



REVIEW

Environmental health and infectious diseases in north of Italy

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ABSTRACT



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The lower Po Valley in northern Italy presents critical issues that impact human health. This geographical area is one of the most polluted in Europe, with increased concentrations of CO₂, PM₁₀ and PM_{2.5}, nitrous oxide (NO₂), and ozone (O₃), which promote respiratory infectious diseases, cardiovascular diseases, neoplasms, degenerative neurological diseases, toxicity during pregnancy as well as the main environmental risk factor for human health and ecosystems.

The entire Po Valley is affected by excessive livestock farming (pigs, cattle, and chickens), the spread of sludge and gypsum on agricultural land, numerous landfills, including those containing toxic and harmful substances, a reduction in water availability, and an exponential increase in urban development, causing heat islands and climate change. Urban temperatures are approximately 0.6–3.9°C higher than surrounding areas, and nighttime temperatures are approximately 1.1–2.8°C.

All this is altering the environmental matrices of Earth, Water and Air with ever-increasing risks to human health.



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Introduction

As Chinese Medicine teaches, human health is correlated with the quality of the various environmental matrices: air, water, and soil. Inevitably, when these matrices are altered, the health of citizens is also at risk⁽²¹⁾.

The European Environment Agency (EEA)⁽¹⁾, the World Health Organization (WHO)⁽²⁾ and the National Prevention Plan 2026/2031 (PNP)⁽³⁾ indicate that air pollution is one of the main causes of premature death and respiratory infectious diseases (Chronic Obstructive Pulmonary Disease - COPD, Pneumonia, Asthma), cardiovascular diseases (Atherosclerosis, Stroke, Myocardial Infarction), neoplasms, degenerative neurological diseases, toxicity during pregnancy as well as the main environmental risk factor for human health and ecosystems.

Transport, production activities and domestic heating are the main responsible for emissions of pollutants of toxicological interest and raise the greatest concerns in terms of health impact due to the high number of people exposed, in urban and extra-urban areas. Emissions from agriculture, energy production, industry and domestic settlements also contribute to air pollution⁽³⁾. The main health problems are associated with pollution in urban areas due to the high density and size of the population.

Article 5 of the Code of Ethics for Italian Doctors is reported⁽¹⁹⁾:

Health education and relations with the environment

"The doctor is required to consider the environment in which man lives and works as a fundamental determinant of the health of citizens.

To this end, doctors are required to promote a civil culture aimed at the appropriate use of natural resources, also with the aim of ensuring future generations enjoy a livable environment.

The doctor promotes and participates in prevention initiatives, health protection in the workplace and the promotion of individual and collective health".

Point 2.8 of the 2014/18 National Prevention Plan is reported, taken from the 2020/2025 Plan⁽³⁾.

2.8 Reduce potentially harmful environmental exposures to health

Soil, water, and air protection, waste prevention and disposal policies, noise, ionizing and non-ionizing radiation exposure prevention, chemical safety policies, the fight against pollutants and climate-altering production, and the quality of construction projects represent opportunities for developing cross-sector policies and for the potential integration of health objectives with the "green economy." Participatory processes must be improved, taking into account the public's concerns regarding the planning and management of activities that impact the environment and health. In this context, general practitioners and pediatricians can contribute to raising awareness and informing the public, as well as reporting any critical situations, by implementing a networked assessment system that involves key stakeholders in the national health system and environmental surveillance and control systems. Indeed, Regional Health Service operators are increasingly called upon by the public to provide competent responses to their needs, not only in terms of medical care, but also in relation to prevention and health promotion.

The Po Valley is a basin with poor wind circulation and the formation of persistent fogs (Photo AFP-NASA) (Figure 1).



Figure 1

The climate is characterized by very hot summers, with heat waves, which often follow one another for several weeks, during which air exchange is almost impossible.

It is a densely populated area: 23,562,000 inhabitants with a density of 262.25 per km², with high industrialization, intense mobility of people and high rates of commuting in multiple directions, as well as intense mobility of goods and intensive agriculture.

All these factors are responsible for the production and accumulation of various air pollutants such as PM₁₀, PM_{2.5}, nitrogen oxides (NO₂), ozone (O₃), microplastics (MP), all of which are critical for air quality⁽²⁴⁾.

In 2008, the EU had indicated these values as much higher than the WHO values.⁽²⁵⁾ The reduction occurred progressively throughout most of Europe. In the Po Valley, a constant exceeding of the EU values set was observed, with values even double those set, so much so that three infringements by the European Commission followed: 2014, 2015, 2020⁽²⁶⁾, with a condemnation by the European Court of Justice in 2020 for the continuous exceeding of the PM₁₀ limits in the period 2008-2017⁽²⁷⁾.

Purpose and Scope

The aim of this study is to assess the inconsistency between the National Prevention Plan and the ever-increasing environmental degradation of the Po Valley in its three matrices and, in particular, to highlight some risk factors.

1. Numerous cattle, pig and poultry farms.
2. Numerous landfills of toxic and harmful waste.
3. Spread of chalk and mud over numerous hectares of countryside.
4. Critical issues in water management (lakes, rivers, wells).
5. Climate change with heat islands due to the cementing of agricultural land.

This environmental change has favored a greater presence of infectious diseases (*Legionella Pneumophila*, Avian Flu, Covid 19) as well as neoplastic diseases and epigenetic alterations.⁽⁸⁻⁹⁻¹⁰⁻¹²⁻¹³⁻¹⁴⁻¹⁵⁾

These diverse situations have raised awareness among many citizens, who have organized themselves into various Public Health Committees, engaging in demonstrations and public interventions with health



authorities and various political groups. It is worth noting the frustration with the lack of political response to the various Committees' requests, a reflection of compromises between the political class itself and economic, financial, and trade lobbies.

Results

Let's analyze the various items:

1. Numerous intensive farms of cattle, pigs, chickens, rabbits and turkeys

In the Province of Brescia (1,200,000 inhabitants) there are 450,000 cattle in 3,540 stables, 2,000,000 pigs in 1,916 farms, 10,600,000 poultry in 403 farms, almost all located in the south of the Province and monitored by 85 veterinary doctors.

In the Lombardy Region (10 million inhabitants) there are 1,515,000 cattle, 4,000,000 pigs, 12 million laying hens and 11 million broiler chickens.

In Italy (59 million inhabitants) there are 5,300,000 cattle, 8,100,000 pigs and 38/44 million chickens⁽²³⁾

Across Europe there are 12 million farms for over 100 million cattle.

Intensive livestock farming is considered the main amplifier and reservoir for the emergence of infectious diseases and zoonoses. Overcrowding, low genetic diversity, and stressful conditions increase the possibility of pathogens mutating and spreading as spillovers, allowing various epidemics.⁽¹¹⁻¹²⁻¹³⁾

Regarding avian influenza (Avaria), considered a disease foreign to humans, in recent years numerous transfers of the virus from animals to humans have been observed. This situation requires constant surveillance. The risk is that, by continually mutating, Avaria will eventually adapt to humans and trigger an influenza pandemic, as happened in the past with the Spanish and Asian flu. In 2020, the great Covid-19 pandemic occurred, a Big One of influenza.⁽¹⁷⁻¹⁸⁾

2. Numerous landfills of toxic and harmful waste

The quantity of harmful toxic waste buried in the province of Brescia (94 million cubic meters) is significant when one considers that 10 million cubic meters are buried in the "Land of Fires" of Caserta. In Montichiari (Brescia), considered the "garbage dump of Italy," there are 13 active landfills and 11 abandoned ones. In Calcinato (Brescia), the pressure index is 167,000 m³/km, while the pressure index indicated by the Lombardy Region is 145,000 m³/km.⁽¹⁵⁾

These landfills produce leachate, rich in PCBs, PFAS, nitrates, heavy metals, and many chemicals that, despite the protective covers, can pollute groundwater.

3. Spreading of chalk and mud over several hectares of countryside

Following the Nitrates Directive with the Genoa Decree, which allowed the use of industrial sewage sludge as fertilizer, the Lombardy Region issued a decree on February 1, 2022, prohibiting the spreading of sludge and gypsum in areas already rich in livestock waste. This follows the 2020 complaint against a company in the sector, WTE srl of Calvisano (Brescia), which in 2018/2019 dumped 150,000 tons of these uncontrolled products, rich in sulfuric acid and calcium, on 3,000 hectares of agricultural land in 78 towns in Lombardy and Emilia-Romagna.⁽¹¹⁻¹⁵⁾

All this allows for an alteration of the Agri -food supply chain with repercussions on human health.

4. Critical issues in water management

For several years, there has been an institutional conflict between the Lake Garda Water Consortium and numerous mayors and active citizens' committees over the decision to transfer the wastewater treatment plant on the western shore of Lake Garda to the Chiese River, the outlet of Lake Idro, rather



than to the natural outflow of Lake Garda, the Mincio River, which has a much greater flow than the Chiese River. The Chiese River was already the direct and indirect cause of a *Legionella pneumophila* outbreak in 2018.⁽¹³⁻¹⁶⁾

Furthermore, the Alpine lake basins are suffering from the agricultural irrigation activity of the Po Valley.

5. Climate change

Climate change accelerates the spread of infectious diseases by altering the habitat and life cycle of vectors (mosquitoes, ticks) and pathogens such as *Legionella pneumophila*. In Europe and Italy, global warming is favoring the arrival of new viral and bacterial infections.⁽⁴⁻⁵⁻⁸⁻⁹⁾

Rising temperatures and prolonged humidity are allowing mosquitoes such as *Aedes albopictus* (tiger mosquito) to survive in new areas, increasing the spread of diseases such as dengue, chikungunya, and West Nile.

Conclusions

This analysis highlights the critical environmental situation of the Po Valley, both due to its orographic conformation and the multiple productive activities of its 23,562,000 inhabitants. It is one of the most polluted areas in Europe, causing an increase in respiratory infections, cardiovascular diseases, and cancer.

On the basis of all the scientific evidence, the evidence from studies and International Agencies⁽²²⁾ indicate that there is no immediate remedy for effective health protection apart from the reduction of traffic, particularly in urban areas. And at the same time the implementation of all the other measures already indicated by the EU : interventions on traffic/transport, commercial and residential energy sector linked to domestic heating, raising public awareness on air pollution, public green spaces, industrial emissions, emissions from agricultural areas, far-sighted urban planning.

It is important that every doctor be a sentinel of the territory, addressing complex situations where scientific knowledge of the various issues is essential, coordinating with other professionals with whom they interact with the utmost respect for professional ethics, and promoting environmental change at the political and social levels. It is reiterated that the current environmental situation in Northern Italy is critical in its three dimensions: land, water, and air. The satellite image shows the dense blanket of smog over the Po Valley in Northern Italy, extending to the northern Adriatic Sea (Photo AFP-NASA) (figure 1)

A constructive commitment from every doctor in the One Health logic.⁽¹⁷⁻¹⁸⁾

Conflicts of interest

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