Air Pollution a Major Factor in Asthma Predictability Index among Children Living in and Around Kolkata Metropolis

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Abstract

Asthma is the most common paediatric chronic disease. Hindrance in asthma diagnosis is widespread resulting in unsatisfactory management in asthma. About 80% of paediatric asthma patients have symptom onset before age six, most of them before age three. However, only about 1/3 of children with at least one episode of asthmatic symptoms by age three will have asthma at age six and over, Asthma is under-diagnosed in 18-75% of asthmatic children. This city is categorized unhealthy for human beings. Deterioration in urban air quality in most megacities is quite profound and Kolkata Metropolitan City is no exception to this. An assessment of Kolkata air quality is done where the listed pollutants' (RPM, SPM, NO_2 and SO_2) annual average concentration are classified into four different categories; namely critical, high, moderate, and low pollution. There are 17 monitoring stations in Kolkata and out of which five fall under the critical category, and the remaining 12 locations fall under the high category of NO_2 concentration, regarding RPM, four stations are critical, and 13 stations record data which are under the high pollution category. Model questionnaires were run through 10% of the households to assess socio-economic conditions, critical environmental conditions, nature and types of health burdens as well as gauge the attitude in the direction of health care facilities were done. A comprehensive and up-to-date knowledge about the seasonal and spatial variation of asthma and studying air quality of the area. Mapping through GIS. It is desirable to construct an accurate model (Asthma Prediction Index) to predict whether a child will develop asthma in the future due to the deteriorating air pollution in the city.

Keywords: Asthma predictability; Air pollution; Paediatric; Metropolis

Introduction

Kolkata is one of the most prominent metropolises in Asia. The Kolkata Metropolitan Area (KMA) is a large urban-industrial corridor covering area of 1,350 sq.km (38 municipalities and 3 municipal corporations). Kolkata had been placed among the most polluted cities of the world with respect to SPM levels according to Global Pollution and Health, a report published by WHO and UNEP. A health impact study with respect to air pollution was conducted during November 1996 to July 2001 to assess the degree of lung function impairment in persons chronically exposed to Kolkata's air. Asthma is the most widespread paediatric constant disease. To help stay away from delay in asthma diagnosis and advance asthma prevention research, researchers have projected various models to predict asthma development in
children. The prediction of clinically severe allergic reactions would be of great importance [1]. The valid prediction of severe asthma (and especially those needing hospital treatment) in a region, could alert
health authorities and implicated individuals to take suitable preventive methods. About 80% of paediatric asthma patients have symptom onset before age six, most of them before age three. However, only about 1/3 of children with at least one episode of asthmatic symptoms by age three will have asthma at age six and over, Asthma are under-diagnosed in 18-75% of asthmatic children.

Background and statement of the problem

Six pollutants are considered in the reporting of air quality in the Air Quality Index (AQI): ground-level ozone (O3), fine particulate matter (PM ≤ 2.5 μm in aerodynamic diameter; PM 2.5), nitrogen dioxide (NO2), sulfur dioxide (SO2), carbon monoxide (CO). Fine Particulate matter (PM 2.5) is much above the permissible level (Kolkata US Consulate Air Pollution 2017).

It is advantageous to build a model (Asthma Prediction Index) to predict whether a child will develop asthma in the future. By identifying children at high risk for asthma and scheduling more frequent followup with a clinician familiar with asthma, the clinician can diagnose asthma in a timely manner and start asthma treatment earlier.

Second, asthma is a clinical diagnosis in children under five. Most children under five cannot work together reliably with lung function measurements. Using a predictive model can help physicians better diagnose asthma, particularly in children under five.

Third, the information provided by a predictive model can have a say directly to children's quality of life. Predicted risk of low category for asthma can improve concern of the child [2]. A high predicted risk may help the child identify symptoms, improve treatment and adjust lifestyle and living conditions to keep away from revealing the child to environmental pollutants and allergens.

Objectives

The main objectives are:

a) To draw an Asthma Prediction Index (API) to assess and predict

asthma in children.
b) Identify the areas with higher incidence
c) To assess the air pollution of the study area regarding air pollution parameters and pollens. Four air pollutants viz., Sulphur Dioxide (SO_2), Oxides of Nitrogen as NO_2 and Suspended Particulate Matter (SPM) and Respirable Suspended Particulate Matter (RSPM/PM10), are to be identified for regular monitoring.

Other sources of pollutants can be screened. Different types of pollens escalating the shortness of breath are to be highlighted.

Review of research and development in the subject

The Asthma Predictive Index (API) was developed by CastroRodriguez et al in 2000 to identify children who may develop asthma. The API has since been well validated and internationally supported, although many clinicians remain skeptical about its utility.

Not all children who wheeze will develop asthma [3], and yet identifying asthmatic children early may be important in reducingrespiratory complications later in life [4]. Evidence suggests that children, who develop asthma early in life, before the age of 3 years, may develop persistent lung function abnormalities [5]. Having a tool, such as the API, to determine which children may develop asthma may help clinicians target and treat atopic and asthmatic children before they develop chronic and persistent lung function abnormalities.

Appropriate asthma treatment can prevent serious asthma complications. A delay (median=3.3 years) in diagnosis is experienced by 2/3 of asthmatic children [6]. By identifying children at high risk for asthma and scheduling more frequent follow-up with a clinician familiar with asthma, the clinician can diagnose asthma in a timely manner and start asthma treatment earlier [7]. Asthma is a subjective, clinical diagnosis in children under five [8].

Methodology

Asthma data

Asthma data in this study was collected from outdoor department of Allergy and Asthma Research Centre, Kolkata, Missionaries of Charity, Kolkata.

Standard questionnaires to assess demography, literacy, standard of living with socio-economic variables, basic environmental conditions, confounding factors, load, nature and types of health burdens as well as assess the attitude towards health care facilities.

Evaluation of respiratory symptoms

By questionnaire and clinical examination of children belonging to different economic structure.
Assessing the air pollution condition of different areas of Kolkata and correlating that with the incidence of respiratory disorder.

Parents provided informed consent and completed a baseline and yearly questionnaire with information about demographic characteristics, respiratory illness, and risk factors for asthma at study entry. To ensure that the study population was free of any previously undiagnosed asthma, I also excluded children with a history of wheeze (n=24, 29.3%) and additional children with missing information about wheeze, or missing or a "don't know" answer about asthma (n=12, 14.6%).

77% of active asthma was associated with a positive API score by the age of 5; children with a negative API score at the age of 5 years had less than a 3% chance of having active asthma during their school years.

- Loose index for the prediction of asthma: early wheezer plus one of the two major criteria or two of three minor criteria (Table 1).
- The study included a questionnaire, completed by the parents, and a clinical examination, conducted by a trained physician, according to an enhanced version of the International Study of Asthma and Allergies in Childhood (ISAAC) standardised protocol (ISAAC II).
- The questionnaire contained the core ISAAC questions on respiratory and allergic diseases.

Discussion

Urbanization appears to be correlated with an increase in asthma. The cause of high risk factors in incidence of asthma have not taken into account indoor allergens although these have been acknowledged as considerably hazardous.

Experts are under pressure to be aware of high rates world-wide, on average, rising by 50% every decade. And they are puzzled by local incidents involving hundreds of people in a city, who suffer from allergies but never had asthma.

Among children <5 yr of age, the proportion with asthma was 8.2%. Among children ⩾ 5 yr of age, this proportion was greater: 17.9% among children between 5 and 10 yr of age.

Air pollution

Air pollution data included the annual (January 2017 to December 2017)) average values for particulate matter less than or equal to 10 µm PM10 (µg/m3), sulfur dioxide SO_2 (µg/m_3), and nitrogen dioxide NO_2 (µg/m3). All the data were obtained from the Central Pollution Control Board, Kolkata which collected monthly average concentrations of air pollutants through automated fixed-site monitoring stations. The data were regularly recorded from January 1, 2017, to December 31, 2017. The world health organization air quality guidelines for annual mean concentrations of PM10 and NO_2 and for 24-hour mean concentrations of SO_2 were 20 µg/m^3, 40 µg/m^3 and 20 µg/m^3 respectively (Figures1-5).

Major Criteria	Minor Criteria
1. Parental MD asthma	1. MD allergic rhinitis
2. MD eczema	2. Wheezing apart from colds
	3. Eosinophilia

Table 1: Loose index for the prediction of asthma: early wheezer plus one of the two major criteria or two of three minor criteria.

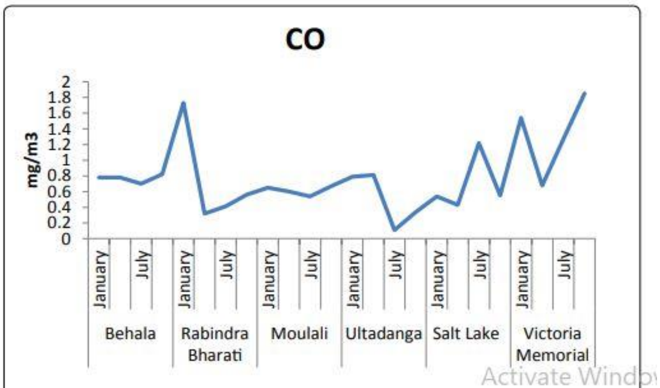

Figure 1: Air pollution data included the annual (January 2017 to December 2017)) average values for CO_2.

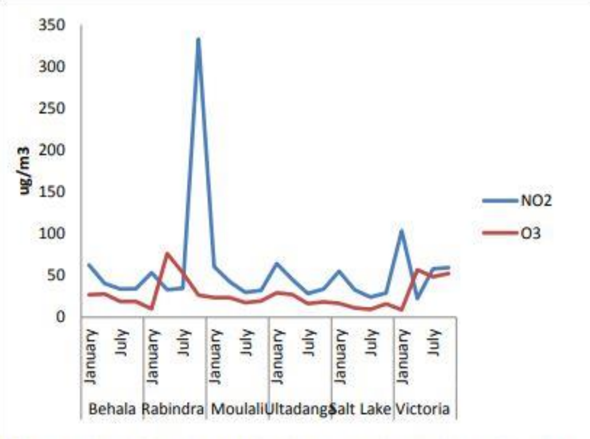

Figure 2: Air pollution data included the annual (January 2017 to December 2017)) average values for NO_2 and O_3.

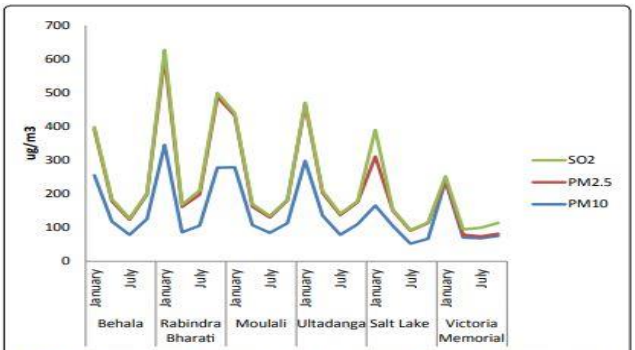

Figure 3: Air pollution data included the annual (January 2017 to December 2017)) average values for particulate matter less than or equal to 10 μm PM10 ($\mu g/m^3$), sulfur dioxide SO_2 ($\mu g/m^3$).

Traffic-related pollutant levels may also be considerably higher during the morning hours, when children are arriving at school, especially during temperature inversions that occur largely in the winter months when children are attending school.

Asthma and air pollution --------A co relation

Concentrations of traffic-related air pollutants (TAP) (nitrogen oxides (NOx), small particles and organic compounds) have increased steadily due to the growing number of motor vehicles, concentrations of SO_2 and coarse particles, mainly emitted from industry, havesignificantly decreased in industrialised countries, so in urbanareas where road traffic has become the main source of air pollutant emissions [3]. The increase air pollution mix may have contributed to the epidemic of asthma and allergies..

Thermal disinfection was named “pasteurisation” after Louis Pasteur (1822-1895). Pasteurisation by boiling water is widely recognised as a safe way to treat water from major pathogens dangerous to human health [5]. However, boiling water requires fuel, which is an unsustainable and often costly option. Despite this, it was proven that pasteurisation can take place at temperatures under 100°C. Solar pasteurisation has been safely achieved with values as low as 65°C for a period of 6 minutes [6]. However, the main drawback of current thermal pasteurisation methods is cost [7], as shown in Figure 1.

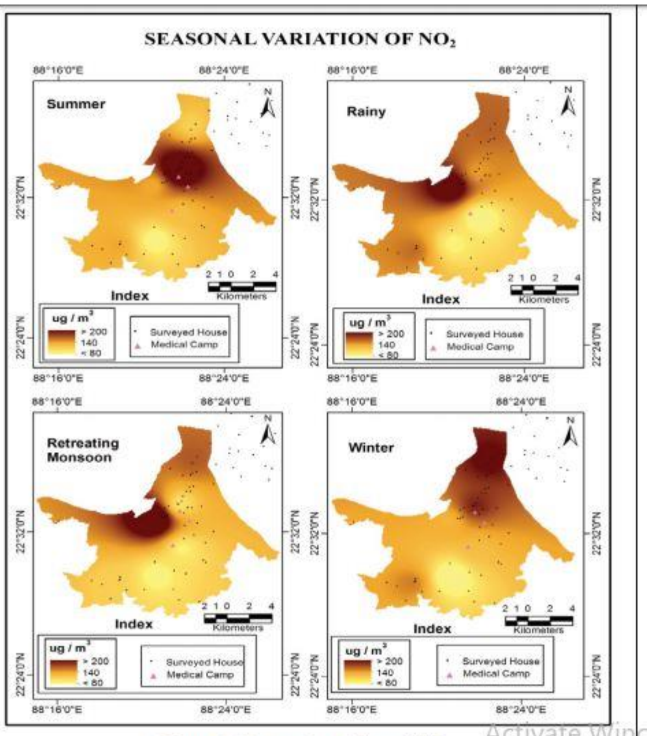

Figure 4: Seasonal variation of NO_2

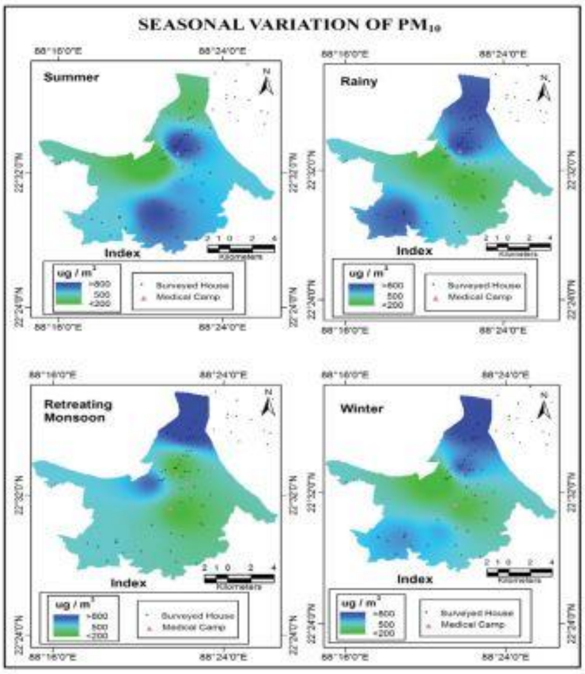

Figure 5: Seasonal variation of PM10.

those (44.3%) with no traffic count ≤ 300 m (p<0.0001). The same relationship was found for ETS exposure: 51.9% of those living close to a busy road were exposed compared with 35.1% in the low traffic areas (p<0.0001).

According to Pearson correlation analysis, there were significant associations between asthma prevalence and several factors including SO_2 (r=-0.323, <0.05), relative humidity (r =-0.351, p< 0.05), and hours of sunshine (r=-0.476, p <0.05). As can be seen, these correlations between PM10, NO_2, air temperature, precipitation, and asthma prevalence were not statistically significant.

The adverse effect of air pollution on respiratory health has been well established. But our results are not consistent with this evidence. The concentration of pollutants such as PM10 and NO_2 no longer provides a statistical explanation for variations in asthma prevalence. Interestingly, the relationship between childhood asthma and SO_2 was consistently negative. And surprisingly, these annual mean levels of PM10 (0.091 mg/m^3), NO2 (0.042 mg/m^3), and SO_2 (0.042 mg/m^3) detected during the sampling period did not conform with.

Conclusion

In this survey, high vehicle traffic density close to the home was related to respiratory complaints among parents and other discomforts such as cough, wheeze and current asthma in children.

In this city, most road segments are small side streets and had no counts available. This may have led to some misclassification of traffic exposure. Also, pollutant exposure values at the homes were used to estimate personal exposure rather than direct personal samplers.

Children living close to road crossings with heavy traffic had particular lifestyle characteristics, which make it difficult to differentiate a possible direct effect of car-traffic exposure from these sources. Their families were of a lower SES and their children were more often exposed to ETS.

Two interesting observations can be derived from the data presented here. Firstly, high traffic exposure was associated with cough, asthma and wheeze in all children, and with atopic sensitisation in children additionally exposed to ETS. Similar associations with outcomes were seen for traffic related air pollution levels. Secondly, when streetsw50 m from home were included in the exposure assessment, the traffic effect was diluted. There was lorry traffic at the road residence but not in the zone of residence.

This could indicate that the observed effects of traffic in streets <50m from home on atopy are not caused by emissions from vehicles but rather due to residual confounding, e.g. socioeconomic characteristic associated with such a place of residence.

The most impressive aspect of the API is its ability to rule out the likelihood of asthma by school age in young children with wheezing. For children who are “early wheezers” during the first 3 years of life, API negative predictive values ranged from 93.9% at 6 years of age. For children who are “early frequent wheezers” during the first 3 years of life,” the negative predictive values were 91.6%.

Factors such as genetic polymorphisms, environmental and socioeconomic factors and family health beliefs might also be taken into consideration. The simplicity of the API allows its use in every health care setting worldwide.

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