring arsenic in some regions of Bangladesh.

People in rural areas who use contaminated wells are even more exposed. Such a situation can be found in Thailand, Argentina, China, Taiwan and Chile.

The most affected systems are:

- Nervous system (neuropathy, decreased intellectual and motor capacity)
- Cardiovascular system (hypertension, coronary artery disease)
- Renal system (kidney cancer, bladder cancer)
- Teguments (keratosis, skin cancer)
- Endocrine system (diabetes, decreased glucose tolerance)

-Respiratory system (bronchiectasis, bronchopulmonary cancer)

-Digestive system (liver cancer)

-I may also have a negative influence on embryonic development.

Arsenic contamination may come from industrial and mining areas, where the quantities are exponentially high. Other sources are pesticides, fertilizers, sludge, manure, soil dust, forest fires, volcanic eruptions, coal combustion. Arsenic can also be found in plants - green vegetables (especially cabbage), especially in those grown in soils already contaminated with arsenic [5-7].

#### Cadmium pollution (Cd)

Among the most common sources of cadmium exposure, we should mention:

-Smoking: tobacco plants absorb cadmium in the soil, like other plants and represent an important source of exposure; even non-smokers can be exposed through passive smoking.

-In the case of non-smokers, the source is 90% in the diet: the crops absorb cadmium from the soil and the absorption rate is influenced by factors such as soil pH, salinity, humus content, crop species and the presence of other elements (e.g. zinc). The most exposed people are those that consume large quantities of cereals, but also those that have a high intake of crustaceans and aquatic food. People with small iron reserves in the body, especially pregnant women or with a low zinc intake or other nutritional deficiencies, have higher rates of cadmium absorption

-Industrial and mining sources

-TVs, rechargeable batteries (nickel-cadmium batteries consume 1/4-1/5 of cadmium) [5,6,8].

#### Cobalt pollution (Co)

This is an essential element for people, found in vitamin B12.

Excessive ingestion of Cobalt can cause: polycythemia, cardiomyopathy, hypothyroidism, pancreatic insufficiency and neoplasia.

If inhaled, it can induce: bronchial asthma, fibrotic alveolitis and bronchopulmonary cancer. Repeated contact with cobalt alloys (as in the case of dental technicians): Severe cases of contact dermatitis.

It is used in the production of stainless steel, aerospace equipment, cement, galvanization and magnetic devices, as a catalyst in the synthesis of fuels, paints (the obtained pigment has an intense blue color called cobalt blue) and plastic curing agents. Exhausted rechargeable batteries of phones have a high Co content, which can be released into the environment. The most polluted areas are located in heavily industrialized areas, places where solid waste is incinerated and in the vicinity of mines [5, 6, 10, 11,18].

#### Chromium pollution (Cr)

The main application of chromium include: metallurgy, chemical industry and the production of refractory materials (resistant to high temperatures), originally used as yellow pigment.

Pollution may come from:

-Paints, leather industry

-Municipal waste (all waste generated in urban and rural areas in households, institutions, commercial units, economic entities (domestic and similar waste)

-Street waste collected from public spaces, streets, parks and green areas, construction and demolition waste generated in households and collected by sanitation operators and

-Sludge from the treatment of city waste water.

Exposure to excessive doses of chromium can lead to:

-Hepatic insufficiency, renal insufficiency (through tubular necrosis), anemia, muscle lysis, coagulopathies, acute and eczematous allergic dermatitis, bronchial asthma, skin ulceration (by corrosive action)

-Perforation of the nasal septum (predominantly in the 20th century; nowadays it is very rare)

-If inhaled, it can induce oncological pathology in the respiratory and possibly in the digestive system (stomach) [10-12, 19-25].

#### Mercury pollution (Hg)

Used in various fields and for various purposes - thermometers and barometers, incandescent lights, batteries, paints, bactericidal soaps, skin creams, dental amalgams. Used in small quantities and organic forms in various vaccines, medicines and cosmetics for various effects, among which the most common are: antiseptic, diuretic, laxative and skin moisturizer

Among the anthropogenic sources we should mention:

-Chlor-alkali plants, coal burning, use of mercury pesticides.

-Elemental mercury is released in the air and returns to the soil through rainfall phenomena, where it is deposited.

It is mostly absorbed through the respiratory tract due to its high solubility through the membrane, while methylmercury is absorbed at the gastrointestinal level. Mercury is one of the most toxic heavy metals and therefore it can generate: neurotoxicity, nephrotoxicity and cardiotoxicity.

Recent history has recorded the deposition of industrial waste rich in methylmercury - the most toxic mercury compound - in two cities in Japan, which generated:

-An epidemic of neurological disorders (uncontrollable tremor, difficulties in verbal discourse, loss of motor control, sensory disturbances, blindness, mental retardation, coma and even death)

-An entire generation of newborns with different pathologies (Hg is teratogenic) and a low IQ

Other effects include: gastric, liver, kidney and heart diseases in adults and children [10-14].

#### Lead Pollution (Pb)

It is used in the manufacture of automotive batteries, lead glass, ceramics, printing and recycling plants.

It can also be released by demolishing or sanding houses painted with lead products, plumbing (if the pipes contain lead) and burning fuels with lead.

Lead enters the body through ingestion, inhalation and absorption through the skin. It is distributed in both soft tissues and bone tissue, where it has a half-life of more than 20 years. Among its manifestations, we should mention: blockage of neurotransmitters, induction of neuronal death, poor hematopoiesis and renal tubular dysfunction.

#### Results and discussions

Subclinical exposure may induce anemia, peripheral demyelinating neuropathy (with predominant motor damage), reaction time delay, hypertension, AV blockages, interstitial nephritis, chronic renal disease, infertility due to the decrease in sperm count and spontaneous abortions.

If the exposure dose is very high, it can cause acute encephalopathy (seizures, coma and death). One of the clinical signs is the Burton's line - a blue line in the gums.

Epidemiological studies have shown that the exposure of children to lead at early stages of development is related

to a decrease in intelligence, deficits on language and expression, deafness and loss of balance or motor function. There has been proven a decrease in the intelligence index of at least 1-3 points for every increase of 10  $\mu\text{g}/\text{dL}$  in lead levels, which may seem insignificant for an individual, but may produce a great burden for society by lowering the global intellectual performance and the associated economic efficiency.

Romania has had long contact with lead. The famous leaded gasoline was banned in our country in 2004 compared to other countries like Japan, which banned it in 1980. It was hypothesized that the high crime incidence period, especially in the 1990s (in Romania, the US and other countries) was also due to exposure to lead.

In order to measure lead exposure, X-ray fluorescence is used to detect lead deposition in bones over the years. The serum level of this element is taken into consideration for recent exposure.

Average values of lead levels in areas with different lead exposure (Source: WHO, Europe 2009) (fig. 1) [10-13, 15, 26-32].

Among artists that were likely affected by Pb poisoning, we should mention:

- Caravaggio (high levels of Pb were found in the presumed remains of the painter),

- Pierro Della Francesca (who went blind in this last years of life),

- Rembrandt van Rijn (the cause of death is controversial but some researchers say that he died in depression and melancholy),

- Francisco de Goya (the analysis of this painting showed that the pigments used by this painter are very rich in Pb. Besides that, history recorded that he used to stretch the pigments on the canvas directly with his fingers),

- Vincent Van Gogh (a person whose pathology has been debated for long and remains controversial. He preferred Pb-based pigments due to the particular yellow color),

- Rubens, Dufy, Renoir, Von Jawlesnky and Klee are known because of the vivid colors used on the canvas, which are the result of mixing pigments containing many toxic substances: lead, arsenic, cadmium, cobalt and antimony.

- Candido Portinari, a Brazilian painter known for his two mural paintings *War and Peace* in the United Nations building in New York, was diagnosed with saturnism eight years before his death. At the doctors' advice, he left his workshop for a time and tried some replacing materials. However, disappointed with the results and against all medical warnings, returned to Pb-based pigments, which accelerated his premature death at the age of 58 [15].

### Conclusions

Chemical industrialization leads to technical and scientific progress, but at the same time it can develop related pathologies, which means that the role of the occupational health physician is essential in ensuring prophylaxis and the early detection of occupational diseases.

Although chemical soil pollution may have natural causes (e.g. volcanic eruptions), most of the pollutants come from human activities.

The growing concern of all nations for the adoption of measures to limit chemical pollution is partially found so far in viable and effective solutions intended to combat soil contamination and degradation and ensure its restoration.

Chemical pollution is a major challenge for ecologists, given that it is an important risk factor for many types of diseases. That requires maximum attention from the civil society, health specialists (especially Occupational Medicine) and Government Institutions.

Prevention is required from childhood. That implies the involvement of pediatricians, who will monitor the health of exposed children, as well as the prevention of cardio-respiratory, digestive and hepato-renal diseases and even of neuro-motor and degenerative diseases.

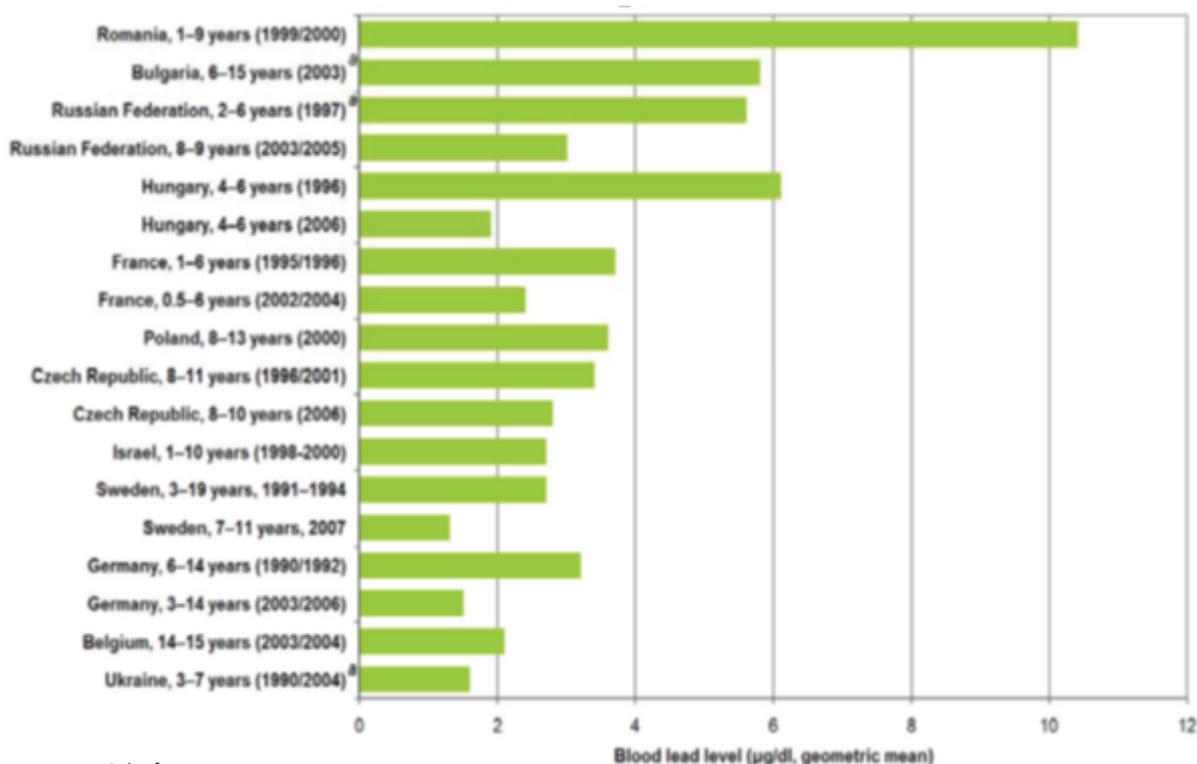


Fig. 1.

\* Arithmetic mean.

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