EDITORIAL

Ambient air quality, inhaled pollutants, and emergency department visits

Calidad del aire ambiente, inhalación de contaminantes y consultas en los servicios de urgencia

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Ambient air pollution has become a global health problem, causing around 7 million deaths per year according to the World Health Organization (WHO) estimates[1]. Many of these pollutants are discharged in urban areas, now home to more than half of the world's population. Nonetheless, the effects of pollution are not limited to these areas. Phenomena such as major forest fires[2], dust storms[3] and the atmospheric transport of pollutants make the health effects of poor air quality a cross-border problem requiring global action to be resolved. Recently, on 22 September 2021, the WHO presented its new global air quality guidelines[1], which provide states and regions with guidance on the maximum levels of ambient air pollution to which the population should be exposed.

Atmospheric pollutants are a complex mixture of suspended solid and liquid particles (also called particulate matter or PM) and gaseous substances. Among the pollutants in the gaseous phase are those whose concentrations in ambient air are limited by European Union legislation, as is the case of carbon monoxide (CO), nitrogen oxides (NO_x = NO_2 + NO), sulphur dioxide (SO_2) and tropospheric ozone (O_3).

PM is a substance mixture with different toxicities, consisting of soot, hydrocarbons, sulphur and nitrogen compounds, dust and a cocktail of metals. PM also contains polycyclic aromatic hydrocarbons, and metals such as arsenic, cadmium and nickel. Given the technical difficulties in continuously measuring each PM element, air quality monitoring networks measure concentrations of PM_{10} and $PM_{2.5}$, i.e., concentrations of all inhalable PM (regardless of composition) under 10 microns and 2.5 microns, respectively; parameters in which maximum concentrations in ambient air are also limited by European legislation. These pollutants are discharged during combustion processes (by automobiles, power plants, biomass burning, etc.), from which CO, NO_x and primary PM (soot, hydrocarbons and metals) are released into the air, and also SO_2 when operating with heavy fuels (coal or fuel oil in power plants, bunker fuel in vessels or heavy hydrocarbons in refineries). Other pollutants, such as O_3 and secondary PM (sulphate, nitrate, ammonium and organics), are formed in the ambient air following the release of any gaseous precursor. Many of the health impact studies are based on these gaseous (CO, NO_x, SO_2 and O_3) and particulate (PM_{10} and $PM_{2.5}$) pollutant data measured in these governmental air quality networks.

The European Environment Agency estimates that in Europe (41 countries) $PM_{2.5}$ particles, nitrogen dioxide (NO_2) and tropospheric ozone currently cause around 417,000, 55,000 and 21,000 deaths per year, respectively; in Spain the figures are 23,000, 6,800 and 1,800 deaths/year[4]. These deaths occur mainly due to ischemic heart disease, stroke, pulmonary diseases and lung cancer[5]. Another important aspect, and one on which perhaps fewer public campaigns have been carried out, are the conditions and diseases caused by air pollution, which do not cause death in the short term but seriously impair the quality of life. These include reduced lung function, respiratory infections, asthma exacerbation, impacts on pregnancy and new-borns[5,6], development of new-onset type 2 diabetes in adults, obesity, systemic inflammation, Alzheimer's disease and dementia[7,8]. The impact of these conditions on emergency departments (ED) is being studied.

Ruiz Albi et al.[9] published an important study where they demonstrate that exposure to NO_2 in ambient air is associated with the number of ED visits for asthma exacerbations in adults. Specifically, their results show that an increase of 10 µg/m^3 in the average daily concentration of NO_2 in ambient air is associated with a daily increase of 5.3% in ED visits with a 3-day delay. Earlier studies had already linked increases of 10 µg/m^3 in 5-day average NO_2 concentrations to a 50% increase in the number of asthma cases in children 2-4 years of age[10].

The relationship between pollution and paediatric asthma is a well-known fact, so the results of Ruiz Albi et al.[9], showing the relationship between NO_2 and asthma in adults, are novel. Ambient air pollution is also related to ED care for other conditions. In a 14-year registry in Rome, it was observed that increases of 10 µg/m^3 in daily concentrations of PM10 and PM2.5 are associated with increases of 1.7% and 3% in ED care for joint fibrillation, respectively[11]. In Canada (1 decade of re-

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cords from 13 hospitals in 7 cities), findings showed that daily increases of 10 µg/m^3 in the concentrations (i) of NO_2 are associated with daily increases of 1% in cases of myocardial infarction and 1.3% in heart failure; (ii) of PM_{10} and $PM_{2.5}$ were associated with increases of 7% and 9%, respectively, of asthma cases; and (iii) of O_3 were associated with increases of 0.9% and 1% for asthma and chronic obstructive pulmonary disease (COPD)[12]. The concentrations of these pollutants in ambient air can vary by tens of µg/m^3 in a few days and can thus lead to 5 to 40% more visits to the emergency department for certain conditions.

Pollutant abatement techniques occasionally cause changes in their properties which prevent the health effects of pollution from decreasing at the expected rate. Between 1990 and 2000, the technology used to reduce particulate emissions in automobiles led to a decrease in emissions of primary PM_{10} and $PM_{2.5}$, although emissions of ultrafine particles (smaller than 0.1 microns in size), consisting of soot, hydrocarbons and sulphur, increased[13]. In Spain, exposure to this ultrafine material in urban ambient air has already been associated with mortality[14]. In Chile, daily increases of 10 µg/m^3 in ultrafine particulate concentrations have been associated with a 30% increase in cases of respiratory diseases in the emergency department, with a 5-day delay[15].

The new WHO air quality guidelines include two key aspects. It lowers, with respect to the previous guidelines (2005), the maximum daily and annual concentrations of NO_2, PM_{10} and $PM_{2.5}$ to which the population should be exposed; and it includes new pollutants, such as black carbon (a metric of soot), ultrafine particles and desert dust. These pollutants are still not routinely measured in governmental air quality surveys, which is why health impact studies will require collaborations between the medical community and research groups specializing in atmospheric and environmental sciences. A multidisciplinary approach may be an optimal strategy to undertake this line of research for the benefit of public health. Investing in air quality research is an investment in public health.

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