

Air Pollution and Asthma: Is There a Doubt?

Air pollution is rising in many parts of the world, especially in developing countries, including in India. Many of the Indian cities are listed amongst the world's worst polluted cities. Pollution in the cities is mostly attributed to un-regulated vehicular and industrial activities. Country side and rural areas are largely pollution free in the developed countries while in the developing countries, the condition is not good because of the use of solid biomass fuels, such as the dried cattle-dung and fire-wood for domestic cooking and heating. The widely prevalent practice of open burning of crops-residue, dust-storms and forest-fires add to the problem of air-pollution.

There is global concern about increase in pollution related respiratory diseases. Air pollution due to particulate matter as well as the gaseous content is associated with an increase in the prevalence of respiratory symptoms and diseases. A large number of studies have shown an increase in morbidity and mortality from different diseases. Globally, seven million deaths are attributed to the adverse effect of air pollution. House-hold air pollution in particular is associated with chronic respiratory diseases.¹

Air pollution is an important risk factor for respiratory disease which include chronic obstructive pulmonary disease (COPD), respiratory allergies and lung cancer, even though the causality remains somewhat debatable.²⁻⁴ There is also evidence to link the prenatal exposure of pregnant mothers to different air pollutants with children's growth during the first few years of life.⁵ Another recent report⁶ substantiates the relationship of gestational and early life exposures to ambient nitrogen dioxide with an increment of 20 $\mu\text{g}/\text{m}^3$ with risk of asthma (Odds ratio of 1.77) and allergic rhinitis (Odds ratio of 1.67).

It is a moot question whether air pollution is also responsible for asthma which remains the most common respiratory disease amongst children as well as young adults. The relationship has been debated from time to time and contradictory observation made in different studies. It had been generally believed that air pollution may trigger asthma attacks and increase hospital admission but does not cause new onset disease to increase the incidence of asthma.

A large number of reports point to an increased prevalence of asthma among both children and adults while others seem to suggest that the increase has levelled off in the last few years.^{7,8} From the United States, an analysis of 2001-2013 data from National Health Interview Survey on asthma in children of 0-17 years of age revealed a plateau of prevalence followed by a decline in 2014.⁹

It was also observed that the numbers of adverse asthma outcomes associated with allergy of all kind had increased.⁸ In Europe, substantial stabilisation of asthma incidence has been reported since late 1993 in Italy after 50 years of continued upward trend.¹⁰ However, a general population survey, also from Italy showed an increasing trend of prevalence of respiratory systems, current asthma attacks and allergic rhinitis over 25 years.¹¹

We have limited longitudinal data from this country to comment upon the changing trends in prevalence. Cross-sectional population-based studies from India show a prevalence of about 2% to 5% in different populations.¹²⁻¹⁴ The centre-wise prevalence, however, was highly variable.

While various investigators have made variable observations on prevalence, most of them have consistently observed an increase in morbidly and adverse asthma outcomes particularly amongst the urban and inner-city dwellers of metropolitan cities.^{7, 15-17} This has been largely attributed to their exposure to vehicular air pollution due to heavy traffic in the cities.

The condition in the cities is further worsened especially in the indoor air due to living in closed environments in flats of high-rise buildings. Indoor air pollution in particular is not limited to smoke from domestic fuels but extends to a large number of chemical and biological pollutants identified as asthma triggers. These include different volatile organic compounds, environmental tobacco smoke from side stream smoke, pollens, pets and insect parts. Factually, both outdoor and indoor air pollution are related to increased asthma morbidity.

The condition is not any better in rural areas in developing countries, such as India where there is little rural-urban difference in air-pollution. The same is reflected by lack of difference in the incidence of respiratory health. For example, the INSEARCH report demonstrated almost a similar prevalence of asthma in the urban and rural areas with some variability between different centres.¹²

Two other studies respectively from Mumbai and Lucknow also report significant prevalence of asthma in these two cities.^{15,16} On the other hand, the other large study utilising data from India's third National Family Health Survey (2005-2006) reported higher rates in rural than in urban areas.¹⁷ The study amongst school children in rural South India also showed a high prevalence of 4.9%.¹⁴ The rural predominance in several studies from India has been attributed to exposures to smoke of domestic combustion of solid biomass fuels used for cooking and heating.^{17,18}

There is enough evidence to support air pollution as an important risk factor for increased

exacerbations and adverse outcomes of asthma.^{1-3,19-21} Some of the investigators have also blamed air pollution as the cause of new asthma onset, even though the evidence is not conclusive.²² A systematic review of 1840 studies of which 24 met the inclusion criteria for the study on effects of indoor air pollutants with wheeze and asthma during early childhood revealed contradictory results.¹⁹ The authors further suggested the need for additional research to establish causality.

Development of new asthma is a complex issue with multiple mechanisms taking part in addition to exposure to air pollutants. A systematic review of studies on association between environmental exposures and asthma development in children of up to 9 years of age reported a modest increase in risk by odds ratios of 1.5 to 2.²²

Risk for asthma development is likely to mediate through environmental exposures, immune mechanism, gene environmental interactions and epigenetic repletion.²¹ Different gene polymorphisms and epigenetic changes may play an important role in the relationship between air pollution and asthma.²³

While the relationship between different air pollutants and asthma seems established from the currently available evidence, there is need for continued epidemiological investigations to identify the relationship in different populations of different ages and ethnicity. The changing trends of asthma prevalence in US children clearly highlight the role of ethnicity and gene-environment interactions; there were significant differences in prevalence among non-Hispanic white and Puerto Rican children from those in the Northeast and West.³ We also need to identify the genetic and molecular mechanisms responsible for disease-worsening as well as development of new onset asthma.

Finally, environmental factors are important to identify for the purpose of an effective asthma management plan. Environmental control measures become as important as pharmacotherapy to improve asthma outcomes as well as to control the increasing trends of prevalence in the developing countries. Regulatory and public health interventions to reduce air pollution add to the efficacy of available pharmacotherapy.²⁴

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