Original Article

Impact of Pollen Counts and Air Pollution Over Hospital Visits for Respiratory Illnesses in North Delhi Region

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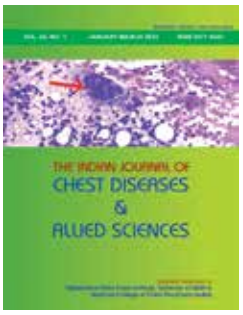

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ABBREVIATIONS USED IN THIS ARTICLE

NO_2 = Nitric dioxide

SO_2 = Sulphur dioxide

PM = Particulate matter

OPD = Out-patient department

CO = Carbon monoxide

Abstract

Background. Ambient aeroallergens and organic or inorganic air pollutants are known to cause asthma exacerbation and subsequent asthma-related hospital admissions.

Methods. This study was carried out to study the impact of meteorological factors, air pollution, pollens over hospital visits for respiratory illness in north Delhi region from July 2014 to June 2015. Daily monitoring of pollen grains was done on the roof of the multistorey building (height up to 20m) of the Institute. Meteorological factors including temperature, relative humidity, and precipitations were recorded daily. Daily concentrations of nitric dioxide (NO_2), particulate matter ($PM_{2.5}$) and sulphur dioxide (SO_2) were also recorded. Number of hospital visits of patients with respiratory illness were assessed in relation to air pollutants (NO_2, SO_2 and $PM_{2.5}$) and climate change (temperature, relative humidity and rain).

Results. During the study period, 113,462 pollen counts were recorded. Two highest peaks of mean pollen counts were observed in post-monsoon season (October-2014) and in the spring season (March 2015). The maximum and minimum pollen concentration was observed in the month of March 2015 (18818/m^3) and August 2014 (4731/m^3). Our results showed that pollen numbers significantly correlated with respiratory emergency department patient visits (P=0.037, r=0.604), and temperature and humidity (P=0.711, r=-120, and (P=0.670, r=-0.137), respectively. NO_2 significantly correlated with SO_2, respiratory emergency department patient visits and new respiratory OPD patients (P=0.017, r=0.670, P=0.031, r=0.622 and P=0.016, r=0.675, respectively). A statistically significant correlation between rainfall and SO_2 was observed (P=0.004, r=-0.757) in the present study.

Conclusion. Our study suggests that significant increase in pollen concentration and air pollutants in the ambient environment causes respiratory illness.

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Introduction

Deteriorating air quality due to air pollution can cause major health-related problems in developing countries, like India. Ambient aeroallergens and organic or inorganic air pollutants are known to cause asthma exacerbation and subsequent asthma-related hospital admissions.[1,2] Air pollution may trigger asthma and lower the bronchoconstrictive threshold to other respiratory antigens.[3-9] Air pollution is a major and permanently rising hazard for the environment, that is associated with an increase in medical expenses and morbidity (about 800,000 annual premature deaths worldwide).[10] In industrialised countries,[11-15] prevalence of allergic respiratory diseases has also increased in the last three decades. Some studies[16-18] have also reported that weather conditions can affect both biological and chemical air pollutants. There is more evidence on the effect of air pollution upon allergens, increasing exposure to the latter, their concentration and/or biological allergenic activity.[16-18] The considerable increase in respiratory diseases in industrialised countries may be partly allocated to a combination of chemical air pollutants and allergenic pollen existing in the air of big cities. Several studies[19-24] have separately reported the effect of either pollutant or allergenic pollen on hospital admissions in patients with respiratory illness. However, only a few studies have yet examined the effect of these two kinds of variables together.[19-24]

The aim of the present study was to determine the impact of pollen counts and air pollution over hospital visits of patients with respiratory illnesses in Delhi.

Material and Methods

The study was carried out over a period of one year (July 2014 to June 2015) at our Institute. The concentrations of sulphur dioxide (SO_2), nitrogen dioxide (NO_2), and particulate matter ($PM_{2.5}$) were recorded from air quality monitoring stations reported by the Central Pollution Control Board, Delhi. The meteorological factors including temperature, relative humidity and precipitation were recorded from Indian Agricultural Research Institute, Pusa, New Delhi.

Pollen grains were collected daily by using Burkard Volumetric Spore Traps (Burkard Manufacturing Co. Ltd, Rickmansworth, Hertford-shire, UK); 24 hours sampling of pollens were done and then counted under a light microscope. Pollen counts were reported as total grains per cubic meter of air (grains/m^3).

A standard microscope slide (7.62 cm × 2.54 cm) was cleaned with a dry tissue paper and then coated with a thin and uniform layer of petroleum jelly with the help of a painting brush and then placed in the carriage that moves past the orifice. The sampler was started by connecting with the power supply (12V) and left for one day recording. After 24-hour recording, the slide was removed from the sampler trap and pollen film was stained with a fuchsin stain, protected with a coverslip and examined under a light microscope.

Statistical Analysis

Pearson's correlation test was performed to find out a correlation between the concentrations of pollens and environmental factors, such as humidity (%), temperature (°C), air pollutants (NO_2, SO_2 and $PM_{2.5}$) and hospital visits of the patients over the last one year. The significant Pearson's correlation and their P values were analysed, using Statistical Package for the Social Sciences (SPSS, version 16.0).

Results

During the period of our study, 67943 patients visited the out-patient department (OPD) of the hospital for respiratory illness. Out of 67943 patients, 11962 were new respiratory OPD patients and 55981 were old respiratory OPD patients. However, a total of 21336 patients visited the respiratory emergency department.

In a total of 365 days Burkard air sampler runs, annual catches of 113,462 pollens were recorded during July 2014 to June 2015. Two peaks of mean pollen count were observed, the first peak was observed in the month of October 2014 (post-monsoon) and other in March 2015 (Spring). In this duration, rate of pollination was found greater than other months of the year. The maximum pollen concentration was observed in March 2015 (18818/m^3) with a mean daily pollen concentration of 607±196.2/m^3. The minimum pollen concentration was observed in the month of August 2014 (4731/m^3) with a mean pollen concentration of 152.6±40.5/m^3 (Table 1).

Highest mean temperature (32.6±2.7 °C) was observed in May 2015 and lowest mean temperature (11.8±1.8 °C) was observed in January 2015. The relative highest mean humidity (81.1±1%) was observed in January 2015 and lowest mean humidity (44.9±8.7%) in May 2015. Maximum rainfall (227.8mm) was observed in the month of July 2014 (Table 1).

Pollen count was significantly correlated with patient's respiratory emergency department visits (P=0.037, r=0.604), whereas temperature and humidity were correlated with pollen numbers which was not statistically significant (P=0.711, r=-120 and P=0.670, r=-0.137). Air pollutant NO_2 had a significant correlation with SO_2 (P=0.017, r=0.67), respiratory emergency department visits (P=0.031, r=0.622) and new respiratory OPD patient visits (P=0.016, r=0.675). The amount of rainfall had a negative correlation with SO_2 (P=0.004, r=-0.757), but for NO_2 the relationship was not statistically significant (Table 2).

Table 1. Mean pollen count and environmental parameters during the study period

Month	Mean Pollen Count (No./m^3)	Humidity (%)	Temperature (°C)	Rainfall (mm)
July 14	6953 (224.3)	72.3	31.5	227.8
August 14	4731 (152.6)	72.8	30.8	98.9
September 14	8755 (291.8)	58.3	30.2	124.3
October 14	9624 (310.5)	61.5	25.9	0
November 14	6649 (221.6)	62.1	20.7	0
December 14	5833 (188.2)	75.8	13.0	26.4
January 15	5559 (179.3)	81.1	11.8	35.8
February 15	16051 (573.3)	70.0	17.6	0
March 15	18818 (607.0)	70.9	20.3	201.8
April 15	17618 (587.3)	59.2	26.6	51.8
May 15	8433 (272.0)	44.9	32.6	0.8
June 15	5647 (188.2)	63.7	32.0	124.4

The mean concentration of NO_2 was highest (85.8µg/m^3) in November 2014 and lowest (17.4 µg/m^3) in August 2014, while SO_2 concentration (27.3µg/m^3) was highest in October 2014 and lowest (4.0 µg/m^3) in July 2014. The $PM_{2.5}$ concentration was highest (303.5 µg/m^3) in November 2014 and lowest (69.6µg/m^3) in March 2015. The highest values of air pollutants were mainly observed in the months of October and November (Table 3).

Discussion

This study investigated the potential impact of meteorological factors (temperature, humidity, and rainfall), level of all types of pollen grains (trees, grasses, and weeds) and air pollutants (NO_2, SO_2 and $PM_{2.5}$) on hospital visits of patients with respiratory illness.

Short-term association between ambient concentrations of pollens of *Taxa* and emergency department visits for asthma and wheeze were evaluated in a study[25] from Atlanta. The authors[25] observed a 2% to 3% increase in asthma-and wheeze-related emergency department visits per SD increase in *Quercus* species and *Poaceae* pollen and a 10% to 15% increased risk on days with the highest concentrations. A study[26] attempted to understand how meteorological variables, air quality variables, and pollen counts collectively contribute to asthma-related emergency department visits and asthma-related hospitalisations among paediatric and adult patients and found distinct peaks of increased asthma-related emergency department visits were closely associated with increased tree pollen counts in the spring. Our study also showed that respiratory emergency patient visits significantly correlated with ambient pollen count (P=0.037, r=0.604).

Several other studies have also observed a positive association between airborne pollen levels and asthma-related hospital emergencies.[27-31] Our study, however, provides a positive association between pollen count and respiratory illness related respiratory emergency department visits.

Also a recent study analysing the trend of emergency room asthma admissions to investigate the relevance of specific patient-related determinants and environmental triggers (pollens, mold spores, and pollutants) found that grass pollen peak and PM_{10} high levels represent environmental determinants of increase in emergency room admissions.[32] Some studies [33,34] have shown no relationship between various indicators and concentration of pollen. This lack of consistency may be due to geographical differences and prevalence of atopic population.

Association between air pollution and health in Delhi city was assessed in a study[35] which reported that levels of ozone, NO_2, and respirable suspended particulate matter have a significant impact on the increase in the respiratory diseases related hospital visits. Studies have also reported a linear association between NO_2, carbon monoxide (CO), PM_{10} and out-patient hospital visits.[36,37] A study[38] concluded that there was an increase of 10% (95% CI [confidence interval] 2.3 to 18.2) in emergency visits of children associated with a 10µg/m^3 increase of PM_{10} air level of the previous day and an increase of 11.8% (95% CI 1.4 to 23.3) was associated with an analogous increment for NO_2 of two days before. Our study also shows a significant positive correlation between NO_2 levels and new respiratory OPD patients visits.

In a recent study on longitudinal trends in asthma emergency department visits, pollutant, pollen levels, and weather variables significant positive associations were found between asthma related emergency department visits and SO_2, CO, NO_2, and humidity.[39] Another study[40] showed that increase in ozone, NO_2, CO, and PM_{10} was associated with upper respiratory

Table 2: Annual observations on pollens, air pollutants and meteorological factors during the study

Factors (P Value)	Pollen (N)	Humidity (%)	Temperature (°C)	Rainfall (mm)	NO_2 (µg/m³)	SO_2 (µg/m³)	$PM_{2.5}$ (µg/m³)	Respiratory Emergency Department Visits (N)	New Respiratory OPD Patients (N)	Old Respiratory OPD Patients (N)
Annual mean ± SD	300.9 161.0	66.0 9.7	24.4 7.5	74.3 80.7	48.2 22.2	14.1 7.3	173.0 75.3	57.5 9.5	48.3 9.1	221.3 29.1
Pollen	–	0.67	0.711	0.807	0.134	0.54	0.151	0.037	0.058	0.283
Humidity	0.67	–	0.030	0.417	0.261	0.043	0.293	0.954	0.355	0.79
Temperature	0.711	0.030	–	0.242	0.334	0.883	0.656	0.134	0.84	0.994
Rainfall	0.079	0.417	0.242	–	0.130	0.004	0.499	0.148	0.558	0.619
NO_2	0.134	0.261	0.334	0.130	–	0.017	0.829	0.031	0.016	0.788
SO_2	0.540	0.043	0.883	0.004	0.017	–	0.962	0.239	0.212	0.444
$PM_{2.5}$	0.151	0.293	0.656	0.499	0.829	0.962	–	0.516	0.976	0.056
Respiratory emergency department-visit	0.037	0.954	0.134	0.148	0.031	0.239	0.516	–	0.011	0.639
New respiratory OPD patients	0.058	0.355	0.840	0.558	0.016	0.212	0.976	0.011	–	0.750
Old respiratory OPD patients	0.283	0.790	0.994	0.619	0.788	0.444	0.056	0.639	0.750	–

Table 3. Concentration of air pollutants (NO_2, SO_2 and $PM_{2.5}$) and hospital visits of patients with respiratory illness

Month	Pollen Count (No./m³)	NO_2 (µg/m³)	SO_2 (µg/m³)	$PM_{2.5}$ (µg/m³)	Respiratory Emergency Department Visits	New Respiratory OPD Patients	Old Respiratory OPD Patients
July 2014	224.3	33.4	4.0	205.0	50.2	45.7	203.3
August 2014	152.6	17.4	9.0	265.1	51.7	50.4	242.0
September 2014	291.8	26.2	9.8	177.7	48.6	32.8	230.0
October 2014	310.5	55.0	27.3	192.7	51.1	42.9	229.1
November 2014	221.6	85.8	20.4	303.5	66.9	59.7	267.0
December 2014	188.2	59.5	11.3	171.6	56.3	41.5	218.0
January 2015	179.3	27.3	10.0	164.1	54.5	35.9	192.0
February 2015	573.3	56.4	17.9	241.7	80.9	57.3	244.0
March 2015	607.0	60.8	11.4	69.6	59.4	54.3	231.0
April 2015	587.3	72.6	16.4	87.8	65.0	35.3	152.2
May 2015	272.0	62.8	24.7	70.2	56.0	54.0	228.8
June 15	188.2	21.7	6.7	126.5	49.3	45.0	217.6

infection visits; an increase of $PM_{2.5}$ organic carbon was associated with a increase in pneumonia visits; and increase of NO_2 and CO were associated with increase in chronic obstructive pulmonary disease visits. The probable explanation for the association of increase in NO_2 levels and increase in hospital visits for respiratory illness could be increased upper and lower respiratory tract inflammation due to inhalation of NO_2.

A study[41] observed washout and rainfall showed significant correlation with atmospheric SO_2, although other variables also exhibit significant relationships; particularly wind speed, temperature, and relative humidity. In our study also atmospheric SO_2 levels decreased during rainfall.

Since our centre is a tertiary care centre and receives patients from far off regions. The representative pollen

count, atmospheric factor levels, may not represent the entire Delhi. This is the limitation of the present study. Nevertheless, the study attempts at evaluating atmospheric factors in the evaluation of patients with respiratory ailments related respiratory emergency department visits. The future studies will be aimed at isolating the specific pollens contributing to increased respiratory emergency visits.

Conclusions

The present study suggests that increased concentration of pollen and air pollutants in the ambient environment causes respiratory illness in patients. Our findings call for greater awareness of environmental protection and the implementation of effective measures to improve the quality of air, which may reduce the risks of adverse effects on the respiratory health. The effects of climate change on respiratory illness are still not well defined, and more studies addressing this topic are needed.

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