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Study on impact of air pollution on asthma among school going children residing in urban Agra

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Abstract

Background: Air pollution is one of the world's most serious environmental problems. Air pollution has many negative health effects on the general population, especially children, individuals with underlying chronic disease, and the elderly. The aims of this study were to evaluate the effects of traffic-related pollution on the exacerbation of asthma and development of respiratory infections in schoolgoing children in Agra, suffering from asthma compared with healthy subjects, and to estimate the association between incremental increases in principal pollutants and the incidence of respiratory symptoms. **Materials and Methods:** We enrolled 702 children aged 6–18 years in this prospective study. A total of 342 children with asthma and 360 healthy subjects were monitored for 6 months from September 2013 to February 2014. Clinical data were combined with the results obtained using an air pollution monitoring system of the five most common pollutants. A total of 328 children with asthma and 345 healthy subjects completed follow-up. **Results:** Children with asthma reported significantly more days of fever ($P < 0.001$) and cough ($P < 0.001$), episodes of rhinitis ($P = 0.087$), asthma attacks ($P < 0.001$), episodes of pneumonia ($P < 0.003$), and hospitalizations ($P = 0.01$). In the asthma cohort, living close to the street with a high traffic density was a risk factor for asthma exacerbations (odds ratio [OR] = 1.79; 95% confidence interval [CI], 1.13–2.84), whereas living near green areas was found to be protective (OR = 0.50; 95% CI, 0.31–0.80). **Conclusion:** There is a significant association between traffic-related pollution and the development of asthma exacerbations and respiratory infections in children suffering from asthma. These findings suggest that environmental control may be crucial for respiratory health in children with the underlying respiratory disease.

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Full Text

Introduction

In the last two decades, epidemiological research has shown the significant impact of air pollution on health. Growing evidence indicates that increasing levels of ambient air pollution are associated with exacerbation of chronic diseases, such as chronic

pulmonary diseases and respiratory health effects.[1],[2],[3] The adverse health effects may be attributable to short term (a few minutes to 24 h) exposure or long-term (months to decades) exposure.[2],[4] Ambient air pollution consists of a highly variable, complex mixture of different substances that may occur in gas, liquid, or solid phase. Common outdoor pollutants affecting health are particulate matter (PM), nitrogen dioxide (NO₂), carbon monoxide, volatile organic compounds, and ozone (O₃). Urban ambient air pollution is the result of emissions from multiple sources, mainly stationary, industrial, and domestic fossil fuel combustion, and petrol and diesel vehicle emissions.[2] PM is the most common type of air pollution that causes the most serious effects on human health as it contains a broad range of diverse toxic substances.[5] The term PM includes airborne solid particles and/or droplets. These particles may vary in size, composition, and origin.

O₃, a highly reactive form of oxygen that is the primary component of urban smog, is commonly known as an irritant air pollutant. In several studies, respiratory morbidity, including asthma and chronic obstructive pulmonary disease, has been linked with the short-term changes in O₃ levels.[6],[7] Several studies indicate that an increase in ground-level O₃ may actually cause asthma.[8],[9],[10]

Air pollution has many negative health effects on the general population, especially children, elderly having underlying chronic lung disease. The aims of this study were to evaluate the effects of traffic-related pollution on the exacerbation of asthma and development of respiratory infections in schoolgoing children suffering from asthma compared with healthy subjects and to estimate the association between incremental increases in principal pollutants and the incidence of respiratory symptoms.

Materials and Methods

Setting

The study was conducted in TB and Chest department, S. N. Medical College, Agra, Uttar Pradesh, India.

Study design

The study is hospital-based prospective observational carried out in schoolgoing children with asthma, age- and sex-matched with apparently healthy children attending TB and Chest Department, S. N. Medical College, Agra, Uttar Pradesh, India.

Study period

The study was carried out from September 2013 to February 2014.

Study sample

All patients who reported during the study period were included in this study. This prospective study enrolled 702 children aged 6–18 years (342 with asthma and 360 healthy subjects) [Table 1]. Clinical data were combined with the results obtained using an air pollution monitoring system of the five most common pollutants.{Table 1}

The study was based on two cohorts of children. The first cohort included 342 children attending respiratory outpatient department with a history of asthma. Asthma is a heterogeneous disease usually characterized by airway chronic airway inflammation. It is defined by the history of respiratory symptoms such as wheeze, shortness of breath, chest tightness, and cough that vary over time and in intensity, together with expiratory airflow limitation.[11]

The second cohort comprised 360 healthy children born at term, with no history of asthma, were randomly selected and enrolled in the study during the same period. All asthmatic children were advised to use dry powder inhaler (DPI) of inhaled corticosteroid (ICS) plus long-acting beta agonist. None of them was on ICS alone. All were instructed to do gargle and mouth rinsing properly after DPI. None was having poor oral hygiene. The study cases and control cases were selected from the same locality on the basis of presence or absence of symptoms. Differentiation by economical status of the children was not made.

Statistical analysis

Comparisons between children with asthma and healthy children were performed by Chi-square test for categorical variables or independent t-test. Odds ratios and 95% confidence intervals were calculated to measure the association between various indices of air pollution exposure and the occurrence of asthma among cases.

The data were analyzed using IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp. Chi-square test was used wherever applicable. $P < 0.05$ was considered statistically significant.

Results

Out of 742 children who were initially recruited for the study, 29 were lost during the follow-up period. Finally, 328 children with asthma and 340 healthy subjects were included in the study. On analysis, all the respiratory symptoms, when followed up and compare between asthma and healthy children were found to be significant, except rhinitis (P 0.089) [Table 2].{Table 2}

Asthmatic episodes were 1.79 times more in children, who were residing in proximity to traffic (P 0.001) [Table 3].{Table 3}

Discussion

The results of the present study demonstrate that exposure to traffic-related air pollution is associated with an increased risk of respiratory morbidity in children with preexisting asthma or lower respiratory tract disease with wheezing. Our findings are consistent with the results of a recent prospective study in Sweden, in which 4089 children followed from birth to the age of 12 years showed a positive association between exposure to air pollution (PM10 and NO2) during early years of life and asthma exacerbations.[12] Additionally, the association between exposure to particulates and persistent wheezing during infancy was confirmed in the Cincinnati birth cohort study of more than 700 infants born to atopic parents.[13] Furthermore, a cross-sectional study conducted in China of more than 3000 schoolchildren documented that long-term exposure to high air pollution concentrations was associated with reduction in lung function and that asthmatic children were more susceptible to this effect. [14]

The finding that episodes of bronchial obstruction related to air pollution due to traffic occurs almost exclusively in children born to atopic parents or in children who have been previously diagnosed with asthma could be clinically relevant because it could permit the early identification of subjects living in areas with traffic-related air pollution who have an increased risk for the development of respiratory problems later in life.

In the present study, the risk of developing asthma was strictly related to the degree of exposure to traffic-related air pollutants, with fewer incidences occurring in children living in a green area compared with those living in areas with the highest degree of air pollution. This finding is consistent with the results of several studies showing greater evidence of an association between traffic-related air pollutants and respiratory problems in children living near roads with heavy traffic with a higher incidence of exacerbations with increasing concentrations of pollutants.[15],[16]

In the present study, traffic-related pollutants appeared to play a relevant role in conditioning the incidence of respiratory infections. Children with asthma presented more respiratory tract infections including pneumonia compared with controls. These findings are not surprising as patients with asthma are more susceptible to recurrent viral respiratory infections.[17] Allergic inflammation in the airways leads to an impaired barrier function that facilitates the penetration of infectious particulate allergens, favoring the development of inflammatory responses and impaired interferon responses to viral infection in asthmatic children irrespective of their atopic status.[11],[18]

In a recent meta-analysis, Dherani et al. documented that the risk of pneumonia nearly doubled in young children exposed to unprocessed solid fuels.[18] Gurley et al. showed that each hour of exposure to PM2.5 concentrations exceeding 100 µg/m3 was associated with a 7% increase in the incidence of acute lower respiratory infections among children aged 0–11 months. [19] Finally, a study conducted in 33,632 Italian children (aged 6–7 years) and adolescents showed that children living in polluted areas had a great risk of cough or phlegm, whereas traffic pollution was weakly associated with asthmatic symptoms. [20] The present study demonstrates that the effects of air pollution on the occurrence of respiratory tract infections are observed only in children with asthma. This finding might be explained by an increase in pollution-induced airway inflammation, genetic susceptibility to oxidative stress, and the role of epigenetics in lung damage induced by air pollutants. [21]

Conclusion

Our findings provide evidence that there is a significant association between air pollution associated with traffic and asthma exacerbations and respiratory infections in children born to atopic parents and in children suffering from recurrent wheezing or asthma. Although this association may also occur in healthy children, correlating with the duration and intensity of exposure, children with a preexisting respiratory susceptibility seem to be more vulnerable to the adverse effects of air pollutants. Further studies are needed to confirm this finding and to evaluate whether other factors can contribute to this association.

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Conflicts of interest

There are no conflicts of interest.

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