Global Warming, Climate Change, Air Pollution and Allergic Asthma

“Lord, what fools these mortals be!”

William Shakespeare

A delicate balance exists between man and his environment. The impact of changes in the surrounding atmosphere on human health was first reported by Plinius, the Younger, in 73 AD. In his documentation of fatal respiratory consequences of natural air pollution caused by the eruption of Mount Vesuvius in Pompeii, he described succinctly, the effect that the clouds of airborne matter in the atmosphere had on Plinius, the Elder, a scientist as well as the commander of the Roman fleet. Hypothesising that the dense fog was obstructing the airways, he suggested that this effect was caused by “inflammation of airways”.

The race for development, coupled with the greed of man, has led to pollution of the environment in several ways, threatening the precarious equilibrium between all objects on the planet, living and non-living. Industrial revolution led to a surge in the consumption of nature’s bounties including hydrocarbonaceous fuels, leading to increase in the emission of carbon dioxide (CO₂) and other noxious gases, never before documented in the evolutionary history of earth. These, along with particulate matter, increase the atmospheric trapping of radiated heat from the sun which is known as the “green-house effect”. The resultant abnormal rise in the earth’s surface temperature is “Global Warming,” and the climatic changes, thus, brought about are termed “anthropogenic climate change”.

The global rise in the concentration of CO₂ is conspicuously linked to “deforestation” a term coined for the rampant destruction of our forests along with, consumption of natural resources by an exploding population and its insatiable appetite for fossil fuel. For centuries, until the commencement of the industrial revolution in the second half of the 18th Century, the level of atmospheric CO₂ concentration was estimated to have remained stagnant at about 280 ± 10 ppm. The Mauna Loa Observatory in Hawaii recorded a stupendous increase in CO₂ from 316 ppm in 1959 to approximately 380 ppm in March 2008. More importantly, two-thirds of this startling increase in the atmospheric CO₂ concentration has occurred over the last 50 years.

The World Metrological Organisation and United Nations Environment Programme (UNEP), in an effort to combat the worsening situation, set up the Intergovernmental Panel on Climate Change (IPCC) in 1988. In recognition of the strong body of evidence that this panel has painstakingly collated, it was honoured with the Nobel Peace Prize last year. The panel recently released their Fourth Assessment Report which categorically states that the “warming of the climate system is unequivocal, as is now evident from observation of increases in global average air and ocean temperature, widespread melting of snow and ice and rising global average sea level”. With 11 of the last 12 years (1995-2006) being the warmest years since the commencement of the temperature records, the average global surface temperature would increase by 1.1 oC to 6.4 oC causing alteration of planetary ecosystem dynamics. The observational evidence garnered by the Fourth Assessment Report has just been confirmed by a meta-analysis published in mid May by Rosenzweig and colleagues. This meta-analysis was the first to formally link the observed alterations in the physical and biological systems in the continents to the anthropogenic climate changes that have occurred since the 1970s.

The Fourth Assessment Report has already identified three areas in which human health has already been affected by climate change. These are: (i) alteration of distribution of some infectious disease vectors, (ii) seasonal distribution of some allergenic pollen species, and (iii) increased heat wave related deaths. That climate change impacts health in many ways was highlighted by the World Health Organization (WHO) when it chose to mark World Health Day on April 7 this year with the theme “Protecting health from climate change”. The WHO has estimated that climate change is responsible for around 150,000 deaths annually and 5 million Disability Adjusted Life Years (DALY), mainly in developing countries.

With this background, this editorial aims to focus on the possible effects of climate change on allergic asthma. The major environmental pollutants that have been linked to asthma are ozone (O₃), nitrogen dioxide (NO₂), sulphur dioxide (SO₂) and particulate matter (PM) smaller than 2.5 µm in diameter. The Fourth Assessment Report of the IPCC clearly states that “exposure to elevated concentrations of ozone is associated with increased hospital admissions for pneumonia, chronic obstructive pulmonary disease, asthma, allergic rhinitis and other respiratory diseases, and with premature mortality”. Vehicular emissions are the major contributors to the rise in the levels of these pollutants. Incidence of respiratory symptoms has been shown to increase in populations living in areas of high...
road traffic. Due to inversion effect, ozone is trapped close to the surface of the earth which when inhaled causes airway inflammation and increases responsiveness to allergens in subjects with asthma and/or rhinitis. It not only increases asthma exacerbations, but has also been associated with higher incidence of asthma in children. This is especially in those children who undergo heavy physical exercise while living in areas of increased concentrations of $O_3$. The combustion of fossil-derived fuels, along with vehicular emissions, is an important source of NO$_2$. Apart from its role in production of $O_3$, it could possibly cause acute decline in lung functions in asthmatics. Sulphur dioxide, produced primarily from the industrial combustion of sulphur containing fuels, can cause bronchoconstriction in asthmatic individuals even after brief periods of exposure.

Air borne particulate matter, another predominant component of air pollution, is largely due to diesel exhaust particulate (DEP). The WHO estimates that more than 500,000 deaths every year could be attributed to inhalation of particulate matter. Chronic exposure to diesel exhaust could cause cough with sputum production and decrease in lung functions. It enhances IgE synthesis in atopic individuals, increasing the sensitivity of the airways to airborne allergens. The carbonaceous core of the DEPs can adsorb several large molecules and allergens, including pollens, thus prolonging their retention. The change in the morphology of the pollen, brought about by its attachment to the pollutant, enhances its allergenic potential. There is evidence to suggest that air pollutants affect the allergenicity of air-borne allergens which could possibly lead to increased airway hypersensitivity. The DEPs can also serve as a vehicle for airborne pollens and, thus, facilitating its deposition in the lower airways. This interaction between air pollutants and allergens could lead to an increased allergic inflammatory response in the airways causing a possible upsurge in development of atopy and respiratory allergy.

The link between climate changes, aeroallergens and air pollution has been documented; however, the health care providers, in general, continue to remain unaware of this nexus. Although, we have gained tremendous insights into the pathophysiology of asthma over the past two decades, it still remains, aetiologically, a very complex disease. It has been speculated that one of the possible reasons for the increase in the global burden of asthma may be due to the climate changes that have occurred recently. One possible contributor is the influence of climate changes on pollen-related allergies. The Fourth Assessment Report of the IPCC has recognised evidence to suggest that climate change could have caused an early onset of spring pollen season in the northern hemisphere, leading to an increase in the duration of the pollen season. This has been attributed to an increase in the atmospheric temperature in the last few decades. Pollens that are grown in temperatures more than usual could possibly have stronger antigenicity. Production of pollen too is enhanced by an increase in atmospheric CO$_2$ concentration. Fungal spores are also known for exacerbation of allergy and asthma. Currently, there is insufficient evidence to link the effect of climate change to growth of fungi, but it appears likely that fungal biomass may proliferate with rise in both CO$_2$ and temperature. This would further contribute to the increase in the burden as well as in the severity of asthma. Moreover, the warming of earth’s environment reduces winter months. The cold weather which suppresses fungal sporulation is curtailed. In addition, the lower pollen counts due to reduced flowering during the colder months occur for a shorter period.

Environmental scientists have further suggested that the rapidly changing climate could have altered the interaction between air pollutants and respiratory allergens. This phenomenon could be due to the atmospheric air pollutants adhering to the surface of microaerosol suspensions of pollens and other plant allergens which may be present even before the usual peak pollen months. They then cause morphological change in these antigen carrying agents, thereby rendering them more allergenic. Furthermore, these ultra small particles can travel easily to the lower airways, thus increasing the morbidity in pollen-sensitive asthmatics. Till date, these aspects were never considered of consequence to human health. Evidence regarding the association of asthma with global warming, climate change and air pollution continues to accumulate at a startling speed. Even in the absence of large scientific trials, several contributory factors, as outlined above, have clearly been implicated. The pulmonologists must not only be aware of the menacing situation but also must play a proactive role to diminish the consequences of these changes on respiratory health.

Since the Vedic Era “Prakriti” and “Brahmand” have dominated the thought processes in India but it appears that we have forgotten our legacy. The environmental effect of global warming on India has already been documented but the health hazards, especially the effect on vector-borne diseases like malaria and dengue, are yet to be considered by the authorities concerned.

The atmosphere that surrounds us is changing at an alarming pace, and this fact is now being increasingly recognised. Even if the concentrations of greenhouse gases were to be miraculously frozen at the current levels, it is estimated that the weather patterns would continue to change, for the worse, for the next hundred years before stabilising. Clearly, this phenomenon is here to stay for our lifetime, and it would be prudent for health care providers in India to be aware of the
looming disastrous situation. We should work closely with the experts on global warming in order to minimise the impact on human health. There is an urgent need by the society as well as the leaders to acknowledge the ongoing changes so that steps may be initiated to curb the detrimental effects of the global warming.

I conclude with a translation from the Atharva Veda “The earth, which possesses oceans, rivers and other sources of water and which gives us land to produce food grains and on which human beings depend for their survival — may it grant us all our needs for eating and drinking: water, milk, cereals and fruits.”

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