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Editorial

Climate change, air pollution, and biodiversity in Asia Pacific: impact on allergic diseases

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The prevalence of allergic diseases is increasing worldwide with the rapid industrialization and urbanization. Globally, 300 million people suffer from asthma, 400 million from rhinitis [1]. Air pollution, climate change, and reduced biodiversity are major threats to human health with detrimental effects on a variety of chronic diseases in particular respiratory and cardiovascular diseases. The extent of air pollution both outdoor and indoor is increasing to alarming proportions particularly in the rapidly industrializing countries. According to the World Health Organization (WHO) every year 3 million people die prematurely due to outdoor air pollution, which is heaviest in major cities of Asia, Africa, and Latin America.

In recent years, Asia has experienced rapid economic growth and a deteriorating environment coupled with an increase in allergic diseases to epidemic proportions. In the Asia-Pacific region, 2.3 billion people are exposed to levels of air pollution several times higher than the WHO guideline for safe air especially in China and India. Moreover, industrial, traffic-related, and household biomass combustion, indoor pollutants from chemicals, phthalates, and tobacco are major sources of air pollutants, with increasing burden on respiratory allergies.

Epidemiological and experimental studies have shed light on the relationship between various environmental factors and climate change on respiratory allergies [2-9] such as rhinitis and asthma. Increased exposure to outdoor pollutants like carbon dioxide (CO_2), sulfur dioxide (SO_2), ozone (O_3), and indoor pollutants like tobacco smoke and chemicals leading to limited plant, animal and microbial life lead to immune dysfunction and impaired tolerance in humans [5, 6]. Urbanization, high levels of vehicle emissions and westernized lifestyle correlate with an increase in the frequency of pollen-induced respiratory allergy in people living in urban areas in comparison with those living in rural areas [10]. Ozone has been reported to cause respiratory symptoms by inducing increase in airway responsiveness, airway injury and inflammation and systemic oxidative stress [11] Furthermore, pollen collected along high-traffic roads showed a higher allergen city and children living closer to high traffic roads has been shown to have greater symptoms of respiratory allergies. in this context, it is important to point out that air pollution can interact with allergen-carrying submicronic and paucimicronic particles derived from pollen or other part of the plants [12, 13]. These allergens are able to reach peripheral airways with inhaled air, inducing asthma in sensitized subjects.

Weather changes like wind patterns, precipitation timing and intensity, increase of temperature may have an effect on the severity and frequency of air pollution. One of

the effects of climate change and global warming that can threaten respiratory health is "Thunderstorm related asthma." Thunderstorms occurring during the pollen season have been observed to induce severe asthma attacks and also deaths in pollen-allergic patients. The thunderstorm asthma of Melbourne in 2016, with the involvement of more than 9,000 persons and 10 deaths, was a major event in the Asia-Pacific region [13]. The thunderstorm in a pollen season led to a major rise in concentration of pollen grains, hydration and rupture of pollens by osmotic shock with release of allergen-carrying paucimicronic particles of respirable size such as starch granules and other cytoplasmic components into the atmosphere. This resulted in the inhalation of these particles by those who had seasonal allergic rhinitis to the pollen with or without comorbid asthma and resulted in the onset of asthma epidemics [3, 14, 15]

A third of the world's population uses solid fuel derived from plant material (biomass) or coal for cooking, heating, or lighting. These fuels are smoky, often used in an open fire or simple stove with incomplete combustion, and result in a large amount of household air pollution. Volatile organic compounds (VOCs) are a group of carbon-based chemicals that easily evaporate at room temperature. Many common household materials and products, such as paints and cleaning products, give off VOCs [3]. Common VOCs include acetone, benzene, ethylene glycol, formaldehyde, methylene chloride, perchloroethylene, toluene, and xylene. Several studies suggest that exposure to VOCs may worsen symptoms in asthmatics or are those particularly sensitive to chemicals.

A global study of 9–23 million and 5–10 million annual asthma emergency room visits (ERVs) globally in 2015 was shown to be attributable to O_3 and particulate matter ($PM_{2.5}$), respectively, representing 8%–20% and 4%–9% of the annual number of global visits, respectively. Anthropogenic emissions were responsible for ~37% and 73% of O_3 and $PM_{2.5}$ impacts, respectively [16]. Remaining impacts were attributable to naturally occurring O_3 precursor emissions (e.g., from vegetation, lightning) and $PM_{2.5}$ (e.g., dust, sea salt), though several of these sources are also influenced by humans. The largest impacts were estimated in China and India. The top 3 countries for both asthma incidence and prevalence in Asia were India, China, and Indonesia. Nearly half (48%) of estimated O_3-attributable and over half (56%) of $PM_{2.5}$-attributable asthma ERVs were estimated in Southeast Asia (includes India), and western Pacific regions (includes China). The percentage of national pediatric asthma incidence that may be attributable to anthropogenic $PM_{2.5}$ was estimated to be 57% in India, 51% in China, and over 70% in Bangladesh.

Furthermore, changes in the environment and human activities have caused an alteration in the biodiversity [17, 18]. Metagenomic and other studies of healthy and diseased individuals reveal that reduced biodiversity and alterations in the composition of the gut and skin microbiota are associated with various inflammatory conditions, including asthma and allergic diseases.

Asia-Pacific comprises over half of the world's population. There is an urgent need to highlight the key components of outdoor and indoor air pollutants and their impact on respiratory allergies like asthma and allergic rhinitis, increase public awareness, highlight targets for interventions, increase awareness amongst patients and physicians on the importance of diagnosis and evidence-based treatment with safe and efficacious drugs, public advocacy and a call to action to policy makers to implement policy changes towards reducing air pollution with strategic interventions at a population-based level.

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The Asia Pacific Association of Allergy Asthma and Clinical Immunology has developed a white paper on the burden of air pollution in Asia Pacific and impact on respiratory allergies and a charter of recommendations addressing this very important environmental issue that has a wide impact on health.

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