Does urban asthma exist? How climatic changes and urban air pollution intervene on asthma and respiratory allergy

Esiste l'asma urbano? In che modo le modificazioni climatiche e l'inquinamento urbano intervengono sull'asma e sulle patologie respiratorie allergiche

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In his important article [1], Gennaro D'Amato provides elements that contribute to reply to two burning questions of the present time. How bad is the fact of living in a city for asthma and, more generally, for respiratory allergy? And to what extent does climate change worsen asthma in individuals living in cities? The two questions are strictly related.

How bad is living in a city for asthma?

Several investigations have indicated that individuals living in cities have a higher risk of suffering from asthma and allergies compared to those living in the countryside, this being due to several factors. Besides the fact that individual susceptibility varies between urban and rural settings, there are environmental factors that are typical of living in a city.

First of all, as perfectly indicated by D'Amato in his article, urban air pollution is composed of gases and particles. Whereas industrial pollution has decreased in recent decades, at least in industrialized countries, air pollution related to traffic is rising or remaining at the same level (www.eea.org). Gases and particulate matter have been shown by experimental and epidemiological studies to be involved in respiratory adverse effects. At the population level, not only can short-term exposure to elevated concentrations of urban air pollutants exacerbate pre-existing asthma and allergic rhinitis but also long-term exposure to these pollutants can be responsible for adverse effects, including asthma and the development of allergies [2]. Most investigations reporting long-term effects of air pollution have considered exposure to background air pollution as assessed by monitoring stations, which provide an under-estimation of the real exposure to these pollutants. Fewer studies have considered a more robust assessment of the individual's exposure to air pollution so avoiding miss-classification of exposure. Among them, very recently, is the French 6 Cities study in which long-term average exposure to major urban air pollutants, including benzene, volatile organic compounds (VOCs), sulfur dioxide (SO_2), particles with an aerodynamic diameter of 10 µm or less (PM_{10}), nitrogen dioxide (NO_2), nitrogen oxides (NOx), and carbon monoxide (CO), was assessed using a dispersion model capable of capturing small-scale variations in 6,683 children. These children underwent clinical examinations, including lung function and skin prick tests, and their parents completed questionnaires on asthma and aller-

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gic diseases [3]. Children constitute a good model because they do not commute. In this study, we found associations between long-term exposure to urban air pollution, and asthma and allergies including skin prick test positivity after taking into account potential confounders like passive smoking, familial history of asthma and allergies, type of diet, etc. Among the 4,907 children who had lived at their current address for at least the past 3 years, each incremental increase in the average interquartile range for benzene (1.1 μg/m^3), SO_2 (5 μg/m^3), PM_{10} (10.5 μg/m^3), and CO (199 μg/m^3) was associated with an increased risk for lifetime asthma, with adjusted odds ratios (ORs) of 1.25, 1.26, 1.28, 1.21, respectively. Each incremental increase in PM_{10} levels was also associated with an increased risk for allergic rhinitis (OR = 1.20) and sensitization to pollen (OR = 1.35). Among the 2,213 children who had lived at their current address since birth, each incremental increase in the interquartile range for benzene and PM_{10} was associated with a respective 1.30- and 1.40-fold increased risk for lifetime asthma, while each incremental increase in average VOCs and PM_{10} was associated with a respective 1.30- and 1.20-fold increased risk for sensitization to pollen. As reported in D'Amato's article, pollens are particularly sensitive to pollution effects. In addition, various studies suggest that there is an interaction between air pollutants and pollen allergens that exacerbates atopy and respiratory symptoms [4]. The links between chemical and biological pollutants and asthma and allergies in children living in polluted areas are confirmed, although for less pollutants, by prospective birth cohorts. All together these results corroborate an emerging body of evidence that traffic-related air pollution could induce asthma and allergies.

However, air pollution is not the only culprit for asthma and allergies in individuals living in the cities. Other urban factors associated with asthma include: passive smoking, high exposure to cockroaches or other pests, damp, indoor air pollution, poor ventilation, inadequate heating or faulty air conditioning, air-borne viral infections, overcrowding, stress and violence as well as, for low social classes of some countries, inadequate access to health care. These "stressors" have been identified thanks to epidemiological investigations among which the study of inner-city asthma in the USA showing that children living in inner cities suffered more from asthma and related diseases than other children from the same city. These other factors are essential to explain why worldwide the geographical distributions of air pollution and asthma and allergies do not match with the lowest prevalence of asthma in megalopolis of developing countries where the level of air pollution is very high and the highest prevalence in English-speaking countries, like Australia, New Zealand or UK, in spite of the fact that the levels of air pollution are not exaggerated there (Figure 1). Indeed, asthma is a multifactorial condition caused by several environmental and genetic factors. These factors influence the degree of severity of asthma and how well it responds to medication. Their interaction is complex and not fully understood. Indeed, in developing countries children and their families still preserve some protective factors of the traditional lifestyle which exert their influence, despite the fact the children are exposed to many environmental factors including air pollution, and this could protect them from asthma. This phenomenon has been discussed in the frame of the Hygiene Hypothesis [5]. Of note, in this respect, a difference could exist according to whether asthma is allergic or not, but this aspect has been little investigated.

How much can climate change worsen urban asthma?

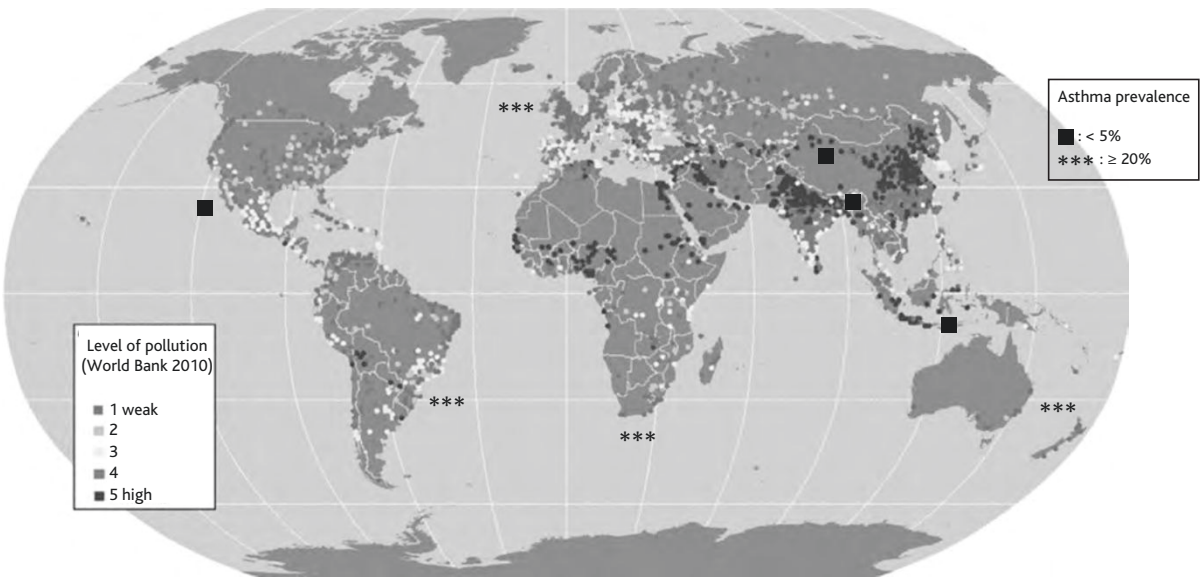
The year 2010 was the warmest recorded on Earth since the first "rélevé" in 1880, *ex aequo* with 2005, as reported by two U.S. agencies (NOAA and NASA). 2010 was the 34th consecutive year that global temperatures ranged above the average of the 20th century according to the National Climatic Data Center (NCDC), an organization dependent on the National Oceanic and Atmospheric Administration. Last year, the temperature at the earth's surface was about 0.62 degrees Celsius above the average of the century. The rise of mercury on Earth coincides with a major change in the warm ocean current El Niño in the Pacific that affects global temperatures and precipitation. Despite a summer season shorter than normal in 2010 during which the ice cap melted, the Arctic surface witnessed the third lowest amount of ice since 1979, after 2007 and 2008. Antarctic sea ice has reached its eighth lowest annual maximum in March and in September the size of the ice has increased rapidly, reaching its third largest area on record. These results show that the climate continues to reflect the influence of greenhouse gas emissions. This is evidence of global warming and climate change.

D'Amato's article reports with precision that various data indicate that climate change and global warming act on both individual health, including allergic and respiratory diseases, as well as on risk factors for such diseases like temperature, humidity, chemical and biological air pollutants [6-7]. Climate change will affect individuals with pre-existing respiratory disease [6]. In addition, climate change is expected to alter the concentration and distribution of pollutants in the atmosphere. Climate change will be responsible for an overall increase in ozone concentrations in high-income countries. Ozone is a powerful oxidant that has been associated with reduced lung function, exacerbation of chronic respiratory diseases, and increases in respiratory hospital admissions and mortality in both Europe and the USA. Desertification and a higher frequency of forest fires may increase transboundary transport of particles, which will have significant public health consequences. Climate change has also an impact on living organisms, including plants and fungi [7]. Over the last three decades, studies have shown changes in production, dispersion and allergen content of pollen

and spores, which may be region- and species-specific. These changes may have been influenced by urban air pollutants interacting directly with pollen, which suggests an increasing effect of aeroallergens, pollens, mold, house dust mites, on allergic patients over this period, which may also imply a greater likelihood of the development of an allergic respiratory disease in sensitized subjects and exacerbation of symptoms in pre-existing asthmatic patients. However, contrary to what is the case for air pollution, the scientific community lacks sufficient data to allow it to investigate the repercussions of climate change on the environment as well as on individuals. Ecological but not semi-individual analyses have been conducted so far. Hence, predictions for the future are uncertain.

In summary: living in a town is bad for asthma because of urban air pollution but also because of other urban factors like overcrowding, indoor air pollution in confined dwellings including passive smoking, and inadequate heating, and the situation should result worsened by climate change although data are few in this respect. Thereafter, and this is very relevant, D'Amato's article raises the hypothesis according to which there exists "urban asthma", a specific phenotype for asthma in individuals living in cities, and intimately related to climate change in the long term. This urban asthma phenotype will pay the price for wrong actions taken by mankind in its fight against global warming. Because of its features, urban asthma is not only a clinical variant of asthma characterized by an inflammatory response of cells and airways after exposure to chemical and biological air pollutants and toxicants but a social condition affecting the less affluent individuals in high income countries and for which the main factor responsible is poverty with its manifold facets encountered in the cities. Further and specifically designed studies are needed to better understand the urban phenotype of asthma. These investigations have to be multidisciplinary to catch the multifaceted aspects of urban

FIGURE 1: WORLDWIDE DISTRIBUTIONS OF PARTICULATE MATTER POLLUTION AND ASTHMA PREVALENCE



Ranking of concentrations of particulate matter (PM_{10}) in 3,200 cities hosting more than 100,000 inhabitants as mapped by the World Bank.

Asthma prevalence as assessed by the International Study of asthma and allergies in childhood. Phase III.

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